

AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE

MANHATTAN, KANSAS



TWELFTH BIENNIAL REPORT
OF THE DIRECTOR

1942-1944



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TABLE OF CONTENTS

	PAGE
LETTER OF TRANSMITTAL	4
INTRODUCTION	5
COöPERATION WITH OTHER AGENCIES	5
ADJUSTING STATION WORK TO MEET WAR NEEDS	6
BUILDINGS AND EQUIPMENT	8
PERSONNEL CHANGES	9
SCOPE OF THE STATION WORK, JULY 1, 1942, TO JUNE 30, 1944	12
Studies in the Economics of Agriculture.....	12
Soil Investigations	19
Investigations in the Plant Industries.....	29
Investigations in the Animal Industries.....	47
Diseases, Insects and Other Pests Injurious to Plants.....	60
Diseases of Farm Animals	66
Studies in Home Economics and Food Research.....	72
Branch Experiment Stations	82
Fort Hays Branch Experiment Station.....	82
Garden City Branch Experiment Station.....	85
Colby Branch Experiment Station	86
Tribune Branch Experiment Station	87
STATION PUBLICATIONS,	88
PUBLICATIONS BY DEPARTMENTS	89
FINANCIAL STATEMENT, 1942-'43	99
FINANCIAL STATEMENT, 1943-'44	99

LETTER OF TRANSMITTAL

OFFICE OF DIRECTOR,
June 30, 1944.

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

I have the honor to submit herewith the report of the Agricultural Experiment Station of the Kansas State College of Agriculture and Applied Science for the biennium ending June 30, 1944. The report contains brief descriptions of the work in progress during the past biennium, summaries of some of the more significant results, changes in the personnel of the station staff, a list of the publications of the station and of the published scientific contributions of the station staff, and a statement of receipts and expenditures during the biennium.

L. E. CALL, Director.

DIRECTOR'S REPORT¹

INTRODUCTION

This report contains a brief statement of the work of the Kansas Agricultural Experiment Station for the two-year period ending June 30, 1944. The station is both a state and federal agency. It was authorized by Act of the United States Congress and was organized following the acceptance of this act by the Kansas Legislature on March 4, 1887. The station receives support from both state and federal sources in about equal amounts. The central station is located at Manhattan as a part of the Kansas State College of Agriculture and Applied Science. Work is conducted also at four branch stations located at Hays, Colby, Garden City, and Tribune, as well as on several experiment fields located chiefly in the eastern part of the state and on many privately-owned farms throughout the state.

The work of the station is conducted on a project basis. Brief mention is made in this report of the objectives of each of the more important projects, the source of the funds for the support of the projects, the names of the workers most actively engaged upon the work of the projects, and summaries of the more important results secured during the biennium.

COOPERATION WITH OTHER AGENCIES

The station has coöperated actively during the biennium with a number of other agencies. This coöperative work has been highly advantageous to the station. Agencies with which coöperative relations have been maintained include state agricultural experiment stations in other states, the United States Department of Agriculture, and other federal agencies, state agencies, commercial agencies, and farmers. A state agency with which extensive coöperative investigational work has been conducted during the biennium has been the Kansas Industrial Development Commission. The Kansas Legislature of 1943 made an appropriation to the Kansas Industrial Development Commission of \$90,000 "for the purpose of conducting industrial research, provided, however, that at least 60 percent shall be used for experiments pertaining to agricultural products." The Kansas Industrial Development commission arranged with the college through the agricultural experiment station for the conduct of the investigational work with agricultural products. Three projects are now being financed by this source and conducted coöperatively with the Kansas Industrial Development Commission. These projects relate (1) to the dehydration of Kansas foods and food products; (2) to the chemical and physical properties of starch; and (3) to the nutritive value of the wheat plant.

1. Contribution No. 80 from the Office of the Director.



Meat chemistry laboratory, Agricultural Experiment Station, Kansas State College, where cooperative investigations on dark-cutting meat are conducted.

ADJUSTING STATION WORK TO MEET WAR NEEDS

Many adjustments have been made in the work of the station to enable it to meet better the war needs. Loss of personnel to the armed forces and to highly essential work intimately associated with the war effort, has made necessary many adjustments, since 25 percent of the members of the station staff at the outbreak of the war are now engaged in these activities. In the second place, adjustments have been made freely in the station program to enable the station to supply the information and lend the assistance most urgently needed in connection with the war effort.

In adjusting and reorganizing the work of the station in an effort to lend all possible assistance to the war effort, it has been the policy not to discontinue all so-called basic or long-time types of research in favor of that which may be considered immediately applicable. An effort has been made to continue as much of the basic research as possible. Researches have not been suspended such as:

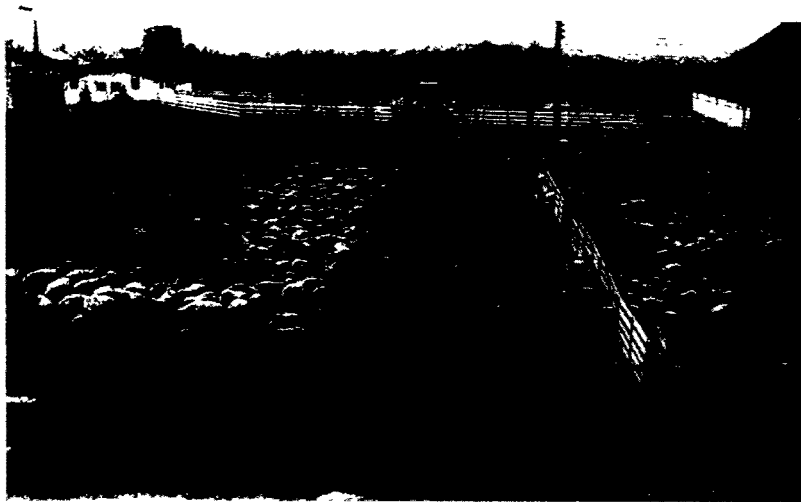
1. Long-time studies in the field of economics that may produce facts that will aid in cushioning post-war adjustments.
2. Basic studies in genetics that may provide new tools to use in the application of these sciences to the improvement of plants and animals including the human animal.

3. Crop rotation and fertility studies, the value of which depend chiefly upon time and continuity.

4. Basic studies in nutrition that may provide additional facts in this rapidly expanding field of knowledge that is contributing so much to human welfare.

5. Long-time studies having to do with plant and animal diseases, insects, and other predators, the solution of which is dependent upon carefully planned methods of attack extending over many years.

While an effort has been made to carry as much basic research



Feed lots at Garden City where feeding experiments with sheep and lambs are carried on.

of the character mentioned above as possible, major emphasis has been given to project work that would appear to be especially valuable in the war effort. For example, at the outbreak of the war there developed a need for starch to replace the root starches that formerly were imported from the East Indies. The station has made a special effort to produce this type of starch from the sorghums and has developed a variety of sorghum that produces starch satisfactory for this purpose.

Emphasis in plant breeding has been shifted to those types of work that give promise of having practical application. For example, in hybrid corn work, the emphasis has been placed on getting out more hybrids adapted to Kansas conditions, with less emphasis and attention to a study of the characteristics of inbred lines. In wheat breeding, major emphasis has been on the increase of promising new strains and the development of such new varieties as Pawnee and Comanche, rather than on more basic types of work in deriving varieties having such characteristics as earliness and winter

hardiness, which are characteristics needed in a good wheat for this state.

In sorghum breeding, emphasis has been placed on the increase and distribution of new combine types such as Wheatland and the new Kalo sorghums, that promise to be immediately useful in western Kansas, rather than to a continuation of more technical types of breeding work. With alfalfa a special effort has been made to increase and distribute the new variety of wilt-resistant Buffalo alfalfa and in order to do so, effort has been diverted in part from the more basic type of research with alfalfa to the increase and distribution of this new variety.

At the same time it is recognized that the agricultural problems of the postwar period may be no less serious than the problems of today. Just as the contribution of agricultural research toward the war effort will be chiefly the application of discoveries from research of past years, so the contributions of research for solving the problems of the postwar period may be chiefly the research that is being conducted today. It would be, therefore, a short-sighted policy to fail to include in a research program of study, work that will be needed to help solve first the postwar problems, while at the same time devoting all possible effort to the problems of the war.

BUILDINGS AND EQUIPMENT

Because of the urgent need for material in the war effort resulting in restrictions being placed upon the purchase of building material and equipment, no major buildings have been constructed during the biennium and only a few of the most urgently needed pieces of equipment have been purchased. The small-animal laboratory building mentioned in the last report, for which an appropriation of \$50,000 was made by the Legislature of 1941, has not been built. This money was re-appropriated by the Legislature of 1943 and it is expected that this building will be constructed as soon as conditions will permit.

Minor improvements and repairs that have been made during the biennium at the central station consist of the remodeling of the animal husbandry barn and the strengthening of the floors of the building, at a cost of \$3,900; the construction of a stone barn at the new horticultural farm, costing \$3,000; and the construction of a poultry house at the poultry farm, costing approximately \$1,600, paid for in part by the Kansas Poultry Improvement Association. Other minor improvements at the central station have been the construction of two small buildings, one at the botanical nursery, and the other at the entomological field plots for the storage of small tools and equipment.

At the branch experiment stations and experiment fields the following improvements have been made:

1. The construction of four pit silos at the Fort Hays Branch Experiment Station, at a cost of \$3,000.

2. The remodeling of the dairy barn at the Garden City Branch Experiment Station, at a cost of \$3,000.
3. The construction of a machine shed at the Dodge City Experiment Field, at a cost, of \$1,000.
4. The building of a small machine shed at the Bindweed Experiment Field at Canton, McPherson county, at a cost of \$650.

PERSONNEL CHANGES

Major changes in administrative personnel that have occurred during the biennium were the following:

1. On July 1, 1943, Dr. F. D. Farrell, President of the College since 1925 and Director of the Station from 1918 to 1925, retired as President with the title of President Emeritus and Professor of Rural Institutions. He will devote three-fourths time to teaching and research in the field of rural institutions. President Farrell was succeeded by Milton S. Eisenhower of the Office of War Information and previously Director of Information of the United States Department of Agriculture.

2. On July 1, 1943, Dr. Roger C. Smith, a member of the Department of Entomology since 1920, succeeded Prof. George A. Dean at head of the department. Professor Dean has been a member of the staff of the Department of Entomology since 1902 and head of the department since 1913. Professor Dean continues as a member of the Department of Entomology on a part-time service basis devoting his major efforts to research work of the Station.

Dr. W. H. Metzger, a member of the Department, of Agronomy who was granted an indefinite leave of absence in 1942, because of sickness, died July 7, 1942.

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

Glen H. Beek, dairy production.
Charles J. Birkeland, assistant, pomology.
Walter M. Carleton, agricultural engineering.
Don E. Crumbaker, assistant, Bindweed Experiment Field.
Raymond J. Doll, farm organization.
Robert P. Ealy, graduate assistant, landscape gardening.
Wilbert Greer, superintendent Poultry Farm.
Roland T. Johnson, assistant in milling industry.
H. D. Hollembeak, cooperative experiments.
J. W. Martin, agricultural engineering.
W. H. Martin, dairy manufacturing.
George Montgomery,* marketing.
Harold E. Myers, soils.
Hugh G. Myers, soils.
Wilfred H. Pine, land-use planning.
Arthur W. Pryor, chemical engineering.
R. C. Smith, entomology.
C. H. Whitnah, dairy chemistry.
C. Peairs Wilson, marketing.

* Returned from leave with OPA, July 1, 1943.

Resignations.—Twenty-five of the staff resigned during the biennium. Those resigning were:

A. C. Andrews, chemist.
B. B. Bohren, poultry husbandry.
L. H. Burket, temporary, bacteriology.
Douglas Chapin, assistant chemist.
J. C. Crupper, Jr., forest nurseryman, Ft. Hays.
P. L. Dittmore, station editor.
W. L. Faith, chemical engineering.
Herman Farley, veterinary medicine.
Geo. M. Fisher, forestry.
Hazel Fletcher, clothing and textiles.
Roy F. Fritz, entomology.
R. E. Hauke, temporary, bacteriology.
R. W. Hoecker, marketing.
Warren F. Keller, research miller.
R. L. Kitchell, temporary, bacteriology.
R. C. Klotz, animal husbandry, temporary.
F. C. Nelson, dairy bacteriology.
Henry J. Meenen, agricultural economics.
W. W. O'Donnell, milling industry.
F. L. Parsons, marketing.
Mary Schroller, temporary, zoölogy.
Wm. H. Tompson, temporary, zoölogy.
P. H. Vardiman, temporary, bacteriology.
L. E. Wenger, forage crops, Fort Hays.
J. A. Weybrew, assistant chemist.
Earl B. Working, cereal chemist.

Appointments.—The average number of persons employed on the scientific staff of the Station were 160. Forty-six appointments were made during the biennium as follows:

A. C. Andrew, chemist.
Leah Ascham, food economics and nutrition.
J. C. Bates, temporary, horticulture.
Joe Bryske, assistant chemist.
V. F. Bruns, assistant bindweed, temporary.
M. S. Buckley, milling industry.
L. H. Burket, temporary, bacteriology.
M. J. Caldwell, chemistry.
Douglas Chapin, assistant chemist.
Jehiel Davidson, milling chemist, U. S. D. A.
J. W. Greene, head of chemical engineering.
Dorothy B. Gudgell, temporary, agricultural economics.
Jewell G. Harrison, nurseryman, Fort Hays.
Mildred C. Harold, temporary, agricultural economics.
J. O. Harris, temporary, bacteriology.
R. E. Hauke, temporary, bacteriology.
Helen Herren, food economics and nutrition.
Wm. E. Honstead, chemical engineering.
Roland T. Johnson, milling industry.
Louise Keesee, temporary, agricultural economics.
R. L. Kitchell, temporary, bacteriology.
R. C. Klotz, temporary, animal husbandry.
Martha M. Kramer, food economics and nutrition.
Elizabeth Lightle, temporary, agricultural economics.
V. K. McMahan, veterinary medicine.
Frederick Meenen, agent, U. S. D. A., forage crops.
Walter A. Moore, assistant, S. E. Kan. Expt. Fields.

Hugh G. Myers, temporary, soils,
W. W. O'Donnell, milling industry.
Louis B. Olmstead, physicist, U. S. D. A., soils.
Clare R. Porter, agronomy.
J. J. Porter, temporary, bacteriology.
Arthur Pryor, chemical engineering.
Walter O. Scott, agronomy.
Wm. G. Schrenk, chemistry.
Mary Schroller, temporary, zoölogy.
J. A. Shellenberger, milling industry.
B. L. Smits, food chemistry.
Edward Stickley, assistant chemist.
E. C. Swanson, milling industry.
Wm. H. Thompson, temporary, zoölogy.
Gwendolyn Tinklin, food economics and nutrition.
P. H. Vardiman, temporary, bacteriology.
Chas. Wagoner, assistant chemist.
Robert E. Wagner, forage crops, Fort Hays.
Beulah D. Westerman, food economics and nutrition.

SCOPE OF THE STATION WORK JULY 1, 1942, TO JUNE 30, 1944

STUDIES IN THE ECONOMICS OF AGRICULTURE

Thirteen principal lines of research were under way during the biennium, nine 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, 1942, to June 30, 1944, consisted of several phases which were more or less closely interrelated. They may be differentiated as follows:

1. *Production adjustments in Kansas agriculture*.—This included work in developing goals, a study on the maximum wartime production of Kansas agriculture, and preliminary consideration of needed postwar adjustments. This necessitated cooperation with other departments of the experiment station, the Extension Service of Kansas State College, the Bureau of Agricultural Economics of the United States Department of Agriculture, and other interested agencies. The study of adjustments, which tended to correlate results and information from numerous sources, has furnished a basis for setting agricultural goals and directing policy for agriculture, including the research and extension work needed. It has tended to direct attention to the pattern of production which has existed in recent years and indicated desirable changes in connection with national needs and the difficulties to be encountered.

2. *Analyzing farm records from the farm management associations*.—In cooperation with the Extension Service of Kansas State College, in excess of 400 books were received for 1942 and approximately 500 for 1943. It was necessary to complete the majority of these before March 15 following the close of the accounting year in order that the records might be used for filing income tax returns. On most of the association farms, 1943 sales increased compared with 1942, but inventories, particularly of grains and feeds, were greatly depleted and in most areas net production changed little or was less than in 1942. Incomes were good but expenses were becoming more important in determining net income. Hired labor and the decreasing favorableness of feeding ratios were outstanding problems. A comparison of 80 identical farms in southcentral Kansas for 1942 and 1943, showed an increase in crop acres handled per man from 160 to 180 and an increase in net production, including livestock and livestock products, of about 16 percent.

3. *Maintaining files by type-of-farming areas*.—Files of a large number of series of data on such subjects as crop acreages and yields, numbers of livestock, and others are maintained for comparative historical and analytical purposes. They have been particularly useful as an aid in determining actual and desirable shifts in the various crop and livestock enterprises in Kansas.

4. *Preliminary report on a survey in Marshall county*.—This study on the relation between the organization of resources on farms and the systems of farming followed in a community was initiated and almost completed in the previous biennium.

(Project 95. Department of Agricultural Economics. Leaders, J. A. Hodges, W. H. Pine. Purnell and State funds.)

The 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. The investigations may be divided into the following phases.

1. The area analysis of Ness county has been completed and the agricultural adjustments desirable have been determined. The area analysis of Ness county revealed 15 agricultural areas. These areas were delineated primarily on the basis of soil, proportion of the land in cultivation, type of farming, and size of farm. The areas vary in intensity of cultural management from one in the Pawnee valley in which there is now some irrigation and in which irrigation is feasible, to areas consisting largely of shallow, rocky, upland pasture. Comparisons of the areas along with the use of farm budgets indicate that larger post-war incomes could be obtained by greater emphasis on livestock on the farms than in 1940. While adjustments are needed in the size of farms among some of the areas, with proper land use the land could supply a reasonable income to the same number of farm units as were in the county in 1940. The areas having the poor soil, in general, should have fewer farms and less of the land should be cultivated; in the areas having the better soil there could be more farms and in some cases more of the land could be cultivated. The general procedure used in the earlier studies of Nemaha and Chase counties was used for Ness county.

2. The systems of farming and inter-relationships among farms in Jackson county were investigated by an analysis of the survey records obtained in 1941. Two studies of a similar nature had been made in eastern Kansas by the Bureau of Agricultural Economics and the Kansas Agricultural Experiment Station: (a) Inter-relationships between farms in the Frankfort, Kansas, community and (b) a study covering nine counties in southeastern Kansas. The results of these three studies were combined and a report prepared for publication. Farms in a mature community in eastern Kansas, such as Jackson county, were found to vary from less than 50 acres to more than 1,000 acres. The farms in this community also vary as to type of farming, tenure, age of operator, and in many other ways. In spite of these variations, communities which mature under similar physical and economic conditions will have rather definite and similar patterns.

3. In coöperation with the Soil Conservation Service and the Bureau of Plant Industry, the reconnaissance soil survey is being completed in four remaining counties of the state. This will complete the survey of the state. These surveys show soil groups, parent soil materials, soil texture, slope, degree of erosion, and the land-use capability on a county unit basis. The field work is near completion. A soils map and a brief report are being prepared for each county. This survey will provide the fundamental basis on which to classify Kansas land and for developing agricultural land-use programs.

4. A study of Kansas farm labor in 1942 and 1943 was made in cooperation with the Kansas Extension Service. A report has been published by the Extension Service. The objective of this study is to provide assistance to farmers and agencies in handling farm labor during the remainder of the war.

(Project 215. Departments of Agricultural Economics, and Agronomy. Leaders, W. H. Pine, Merton L. Otto, J. C. Hide. Purnell 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.*—Considerable effort should be directed continuously toward obtaining an understanding of proposed taxes and of new taxes. Consequently, a large part of the work under this subproject consists of collecting information on problems which are of current interest.

During the biennium data on the trend of real estate taxes were collected for the years 1936 to 1942, inclusive. This information, together with previously collected data, now shows the trends from 1910 to 1942. The period 1910 to 1942 may be characterized in general terms, as one of steadily increasing government activity and increases in real estate taxes. Farm and city real estate taxes both increased at a rapid rate during the first twenty years of the period under study. During the years since 1930 decreases occurred. The decrease in total farm real estate taxes has been larger than the decrease in total city real estate taxes. The burden on real estate would have been much greater had it not been for the introduction of important new sources of revenue to supplement the property tax. In Trego county an improved method of classifying and setting values on farm land for assessment purposes has been in successful operation for a period of six years. A report entitled "A Brief Description of the Assessment Plan used in Trego county, Kansas," was released as a mimeographed report.

2. *Land tenure, land acquisition, and related problems.*—During the biennium the principal work consisted of (a) preparing for publication the materials collected in the general study of Kansas tenure conducted, coöperatively, during the previous biennium by the Federal Bureau of Agricultural Economics and the Kansas Agricultural Experiment Station and (b) using this information to improve leasing agreements throughout the state. In 1941, approximately 24 out of each 25 corporate farms in Kansas were for sale. That statement summarizes the situation with regard to corporate land. It is in accord with Kansas laws which prohibit certain corporations, notably insurance companies and banks, from becoming permanent owners of agricultural land. Events since the beginning of the present decade indicate that the role of the corporation as a landlord in the Kansas farm tenure pattern is diminishing. Such a trend, however, may be altered by another land boom and the unavoidable price collapse which always follows. In Kansas in 1940, 44.9 percent of the 156,327 farmers rented all of the land they operated. Part-owners (those farmers who own a part and rent from others the rest of the land they operate) accounted for 21.1 percent of the total. Tenants and part-owners together accounted for about two-thirds (66 percent) of all farmers in the state. Full-owners (those farmers who own all the land they operate) constituted the other one-third (33.5 percent). Managers (those who operate farms for others and receive wages or salaries for their services) numbered only 630 and constituted only 0.5 percent of the total. Farm tenancy in Kansas has increased each census year since 1880, when records on tenancy were first obtained. The percentage of the acreage of land in Kansas operated under lease is higher than the percentage of tenancy. The average part-owner farm in Kansas is much larger than either the full-owner or the tenant farm.

The equity held in land by persons not classified as farmers is a measure that is helpful in explaining the tenure picture. According to the census of 1940, Kansas farm operators as a group had an equity of 31.6 percent in the real estate they operated. According to the census of 1930, 31.1 percent of all farm tenants in the state were related to their landlords. This study also showed that approximately 41 percent of all related tenants were sons of their landlords. About one-eighth of the tenants in Kansas were sons of their landlords. Sixty percent of the landlords of Kansas were men and about 37 percent were women. The balance was represented by estates. During the biennium three forms of leases were prepared and printed for distribution. These are the crop-share, the crop-share-cash, and the cash leases.

(Project 132. Department of Agricultural Economics. Harold Howe, leader. Purnell funds.)

The Marketing of Kansas Grains.—Work on this project included the following studies:

Daily high and low prices of fourteen major feed ingredients and feed concentrates on the Kansas City market were tabulated and summarized. The price series of these feed ingredients cover periods of 15 to 20 years. The study of the prices of feed concentrates indicates that there are established relationships between the prices of various feed ingredients. These vary with the season of the year and show a higher degree of relationship at certain seasons than at others. A knowledge of the price trends should be of material benefit to farmers who buy proteins and other ingredients for home mixing of feed.

The analyses of the financial statements and operating records of Kansas cooperative elevators were continued for a limited number of elevators. A study was made of the gross margin realized on the sale of feeds and flour by cooperative elevators. The analysis of business of the cooperative elevators indicated that 1942 was more profitable than 1941. The usual analyses of price and supply statistics on wheat, corn, oats, barley, and grain sorghums were continued.

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

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

1. *Transportation of livestock to the Kansas City market.*—Efficient utilization of transportation facilities is desirable at all times but it is very necessary during the present war when equipment, especially trucks, cannot be replaced so rapidly as they wear out. A study of truck transportation of livestock to the Kansas City market was started in 1942 in cooperation with the Missouri Agricultural Experiment Station. This study was continued through 1943. Only 38 of the 385 trucks surveyed on the Kansas City market in 1943 were of the pickup type. This was a slightly larger proportion than were found in 1942. Seventy percent of the 385 trucks surveyed on the Kansas City market in 1943 were of the standard type, which is more common in Missouri than in Kansas. About 75 percent of the trucks surveyed were non-farmer owned and were operated for hire. The average age of trucks in 1943 was 3.2 years. About nine of every ten trucks were reported to be in fair condition in 1943; however, only one-half as many operators reported their trucks in excellent condition in 1943 as in 1942.

Only about 60 percent of the trucks were able to load a full load from one consignor. The remaining 40 percent probably had to assemble their loads at two or more places. About 50 percent of the standard trucks were able to find return loads. Truckers reported difficulty in obtaining repairs for trucks and in obtaining drivers and skilled mechanical service on their trucks. This phase of the project was in cooperation with 13 other state experiment stations and the Bureau of Agricultural Economics under the guidance of the Corn Belt Livestock Marketing Research Committee. Data gathered in this study will be combined with results of studies in other states for the third of a series of publications by the regional research organization. This work will continue through the coming year with a study of market price differentials on hogs.

2. *A study of livestock production and price trends as an aid to judging future livestock movements and prices.*—An attempt has been made to keep farmers well informed on market conditions and probable trends in market prices for the various classes of livestock. The establishment of price ceilings and floors has simplified this problem to some extent; however, changes in regulations have been difficult to foresee and many of such changes have had

marked influences on price trends. All of this information is taken to farmers through various publications.

(Project 149. Department of Agricultural Economics. Leader, Merton L. Otto. Purnell funds.)

An Economic Analysis of the Meat Packing Industry in Kansas.—This has been a study of factors affecting the meat packing industry in Kansas.

1. The project was started in September, 1939, for the purpose of studying the advantages and limitations of Kansas productive facilities as they are related to the meat packing industry. Most of the results obtained have been reported in previous progress reports. Work on the project has been hampered by lack of personnel during the past biennium.

In connection with Project 149 considerable work has been done in studying price differentials between markets on various kinds and grades of livestock. Some of these data were used by representatives of this state in meetings with officials of the office of Price Administration. As a result, more equitable prices were established for the Kansas City and Chicago markets, enabling the Kansas City market to draw a larger percentage of the cattle from the midwest. This should result in a more efficient utilization of meat packing and storage facilities at both Kansas City and Chicago.

2. The rapid expansion of the frozen food locker plants and the expected further development in this field present a fertile field for study. Some of the problems involved are:

Possibility of over expansion.

Development of more complete service, such as slaughtering and curing of meat animals, and the processing of fruits and vegetables.

Costs of locker service compared with retail purchases of products.

Effect of the locker development on the present system of processing and distribution of products.

The effect on locker plant operation of specialization in the preservation of frozen foods, including meat, and the dehydration of food products.

Many data were accumulated on this phase of the project during the period, 1939 to 1941, inclusive, but very little was published and results are not in form for publication at this time.

(Industrial Fellowship Project No. 5. Department of Agricultural Economics. Leader, Merton L. Otto.)

Economics of the Poultry Industry in Kansas.—Work on the project during the biennium has included three phases:

1. *An analysis of current factors affecting the prices of poultry and eggs on Kansas farms.*—Annual, monthly, and weekly information for poultry and egg producers has been prepared for distribution by press, radio, and the Extension Service.

2. *A study of the economic factors of the poultry enterprise on Kansas farms and preparation of Bulletin No. 308 for publication.*—During the period, 1935 to 1940, the most profitable time to market young chickens hatched before April 1 was at weights of 3½ to 4 pounds. Those hatched after April 1 brought the most profit if marketed between September 10 and 20.

3. *A study of the cost of producing turkeys on 22 Kansas farms.*—The study has provided turkey growers with information on production and marketing problems.

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

Marketing of Kansas Fruits and Vegetables.—Work on the project during the biennium consisted of the following:

1. Economic data pertaining to fruits and vegetables were compiled or brought up to date. These data were used in preparation of market, outlook report, radio talks, and in supplying economic information to those interested.
2. A study was completed on the influence of size of farm on the quality of potatoes produced in the Kaw Valley. The study revealed no conclusive relationship between the size of farm and quality of potatoes, but indications are that growers having 90 to 100 acres sell slightly higher quality potatoes than growers with larger or smaller acreage.
3. A study of the Kaw Valley Potato Growers' Association was completed. Records of the association were analyzed for all of the years of its operation from 1930 to 1936. Mistakes to be avoided in organizing cooperative associations were revealed.
4. The study, "Some Cold Storage Studies of Kansas Potatoes," was completed. The greatest amount of shrinkage of potatoes in cold storage occurs during the first month. Unwashed No. 1 potatoes stored in close meshed sacks shrank the least.

(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 of the project has included the following fields of study:

1. Distribution of milk in Manhattan in relation to possible savings in transportation and conservation of tires. The distance traveled each day by the milk distributors was equal to 4.3 times the total mileage of streets within the city limits.
2. Data were brought up to date and the manuscript on butterfat prices was prepared for publication.
3. Transportation data were analyzed for use in making transportation plans and reorganizing truck routes of creameries.
4. Series of continuing data on prices, production, and storage holdings of dairy products were maintained currently to aid in preparing price forecasts and outlook material and for radio talks, news releases and educational material for 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.—The Department of Agricultural Economics in cooperation with the Division of Farm Population and Rural Welfare of the Bureau of Agricultural Economics has continued its study of population changes and movement in the state.

Composition and movement of rural population.—In January, 1943 a questionnaire concerning farm population was sent to approximately 5,200 farm women representing every township in the state. On a basis of returns in comparison with the year 1941 it is estimated there was a decline of 33,000 in farm population, an increase in both the number of births and deaths, a greater natural increase and a slight decline in the net migration from farms to towns

and cities. It is estimated that 18,000 persons entered the armed forces from Kansas farms during 1942.

Nature and extent of health facilities in rural Kansas.—Work has continued on the survey of the health resources, facilities and trends in Kansas. Charts and maps were made showing the incidence and rate of morbidity of the following diseases: Whooping cough, measles, pneumonia, diphtheria, scarlet fever, typhoid fever, smallpox, tuberculosis, syphilis, and cancer. The data show a decline in the number of physicians, a greater proportion of physicians in the old age groupings in 1940 compared with 1929 and 1934. The number of physicians per thousand population was less in Kansas than for the nation. The information suggests an urgent need in parts of the state for hospital service, physicians, and other medical care.

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

Agricultural Finance and Related Problems.—During the year, 1942-43, a study was made of insurance companies as a source of farm mortgage credit in Kansas, land and building valuations, mortgage history in Riley county, and short-time and intermediate credit.

1. *Farm real estate credit.*—Sixty-six insurance companies owned farm mortgages in Kansas in 1941. Fifty-three of these were life insurance companies and 13 were other kinds of insurance companies. Approximately four-fifths of the life insurance companies owning farm mortgages in Kansas were out-of-state companies. They owned 95.3 percent of all the farm mortgages held by life insurance companies in Kansas in 1941. A study was also made of the ratio of mortgage debt to land and building valuation and the percent of equity of owners grouped on the basis of delinquency of interest, taxes, and assessment. Selected insurance companies were used for this study.

2. *Land and building valuations in Kansas.*—Total number of farms and acreage of land in farms in Kansas increased from 10,400 farms comprising 1,778,400 acres in 1860 to 156,327 farms with a total acreage of 48,173,635 in 1940. The average size of farm was 171 acres in 1860, 274.8 acres in 1920, and 308.2 acres in 1940. The average value of land and buildings per farm was \$1,179 in 1860, \$17,122 in 1920, and \$9,092 in 1940. It appears that the total land and building valuation and the farm mortgage debt are influenced by the same factors. Increase in land and building valuation has been associated with increase in the farm mortgage debt; however, the peaks and lows in farm mortgage debt lag behind the peaks and lows in land and building valuation. In 1910 the farm mortgage debt was 9.4 percent of the valuation of land and buildings. By 1940 this percentage had risen to 21.8, but it had declined from 24.2 in 1935.

3. *A study of mortgage history in Riley county, Kansas, from 1870 to 1940.*—Trends in the mortgage history for the township studied are based on 304 sample mortgages taken from 351 total mortgages recorded.

The average number of acres mortgaged during the period from 1870 to 1940 was 185.25 acres and it reached a peak of 228 acres in the 1930-'34 period. The average amount loaned per acre increased from \$1.96 during 1870 to 1874 to \$22.46 in 1920 to 1924.

4. *Credit for agricultural coöperatives.*—As a result of a study of coöperatively financed cotton gins, a thesis was developed by Harold Fox under the guidance of Franklin L. Parsons.

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

Case Studies of Kansas Rural Institutions.—The Fort Hays Branch Experiment station is the first subject of study. The assembling of preliminary data was begun late in April, 1944. It is expected that the study will be concluded by the end of the calendar year.

(Project 234, Department of Agricultural Economics. Leader, F. D. Farrell. State funds.)

Coöperative Study of Small Industries of Kansas.—The Department of Agricultural Economics of the Kansas Agricultural Experiment Station and the Kansas Industrial Development Commission have been coöperating in this project.

In the five months during which this project has been conducted, study and research have been devoted largely to three major phases; namely, (1) the possibility of strengthening existing local industry, (2) the establishing of new local industry, and (3) opportunities for promoting community welfare through the introduction and establishing of service enterprises. Elements of strength in localized, small-scale industry have been reviewed, as have also the limitations. The importance of adequate supplies of raw materials, the availability of skilled labor, the availability of sufficient amounts of low-cost power, the extreme importance of good management, and the importance of sound financing have all been reviewed. The reaction of firms concerning decentralization in industry has been sought. The experiences of communities in this and other states with local industry and postwar planning have been studied. These significant aspects of postwar industrial development have been discussed in a manuscript prepared for publication.

(Coöperative project. Department of Agricultural Economics. Leader, W. E. Grimes. State funds.)

SOIL INVESTIGATIONS

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

Soil Fertility Investigations.—The field work which has been continuous through 33 crop years was continued with little change. Various supplementary studies during the biennium include: Placement tests of fertilizers for wheat and Atlas sorgo, testing growth-promoting substances, testing fused phosphates, determining the effect of applying ammonium sulphate at different rates with flax seed, and the addition of strips of ammonium sulphate to the wheat plots.

The following average yields from unfertilized plots, obtained in the past 33 years, emphasize the importance of good rotations. In a 16-year rotation of alfalfa 4 years, and corn-wheat-wheat 12 years, corn has yielded 27 bushels, wheat after corn 18 bushels, and wheat after wheat 21 bushels. In a rotation of corn, soybeans, and wheat, the corn has yielded 25 bushels and the wheat 17 bushels. Corn in a corn-corn-wheat rotation has yielded approximately 22 bushels, and wheat grown continuously has averaged 15 bushels. Increases in wheat yields due to superphosphate have averaged approximately 10 bushels per acre for the past, two years as compared to an average 3-bushel increase for the period 1911-1940.

Phosphate drilled with wheat seed in field plots gave an increase of 12 bushels per acre in 1943 as compared to an increase of 3 bushels per acre for plow sole placement.

In 1942, placement of fertilizers 6 inches below sorghum seed gave greater increases than placement near the seed. In 1943 there was very little difference in response of sorghums to the two methods of application.

Fused phosphate has not proved to be an effective fertilizer on eroded Geary silty clay loam in greenhouse tests with wheat.

As little as 50 pounds of ammonium sulphate drilled with flax seed decreased germination materially.

None of several growth-promoting substances tested gave yield increases on any of the crops used.

(Project 17. Department of Agronomy. Leader, Hugh G. 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 20 years ago.

Soil in the 32 cylinders under study in subproject No. 7 received various treatments designed to influence the presence and activity of azotobacter 20 years ago. These soils have been grown to some crop annually and the presence or absence of azotobacter in the soil has been followed. The soil of each cylinder was carefully sampled initially and again during the past year. These samples are being analyzed for total nitrogen and when these data are available it is hoped they may throw some light upon the practical significance of azotobacter as a factor influencing the nitrogen content of soils under field conditions. It is planned to discontinue this subproject after this year.

Studies under subproject No. 9 during the past two years have been concerned primarily with the influence of varying the H^+ concentration upon growth (increase in cell numbers) and upon respiration.

Efforts to measure growth by various means revealed that the direct microscopic count, with adequate replications to permit of statistical treatment of the data, was the only method that could be relied upon for accuracy during an entire growth cycle.

The limiting H^+ concentration, expressed as pH, for growth was found to vary between 5.4 and 6.0 for 37 strains studied, most strains ceasing to grow in the vicinity of pH 5.8-5.9.

Results suggest that calcium plays an essential role in the respiration of azotobacter, and the injurious effect of high H^+ concentration upon these organism may be due to calcium being rendered nonavailable under such conditions. Further studies along this line are underway.

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

A Study of the Effect of the Substrate upon the Respiration of Azotobacter.—The purpose of this investigation was to study the effect of the chemical compounds serving as a growth substrate for bacteria upon the physiological activity of such organisms. The bacteria studied were 10 different strains of *Azotobacter chroococcum* isolated from soils in the vicinity of Manhattan.

The experiments were carried out by growing the cultures in media containing different energy sources and then studying the enzymatic activity of these cultures. Measurements of oxygen uptake by Warburg's method and dehydrogenase activity with Thunberg's technic were the basis of the enzyme studies. Cultures were grown upon mannitol, ethyl alcohol, glucose and sodium

salts of gluconic, succinic, lactic and acetic acid. Respiration measurements were made using the above compounds as the substrate and also sucrose, lactose, maltose, propanol, butanol, and the sodium salts of malic, malonic, tartaric, citric, pyruvic, oxalacetic, glycolic and formic acid.

The compounds serving as the growth substrates have a marked influence on the physiological activity of the organism. In all cases, the cell suspension readily utilized the compound which served as the growth substrate and exhibited only slight ability to metabolize immediately most of the other compounds tested.

However, the data support the suggestion that under proper conditions azotobacter cells can adapt themselves very rapidly to the utilization of new respiratory substrates.

(Department, of Bacteriology. Leader, J. O. Harris. State funds.)

The Nitrogen Balance and Physical Properties of Soils as Influenced by different Legumes and Grasses.—Field work has consisted of determining yields and protein contents of the more important field crops in this area grown in various rotations and sequences. The application of ammonium sulphate strips to the wheat on late-prepared seedbeds constitutes the only change in the regular field project. Laboratory studies consisted of aggregate analyses of the soil at different periods following a legume and at corresponding times in a non-legume rotation, and nitrogen analyses of the soil from the different rotations. Statistical analyses of the nitrogen determinations on soil samples from Hays, Colby, and Garden City were completed.

1. *Influence of legumes on crop production and nitrogen balance in soils.*—Spring application of ammonium sulphate to wheat on seedbeds prepared in August and September overcame to some extent the poor yields usual with these methods.

Fall-seeded sweet clover has yielded some less than spring-seeded sweet clover. The forage has had approximately the same protein content.

Rotations containing legumes have, in general, maintained, and in some instances, increased, the nitrogen content of the plow layer during the past 17 years. In general, the nitrogen content of the soil at depths of 7 to 20 inches and 20 to 36 inches has decreased slightly during the 17-year period.

2. *Effect of legumes on the physical properties of soils and factors influencing aggregation.*—The favorable effects of two years of alfalfa or sweet clover upon soil aggregation last between two and three years. There apparently is a rapid breakdown of structure within the year after oat seeding in a rotation of alfalfa or sweet clover two years, row crop, oats, and wheat.

3. *Factors affecting the "sod-bound" conditions in grasses.*—Urine spots in a "sod-bound" bromegrass field yielded twice as much bromegrass as unaffected areas and contained one percent more protein.

(Project 172. Department, of Agronomy. Leader, Hugh G. Nyrcs. Purnell funds.)

The Storage, Utilization, and Evaporation of Soil Moisture.—The utilization of moisture from 30 lysimeters was studied throughout the biennium. A record of soil temperature at depths of 1/2 inch, 2 inches, 6 inches and 12 inches has been obtained. The data for one year have been summarized and published. A study of the effects of "crop residue mulch" has been under way.

Temperature fluctuations.—Soil temperatures were recorded continuously at depths of 0, 2, 6, and 12 inches and show a daily inversion to the maximum depth. Daily fluctuation of surface soil temperatures of 60° to 70° F. are not unusual in hot, dry summer weather. However, the heat conductivity of the dry soil, usually encountered during periods of high temperature, is so much lower than moist soil that at a depth of 2 inches the summer temperature fluctuations are less than during the spring, when surface temperature fluctuations are about 15° lower.

It was found that when freezing occurs in a soil in which a temperature gradient exists, moisture tends to accumulate adjacent to the frozen layer.

Effects of crop residue.—In 1943, plowed plots yielded on the average about 3½ bushels more wheat per acre than did plots on which the crop residue was left on the surface. The unusually wet Junes of both 1942 and 1943 left all plots met to a depth of 5 feet at the first sampling date so that differences in moisture accumulation under the different treatments could not be anticipated. Where crop residues were left on the surface, the accumulation of nitrate was significantly lower than where they had been plowed under.

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

A Study of Soil Solution and Its Effect on Soil Minerals and Their Chemical Activities.—This has been a study of the effect of fine-grinding on the chemical character of certain minerals from which soils are derived.

Massive crystals of minerals commonly found in a large variety of soils were obtained. Portions of these minerals were ground and separated by water sedimentation according to particle size. These mineral separates of distinct particle size were studied individually. Solution studies were made, titration curves established, x-ray pictures obtained. Along with the pure mineral studies, portions of a normal soil were treated with acid at several pH values and these soils were separated according to particle size. These clay and sand minerals were studied to determine the effect of acidity on mineral species.

The x-ray patterns of the various minerals show that as the particles become smaller they definitely change in character. As muscovite, phlogotite, talc, etc., particles are ground to particle-size of about 1 micron, certain x-ray lines appear while others disappear indicating that the mineral changes with size. The interpretation of the x-ray pictures has been substantiated by solution studies which definitely show that as particle size decreases the alkalinity of the suspension increases.

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

A Study of Phosphate Fixation in Kansas Soils with Especial Reference to Soil Separates, Fractions and Minerals.—The minerals used in project 229 also have been studied from the standpoint of phosphate fixation.

1. Pure minerals were ground and separated according to particle size. The principal minerals studied belong to the mica and clay groups and the oxides of iron, silica, and titanous. The effect of mineral species and particle size of the individual mineral on phosphate fixation has occupied most of the attention during the year. Soil separates from variously treated soils have also been studied and compared with the pure mineral studies.

In general maximum phosphate fixation occurs between pH values of 4 and 4.5. Data obtained with minerals ground to 100 mesh indicate that the

pyroxenes, amphibols, feldspars and plagioclase feldspars fix small amounts of phosphate. The individual minerals of the mica and related groups fix large amounts of phosphate while the clay minerals fix smaller amounts. In general, the aluminum minerals fix much more phosphate than the corresponding magnesium minerals. The iron minerals ground to the same size fix smaller amounts of phosphate than the mica minerals. Magnetite fixes practically no phosphate while hematite and limonite fix considerably more than magnetite. The carbonate minerals fix considerable amounts of phosphate in the alkaline range but are decomposed by acid soil.

2. This study was undertaken to determine the effect of mixing small amounts of various minerals as muscovite and kaolin on plant growth. Results obtained from greenhouse studies indicate that the added minerals have considerable effect on the growth of oats. Air dry weights show: (a) That on Cherokee soil, a soil relatively poor in phosphate, applications of muscovite increase plant growth about 6 percent while applications of kaolin decrease plant growth about 25 percent; (b) that on Wabash soil, a soil relatively rich in phosphate, applications of muscovite increase plant growth about 4 percent while applications of kaolin decrease plant growth about 2 percent; (c) the influence of phosphate applications is highly variable.

The only significant change in plant growth is the decrease on the poor soil with kaolin additions. The project was initiated as a phosphate study. Data collected indicate that other factors may be important.

(Project 230. Subproject No. 2, Department of Chemistry and Department of Agronomy. Leaders, A. T. Perkins and J. C. Hide. Purnell funds.)

Soil and Crop Experimental Fields.—Ten out-lying 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, (three); Southcentral Kansas Experiment Fields, (three); Northcentral Kansas Experiment Fields, (two); Northeast Kansas Experiment Fields, (four); 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.—Meade Field. Work on the Meade field was reduced to a minimum during the biennium because of wartime restrictions, but all experiments on the Dodge field were continued as outlined. Grubbing of prickly pear cactus was found effective at any season of the year in ridding pastures of this plant. Scraping and forking required less labor but was not so effective in killing the plants. New growth appeared within two years.

Basin listing as a method of preparation and seeding of forage sorghums has proved its worth during the two-year period. On basin-listed land, the average yield of air-dry forage was 4.12 tons per acre, while on ordinary listing the average yield was 2.77 tons.

Contouring in preparation for and seeding of wheat produced adequate returns during the biennium with an average annual yield of 19.2 bushels per acre, while a noncontoured area produced only 15.2 bushels per acre. Depth of moisture penetration at seeding time averaged 50 inches and 42 inches respectively for the two methods.

Date of seeding wheat tests indicate that on fallow, the best date for seeding is about September 20, while in continuous wheat, seeding might well be delayed until early October. Seeding as late as October 30 caused severe reduction in yields.

Results from the rate of seeding wheat tests show that 40 pounds of seed per acre is preferable to 20 or 60 pounds on fallow, but under continuous cropping the average yield was 1.2 bushels more per acre from using 60 pounds of seed than from using 40 pounds.

Southeast Kansas Experiment Fields.—Columbus Field.

Economical increases were obtained from the use of phosphatic fertilizers on wheat, oats and alfalfa. Soybeans, flax, and corn showed little or no response to this treatment. Although all crops respond to applications of barnyard manure, the largest increases were obtained on wheat and soybeans. Legumes in the rotation greatly increased the yields of corn and flax

During the last two years there have been definite and consistent increases from the use of potash on corn, alfalfa and soybeans. Potash has not affected the yield of other crops.

Due to wartime transportation problems, all work except the soil fertility and wheat variety experiments were discontinued on this field in the fall of 1942.

Moran Field. Due to transportation problems, the Moran Field was discontinued in the fall of 1942. Also, due to adverse weather conditions during the spring and early summer of 1942, only alfalfa and sorghum fertility and alfalfa, flax and oats variety tests were conducted.

Large increases in the yield of sorghum seed were obtained from the use of superphosphate and from legumes in the rotation. Increased yields of 12 and 15 bushels per acre, respectively, were obtained. Legumes increased the yield of sorghum forage about 35 percent, but superphosphate had practically no influence on forage yields.

Thayer Field. The results of the fertility experiments are very similar to those obtained at the Columbus field. Where cultural practices are such that nitrates are not a limiting factor, phosphatic fertilizers have given greater increases than at the Columbus field. Potash has not influenced the yield of alfalfa or wheat.

One of the most interesting fertility experiments on this field has been the comparison of different amounts of 0-20-0 and rock phosphate on wheat grown on soil that has received a 2.5-ton application of limestone. Rock phosphate increased the yield of wheat only slightly over no treatment even when the rate of application was 1,200 pounds per acre, while an application of 60 pounds of 0-20-0 increased the yield of wheat 50 percent.

Some deep placement of fertilizer experiments have been conducted in which the fertilizer was applied on the plow sole as the ground was being plowed. These treatments were compared with no treatment and with similar amounts of fertilizer applied in the row with the seed. These tests were conducted with superphosphate, ammonium sulphate, and a mixture of the two on corn, oats, sorghum and soybeans. In most cases the deep-placement method was better than no treatment, but in no case was it superior, and in most cases it was inferior to the method of applying the fertilizer in the row with the seed.

The flax breeding and improvement program has been enlarged the past two years. However, with two possible exceptions, there are no new varieties far enough along in the testing program to recommend for distribution. The results of the past two years indicate that Koto and Biwing are at least equal to Linota in yield and adaptation and have other superior qualities.

South Central Kansas Experiment Fields.—The work for the past biennium on the South Central Kansas experiment fields has been carried out on fields located at Hutchinson, Kingman and Wichita.

Work on the Wichita field has progressed according to permanent plans during the past two years which includes variety testing as well as fertility work. Experiments on the Kingman field have not been fully developed due to wartime condition and the shortage of help. Most of the Kingman field work has consisted of variety testing and only limited work is being done on soil fertility. Hutchinson field work has consisted of variety testing during the past biennium.

Wheat. Pawnee wheat has been an outstanding variety in south central Kansas especially during years of severe Hessian fly damage. Comanche wheat has done well when Hessian fly is not a factor, and has done better at Kingman than at Wichita and Hutchinson. Wichita wheat also has done well in tests, but it does not carry the disease or insect resistant of Pawnee wheat. The main advantage of Wichita wheat will be in its earliness. In this area, it is about one day later than our Early Blackhull and about a week earlier than Pawnee and Comanche.

The application of superphosphate.—This practice has increased yields of wheat from three to five bushels per acre at the Wichita field. An increase of about eight to nine bushels per acre was secured at the Kingman field in 1942 as a result of applying superphosphate. Past results have not shown that the application of superphosphate in the Kingman area is beneficial. This large increase in yield was secured on wheat which was planted late (November). Under such conditions, the application of superphosphate may be beneficial.

Oats and barley.—Excellent yields of oats and spring barley have been obtained during the biennium. The main advancement, in oats has been the addition of rust-resistant strains to the tests which do not lodge as readily as Fulton and Kanota. The two main strains, C13893 and C14141, showed considerable promise, especially from the standpoint of yield and stiffness of straw.

Beecher barley, a relatively new variety of Spring barley in Kansas, has shown up well in tests. It has yielded somewhat better than Flynn. It is several days earlier than Flynn and has stood up better in the field.

Corn.—Corn testing on the Wichita field has dealt mainly with new hybrid strains. Yields have been good during the past two years. The work in 1943 consisted mainly of the testing of single-crosses to make observation in regard to Southwestern corn borer resistance. The Southwestern corn borer is doing serious damage throughout the southwest. The strains and hybrids have shown some differentiation in regard to resistance to the insect, but the differences have been slight. Plant breeders hope to obtain more resistance.

Sorghums.—Chinch bugs have done considerable damage to sorghums, especially at Wichita during the past two years. Varieties most susceptible have been Hegari, Early sumac and all milo varieties. Kansas Orange and Atlas have shown the most resistance. Pink and Club kafirs have shown less resistance than Blackhull and Red kafir.

Progress is being made toward the development of a combine type sorghum which carries chinch bug resistance and will be adapted to south central Kansas and areas farther east.

North Central Kansas Experiment Fields.—The north central Kansas experiment fields consist of two fields located at Belleville and Smith Center, established in the spring of 1942. The amount of data available is limited.

Belleville Field.—Work on the Belleville field consists of variety testing of corn, oats, barley, wheat, sorghum, alfalfa, and soybeans. Other studies include crop sequences, alfalfa and wheat fertility, dates and seedbed prepara-

tion for seeding sweet clover, seedbeds for grasses, and an intrastate wheat nursery.

The results of the corn test show all open-pollinated varieties of corn tested to be inferior to certain hybrids. An average of the two-years' results show eight Kansas hybrids ranking among the 10 highest-yielding entries. Kuhn's Golden Republic was the highest-yielding, open pollinated variety.

The oat and barley variety tests were successfully completed both years. An average of yields show that Boone oats ranked first with an average of 50.1 bushels per acre and Otoe second with a yield of 48.9 bushels per acre. Fulton, Kanota, and Brunner lodged severely. Beecher and Stavropol barley tied for first place with average yields of 26.4 bushels per acre.

Reward spring wheat and Linota flax made average yields during the two years of 9.9 and 12.6 bushels per acre respectively.

Yields of 14 varieties of winter wheat were obtained in 1943. Pawnee, Blackhull, and Nebred produced almost identical yields, averaging 3.5 bushels above Turkey. Wichita was the lowest-yielding variety.

The sorghum variety test was a failure in 1942 because of chinch bugs. In 1943, Norkan produced the highest yield of grain with Colby a close second. Atlas and Atlas selections produced the highest yield of forage.

In the alfalfa studies, Ladak was the highest-yielding variety, producing 2.0 tons per acre. Applications of manure resulted in 0.3 ton increase in alfalfa yields.

Results secured on the wheat fertility and stubble-mulch tests show no indication of phosphorus deficiency. The use of stubble-mulch tillage resulted in a decrease of 3.8 bushels per acre. Application of manure aided in overcoming the depressing effect of stubble-mulch tillage.

Stands of brome grass, crested wheat grass, and mixture of native grasses, including Big and Little Bluestem, Indian, Switch, Sideoats, Blue Grama and Buffalo, were established on various types of seedbeds.

Smith Center Field.—All work with soil fertility, crop sequences, alfalfa, sweet clover, and grasses has been eliminated at this field because of conditions brought on by the war. Substituted for the eliminated projects is a study, involving methods of seedbed preparation and frequency of fallowing for wheat. This study includes the production of wheat on land fallowed once in two years, once in three years, and once in four years and continuous wheat. Fallowing and seedbed preparation will be done by plowing, listing, and sub-surface tillage in each of the above cases. This project will not be in full operation until 1946.

The oat and barley variety tests were successful in 1942 and 1943. The average yields of the barley varieties in bushels per acre were: Beecher, 31.4; Flynn, 28.3; Stavropol, 27.8; Spartan 25.3. The average yields of the oat varieties tested were as follows: Fulton, 38.4; Otoe, 38.1; Brunner, 36.9; Kanota, 29.2; and Boone, 26.8 bushels per acre. The Boone variety had the lowest test weight.

The corn-yield test was successful in 1942 but was a complete failure in 1943 because of drouth and hot winds. The results of the 1942 test indicate that a number of hybrids are superior to the best open-pollinated varieties tested

Thirteen varieties of wheat were tested in 1943; but because of a severe spring drouth followed by heavy June rainfall, differences in yields were not consistent.

The sorghum variety test on planting dated June 2 gave excellent results in 1942, but some varieties did not mature when planted June 18. Plantings were delayed in 1943 because of heavy June rainfall, and some varieties did not mature. Wheatland was the highest-yielding combine type in 1942, Westland being a close second.

Northeast Kansas Experiment Fields.—The Northeast Kansas experiment fields consisted during the 1942-43 period of the McLouth crops experiment field, the Blair experiment orchard, the

Doniphan experiment orchard, and the Wathena small fruits experiment field.

McLouth Field.—In the fertilizer experiments at McLouth, all treatments increased the yield of all crops as compared with the check plot, with the largest increase in all cases being obtained where lime, manure, and phosphorus were applied. The yield of wheat was doubled by the use of phosphorus, and there was an increase of over four pounds per bushel in the test weight of the grain. Application of lime, manure, and phosphorus increased the yields of alfalfa hay from 3,900 pounds for no treatment to 8,440 pounds per acre.

In a two-year rotation of corn and oats, application of manure increased the yield of oats 10 bushels per acre, while drilling phosphorus in the row with the seed gave a 15-bushel increase. Corn yields were increased nearly 10 bushels per acre by application of manure and over seven bushels by use of sweet clover as a green manure crop.

Reno winter barley yielded 27.8 bushels per acre, while Missouri Beardless produced 21.7 bushels per acre.

Pawnee produced the highest yields of wheat during the biennium with Kawvale a close second. Clarkan produced one-half bushel less per acre than Kawvale.

All 14 hybrids included in the corn-variety test averaged higher in yield than did the four open-pollinated varieties. A Kansas white hybrid, 2234, with a yield of 78.2 bushels per acre, was outstanding. Pride of 'Saline produced 51.5 bushels per acre and the yield of Midland was 46.8 bushels.

Doniphan Orchard.—This orchard was set in the spring of 1942, It is located in Doniphan county, one mile south of Blair, and contains approximately 16 acres. It is devoted entirely to apples and required nearly 550 trees for planting. The two main studies for the present are erosion control and the testing of hardy stocks.

Blair Orchard.—Liquid lime-sulfur and dry lime-sulfur sprays were the most effective in controlling apple scab during the 1942 season, but also caused the most injury to the foliage. Bordeaux, cut down in strength to 1-2-50, still caused 40 percent of the fruit to be badly russeted when used early in the season. A new material, Fermate, gave outstanding control of apple scab and other diseases in 1943, without the fruit and foliage injury caused by either liquid or dry lime-sulphur.

Harvest spray results were very outstanding in 1942. Nearly three-fourths of the fruit had fallen from the unsprayed trees by the time they were picked, and nearly one-half from the trees sprayed only once. Spraying the trees twice kept four-fifths of the fruit on the trees until picking time.

Harvest sprays were of some benefit in 1943, but differences were not nearly so marked. Jonathan drop was not a serious problem in 1943, and the quality of the fruit was so poor that it is doubtful whether harvest sprays would have helped much in preventing premature drop.

Wathena Small Fruit Field.—Average yields of the higher-yielding strawberry varieties in crates per acre were: Avon, 260; Pathfinder, 238.4; Blake-more, 229; Howard, 228; Catskill, 226. The Avon variety has been outstanding in yield in these tests.

Bindweed Experimental Project at Canton.—Work on the bindweed experimental field at Canton was started in the spring of 1942 and satisfactory progress is being made in all phases of the project. Experimental data has been obtained in 20 different types of experiments on various phases of weed control and eradication. Fourteen of these types of experiments are on field bindweed, while six are on other noxious, perennial or lawn weeds.

Weed control by tillage includes experiments on time of beginning cultivation, frequency of cultivating, and frequency of hoeing bindweed; frequency

of cultivating dogbane; frequency of cultivating Johnson grass; and frequency of cultivating Russian knapweed.

Although intensive or clean cultivation is probably one of the quickest and surest methods of bindweed eradication, it appears that this system may not be practical for central and eastern Kansas where severe water erosion has been experienced.

Experiments to determine the best time to start tillage for bindweed control, showed that the average number of cultivations required to eradicate bindweed when cultivation was begun in the spring was 20, while 18 cultivations eradicated the bindweed when cultivation was started immediately after wheat harvest. The latter not only saved two cultivations on the average but caused the loss of only one crop as cultivation was started after harvest the first year.

Experiments on frequency of cultivation as measured by the number of days of top growth showed that the average number of cultivations required to complete eradication of bindweed on the top-growth-interval plots having a start of 0, 4, 8, and 12 days were 28, 23, 17, and 15 respectively. Apparently, frequencies of 8 and 12 days after-emergence are almost as effective and far more economical than the intervals of 0 and 4 days. Cultivation will be necessary on the 16 and 20 days after-emergence plots into a third year. On the plots where the frequency of cultivation was every two weeks, bindweed was eradicated with an average of 21 operations by early fall of the second year.

Results show that on an average a total of 42 hoeings at one-week intervals extending over the growing period of two years were required to completely eradicate bindweed. Bindweed was not completely eradicated on any of the other frequencies and hoeings must be continued into a third year.

In the Johnson grass eradication studies, cultivation every two weeks eradicated the Johnson grass with nine operations. A few plants still remained on the plots cultivated at intervals of three weeks and four weeks at the end of the first season. Cultivation at intervals of six weeks had to be abandoned after three cultivations with the duckfoot because excessive top growth made it impossible to operate the implement.

Cultivation for the eradication of Russian knapweed was started on two patches on May 8, 1942, one being cultivated every two weeks and the other every three weeks with a duckfoot. Knapweed was completely eradicated by the middle of June, 1943, after 12 cultivations at intervals of two weeks. The patch cultivated every three weeks received a total of 11 cultivations and knapweed was eradicated by mid-July, 1943.

Use of smother crops in bindweed control indicate that close-drilled Atlas sorgo grown annually is more effective than other crops.

Chemical treatments to date indicate that it is more desirable to apply a given quantity of sodium chlorate as one application, either in the spray or dry form, rather than as two applications a year in the spray form.

Experiments on time of applying sodium chlorate show that the greatest percentage of bindweed kill was obtained from the October 1 application.

In studying the value of borax as a herbicide, plant counts made early in May, 1943, showed that apparently exceptionally good kills were obtained from the heavier rates of 15, 20, and 25 pounds of borax per square rod. However, during the season plant counts increased, and it was found that these plants were coming from live roots from a depth of from six to eight inches below the surface of the ground. The borax-chlorate mixtures gave disappointing results.

Studies of the depth of root penetration of noxious weeds, show that the downward root penetration of climbing milkweed and bur ragweed averaged approximately 6 and 11 feet, respectively, while bindweed roots were still prominent at the 12-foot depth.

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

INVESTIGATIONS IN THE PLANT INDUSTRIES

Much of the work of the station continues to be devoted to increasing the efficiency of plant production, with added emphasis for this biennium on production to meet war demands and on new problems that came to light in connection with the war. Reports on these projects follow.

Temperature Relations of Crop Plants.—Work under this project dealt with relative heat resistance of types and species of cereal crops.

The material studied included winter wheat (Turkey and Pawnee), spring wheat (Reward), winter barley (Reno), spring barley (Flynn), winter oats (Wintock), spring oats (Kanota) and winter rye (Balbo). The crops were grown in pots in the greenhouse and tested when one to two months old.

The winter type was decidedly more heat-hardy than the spring type of each cereal. Winter oats was more hardy to heat than winter barley or winter wheat and about as hardy as winter rye. Spring oats was more hardy than spring barley or spring wheat. Winter wheat and winter barley were nearly equal in resistance to heat as also were spring wheat, and spring barley.

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

Small Grain and Sorghum Improvement.—The work of 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.

Winter Wheat.—During the biennium, Pawnee (C. I. 11669) was approved for distribution and released to growers in central Kansas. Approximately 700 acres were sown in the fall of 1943.

Early Blackhull X Tenmarq (C. I. 11952) was approved for distribution as soon as seed stocks can be built up. The name Wichita has been suggested for this variety. It is an early maturing variety which in extensive tests has given high yields of grain and high test weight in the southwestern part of the state. It is not resistant to the rusts and smuts common in this area and it has rather weak straw, resembling its Early Blackhull parent in these characteristics. Quality tests indicate the gluten is superior to Early Blackhull which it should replace.

Selections of special merit were studied during the biennium and several, both hard and soft, have been advanced to large scale tests.

Winter barley.—Spring survival records showed that Reno, Admire, Kirwin, and Ward were among the best tested. These have good agronomic characteristics also. Smooth awned, hardy segregates were selected from the cross Purdue C, I. 6562 X Reno.

Flax.—Nursery tests at Thayer, Kansas, covering the period 1939 to 1943 showed that C. I. 890, C. I. 986, Koto, and Biwing have outyielded Bison and Linota. Breeding work in progress is directed toward rust and wilt resistant varieties with good agronomic characteristics.

Oats.—Strains of oats resistant to crown rust, stem rust, and smut continued to prove promising in agronomic tests. Heavy natural infections of crown rust, in 1942 and stem rust in 1943 demonstrated clearly the value of this resistance. Standard varieties, like Fulton and Kanota, yielded about two-thirds as much grain in 1942 and only one-half as much in 1943 as the best disease resistant strains.

Sorghum.—Vigorous types of Sudan grass have been isolated that are more resistant to chinch bugs than commercial sudan. A number of combine grain sorghums have been tested but none has been found that is entirely satisfactory for eastern or south central Kansas. However, promising short types resistant to chinch bugs appear to be present in the cross Club x Westland. Two short kafir-type selections from the cross Weskan x Greeley have been isolated and will be increased for further tests. They probably will be best adapted to the high plains of western Kansas.

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

Inheritance of Factors Affecting Quality in Wheat.—This project is carried on coöperatively between the Departments of Agronomy and Milling Industry.

Several hundred selections of wheat were tested by one or more of the measures of quality including milling, baking and chemical data, doughball time tests, pearling indices, and mixograms. Results of these tests have permitted selection for quality factors in early generations in plant breeding material.

(Project 178. Departments of Agronomy and Milling Industry. Leaders, L. P. Reitz and E. G. Bayfield. Purnell funds.)

Variety Tests of Small Grains and Sorghum.—This is a companion project to No. 67. Coördinated tests of varieties of small grains and sorghum were made at Manhattan and at the branch experiment stations and experiment fields throughout Kansas.

Supplementing earlier work, this project contributed further information about two new superior varieties of wheat, namely Pawnee and Comanche, which have been released and each of which was planted in the fall of 1943 on some 500 to 600 acres in Kansas. The experiments have shown also that another new variety of wheat, Wichita (C. I. 11952), is well adapted and matures early. One-half acre of Wichita was planted on the agronomy farm in 1943 to provide a source of seed for distribution.

Five hybrid varieties of oats that were selected for resistance to crown rust, stem rust and smut have been included in extensive tests. The available seed of each of these was planted in 1944 in areas varying from one-half to 12 acres. The production from these increase fields will facilitate more extensive increases and earlier distribution of any one of the strains that demonstrates superiority.

(Project 129, 1-2. Department of Agronomy. Leader, H. H. Laude. Hatch funds.)

Experiments With Soybeans, Cowpeas, and Field Beans.—Varieties and strains of soybeans, cowpeas, and field beans were studied.

In 1943, 55 varieties and selections of soybeans were grown, 43 of which were part of a uniform test carried on in coöperation with the United States Regional Soybean Laboratory. A test of suitability to harvesting with a combine was made with seven varieties. Twenty varieties of field beans were grown in 1943 to replace most of the cowpeas that were grown in 1942.

Among local varieties Hongkong made the best record ranking first in 1943 and second in 1942. It was at the top in the combine tests both years with 23.15 and 26.30 bushels, respectively. Other high ranking varieties in these tests were Chief, Dunfield and AK.

A disease among the cowpeas in 1942, identified as *Phytomonas vignae*, completely destroyed the seedling plants of some varieties. Those damaged least were Victor, New Era, Grait and Brabham. The soybeans produced 15 percent more hay and approximately five times as much seed as the cowpea varieties.

The highest producing strains of field beans were all of the Great Northern variety, namely Idaho No. 81, a Kansas strain, and one from Michigan with yields of 594, 400 and 393 pounds per acre, respectively. Remaining varieties produced from none to 345 pounds. Nine of the twenty varieties failed to produce seed.

(Project 129, 3. Department of Agronomy. Leader, J. W. Zahnley, Hatch funds.)

Sweet Clover and Miscellaneous Crops.—Tests to determine the effect of stage and height of clipping upon succeeding growth and yields of hay and seed have constituted the major work with sweet clover.

Relative yields and amount of nitrogen produced in fall-sown and spring-sown stands have been studied also. Some plots were cut close in the fall on or about September 1, September 25 and October 20. The following spring plots were clipped at heights of 3, 6, and 9 inches early, and others at 6, 9, and 12 inches later at prebud stage.

Only one year's results of stage and height of clipping trials can be reported because of loss of the stand in 1942 seedings. Clipping in the spring reduced the yield of both seed and total forage. The closer the clipping the greater the reduction. The highest yields of forage on the clipped plots was 1.81 tons on the plot clipped 12 inches high in the prebud stage compared with 2.15 tons on the unclipped check. Highest seed yield was 1.83 bushels on the plot cut 6 inches high at the early stage, before prebud, compared with 4.13 bushels on the unclipped check. Fall clipping as early as September 1, 1941, did not reduce the yield of forage or seed in 1942.

Fall-seeded Madrid sweet clover produced 2.42 tons of forage containing 2.28 percent protein while spring seeded produced 2.68 tons containing 2.30 percent protein in 1943, the first year of this test.

Miscellaneous crops.—Trials with hemp for seed production resulted in a yield of 9.5 bushels of seed per acre in 1943, which is considered a fair yield in hemp-producing states. Results with Birdsfoot trefoil (*Latus* sp.) show that the crop can be grown here but is not equal to alfalfa in yield of forage. The species *L. corniculatus* is superior to *L. Major*.

(Project 129,4. Department of Agronomy. Leader, J. W. Zahnley. Hatch funds.)

Corn Production and Improvement.—This project is conducted coöperatively with the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. The primary objective during the biennium was the increase for commercial production of Kansas-developed hybrid corn.

White corn.—Kansas 2234 (K41 X K55) X (K63 X K64) a late-maturing hybrid, was approved for distribution in Kansas. This white hybrid has consistently yielded more and proved equal to or superior in other agronomic factors when compared with the better open-pollinated varieties and out-of-state hybrids. All inbred lines in this hybrid were developed in Kansas. These lines were increased and single and double crosses made so that enough seed of K2234 was available to plant approximately 20,000 acres in 1944. This hybrid is satisfactory for industrial uses.

Yellow corn.—Two hybrids, Kansas 1583 (K153 x K201) X (K4 X Ind. 38-11) and Kansas 1585 (K155 X K201) X (K4 X Ind. 35-11) were approved for distribution in Kansas: Their performance record is nearly equal to Kansas 2234. They are both full season varieties of corn. Three of the four inbred lines in each of these hybrids were developed in Kansas. Enough seed of these two hybrids was produced to plant approximately 10,000 acres in 1944.

Popcorn.—Three popcorn hybrids KP1001 (KP16 X KP24), KP1003 (KP24 X KP30A) and KP1004 (KP18 X KP30A) X KP24 were approved for distribution in Kansas. They have yielded from 25 to 75 percent more grain than Supergold or South American open-pollinated varieties. The quality is excellent, especially for home consumption, and the popping expansion is high,

(Project 156. Department of Agronomy. Leader, R. W. Jugenheimer. Purnell fund.)

Alfalfa Investigations.—This project is conducted in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture. Those phases dealing with diseases of alfalfa and insects that attack alfalfa are carried on in cooperation with the Departments of Botany and Entomology of this station and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. The hay quality studies are in cooperation with the Department of Chemistry of this station.

Effect of stage, frequency of cutting, and method of curing on hay quality.—The preliminary studies on carotene content of alfalfa hay show that air humidity in itself has very little effect on the loss of carotene in alfalfa during the curing process. Hay cured in the sunlight lost more carotene than hay cured in the dark. Also hay cured in the shade retained its carotene better than hay cured in the sun under field conditions.

Windrowing alfalfa soon after cutting, aided in retaining the carotene content during the curing process. Hay that was high in carotene when stored in the barn came out of storage nine months later higher in carotene than hay that was low in carotene when it went into storage.

Environmental factors affecting seed setting.—In cooperation with the Garden City experiment station, a study was made on the combined effect of time and amount of irrigation, and time of cutting alfalfa on seed production. The results show that high root reserves are important in the production of alfalfa seed. The high moisture and high reserve treatment gave the highest seed yield in both the greenhouse tests conducted at Manhattan and the field tests at Garden City. In the field, increases up to one bushel per acre were obtained. It was apparent from these tests, that the alfalfa seed crop should be grown under slightly below optimum moisture content up to the blooming period with a slightly increased soil moisture through the fruiting period.

Adaptation studies.—Buffalo alfalfa, a wilt-resistant variety from Kansas Common, has been released for commercial production and is recommended for the central and southern states where Kansas Common is generally grown. Eighty bushels of seed were produced in 1943 on the Fort Hays experiment station. Also, a new seeding of 45 acres was made, making a total of 80 acres for increase seed production.

Field plot tests conducted at Manhattan show several new Kansas Common selections with high wilt resistance that are superior to Buffalo. Analysis of variance on three years of data shows them to be significantly higher than Buffalo in hay yield.

Breeding and improvement.—Emphasis in the breeding program is now being placed on the development of a hybrid alfalfa. In the selection of colonial lines for a hybrid alfalfa, the parental stock must be tested for re-

sistance to wilt, blackstem, and cold. Much of this is done by artificial inoculation. Six hundred individual selections were tested for wilt resistance this year.

(Project 183. Department of Agronomy. Leader, C. O. Grandfield. Purnell funds.)

A Study of the Undesirable Physical and Chemical Changes Brought About in the Process of Dehydration.—The carotene content of fresh alfalfa and changes undergone during dehydration were studied. The effects of blanching with steam, grinding, certain added substances, and different storage temperatures were also investigated. A cabinet dehydrator, in which all of the variables affecting dehydration can be controlled, has been constructed. An experimental alfalfa dehydrator has been loaned to the college.

Blanching of fresh alfalfa with steam stabilized the carotene and its destruction during dehydration was avoided.

Certain antioxidants were found partially to protect the carotene during the process of dehydration. Diphenylamine and hydroquinone were the most satisfactory substances of this type which were used. On an experimental basin, storage of alfalfa meals at 3°C. was found to be a satisfactory way to maintain the carotene content. A simplified, time-saving method was developed for the determination of carotene in dehydrated alfalfa.

It was found that a good color could be retained in dehydrated Kaw Valley potatoes if proper care was taken in washing the potatoes after they had been blanched with steam. The results found in the effect of furnace design on quality of dehydrated products have led to three patent applications covering the process and several furnace designs.

(Project, Kansas Industrial Development Commission, No. 1. Departments of Chemistry and Chemical Engineering. Leaders, R. E. Silker, W. G. Schrenk and W. H. Honstead. State funds.)

Pasture Improvement Investigations.—This project is conducted coöperatively with the Bureau of Plant Industry, United States Department of Agriculture.

Grazing management.—The deferred versus season-long grazing studies at the Casement pastures have revealed that spring protection can increase native pasture yields by as much as 50 percent while at the same time improving the stand and vigor of the grass. During the 1942 and 1943 grazing seasons the deferred period was extended into the second week of July. Efficiency of utilization, annual gains, and yields of beef per acre were reduced materially showing that long deferred periods are not practical in the tall grass pastures although they do contribute greatly to improvement of the grass. Only in depleted tall grass pastures should grazing be deferred later than June 15.

During this biennium the moisture conditions have been favorable and this was reflected in certain changes in the effect of burning on grasslands. In dry years the pastures burned early suffer greatly during summer drought, but in 1942 and 1943 the differences were relatively smaller and were not consistent. This serves to substantiate the contention that reductions in yields following the burning of bluestem pastures are due chiefly to lack of moisture, resulting from run-off, evaporation, and early utilization.

Fertilization studies in native grasslands have continued to show that the only response is from nitrogen. The manured plots have consistently out-yielded all other treatments.

Fertilization trials with brome grass have shown that nitrogen fertilizers correct the condition known as "sod-binding." In the 1942 trials, 400 pounds of ammonium sulfate increased the seed yields of "sod-bound" brome grass from 220.8 pounds under no treatment to 435.8 pounds per acre following treatment.

Pasture plots seeded to native tall grasses (as reported in the biennial report for the biennium ending June 30, 1942) have been grazed two seasons. All plots now have good stands and no marked preference for any of the species or mixtures was shown by the animals. This shows that good stands of native grass may be secured by almost any method but that the "hay method" gives good stands more rapidly than drilling or broadcasting.

Brome grass strains and selections have been subjected in their seedling stage to high temperature. In general, all strains are highly resistant to heat although their leafy tissue may be damaged badly. To obtain differential killing between strains it has been found necessary to subject the plants to temperatures which destroy almost the entire top-growth.

Seed setting of native grasses.—As a result, of breeding and selection, a leafier, more uniform, and more productive strain of big bluestem (*Andropogon furcatus*), and one of little bluestem (*A. scoparius*) are being increased. A small number of selections of switch grass and side-oats grama are being observed. Buffalo grass strains and crosses have been sent to the experiment station at Hays, Kansas, where they have been added to the material under observation there.

Seed setting of tame grasses.—Brome grass is the most important tame grass being studied. A large number of head rows from various fields in eastern Kansas have been planted and are being observed.

More than 70 Kentucky blue grass head rows were observed in 1942 and 1943. Two were selected for increase because of their vigor, leafiness, uniformity, and freedom from rust and mildew. Small increase plots from seed and from vegetative material have been planted.

Sudan grass.—A number of head selections were made in 1942 and 1943. In 1943 a smaller number of the leafiest and most productive rows were bulked for increase in 1944. Among the promising strains in this group was a Sudan x Johnson grass cross which apparently has considerable resistance to chinch bugs.

Uniform nursery trials.—These trials, sponsored by the Division of Forage Crops and Diseases, United States Department of Agriculture, have made possible comparisons of a number of strains of brome grass, orchard grass, the bluestems, and switch grass. The results from brome grass plots and rod-rows have shown that northern strains of brome are entirely unadapted here.

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

Weed Control.—Tests to determine the effectiveness of borax as a weed killer compared with sodium chlorate and the duration of the boron toxicity in the soil have been in progress during the biennium.

Applications of 4 pounds per square rod of sodium chlorate have been somewhat more effective than 20 or 25 pounds of borax for killing bindweed. Borax has not been effective on hoary cress. Substitution of borax for sodium chlorate in a ratio of 4 to 1 has been less elective than sodium chlorate alone.

Toxicity of soil treated with 20 and 25 pounds of borax per square rod in 1941 was greater in May, 1944, than where treated with 4 pounds of sodium chlorate, as shown by the growth of oats.

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

Coöperative Experiment with Farmers.—Work conducted under this project includes crop variety and soil treatment tests on farms over Kansas to obtain information under more varied conditions than are represented on the various branch experiment stations and experiment fields.

Scope of the project.—During the biennium, 1,272 coöperative tests were located in 95 counties with the coöperation of county agents, vocational teachers and farmers. These tests included varietal studies on the principal farm crops grown in the state and soil treatment studies on small grains and legumes.

Three corn performance tests were conducted in eastern Kansas in both years of the biennium. Forty-four to 84 entries, including hybrids and open-pollinated varieties, were planted in these tests. The corn performance tests are financed by entry fees paid by producers of commercial hybrid corn seed.

Pawnee and Comanche, new varieties of hard red winter wheat, have continued to show superiority in coöperative tests. Pawnee is best adapted in eastern and central Kansas and Comanche in western Kansas.

The rust-resistant varieties of oats, Cedar, and Boone, made a higher yield than Fulton in 1943; but Fulton made the highest yield in 1942. Linota flax outyielded Bison and Redwing in northeastern Kansas. Reno winter barley was superior to Missouri Beardless and approximately equal to Ward in yield and winter hardiness.

In the combine-harvested soybean tests, Hongkong made the highest yield and shattered the least in the southeast and south-central sections of the state. Dunfield yielded highest in northeastern Kansas in 1942 but not in 1943. Low yield in 1943 was caused by heat in August.

Kansas corn hybrids made the highest yield of all entries in coöperative corn variety tests in each of the seven corn-testing districts of the state in 1943. These hybrids were not included in the 1942 tests because seed was not available.

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

Factors Influencing the Quality of Wheat During Storage.—This project has developed along three lines, all the details of which cannot be reported here. Only a brief report for the biennium follows.

A. *Wheat-storage project at Hutchinson.* —Insect infestation was the most serious problem encountered in the storage of old, dry wheat which had been stored for one year before being moved to these experiment bins. Two effective fumigations per year are required in 1,000-bushel bins for control of storage insects. In small bins which cool quicker, insect growth is sooner arrested, whereas in larger bins insects grow throughout the winter.

Larger bins also have more pronounced "moisture migration" because of warm grain in the center during cold weather. Accumulation of excess moisture near the top surface in the center of bins was observed in several bins. During the biennium, ventilation of wheat in storage has been only partially successful if not positively harmful. Moving grain from one bin to another proved to be less beneficial than formerly believed. Little drying was accomplished; cooling effect even in January was not striking; passing the grain over a screen to remove insects was not an effective method of insect control; and redistribution of moisture which had accumulated in wheat in one area resulted only in a shifting of moist wheat from one place in the bin to another.

Bins painted pure white maintained a lower temperature by 8 to 10° F. throughout the year. The tubular, drag-type elevator has given good satis-

faction in moving grain from bin to bin when used with the Thieman grain auger. An average of 470 bushels per hour can be moved by two men at a cost of about one-fourth cent per bushel.

B. *Piling wheat on the ground at harvest time is successful* where (1) rainfall is infrequent or not heavy; (2) the top soil is dry; (3) good drainage is provided at the edges of the pile; and (4) wheat is not left out in piles more than two to three weeks.

A pile of wheat with smooth slopes is wetted on the surface only to a depth of about half an inch after receiving four inches of rain. When water equivalent to two inches of rainfall was sprinkled on the surface of a pile of wheat, 75 percent ran off the pile, 5 percent wetted the surface layer to a moisture content of 25 percent to 30 percent, and about 20 percent passed down through the mass of wheat and drained out at the bottom. In hot weather the water on the surface of the pile is dried in an hour or two with no apparent injury except some bleaching. Continued rain and damp periods caused the wheat to sprout in two days.

C. *Possibilities of underground storage for wheat in western Kansas.*—Underlying soil materials in the vicinity of Colby have 9 to 10 percent moisture. Wheat samples placed with these soils having varying soil moisture content from 4 to 20 percent molded in all cases where the soil carried more than 6 percent moisture. The conclusion was that wheat could not safely be stored in underground storage pits without an effective vapor barrier between the wheat and soil.

(Project 204. Department of Agricultural Engineering. Leader, F. C. Fenton. State funds.)

Breeding for Disease Resistance in Wheat, Oats, and Sorghums.—This project is conducted coöperatively by the Department of Agronomy and the Department of Botany of the station and the Bureau of Plant Industry, United States Department of Agriculture. This project was established in 1938 and breeding material has now reached a point where promising new selections have been advanced to tests for yield, adaptation, and quality to determine the strains which have suitable characteristics for commercial production on farms. Included are a large number of strains of oats and winter wheat having resistance to two or more major diseases common in this area.

Seventy-five strains of rust resistant winter wheat were advanced to the replicated agronomy yield nursery for 1944. Some strains are resistant to bunt and loose smut also.

Approximately 8,000 selections of oat crosses in F_3 and F_6 were tested in the greenhouse and the rust and smut nursery during the biennium. Many of these had resistance to crown rust, stem rust, loose smut, and covered smut. Eight hundred and five were resistant to the four diseases and were sufficiently good for increase and further study. The best lines will be available for yield tests in 1945.

Seed supplies of Ventura (C. I. 3989), Osage (C. I. 3391), and C. I. 4141 were increased in 1943. These varieties have resistance to smut, crown rust, and stem rust.

Smut resistant forage and grain sorghums were recovered in crosses.

(Project 207. Department of Agronomy, Department of Botany, and Division of Cereal Crops and Diseases, United States Department of Agriculture. Leaders, L. P. Reitz, L. E. Melchers, E. D. Hansing, E. G. Heyne, and C. O. Johnston. Bankhead-Jones funds.)

Factors Influencing the Qualities of Wheat.—Work during the biennium has included five phases which are reviewed below. Parts of the work have been hindered and retarded on account of shortage of trained and experienced workers and also as a result of certain reorganizations within the department.

Studies of varieties composited at several protein levels have been continued. Mixograms were obtained and it is of interest that both Pawnee and Wichita wheat, varieties continued to show tendencies toward a somewhat weaker type of curve than that of Turkey.

An initial study was made into the application of the "several increment" viscosity test to hard winter wheat flours. Approximately 100 samples of the 1942 crop residues gave viscosity results which were correlated with loaf volume about as well as was protein content. When the effect of protein was removed, viscosity was still moderately correlated with loaf volume. This indicates viscosity gives some indication of protein quality. Further work on the viscosity test for bread flours is warranted.

Genetic factors influencing the quality of wheat.—This project continues toward the development and testing of methods to evaluate small samples of wheat, submitted to the department by plant breeders.

Comments from the wheat breeders indicated that the laboratory results aided in making decisions among varieties of competing claims. The fermented dough mixograms were found to be moderately correlated with the customary nonfermented flour-water curves.

The response of variety to its environment.—Varieties of hard red winter wheats are grown at a number of Kansas locations each year. Grain from these plantings is subjected to various milling, baking and other tests.

All samples were analyzed, milled, and baked as individuals as well as in the form of variety and station composites. An excellent series of mixograms resulted from this study. Environment produced significant effects upon the mixogram pattern, the changes varying materially with protein quantity.

Baking results continued to demonstrate the potential usefulness of Comanche for hearth breads. The new variety, Wichita, in 1943, placed between its two parents, Early Blackhull and Tenmarq, in quality. Pawnee baked well, but had a weaker type of curve than Turkey. Crop quality is materially influenced by growing conditions. As knowledge of these influences is gained, methods for compensating for adverse seasonal effects may be devised.

Edaphic factors influencing the quality of wheat.—Manpower shortage has largely restricted this work which consists principally of the analysis of samples obtained from a long-time soils experiment. Thirty-four samples originated from the nitrogen fixation plots, another nine came from other soil-fertility experiments. Protein, moisture and total ash were determined. The protein content of about 450 samples was determined from the variety tests over the state. Nothing unusual appeared in the 1943 crop.

(Project 60. Departments of Milling Industry and Agronomy. Leaders, E. G. Bayfield, A. L. Clapp, H. H. Laude, H. E. Myers and John A. Johnson. Bankhead-Jones funds and state funds.)

Moisture and Relative Humidity Factors Affecting the Quantity and Quality of Wheat Flour.—Additional experience with the W-W short time conditioner using various varieties of wheat was obtained. A start was made to find how this machine might be used to change the character of the wheat gluten. Studies into atmospheric conditions prevailing during milling were continued.

The feasibility of short tempering techniques was proved and the usefulness of such machines for some mills is evident. A four-hour, or even less, rest

period may be used. This cuts down bin space for conditioning and hastens deliveries on rush orders.

Under abnormally high temperatures, the wheat gluten was changed in its characteristics. In some cases the baking strength was greatly reduced.

(Project 170. Department of Milling Industry. Leaders, R. O. Pence and J. E. Anderson. Purnell funds.)

Factors Which Influence the Colloidal Properties of Dough.

—Four principal lines of work have been pursued. (1) Effect of sulfhydryl groups on the mixogram patterns in comparison with wetting agents. Sulfhydryl compounds used were: Cysteine, hydrogen sulfide, ethyl mercaptan, and iso-propyl mercaptan; (2) methods were developed for separating gluten from sticky and otherwise physically unmanageable dough; (3) influence of papain, yeast water, cysteine, and glutathione on mixogram patterns and on gluten dispersion v. decomposition; (4) baking tests were made to determine the effects of agents which lengthen the mixing time and also those which shorten this time. The former are wetting agents and the latter those which contain sulfhydryl groups.

Substances which contain sulfhydryl groups affect mixogram patterns opposite to that of wetting agents. The former made a mixogram pattern of Tenmark similar to that of Chiefkan and the latter made a Chiefkan pattern like that of Tenmarq. The baking tests with wetting agents and also with those which contain -SH groups indicated that both beneficial and detrimental results may be obtained. This will depend on whether the flour used is benefited or harmed by increasing or decreasing the mixing time and also on the quantities of these agents used. The best method for separating gluten from sticky and physically unmanageable dough was by use of the Waring Blendor and the large centrifuge.

Overmixing flour-water dough to such an extent that it resembles a paste does not result in gluten disintegration since gluten from such dough can easily be recovered by the method developed.

The presence of papain in dough results in gluten decomposition to such an extent that gluten from such dough cannot be recovered. The extent of this decomposition depends on the time of contact and on the amount of papain present.

Yeast water, cysteine, or glutathione effected similar changes in the mixogram patterns but none caused gluten decomposition since there was no decrease in the amounts recoverable even after long rest periods.

(Project 200. Department of Milling Industry. Leader, C. O. Swanson. Bankhead-Jones funds.)

The Influence of Some Factors Affecting the Physical Properties of Wheat.

—Observations were made on the physical changes which take place in wheat kernels during maturing, ripening, and as a result of prolonged exposure in the field and in shocks. Supplementary work included artificial wetting of wheat heads and of threshed grain. Effects of these conditions were measured by observing changes in test weights and internal textures. These measures were supplemented by milling and baking tests. The two harvests, 1942 and 1943, may be characterized as above normal in rainfall during field exposure.

Exposure of wheat to rains after it was once dry enough for combining, decreased the test weight, the external vitreous appearance and the internal vitreous texture. These changes were accompanied by corresponding increases in chalky or mealy internal texture. The amounts of these changes increase with the lengths of exposure as well as number of rains, but the first rains which fell after the wheat was once dry have proportionately greater effect than later rains. The decrease in test weight resulted from loosening of the bran layers by wetting and by swelling of the kernels as a whole. In well built shocks the changes were much less than in uncut wheat.

The lowering of test weights and decreases in vitreous condition seriously reduced the wheat grades. There was no decrease in flour yield, no increase in flour ash, maltose value nor lowering of baking value.

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

Conditioning Requirements of Wheat and Their Influence Upon Milling and Baking.—A few large lots of wheat of pure varieties were milled and subjected to commercial bakery tests. These tests confirm experimental bakeshop results on Chiefkan and Tenmarq.

Laboratory tests with the Entoleter showed its potentialities as an impact milling machine. These laboratory studies led to the installation of a number of these machines and commercial scale testing will be conducted in the next biennium.

Considerable work was done in developing and trying out a modification of the pearling test as a method for estimating the amount of moisture required for conditioning wheat.

The large scale millings of pure variety samples indicated that more attention should be given to the response of varieties to commercial bleaching and maturing practices. Further work is required.

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

The Effect of Factors Influencing the Qualities of Kansas Wheat.—Resulting from a special state appropriation for milling and baking research, this project has permitted the undertaking of both immediately practical and longer time basic research work. Much of the work undertaken was in coöperation with either governmental or commercial concerns.

Samples were milled and baked for various state and county fairs in coöperation with the Kansas Wheat Improvement Association. A wheat quality survey was conducted on the 1942 crop in coöperation with the Kansas Grain Inspection and Weighing Department. Protein content of wheat was determined for farmers.

Work of a more basic research nature included a study of bakeshop room temperatures, of baking pan sizes and variability due to operator. The effect of ethylene gas as a wheat-maturing agent was continued in coöperation with the Bureau of Agricultural and Industrial Chemistry. An extensive experiment dealing with the effect of fumigants upon wheat and flour qualities was undertaken in coöperation with the Bureau of Entomology and Plant Quarantine.

As a result of service-type work done much information relative to Kansas wheat became known to wheat growers and the milling trade generally.

The baking studies led to a recommendation for a room temperature of 80° F. and the use of the low-form commercial type pup pan. The ethylene gas

experimented were discontinued due to the war, before conclusive results were obtained. The insecticidal investigations show that some fumigants have definitely bad effects upon the baking qualities of flour and the germination of the wheat.

(Project 220. Department of Milling Industry. Leader, E. G. Bayfield and staff. State funds.)

A Physiological Study of the Hard Winter Wheat Plant.—This study has been along the following four subprojects:

(1) A physiological study of the winter wheat plant at different stages of its development. (Finished.)

(2) A physiological study of the awns of red winter wheats. (Finished.)

(3) The effects of partial and complete defoliation of the wheat plant at different stages on the yield of grain. (Experimental work finished.)

(4) Physiological differences between hard and soft winter wheat plants.

The purpose of subproject No. 3 is to show how much the leaves contribute of the materials from which the grain is made. It is intended to show why leaf rust which affects for the most part the leaves of the wheat does not cause the grain to shrivel nor decrease the yields of wheat to nearly so great an extent as the black rust. It would also show something of the nature of hail injury.

Seven varieties of red winter wheat were used in these experiments. At four stages during the life of the wheat plant, booting, flowering, one week after flowering, and two weeks after flowering, three sets of plants were selected and each set treated as follows: (a) The entire blade was removed from all the leaves, (b) the blades of the basal leaves were removed, and (c) one-half the length of each leaf was removed. For each group of treated plants a similar number of intact plants served as controls.

The data obtained during the first year is summarized in the biennial report of June 30, 1940. It is hoped to finish the work for a technical bulletin by the end of the next fiscal year.

On subproject No. 4 there has been collected, dried and prepared for analyses, material from six varieties of soft wheats and six varieties of hard wheats. It is planned to continue to collect material another year. The material is now being analyzed for ash. It is hoped that the nitrogen determinations can be made soon.

(Project 189. Department of Botany. Leader, E. C. Miller, Purnell fund.)

Physiological Studies of Noxious Weeds in Relation to Their Control.—This research has been organized into the following four subprojects: (1) Studies on field bindweed (*Convolvulus arvensis* L.), (2) studies on hoary cress (*Lepidium draba* L.), (3) studies on Russian knapweed (*Centaurea picris* Pall.), (4) studies on dogbane (*Apocynum cannabinum* L.).

Three phases of work have been conducted during the biennium.

The nature and rate of development, particularly of the underground system, of perennial noxious weeds.—The two species, Russian knapweed and dogbane, spread horizontally by vegetative development of permanent lateral roots. The Russian knapweed type of development involves permanent lateral roots that grow horizontally for a greater or lesser distance and then turn downward to become secondary vertical roots, with additional permanent lateral roots (second order) arising at the bend to continue the plant horizontally. The latter roots eventually turn down to form additional secondary vertical roots (second order). There are additional permanent lateral roots and secondary vertical roots of third and continuing orders developed in a

seven-month growing season. Field bindweed and hoary cress also have this type of development.

In the development of the root system of the dogbane plant the permanent lateral roots (first order) continue to develop horizontally through the growing season and do not turn downward to form vertical roots (secondary verticals). Secondary vertical roots are formed on the permanent roots of the plant, but they arise as branch roots some distance back of the growing point. They grow downward either directly or after short horizontal growth. This type of development appears to favor a slightly more rapid rate of horizontal spread.

This study revealed for Russian knapweed and dogbane, as previous studies had revealed for field bindweed and hoary cress, that it is the deeply penetrating vertical roots which give rise to the plants that persist when control procedures, either cultivation or use of chemicals, are applied.

The food reserves of bindweed.—These studies were of two general types.

(a) The amount, distribution, and seasonal trends of reserves in various parts of the bindweed plant. For the purpose of gaining a knowledge of the amount, distribution, and seasonal trend of the reserves of undisturbed plants, the root systems were arbitrarily divided into the permanent lateral roots and the two types of vertical roots with each of the latter types divided into first, second, and third foot portions making a total of seven portions. The percentages, on a dry weight basis, were determined for the various protein and carbohydrate fractions at 14 times of sampling—April 1 to November 1, inclusive. It disclosed: (1) That all the carbohydrate fractions, except the reducing sugar fraction, reached low levels in all the root portions during the interval of April 15 to May 15; (2) that the readily available carbohydrate fraction attained a maximum in the permanent lateral roots and the first foot portion of the two types of vertical roots about October 1; (3) that the second- and third-foot portions of the two types of vertical roots reached their high point during the interval of August 15 to September 1; and (4) that the differences between the comparable foot portions of the upper three feet of the two types of vertical roots in reserve-food content, particularly the readily available carbohydrate fraction, is significant statistically.

(b) The relative amounts of reserves used by the new growth of bindweed under a seven-day and a fourteen-day cultivation interval. The relative depletion of food reserves, supplied by the underground parts of the plant cultivated every seventh day as compared with cultivation every fourteenth day was determined. From this it appeared that cultivation every 14 days destroyed at least a fifth more of the readily available carbohydrates (the most meaningful fraction in the carbohydrate economy of the plant) and more than double the loss of protein nitrogen, as compared with two cultivations at intervals of seven days in the same unit of time.

A study of the shade tolerance of bindweed.—Data were obtained on bindweed growing under full light, and under the following percentages of full light: 71, 47, 33, 24, 18, 13 and 6. Five or six plants each growing in 200 pounds of soil in a metal container were used under each light situation.

In 1942 four plants each six months old and two plants started from seed at the initiation of the experiment (ie., seedlings) were used under each light situation. The experiment ran from June 15 until frost, after which two of the older plants and one of the younger from each light situation were buried in the field. That year the plants under 47 percent and 33 percent of light had the best shoot development. Plants shaded from their start were dead by September 15 under 6 percent and 13 percent of light and the one grown under 18 percent of light which was buried failed to live through the winter. One of the older plants grown under 6 percent of light died before frost and the two older plants grown under this light which were buried failed to live through the winter. The two older plants grown under 13 percent of light which were buried, also failed to live through the winter. No plant flowered under less than 47 percent of light and only one flowered under that light. All of the older plants under 71 percent and 100 percent light flowered. None of the younger (seedling) plants flowered.

In 1943 five plants two months old at the start of the experiment were used under each light situation. The experiment again ran from June 15 until frost. The plants under 47 percent light had the best developed shoots but those under 71 and 33 percent light were only slightly less developed. All plants growing under 6 percent light were dead by September 15. Of the remaining there was no significant difference in the percentage of readily available carbohydrates (considered the most reliable index of the reserves of the plant) in plants receiving 18 percent or more of light. In the actual amount of dry matter of underground parts produced, however, there was a progressive decrease in the sets of plants receiving less than 71 percent light. In the actual amount of readily available carbohydrates produced, there was a progressive decrease in the sets of plants receiving less than 71 percent light. Only one plant in the entire experiment flowered. It was grown under 100 percent light.

(Project 202. Department of Botany. Leaders, John C. Frazier and Edwin C. Miller. Bankhead-Jones fund.)

Orchard Investigations.—Four major phases of study have been under way under this project during the biennium, as follows: Testing of spray materials; rootstock studies; influence of orchard soil management on frost penetration; and testing new and promising varieties of tree fruits. Progress is reported herewith.

Testing spray materials.—No experimental spraying of fruit plants with insecticides and fungicides was done during the biennium. Young fruit trees in the new orchard were sprayed with lead arsenate 1.5 pounds and hydrated lime 1.5 pounds to 50 gallons for canker-worms in April each year and good control was obtained.

No experimental work was done with nursery waxes.

Harvest sprays to prevent premature dropping of apples were applied in Doniphan county.

Rootstock studies.—A study of the various rootstocks was continued during the biennium. Most of the French crab seedling selections of the K series which have been under observation for several years made good growth on their own roots. In order to get larger numbers of the most promising ones, cion wood was collected in the fall of 1943 and during the winter they were grafted onto apple seedling roots obtained from a Kansas nursery. These grafts were planted deep in nursery rows to get the cions on their own roots. The resulting trees will be top worked to several Kansas apple varieties.

Influence of orchard soil management on frost penetration.—Seven plots representing surface conditions found in orchard soils were prepared for observation and comparison each year of the biennium.

Records taken include air temperature, soil temperature at 6-inch and 12-inch depths, penetration of frost into the soil and the disappearance of the frost from the soil.

The relation between the soil and frost was determined by digging in each plot on 32 dates, December through February the first year, and 24 dates during a similar period in the second year of the biennium. Although both winters were thought of as mild, the maximum frost penetration on the "bare compact" soil plot was 16 inches in 1942-'43 and 7 inches in 1943-'44. Snowfall was light both years and melted quickly giving but little insulating effect. The greatest depth of snow, 8 inches in December, 1943, disappeared in 9 days.

Straw mulch and heavy bluegrass sod continued highly efficient in preventing frost penetration. The deepest penetration in 1943 was 0.5 inch and, in 1944, penetration was 1.5 inches, respectively. Loose surface soil showed little insulating value either year.

During the past year similar observations and results were recorded. Continuation of this subproject is proposed for the next biennium.

Testing new and promising varieties of tree fruit.—An area on the west side of the new horticultural farm was assigned to subproject No. 4 in 1942. It is

about five acres in extent. On an additional area in the southeast corner of the farm a planting of nut tree varieties, set in natural grove form, was established. During the biennium, varieties of tree fruits and nuts were planted in the following numbers: Apple, 28; apricot, 3; cherry, 11; jujube, 1; peach, 25; pear, 5; plum, 27; black walnut, 5; Carpathian walnut, 2; hican, 1 and pecan, 8. Detailed annual studies of the vegetative growth, fruitfulness, phenological reactions, and pest relations of each variety are made and the data recorded. Continuation and expansion are proposed for this subproject.

(Project 25. Department of Horticulture. Leaders, W. F. Pickett, Geo. A. Filing, and R. J. Barnett. State funds.)

Small Fruits Investigations, (Small Fruits Production).—

The yields of strawberries in 1942 were fair, but varied considerably in the various plots. Bramble yields were very low in 1942. Plots of black raspberries and blackberries that were "summer topped" yielded more than those which were not pruned during the summer. Studies of the winter hardiness of brambles were continued. Red raspberries that were protected with straw were less damaged than those with no protection. Bundles of fodder placed on either side of red raspberry rows did not decrease the winter damage.

The 1943 season was fair for strawberries but the brambles were badly damaged during the preceding winter.

The following kinds and varieties of small fruits were planted at the new Horticultural farm:

Strawberries. Dunlap, Howard, Aroma, Blakemore, Fairfax, Aberdeen, Catskill, Dresden, Northstar, Gem, Progressive, Wayzata, Tennessee Shipper, Cheyenne Nos. 1 and 2, and Pathfinder.

Black Raspberries. Cumberland, Logan, Bristol, and Quillen.

Red Raspberries. Cuthbert, Chief, Latham, Newburgh, Marcy, Indian Summer, Taylor, and Flaming Giant.

Purple Raspberries. Sodus, Marion, and Ruddy.

Blackberries. Alfred, Brewer, and Eldorado.

Dewberries. Thornless Young, Thornless Boysen, Lucretia, and Boysen.

Trailing Raspberries. Seedlings and selections from North Carolina.

Currants. Cherry, Fay, Wilder, Perfection, and Red Lake.

Gooseberries. Downing, Glendale, Pixwell Poorman, and Joselyn.

Grapes. Concord, Moore Early, Worden, Delaware, Brighton, Niagara, Diamond, Gloire, Clinton, Yates, Van Buren, Seneca, Ontario, Buffalo, Champion, Alpha, Beta, Agawam, Fredonia, Portland, Golden Muscat, Caco, Eclipse, Concord Seedless Lucile, Urbana; Sheridan, and Campbell Early.

In coöperation with the Department of Physics, a portable machine was designed for the testing of winter damaged raspberry canes.

(Project 26. Department of Horticulture. Leader, Geo. A. Filing. State funds.)

Flower and Vegetable Investigations.—This project is divided into two subprojects: Vegetable variety testing and crop improvement; and culture of greenhouse crops. Sweet corn, tomatoes, beans and potatoes have received most attention in outdoor activities.

The comparative value of hot water, steam, and larvicide for the maintenance of high productivity of old greenhouse soils has been a major greenhouse study.

Beans.—Bountiful, Asgrow Black Valentine, Streamliner, Plentiful and Burpee's Stringless Green Pod are the most productive green bean varieties. Bountiful as an early planting has been outstanding.

Sweet corn.—No outstanding early variety has been found for market garden purposes. Corn earworm causes serious injury on early varieties. There are a number of midseason and late season varieties well adapted to market garden and home garden production. Golden Cross Bantam, Seneca Golden Hybrid, Tendergold, Silver Cross Bantam, Ioana, and Lincoln are good midseason varieties with good market garden sized ears.

Tomatoes.—Rutgers, Stokesdale, Firesteel, and Marbon have given good yield throughout eastern Kansas. Firesteel has a wider adaptation so may be grown in western Kansas where good protection is available.

Potatoes.—Northern grown certified potato seed produced higher yields than good home grown seed.

Greenhouse old-soil studies.—The use of old soils for tomato culture has given the following results: Heat treatment of old greenhouse soil increases tomato production. Tomato plants growing in old soil treated with hot water released from pressure (215° F.) produced yields equal to plants growing in similar soil treated with steam as long as disease was not a factor. Steam treatment gave better control of nematodes and wilt than was obtained by hot water. Larvicide used on old soils infested with nematodes gave control equal to hot water, but production of plants growing in the larvicide-treated plots produced one-third less fruit.

Greenhouse tomatoes as a war crop.—A spring crop of greenhouse tomatoes produce much larger yields than a fall crop.

(Project 27. Department of Horticulture. Leader, S. W. Decker. State funds.)

Relation of Leaf Structure to Rate of Photosynthesis in Fruit Plants.—Previous reports of this project have shown that a positive correlation exists between the ratio of the internally exposed surface to the external surface of apple leaves (R value), and photosynthetic activity.

In 1942, different parts of both greenhouse and field-grown trees were given different spray treatments and the R value of the leaves compared with that of leaves from unsprayed parts of the same trees. The results show that all of the sprays used decreased the R value below that of untreated checks. ("R" is defined as the ratio of the internally exposed surface to the exterior surface of the leaves).

In 1943, experiments were carried out in the field to determine the influence of various sprays and ammonium sulphate fertilizer applied to the soil on the growth and internal structure of the leaves of different apple varieties. (Persons interested may write to the station for a detailed report.)

In 1943, a study was made of the influence of spraying 0.5 percent solutions of ammonium nitrate, sodium nitrate and urea on the foliage of field grown Wealthy, Winesap and Jonared apple trees. Each of three trees of a variety was sprayed with a different salt solution and a fourth unsprayed tree served as a check.

The results show that spraying the foliage of Wealthy, Winesap and Jonared apple trees with 0.5 percent solutions of ammonium nitrate, sodium nitrate and urea increases the R value of the leaves above that of the untreated checks. The influence of sodium nitrate and urea is about the same, but compared with these the ammonium nitrate had less influence on Wealthy and Winesap, and greater influence on Jonared.

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

Investigations with Ornamental Plants.—This project deals with the suitability of various kinds of hardy ornamental plants to Kansas conditions and the control of various weeds injurious to lawns. New and noteworthy herbaceous perennial flowers, vines, shrubs, and trees are under trial.

Over 1,000 species and varieties of ornamental plants are being grown successfully. Five mimeograph lists of ornamental plants adapted to the various sections of Kansas have been prepared and are available on request.

After several years of experimentation on the control of dandelions in lawns, it has been proved definitely that they can be controlled most effectively and economically by the use of kerosene applied at the rate of 200 gallons per acre in the fall during the first two weeks of October.

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

Factors Affecting Survival and Growth in Forest Plantations.—This project was started in the fall of 1941. No analysis of data has been initiated to date; therefore, only the statement of work performed in current, annual examinations is included in this report.

Spacing distances.—The purpose of this project is to determine the influence of different spacing distances upon soil moisture relations and the effect of these changes in soil moisture upon the growth and survival of trees in typical windbreak or shelterbelt plantations.

Tree measurements.—Tree measurements taken called for root measurements and height and diameter measurements.

Due to the existing limitations no root measurements were taken in 1942 and 1943.

Complete height and diameter determination were taken only on the Hays and Durler plantings. Due to limitations in the work, no deep-soil moisture determinations have been undertaken. The first of the shallow determinations were taken in the spring of 1942 on the Hays and Durler plantings following planting at the beginning of the project. No precipitation gauges have been installed on the immediate planting sites. Records will be obtained from the nearest permanent weather stations.

(Project 221. Subproject No. 1; Department of Horticulture. Leader, George M. Fisher. Bankhead-Jones funds.)

Industrial Utilization of Sorghum Grains.—The work on this project is carried on in two phases, coöperatively between the Departments of Chemistry and Chemical Engineering. Kansas soil and climate are ideally suited for the production of an abundance of sorghum grain. The objective of this project is to find uses for sorghum grain in industry.

Chemical phase.—During the biennium, work on the chlorination of starch has continued with special emphasis on the kinetics of the reaction. The film-forming properties of the unaltered starch chlorides have been examined in a preliminary fashion. Preliminary experiments have also been carried out on the pyrolysis of starch in organic systems. In a kinetic study of the chlorination of starch, work has been limited almost entirely to a product containing two chlorine atoms per glucose unit. Technically, the reaction is not unusually difficult to carry out but is very complex in a chemical sense. Numerous factors, such as the source of the starch, granule characteristics and the degree of organization affect the reaction rates.

Continued progress has been made on the study of quality of starches derived from fourteen varieties of sorghum grains commonly grown in Kansas and from several glutinous hybrids.

Thus far, efforts to accomplish the complete hydrolysis of starch dichloride have been unsatisfactory.

The pyrolysis of starch in one organic liquid has given a product in almost 100 percent yield which is entirely soluble in several organic solvents. The product seems to be of high molecular weight and, because of its solubility behavior, is plastic in character.

It is believed that a procedure is being developed for the complete disorganization of the starch granule. When a practical method has been found for doing this, it should be of considerable value in preparing starches to be used in chemical conversions.

Engineering phase.—A study of the various steps in the manufacturing process for producing starch from Blackhull kafir is under way. Variations in (1) time and temperature of the steeping process, (2) fineness of grinding of the steeped grain, (3) amount of fermentation of the resulting starch, (4) purity of the starch, (5) temperature of drying of the starch, and (6) other parts of the process were made. The purpose was to determine the most economical methods for making starch for various uses such as adhesives, foods, sizing of paper and textiles, and laundering.

In addition to the wet milling process, starch is being made on a small scale from the flour produced by grinding sorghum grain in ordinary wheat milling equipment. To date, yields of starch have been low and the color undesirable.

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

A Study of Native and Introduced Plants For Rubber, Oil, and Medicinal Purposes.—Plants under test for rubber production include Russian dandelion (*Taraxacum kok-saghyz*), guayule (*Parthenium argentatum*), desert milkweed (*Asclepias subulata*), a species from California (*Asclepias erosa*), common milkweed (*Asclepias syriaca*), and two species of *Apocynum*.

Attempts were made to increase yield and rubber content by good cultural methods. The rubber content of more than 70 plants native to Kansas was determined. Extensive tests were carried on with *T. kok-saghyz* including propagation by cuttings and transplants, various rates and dates of planting, dates of harvesting, and determination of yields of seed. Sesame, Perilla, and sunflowers were under test for oil production. *Ephedra sinica* was the only drug plant grown during this period.

Results with all plants for rubber production were disappointing. Difficulty of obtaining stands of *T. kok-saghyz*, the effect of bacterial soft rot disease (*Erwinia carotovora*), and the large amount of hand labor involved in the control of weeds are major problems in the production of this crop. Guayule, desert milkweed, and *Asclepias erosa* were unable to withstand the winters here. Common milkweed, and the *Apocynums* grown under cultivation contained 0.32 to 0.48 percent rubber which on the basis of yield of vegetation produced only 12 to 14 pounds of rubber per acre. None of the other native plants analyzed contained sufficient rubber for economical production. Rubber was determined after digestion with oxalic acid by extraction with acetone and benzene as approved by the U. S. D. A. regional laboratory.

Sesame produced 754 pounds of seed per acre in 1943. An early frost reduced the yield about one-half in 1942. Oil content as ether extract ranged from 47.9 to 51.7 percent. The crop has considerable promise if an economical method of harvesting and threshing can be devised.

Perilla was killed by frost before seed was formed in both 1942 and 1943. Sunflowers were seriously damaged by insects which destroyed the seed in the heads before harvest. Yields ranged from 50 to 115 pounds of seed in the early strains to 406 to 520 in the late ones. In addition to insects, lack of suitable methods of harvesting, curing, and threshing are problems which will make sunflowers unpopular on farms in Kansas.

(Project 231. Departments of Agronomy and Chemistry. Leaders, J. W. Zahnley and A. T. Perkins. Bankhead-Jones 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 biennium the work has been a study of the calcium requirements for pigs when the level of phosphorus was 0.3 percent and adequate vitamin D was present.

In the first year, four groups of four pigs each 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 monocalcium phosphate was added to bring the percent of phosphorus to 0.3. Each group was allowed outdoors and exposed to sunshine.

Group 1 received the basal ration supplemented with calcium carbonate to bring the calcium percentage to 0.3.

Group 2 had the same ration as group 1, but with 2,000 units of vitamin D per pig added daily.

Group 3 had the basal ration supplemented with calcium carbonate to bring the calcium percentage to 0.4.

Group 4 had the same ration as group 3, but with 2,000 units of vitamin D per pig added daily.

The second year of the biennium two additional groups of eight pigs each were fed in the same manner as the four groups of the previous year, with the exception that they were allowed different levels of calcium, were allowed sunshine and 2,000 units of vitamin D daily per pig,

Group 1—0.3 percent calcium.

Group 2—0.4 percent calcium.

First year. Regardless of the calcium percentage and the availability of vitamin D, the pigs in the different groups reacted about the same in gains and in general condition. Both levels of calcium either with extra vitamin D or without, it, produced pigs with crooked legs, lameness and partial paralysis.

Chemical analysis and breaking-strength tests of the femur and humerus bones showed them to be weak and low in ash.

Investigations of the cause of some pigs in each lot responding well and some in each lot responding badly, showed that factors were involved which were associated with their breeding. Consequently paired-feeding was incorporated into the next year's experiment.

Second year. The appearance of loss of appetite, crooked legs, lameness and partial paralysis to about the same extent in both groups indicated that levels of 0.3- and 0.4-percent calcium both were below minimum requirements for young pigs. Several pigs in each group, however, appeared to grow normally. One pig in Group II receiving 0.4-percent calcium was paralyzed, lame, and did not eat, or grow for over 30 days. When extra calcium was fed to him, first in his drinking water and then in his feed, he made a remarkable recovery in growth and appetite and except for being stiff appeared to be developing normally at the close of the experiment.

This would indicate that neither a 0.3- nor a 0.4-percent calcium level is adequate for normal pig development.

The chemical and breaking tests of the bones for the second year have not been completed. The blood analysis shows no significant lot differences as regards calcium and phosphorus content.

(Project 38. Departments of Animal Husbandry, Chemistry, and Veterinary Medicine. Leaders, C. E. Aubel, J. S. Hughes, and L. M. Roderick. State funds.)

Swine Feeding Investigations.—During the biennium a series of five experiments has been conducted on the comparative value of various sorghum grains and corn for fattening pigs. (a) Three of the experiments were on fattening fall farrowed pigs in the dry lot. (b) Two experiments were on fattening spring farrowed pigs on alfalfa pasture.

Results may be summarized as follows, after averaging the various tests:

Fattening pigs in the dry lot.—The sorghum grains compared favorably with the shelled corn for fattening pigs in the dry lot.

The best showing was made by the lot fed whole Wheatland, and the poorest by the one fed whole Westland. Whole Colby and whole Blackhull kafir gave smaller gains than shelled corn. It is reasonable to conclude that the farmer who feeds sorghum grains can fatten hogs as well as by feeding corn.

Fattening pigs on alfalfa pasture.—The sorghum grains gave a good account of themselves. In each case except where whole Colby milo was fed, the daily and total gains exceeded the gains made on corn.

Grinding the sorghums increased gains and reduced the amount of feed required for 100 pounds gain. The pigs fed ground Colby milo surpassed the corn-fed pigs in gains and required less grain per 100 pounds gain.

Pigs fed Wheatland milo gained more than those fed Colby milo but required more feed per 100 pounds gain.

Whole Blackhull kafir produced the best gains of any of the sorghums fed equalling the gains produced by ground Wheatland milo. The lot fed Blackhull kafir, however, required the most grain per 100 pounds gain and a considerable amount of protein supplement, thereby increasing its feed cost.

The lot fed whole Westland milo made excellent gains, even surpassing the one fed whole Wheatland milo, both in rate and economy of gain.

All the sorghum grains appeared palatable to the pigs. Each of the sorghums was consumed daily in greater amounts than was the corn.

The finish of the sorghum-fed pigs was equal to that of the corn-fed pigs.

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

Silage Investigations.—The work conducted during the biennium has consisted of three feeding trials: (1) A study of the comparative values of corn, Wheatland milo, Blackhull kafir and Westland milo when each grain was ground to a medium degree of fineness and fed in conjunction with Atlas sorgo silage, cottonseed meal and ground limestone to yearling steers; (2) the effects of different methods of processing Atlas sorgo on returns from silage fed to stock cattle; and (3) a comparison of different levels of grain-feeding for fattening yearling steers.

Grain sorghums versus corn.—The ground grains were fed in self-feeders after the steers were receiving all the grain they would clean up readily. All three grain sorghums were more palatable than corn throughout the entire feeding period as indicated by the quantities consumed. This greater grain consumption was also reflected in larger gains made by the lots fed grain sorghums than were made by the corn-fed steers. The higher grain intake of the steers fed grain sorghums resulted in a larger grain requirement per 100 pounds of gain by these steers. Carcasses of all lots were satisfactory. The results of this feeding test check closely with those obtained in two previous trials and indicate that wheatland milo, Blackhull kafir and Westland milo are equal to corn as cattle fattening feeds.

Processing Atlas sorgo.—The results of this test confirm those of two previous trials and demonstrate conclusively that stock cattle digest much of the grain in Atlas fodder silage. One ton of Atlas fodder silage produced 27 percent more gain than one ton of Atlas stover silage.

In this feeding trial a combination of Atlas stover silage and Atlas heads gave no advantage over Atlas fodder silage, as was the case in 3 previous trial.

Different levels of grain feeding.—Different levels of ground barley were fed as follows: Lot 1, full feed; lot 2, two-thirds feed; lot 3, two-thirds feed; lot 4, one-third feed; lot 5: no grain. All lots received silage and ground limestone and, with the exception of lot 3, each lot received cottonseed meal. The rate of gain was highest in the full-fed and lowest in the no-grain lot. The appearance of the steers and the carcass grades show a positive correlation between degree of finish and the quantity of grain eaten by the different lots.

Detailed reports of the above-mentioned feeding trials have been published in mimeographed circulars 43-B-2; 43-B-3; and 44-B-1.

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

Physiology of Reproduction.—Eight phases of this project have been under way during the biennium.

Adrenalectomy and its effect in relation to general function was published in *Endocrinology*. Reprints are available.

The pituitary glands in relation to adrenalectomized fowls was further observed and the work was published in *Endocrinology*.

Ovarian development from injection of sex hormones was reflected in a depressing action of the sex hormones and resulted in reduced gland size.

Pituitary glands from castrate fowls were more active in producing gonadotropic hormone than normal ones.

Effects of stilbestrol on the genital tract of young fowls was demonstrated when a dosage of 5.5 mg. of this material stimulated growth of the genital tract of young female chicks to 4800 percent greater weight than in normal chicks of the same age.

Reduced pituitary activity from the influence of sex hormones has been studied and a report is ready to be published. Birds that received male sex hormone had testes distinctly smaller than normal birds.

Possible synergism of vitamins A and E was suggested when it became evident that birds fed a synthetic diet deficient in vitamin E required vitamin A in greater quantities to make up for the deficiency of vitamin E.

Vitamin E and pituitary gland relationship was indicated when lack of vitamin E resulted in reduced pituitary activity.

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

Utilizing Native Grass.—Two tests were completed during the biennium in which studies were made of different methods of wintering good quality calves that were to be grazed the following pasture season and sold as feeder yearlings.

In the first test, steer calves gaining 159, 183 and 209 pounds per head during the winter gained 184, 162 and 136 pounds per head respectively during the summer. In the second test, steer calves gaining 135, 105 and 67 pounds per head during the winter, gained 169, 185 and 185 pounds per head respectively during the summer. These results indicated definitely that gains on pasture are determined to a considerable extent by winter gains. As a consequence, total gains for winter plus summer tend to be equal, irrespective of the amount of the winter gain, provided a calf does not gain less than 100 pounds during the winter.

Results of these trials have been published in detail in mimeographed circulars 44-B-2, and 44-B-3.

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

Lamb-Feeding Investigations—Work of this project is divided between the central station at Manhattan and the branch station at Garden City. At Manhattan, three separate subprojects have been completed during the biennium. Subprojects 30 and 32 were carried on during the summers of 1942 and 1943 respectively. They were both repetitions of a previous trial in which three lots of lambs were fed a ration of corn and alfalfa hay ground together and fed in the proportions of 35:65; 45:55; and 55:45 respectively.

Subproject No. 31 was a duplication of the work of subproject No. 29 conducted in 1941-'42. Three lots of 30 lambs each were divided in three series of 10 each. Each lot received the same basal ration of grain and roughage, but for protein supplement one lot was fed cottonseed meal, one lot solvent-process soybean oil meal, and one lot expeller-process soybean oil meal. In the (a), (b), (c) series of each lot, the proportion of concentrates to roughage was varied as listed in subproject No. 30.

Expeller-process soybean oil meal used in subproject 31 produced larger gains than either of the other supplements, and solvent process soybean oil meal produced more gain than cottonseed meal. The differences have not been large. Publications based on this work are Circular 1-S-43 and Circular 1-S-44.

Subprojects 30 and 32.—Lambs receiving a ration composed of 45 percent concentrates and 55 percent roughage have made consistently greater gains than those receiving either more or less concentrated rations.

Slightly better results have been obtained from rations composed of 55 percent concentrates than from those containing 35 percent concentrates, but the difference has been small.

Based on economy of gains, rations composed of 45 percent concentrates and 55 percent roughage have produced gains at significantly lower costs than either of the other proportions.

Physical balance in the ration is in itself an important factor in determining the productive energy value of lamb-fattening rations, irrespective of chemical factors.

Subproject 9.—This experiment at Garden City was begun in May, 1942, but extended into the present biennium. It consisted of further and more detailed studies on physical balance of rations.

Subproject 10. This study followed in the winter of 1942-'43, when 550 lambs were fed in 12 lots and the following investigations were made:

(a) The effect of the physical balance of the ration on its productive energy value. (b) Further comparisons of "deferred" grain feeding and progressive increases in the concentration of rations, with rations of constant concentration. (c) Comparisons of Westland and Finney milo grain, and also of Sumac and Finney milo roughage, alfalfa hay and alfalfa straw. (d) Further studies of wheat pasture fattening of lambs. Wheat pasture alone was compared with wheat pasture plus dry roughage (Sumac Stover) and with wheat pasture plus ground limestone.

Subproject 11. Five hundred and thirteen lambs were fed in 10 lots. The chief studies made were:

(a) The effect of varying the physical nature or the proportion of concentrates to roughage on the productive energy value of the ration of fattening lambs. (b) The per-acre efficiency of producing a strictly grain (combine) type of sorghum and the necessary roughage with which to balance it in a forage sorghum, compared with the production of a combination grain and forage type of sorghum, when the major part or all is to be used for lamb feeding. (c) Further comparisons of various sorghum roughages, alfalfa hay and threshed alfalfa straw. (d) Tests to determine the value of combined milo stalk fields grazed by lambs before they are put on full feed. (e) Comparisons of wheat and Westland milo grain.

Publications based on the above experiments at Garden City are as follows: Cir. GC-S-43; Cir. GC-S-44.

(Project 111, subprojects 30, 31, and 32 at Manhattan; and subprojects 9, 10, and 11 at Garden City. Department of Animal Husbandry. Leaders, R. F. Cox and L. M. Sloan. State funds.)

Studies of Sorghum Roughages, Grains and Cottonseed Meal in the Cattle-Fattening Ration.—The Departments of Animal Husbandry, and Chemistry have coöperated in this study which consisted of digestion trials with sorghum silage and sorghum grains. During the first year of the biennium, chemical analyses and computations were completed for three digestion trials conducted in 1942.

There were no significant differences in the digestibility of Colby milo, Wheatland milo, and corn when each of these grains was ground to a medium degree of fineness and fed with Atlas sorgo stover silage, cottonseed meal, and ground limestone to fattening calves. Grinding Wheatland milo increased its digestibility significantly.

Studies were made of the digestibility of rations composed of Atlas sorgo stover silage, and Atlas sorgo stover silage plus cottonseed meal. Higher digestion coefficients for dry matter, crude protein, ether extract, crude fiber, and nitrogen-free extract were obtained for the ration containing cottonseed meal, but the advantage in the case of crude fiber was so small that it was of doubtful significance.

During the second year of the biennium, chemical analyses and computations were completed for the experimental work done in the first year of the biennium to obtain digestion coefficients for normal Atlas sorgo silage when fed alone and in conjunction with cottonseed meal. Significantly higher digestion coefficients for dry matter, protein, ether extract, and nitrogen-free extract resulted when one pound of cottonseed meal was fed per head daily with a full feed of normal silage to steer calves. The digestibility of crude fiber was not improved by the addition of the nitrogenous supplement.

(Project 222. Departments of Animal Husbandry and Chemistry. Leaders, A. D. Weber and J. S. Hughes. Bankhead-Jones 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 matings 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, a series of carefully-designed body measurements were taken. 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 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 intro-muscular injections of the male sex hormone testosterone, on horn growth and other characteristics of Rambouillet ewes. No effects are visible so far.

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

Deficiencies of Sorghum Crops as Feed for Dairy Cows.—These long-time feeding experiments with dairy cows have been continued as planned and are beginning to yield valuable results. Three phases of the study are here reported.

Feeding experiments with lactating dairy cows.—This project was revised as subproject 1a in November, 1942. Since that time a maximum of 14 cows was used to study the following problems: (a) Extent to which cows long restricted to sorgo rations are injured permanently; (b) influence of short-time feeding of certain fractions of alfalfa hay on lactation; (c) feeding value of sorgo rations supplemented only with alfalfa hay and salt; (d) value of wheat bran as supplement in the experimental sorgo rations; (e) digestibility of the basal sorgo ration as measured with additional cows; and (f) influence on digestibility of adding brewer's yeast or a mixture of available members of the vitamin B complex to the basal ration.

Limited results accumulated during the biennium have continued to indicate that prolonged restriction to the basal ration may preclude complete recovery following the return to a normal feeding regimen. Contrary to earlier results under less accurately controlled experimental conditions in which sun-cured alfalfa hay was used, later data indicated that lactation was affected little, if at all, by the inclusion or exclusion of a water extract of dehydrated alfalfa as a supplement in sorgo rations containing cottonseed meal. In these later experiments the rations were carefully adjusted to constant amounts of dry matter and of total crude protein. Yeast feeding enhanced the digestibility of some constituents in the ration. Feeding a mixture of available members of the vitamin B complex was associated with decreased use of protein and with a slight improvement in the use of crude fiber.

Results with only a limited number of cows suggest that prolonged restriction to sorgo rations may result in irreparable injuries.

Feeding experiments with growing dairy cattle.—Subproject 2a, was established as such in November, 1942, in order to include various studies with young dairy animals. A maximum of 28 animals was on experiment during the biennium. Problems which were studied included the following: (a) Growth of several heifers and steers fed sorgo plus supplements of sun-cured and dehydrated alfalfa hay, cottonseed meal, or a water extract of alfalfa hay; (b) digestibility of sorgo rations as influenced by supplements of alfalfa hay,

cottonseed meal, water extracts of alfalfa hay, brewer's yeast, bone meal, and wheat bran; and (c) influence on the growth of a yearling bull of feeding urea as a supplement to the basal sorgo ration.

Cottonseed meal had approximately the same supplemental value for growth as did dehydrated alfalfa hay. Evidence was obtained, in support of earlier work, showing that alfalfa hay is a useful supplement in sorgo rations for calves. Results were also obtained in which cottonseed meal appeared to be equal to dehydrated alfalfa hay when used as a supplement in sorgo rations for growing calves. Yeast was found to be a useful supplement. Observations with one yearling bull indicated that urea may be ineffective when used to supplement the basal sorgo ration.

The influence of modified sorgo rations on the vitamin content and microbial flora of the rumen of cattle.—Subproject 3a was organized only recently. Ruman liquid samples were withdrawn by stomach tube and vacuum pump on one or more occasions from each of four different animals used in subprojects 1a and 2a. A total of about 20 such samples has been taken since October, 1943. Practically all of these samples were subjected to microfloral studies by the Department of Bacteriology. About one-half of the samples also were microbiologically assayed by the Department of Chemistry for certain of the B vitamins.

Microfloral studies have shown extreme count-fluctuations for the same animal within a few days time. Microbiological assays have indicated the virtual absence of thiamine, and methods for measuring certain of the other components of the B complex appear to be somewhat unsatisfactory. These results are all of an exploratory nature. Improved techniques must be developed for studying the problem.

(Project 206. Departments of Dairy Husbandry, Chemistry, and Veterinary Medicine. Leaders, H. E. Bechtel, J. S. Hughes, and W. W. Thompson. Subproject 2a; Departments of Dairy Husbandry and Chemistry. Leaders, H. E. Bechtel and J. S. Hughes. Subproject 3a, Departments of Dairy Husbandry, Bacteriology, Veterinary Medicine, and Chemistry. Leaders, H. E. Bechtel, L. D. Bushnell, W. W. Thompson and J. S. Hughes. Bankhead-Jones funds.)

Calf-Feeding Investigations—This project was started on October 4, 1943, to determine whether calf mortality during the first 21 days of the growing period can be reduced by supplementing the rations with vitamin A, with crystalline ascorbic acid or chlorobutanol, and with niacin.

To date, 25 calves have been used in this vitamin-feeding study. These animals were divided into treated and untreated groups by breeds in the college dairy herd. The treated calves each received a vitamin capsule orally every-other-day during the first three weeks of life, using chlorobutanol in place of ascorbic acid after the ninth day of life.

This subproject is to be continued for one to three years before attempting to draw any conclusions.

(Project 154. Department of Dairy Husbandry. Leader, H. E. Bechtel. State funds.)

Dairy Production Investigations.—Through the years this project has been expanded so that it now covers a considerable number of miscellaneous studies and observations as follows: Studies related to the Preservation and Feeding of Silage; Observations on

Sorgo and Sorgo Grain Storage; Stack-burned Hay as a Feed for Dairy Cattle; Effect of Certain Feeds on Milk Flavor; Observations on Grass Tetany; Inheritance Studies; Fly Repellant Investigations.

Preservation and feeding of silage.—Some of the observations made during the biennium were as follows: (1) Temporary, above-ground, wire-wall, and snow-fence silos intended for the preservation of alfalfa silage are apt to lead to large losses because of spoilage and excessive heating. (2) Addition of salt may be a practical means of improving the palatability of alfalfa silage preserved with the use of an alkali such as trisodium phosphate. (3) Relatively little is known about the cause of "sour silage," but the presence of a high percentage of moisture in immature Atlas sorgo at ensiling time need not necessarily lead to the production of an unpalatable silage. (4) Sudan grass containing up to 3 mg. of hydrocyanic acid per 100 g. at ensiling time and Atlas Sorgo with 10 mg. of the acid, were consumed later as silage by dairy cows without ill effects.

Observations on sorgo and sorgo grain storage.—The results of the past two years show that (1) Sorgo heads can be stored, chopped or unchopped, and preserved in good condition in pits. (2) Wilting of sorgo bundles before shocking is not beneficial, as many have assumed. (3) Excessively heated silage may be more common in temporary silos than is generally assumed. Losses feeding value occurs when silage turns brown because of excessive heating. Such heating is conducive to large losses in crude protein and in nitrogen-free extract.

Effect of certain feeds on milk flavor.—This is a continuation of work done over a period of years. Cows have shown a definite dislike for mare's tail, rape, and giant ragweed; eating such small quantities that no off-flavors were detected. Cows ate the small prairie ragweed in quantities so that on the second day after the trial began, definite off-flavor was noticed in the milk. All weeds were offered to the cows at the rate of 5 pounds of finely chopped weeds mixed with 10 pounds of silage, 1.5 hours before milking.

Grass tetany.—A survey of ranchers showed that they differ widely regarding the cause and control of wheat poisoning or grass tetany. Chemical analysis have so far failed to reveal anything significant and post mortem findings have brought to light nothing of importance.

Inheritance studies.—Statistical analysis was made of unusual fecundity among females born twin to males within a family of Jersey cattle. The results indicate the possibility that fertility of a heifer twin to a male may be controlled by heredity.

Wrytail is a malformation consisting of a distortion of the tail head. Incidence of the character in 350 Jersey animals was 117 with wrytail; in 505 Brown Swiss animals, 101 wrytails. Wrytailed animals may be produced from apparently normal animals and the condition seems to be inherited similarly in both breeds. The character has been observed in Guernsey, Holstein and Ayrshire breeds also. Apparently the character is inherited as an autosomal recessive.

Bowed pastern, a malformation of the rear pastern joint, was observed on registered Jersey cattle in five widely-scattered herds. That the character is hereditary is supported by frequency of occurrence, relationship of affected animals within a heard, and the preponderance of affected animals among progeny of certain sires. It is not possible as yet to postulate a theory of the mode of inheritance.

Fly repellant investigations.—This study has shown that as a fly-repellant, Thanite (3 percent in a base oil) was superior to all pyrethrum mixtures in the series employed, and Thanite (5 percent in a base oil) was significantly better than the 3-percent mixture. Thanite mixture was superior to all the commercial sprays, but not significantly different from the home-made spray applied for comparison, which spray is recommended by the United States

Department of Agriculture. One cc. of fly spray to about 36 cu. ft. of barn volume is sufficient for good results. Apparently stable flies (which are really house flies, (*Musca domestica* L.) do not cause any more reduction in milk flow than does the spraying itself. Skin injury from the application of fly-repellants seems to be related to the unsulphonated residue content of the oils used. With one exception, oils containing 92.5- to 100-percent unsulphonated residue included, all the most satisfactory oils, while oils containing 87.5 percent, or less, gave unsatisfactory skin reactions. Contrary to published statements, the Saybolt viscosity of an oil was not found to be a reliable index to skin reaction in these tests.

(Project 34. Department of Dairy Husbandry. Leaders, F. W. Atkeson, H. E. Bechtel, O. A. Shaw, Franklin Eldridge; Veterinary Medicine: Leaders, L. M. Roderick, W. W. McLeod; Animal Husbandry, Leader H. L. Ibsen; Entomology, Leader, R. C. Smith. Statistician, H. C. Fryer. State funds.)

Improvement and Conservation of Farm Poultry.—During the biennium the work of this project has been concerned with five major phases: Turkey production; modification of the K. S. C. all-purpose ration; nutritive value of whole dried eggs in chick rations; broiler production; and color inheritance of poultry.

Turkey production.—1. Progeny testing was carried on with three breeding pens of meat-type bronze and one pen of small-type white turkeys. All were trapnested throughout the breeding season and the eggs were pedigree hatched. All breeders were tested for pullorum disease by the tube method and the reactors were removed.

The breeders from the most promising families were selected on the basis of meat qualities, hatchability of eggs of dams, and size of birds at 28 weeks of age.

Results indicated that both fertility and hatchability were much higher from the small-type white than from the bronze breeding stock.

2. Rate of feathering and molt in young turkeys were observed daily on 20 poults until feathers had appeared on all sections of body, following which bi-weekly observations of the wing and tail feathers were made to 30 weeks of age to determine the number of molts which occur during this period. Poults have seven primaries and ten secondaries in the wing when one day old. Feathers appear in other sections beginning with the second day after hatching in the following order: Shoulder, tail, thigh, breast, neck, wing coverts, web of wing, back, and leg. Three to three and one-half weeks are required for complete feathering.

Turkeys observed to 30 weeks of age molted all wing feathers once, except occasionally the last primary. A few wing feathers were molted twice. The first wing molt began as early as the 4th week in females and the 5th week in males. The second molt appeared at 18 weeks in the females and 22 weeks in the males. The No. 1 primary and the No. 2 secondary were the first to molt in both sexes.

The first tail molt began with the two center feathers at 4 weeks of age in both sexes. The first tail molt was completed at 16 weeks of age in the females and 18 weeks in the males. The second molt began about the 12th week. This continued until about one-half of the main tail feathers had been replaced at 30 weeks.

These observations indicate that the original juvenile wing feathers are completely replaced by adult feathers, which in a few instances are succeeded by a second growth of adult feathers. The same development occurs in the main tail feathers except the second molt is more extensive.

Modification of the K. S. C. all-purpose ration.—During the last few years work has been in progress to determine the effect of various supplements to

and modification of the K. S. C. all-purpose ration. Results of a study conducted in 1942 showed that egg production, body weight and mortality were influenced very little by the feeding of dried brewer's yeast or dried skim milk. Hatchability, however, was significantly increased in the lots receiving the dried brewer's yeast and the dried skim milk. Similar results were obtained in 1943 with the exception of hatchability. In this experiment all lots showed a hatchability of 85 percent or better which is considered good.

The nutritive value of whole dried eggs in chick rations.—A study of the nutritive value of whole dried egg was undertaken to determine how much whole dried eggs could be used in chick rations and to what extent it could be substituted for the other protein supplements, namely, meat and bone scraps and soybean oil meal.

Results show that dried whole egg when added to the ration used, increased the rate of growth. Dried whole egg fed at a level of 7 percent of the ration did not produce any egg white injury symptoms, but a 10-percent level did, indicating the maximum amount that can safely be fed must be in the range of 7 to 10 percent of the ration.

When one pound of dried whole egg was substituted for one pound of meat and bone scraps plus one pound of soybean oil meal, results indicated that at least five pounds of both meat and bone scraps and soybean oil meal could be replaced with five pounds of whole dried eggs with equal if not superior growth results. This ration contained a total of 11 percent protein supplement, 5 percent whole dried egg and 3 percent each of meat and bone scraps and soybean oil meal.

Broiler production.—More than 1,000 New Hampshire chicks were used in two different broiler experiments to compare the K. S. C. all-purpose ration, with a K. S. C. war emergency ration, a commercial concentrate, three commercial rations and to test a new sulphur-urea preparation said to prevent coccidiosis. All birds were fed to 12 weeks of age.

While two of the commercial rations gave slightly larger broilers, most profitable gains were received from the lots fed the college all-purpose ration. An average weight of all lots was 2.73 pounds per bird at 12 weeks of age. About 4.04 pounds of feed were consumed per pound of gain. The sulphur-urea preparation when fed at one-percent level for 12 weeks caused no harmful effects and it increased slightly the gain in weight over the control lot.

Color inheritance of poultry.—This was a summarization of the material collected over a period of years by the late W. R. B. Robertson. It consisted of data on crosses of the common varieties of turkeys and involved some 4,800 individuals. The bronze variety was found to be the wild type. The Narragansett pattern behaved as a sex-linked recessive and white as an autosomal recessive. Black was found to be dominant or epistatic to other patterns. The presence of factors for any of the five color patterns was recognizable in most possible combinations with the others.

(Project 77. Department of Poultry Husbandry. Leaders, L. F. Payne, D. C. Warren, A. E. Schumacher. State funds.)

Role of Carotinoid Pigments and Related Compounds in Poultry Nutrition.—Several experiments were under way to study the influence of synthetic alpha-tocopherol on the utilization of vitamin A and carotene. The influence of alpha-tocopherol on the utilization of vitamin A was measured by chick growth, storage of vitamin A in the liver and by the loss of vitamin A from the liver when vitamin A was removed from the diet.

In all 58 lots the results were negative, that is, the alpha-tocopherol either when added to the ration or when fed directly had no effect on the utilization of vitamin A or carotene so far as could be determined. In two lots the birds

receiving the alpha-tocopherol had more vitamin A in the liver at the conclusion of the experiment than the birds receiving vitamin A alone.

(Project 232. Departments of Poultry Husbandry and Chemistry. Leaders, A. E. Schumacher and J. S. Hughes. Adams funds.)

Stimulative Effect of Dried Brewer's Yeast on the Growth Rate of Male and Female Turkeys.—Growth rates showed that as the amount of dried brewer's yeast was increased the average rate of growth increased proportionately with the exception of a lot receiving 8 percent yeast.

This lot showed a slight decrease in growth at 24 and 28 weeks when compared with the lot receiving 6 percent yeast. Examination of the growth rate of the males and females separately revealed that the increased growth was due to the increased growth of the males and not the females. The lots receiving the higher levels of yeast developed a bowed-legged condition similar to rickets which was severe enough in some cases to make it difficult for the birds to get around and some mortality resulted. A large amount of yeast also had a tendency to cause the feed to become pasty.

(Project, Commercial No. 5. Leader, A. E. Schumacher.)

Mechanism and Chemistry of Egg Formation.—Two phases of study have received major attention during the biennium.

Blood calcium.—The component of the adrenal gland that suppresses the blood calcium level of the laying hen has been further investigated. An effort has been made to characterize this principle by the use of chemical and physiochemical treatment.

Evidence so far obtained indicates that the component of the adrenal gland that suppresses the blood calcium in the laying hen is not destroyed by five minutes boiling at pH 7.5, but is destroyed by a similar heat treatment at pH of 5.0 or 9.0. It is filterable through a collodion membrane which will not pass hemoglobin. The tentative conclusion is that the material is a protein of low molecular weight. An understanding of the mechanism and function of the factor present in the adrenal gland would possibly aid in the control of thin shelled eggs during the hot summer months.

Effects of environmental factors on egg formation.—The objective of this study was to determine the influence of seasonal fluctuations in temperature, humidity, and length of day on egg laying and egg quality. White Leghorn pullets have been kept for two years in rooms where these factors of the environment have been under study. The influence of constant and fluctuating conditions are being studied.

The first year's results demonstrated that the spring shortening of interval between successive eggs was due to light changes. No very obvious differences in percentage production occurred except that the normal uncontrolled pen had a spring surge in egg production not observed in the pen where conditions were kept constant. There was a summer decrease in shell thickness and white quality in all pens. High summer temperatures suppressed egg size.

(Project 198. Departments of Poultry Husbandry and Chemistry. Leaders, D. C. Warren, A. E. Schumacher, and R. M. Conrad. Bankhead-Jones funds.)

Chromosome Mapping of the Genes of the Fowl.—This study is a continuation of work carried for a number of years in an effort to place in linkage groups the better known characters of the fowl.

Most of the possible tests for linkage have been made with albino, pinkeye

and retarded feathering. Each appears to be in groups independent of all other established linkage groups. The mode of inheritance of several new genetic factors was studied including double spurs, unguis osteodystrophy, ragged wing, syndactyly, and rosy plumage. Several of these characters shown irregular inheritance. Although no new linkage groups have been found in the biennium it was shown that duplicate toes is in a multiple allelomorph with ordinary polydactyly.

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

Development of Strains of General Purpose Breeds Possessing High Egg Production and Early Feathering Tendencies.—The development of early feathering strains of heavy breeds having other desirable economic qualities was the objective of this project. Early feathering is not a normal trait of most heavy breeds and there is always something to be desired in the expression of other economic characteristics.

The problem of poor broiler feathering has been largely solved in strains of both white and Barred Plymouth Rocks. As early as the eight-week age the backs are completely feathered. Major emphasis on improvement of other economic qualities has been limited to White Plymouth Rocks. High egg production and large egg size are traits being stressed while others such as age at sexual maturity, hatchability and breed characteristics are given consideration. The flock is now large enough to progeny-test on a fairly extensive scale for desired economic traits. A limited number of breeding cockerels are being sent out to practical breeders for trials.

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

Inheritance and Physiology of Reproduction in Mammals.—The guinea pig experiments were greatly handicapped during the last half of 1943 and the early half of 1944 by the presence of an intestinal disease.

Progress has been made in the study of size inheritance. Almost two years ago four pairs of brothers and sisters from the United States Department of Agriculture inbred families No. 2 and No. 13 were obtained. There were two pairs in each family. All except two of the original animals have died, but in spite of the epidemic a fairly large number of the descendants are alive. Both the parents and the offspring have remained small, none weighing much more than 900 grams. All are fairly long, but relatively thin.

In contrast, large animals have been obtained from other sources, and their offspring raised under the same conditions as the inbreds. As might be expected, there is less uniformity in this stock, but some of the offspring have attained great size. One male at two years of age weighed 1550 grams and another, 1450. Many of the females weigh more than 1200 grams. All of these animals are much fatter than the inbreds. The results obtained thus far fit in with the assumption that a dominant gene is responsible to a large extent for the increased size, and that this gene has several modifiers, at least one of which is recessive, which are responsible for the production of the very large animals.

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

Studies in Inheritance in Orthoptera.—In this long series of experiments, the normal inheritance of characteristics, mainly color patterns, in several species of the grouse locusts (*Paratettix texanus*, *Apottetix eurycephalus* and others) have been ascertained.

This work is continued, although with somewhat diminished numbers, due to lack of student help and high costs. While new features of the normal inheritance are still unfolding, our main concern for the present is to provide well-tested stocks for use in the modification of the germinal substance (genes) by X-rays (Adams 104). New characteristics are also being tested in *P. texanus* and one, apparently a mutant, in *A. eurycephalus*.

(Project 72. Department of Zoölogy. Leaders, R. K. Nabours and Florence M. Stebbins, Adams funds.)

Influence of Some Environmental Agencies on the Germ Plasm of Tetriginæ (Orthoptera).—The endeavor is almost wholly devoted to making changes in the hereditary behavior of some of the thoroughly tested characteristics (Project Adams 72) of the grouse locusts (*Tetriginæ*). These alterations in nature are made mainly by means of the application of heavy dosages of X-rays to the chromosomes.

Among the affected specimens of the translocation of 1943-44, the combination of the deficient or minus (–) autosome in the one linkage group with the accreted (+) autosome in the other linkage group *causes a striking improvement in viability over the unaffected or normal brothers and sisters (sibs)*. This is a distinct contrast with the previous translocations reported in which all 50+ combinations of affected chromosomes were deleterious. So far as ascertained this is the first case of an improvement in viability or any sort of good to organisms reported as a result of the treatment of germ cells of any animals or plants.

(Project 104. Department of Zoology. Leaders, R. K. Nabours and Florence M. Stebbins. Adams funds.)

Honeybee Investigations.—Testing of strains of bees of superior quality has been continued with three races, namely, three-banded Italian, Caucasian and Carniolan.

Queens of a strain of American foulbrood resistant Italian bees have been supplied by cooperative agencies of the Division of Bee Culture, Bureau of Entomology and Plant Quarantine, Research Administration, U. S. D. A, and the Texas Agricultural Experiment Station. One of the colonies headed by one of the queens of this strain received in 1941, had the largest net gain in weight of any colony for the 1942 season. One of the colonies headed by one of the queens of this strain received in 1942, and operated for honey production capacity in 1943, produced the largest amount of extracted honey of all colonies in the apiary.

(Project 126. Department. of Entomology. Leader, R. L. Parker. State 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, cooperative with the Bureau of Plant Industry, Soils and Agricultural Engineering of the United States Department of Agriculture has consisted of the study of the diseases of sorghum, wheat, oats, barley, alfalfa, flax and soybeans, together with a plant disease survey.

The weak-neck disease of sorghum has been found to be influenced by environment. Although some differences in strengthening tissue occur in the peduncles, actual breaking tests show that all the sorghum varieties studied had sufficient strengthening tissue to support the heads and that weakness of peduncles occurs after these tissues are formed.

Soil samples secured from western Kansas show that milo disease is widely distributed through that part of the state. The presence of the disease makes necessary the growing of resistant selections of sorghum developed by the agricultural experiment station.

Wheat disease investigations have shown that speckled leaf blotch, *Septoria tritici*, is widely distributed in both the dry and the humid regions of Kansas. Varieties resistant to the disease have been found to be Red Chief, Nittany, Red Rock, Thorne and Marquillo X Tenmarq hybrid. The breeding of a satisfactory hard red winter wheat that is resistant to this disease is under way.

Eleven out of 72 varieties of wheat of foreign introduction were shown to have resistance to take-all disease, *Ophiobolus graminis*.

Comanche has been shown to be highly resistant to bunt and is the first wheat variety resistant to this disease that has been released by this station. Pawnee, another new variety, is highly resistant to loose smut but only moderately resistant to bunt.

Arasan and Spergon were found to be effective as seed treatments in the control of bunt.

Two new promising oat varieties, Ventura and Osage, have been found to be resistant to all races of smut collected in Kansas except the Fulton race of loose smut.

Three barley varieties, Compana, Trebi X Dryland Selection 69, and Odessa X Dryland Selection 21, were found to be resistant to or escaped from brown loose smut infection.

In a study of the black stem disease of alfalfa, *Ascochyta imperfecta*, it was found that neither the age of the culture nor the age of the top growth of the plant had any effect on the degree of infection. There was a significant positive correlation between the average temperature in the inoculation chamber and the degree of infection. Plants high in root reserves had a significantly higher degree of infection than plants low in root reserves.

New Improved Ceresan, DuBay 1452-C, Arasan, and Spergon were effective in increasing the stand of flax, and Arasan and Spergon in increasing the stand of soybeans.

A systematic state plant disease survey of corn, sorghum and soybeans added new knowledge on the occurrence, distribution and prevalence of the diseases of these crop plants.

(Project 76. Department of Botany. Leaders, L. E. Melchers, E. D. Hansing, J. C. Bates, and H. Fellows. State fund.)

Fruit and Vegetable Disease Investigations.—Additional evidence was obtained during 1942-1943 that many tuber-borne *Rhizoctonia sclerotia* are killed after the seed pieces are planted rather than during the treatment period itself. The corrosive sublimate residue carried on treated sclerotia evidently redissolves in soil moisture and then has a lethal effect upon the sclerotia.

When corrosive sublimate deposited on tuber surfaces during a 10-minute treatment period was removed prior to planting, approximately 30 percent more infected plants occurred than when the fungicidal residue had not been removed from the seed pieces prior to planting.

Sperguson was found ineffective for sterilization of *Rhizoctonia sclerotia* on seed potatoes.

Quantitative mercury determinations of acidulated corrosive sublimate treating solution at 6 ounces to 25 gallons water with 1-percent HCl used as a 10-minute soak of whole tubers indicate that the original concentration of corrosive sublimate can be maintained by: (1) adding 1/2 ounce corrosive sublimate after every 700 pounds of tubers have been treated, and (2) maintaining volume of treating solution with acidulated corrosive sublimate at the original concentration.

Investigations on potato soil scurf have been continued. Soil treatment with chloropicrin and with formaldehyde again resulted in prevention of this blemish of the epidermis of the tubers, the cause for which is not known.

Wettable Sperguson at the rate of 1 pound to 8 gallons of water used as a dip has again proved a safe and effective fungicide for the treatment of sweet potatoes at bedding time.

Wettable Sperguson at a similar concentration used for dipping sweet potato sprouts again caused a reduction in stem-rot infection in soils with the stem-rot fungus.

Raspberry spray tests provided additional data that the anthracnose disease can be effectively controlled by spraying the plants with commercial liquid lime sulphur, 1:10 parts water, just before leaves emerge in the spring.

Selections of a small pickling, a large pickling and a slicing-type cucumber have been isolated from a mosaic resistant hybrid.

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

A Study of Combined Resistance of Winter Wheat to Leaf and Stem Rust Races.—During the biennium large numbers of varieties of both soft and hard red winter wheat were tested in the rust nursery and in the greenhouse with known physiologic races of stem and leaf rust.

Selections having resistance to both diseases were made, studied, and the better ones advanced to agronomic nurseries for yield tests. Studies were made on the prevalence and distribution of physiologic races of leaf rust. Further crosses were made in studies relating to resistance to rust.

Many of the winter wheat selections from crosses involving the spring wheats Hope and H44 having resistance to both leaf and stem rust have discolorations of stems, glumes, and awns known as brown necrosis. Strong development of this color has been proved to be accompanied by shrivelling of the grain. The amount of color development has been reduced by careful selection.

Seedling stage resistance to leaf rust has been found to be very important from the standpoint of fall pasture. Tests in the greenhouse and readings in the field have shown that many, but not all, of the lines having combined

adult-plant resistance to leaf and stem rust have this character. Backcrosses are being made to intensify it.

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

Climate and Injurious Insect Investigations.—Work during the biennium of this project has consisted of gathering and publishing information for the annual insect population summaries of Kansas, the daily and seasonal behavior and control of flies around dairy cattle.

Summaries numbers 12 and 13, covering insect populations in Kansas for 1942 and 1943 were prepared and published in the *Journal of the Kansas Entomological Society*.

Several papers have been published based on the observations and cooperative studies of fly sprays by the department of dairy husbandry and the Hercules Powder Co.

Studies are being made by Mr. Chas. Brett, a graduate student, of the life histories of the migratory and differential grasshopper under controlled temperature, humidity and food conditions.

An illustrated book on the Common Insects of Kansas has been printed.

(Project 6. Department of Entomology. Leaders, R. C. Smith and G. A. Dean. Hatch fund.)

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 wheat insects appearing in abundance.

Weather favorable to the Hessian fly, which began in the fall of 1940, has continued through the spring of 1944. In 1942 widespread lodging of the wheat concealed much of the spring fly injury from two spring broods of fly. In August and early September eggs were laid only in local areas, most of the fall infestation taking place during the last week in September and the first week of October. Fields planted after the safe-seeding date in both 1942 and 1943 were relatively free from infestation. In the fall of 1942 infestation was found as far west as Phillips county and reported from Cheyenne county and additional western areas in 1943-44. No infestation was evident in southwest Kansas. Severe killing of wheat by fly occurred in 1942 in Clay, Cloud, Ottawa, Saline, Reno, and other counties.

In the spring of both 1942 and 1943 injury by green bugs occurred further west than usual with the aphids being present behind the top leaf sheath in many fields, especially in the southwest.

Investigations regarding the habits and activities of *Phyllophaga lanceolata* Say show that the population of the beetles in the grassland varies considerably from year to year, that *Arnorpha canescens* is a favorite food plant of the adults and that the species shifted from the dry uplands to the lower lands in the vicinity of Manhattan following a series of dry years.

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

The Corn Earworm and Other Corn Insects.—The following phases of the project have been studied during the past biennium: (a) Control of the corn earworm attacking sweet corn; (b) life history, habits and control of the Southwestern corn borer; (c) habits of subterranean insects attacking corn.

Corn earworm.—It was determined that during seasons of moderate corn earworm populations severe damage to sweet corn may be avoided by planting sweet corn so that its period of silking coincides with the silking period of most of the field corn in the vicinity thus diluting the population of ovipositing moths.

Tying the husks about the ears at one-half inch from the tip gave the most satisfactory control of any of the measures attempted. This method is now widely used over the state.

Southwestern corn borer.—Infestations have been observed or reported from 61 Kansas counties including three counties along the Nebraska border. A rapid increase in intensity of populations and severity of damage has been observed throughout the infested area. Deadheart injury to young corn and girdling of mature corn have been the worst types of injury. The following methods of control have been recommended: (1) Substitute sorghums for corn, (2) plant early, (3) till so that stubble is thrown to soil surface in late fall or winter, (4) plow stubble deep.

Subterranean insects.—A summary of the data and observations pertaining to the over-wintering habits of *Diabrotica duodecimpunctata* and covering a period of six seasons show that the species does not overwinter at Manhattan.

(Project 9. Department of Entomology. Leaders, D. A. Wilbur and H. R. Bryson. Hatch fund.)

Fruit and Vegetable Insect Investigations.—Investigational work during the biennium has dealt with the spring and fall cankerworm emergence and the colonization of *Macrocentrus ancylicorvus* Rohwer. The latter insect is used for the control of the Oriental fruit moth and strawberry leafroller.

The first fall cankerworm females, *Alsophila pomataria*, were trapped December 25, 1942, and January 17, 1944, with the bulk of the emergence of this species occurring during the week of February 14-20, 1943, and in 1944 during the last week of January and first week of February.

The first spring cankerworm females, *Paleacrita vernata* Peck, were trapped February 6, 1943, and January 26, 1944, with the bulk of emergence occurring during the week of March 21-27, 1943, and in 1944 during the first two weeks of March.

The hymenopterous parasite, *Macrocentrus ancylicorvus* Rohwer, was previously liberated in Doniphan county in 1935 and 1940 without colonization. On July 1, 1943, 200 of these parasites were released in peach orchards at Bethel in Wyandotte county and 100 at Wathena in Doniphan county for the attack on the oriental fruit moth. This method of control is the most satisfactory other than the pruning and destruction of infested twigs. Liberations also were made at Girard in Crawford county, at Coffeyville in Montgomery county and at Wichita in Sedgwick county during June, 1944.

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

Insects Attacking the Roots of Staple Crops.—A summary of the notes and data pertaining to the biology of wireworms shows that *Melanotus fissilis* requires three years in which to undergo its life cycle. The larvae are present in the soil for three growing seasons. While the adults may be collected readily under tarpaper bands placed around the trunks of elm trees, the larvae have not been abundant in the field.

Wireworms collected during gardening operations were reared to the adult stage and identified and found to belong to five species; namely, *Aeolus dor-*

salis, *Monocrepidius vespertinus*, *Monocrepidius lividus*, *Melanotus communis* and *Melanotus spp.* *Monocrepidius vespertinus* caused serious injury to muskmelon seeds planted in cold soil which had grown a crop of oats the previous year.

May beetles, *Phyllophaga crassissima* and *Phyllophaga rubiginosa*, were reared from white grubs found causing injury to potato tubers. Greatest damage was caused to tubers left in the soil after maturity.

White grubs excavated from the soil around the bases of corn plants in 1939 were identified and found to belong to three species, *Phyllophaga rubiginosa*, *Phyllophaga crassissima* and *Ligyris gibbosus*. Those collected in some wheat plots were reared to adults and found to be *Phyllophaga submucida*.

Ecological studies of white grubs in strawberry beds showed that the population of grubs increased in the area as the plants died out and the plots became grassy.

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

Insects Affecting Alfalfa and Allied Plants.—During the past biennium emphasis has been given to the following: (a) Study of insects affecting soybeans and cowpeas. (b) Preparation of manuscript on "The Common Insects of Kansas." (c) The arrangement and determination of 80 Schmitt boxes of insects collected from alfalfa, lespedesa, castor beans, yellow and white sweet clover, vetch, bindweed, soybean and cowpea.

Preliminary observations have indicated that soybeans and cowpeas are relatively free from insect attack in Kansas. The chief pests thus far observed have been grasshoppers, leafhoppers, leaf beetles, serpentine leaf miner and certain leaf-eating caterpillars, especially the green clover worm.

The "Common Insects of Kansas" manuscript briefly discusses over 800 of the more important or more interesting species of Kansas insects.

Observations on the widespread pea aphid outbreak during the spring of 1943 indicated that the area most affected was between Marion and Sumner counties west to Clark and north to Rush county. Studies were initiated to determine the effectiveness of cutting alfalfa to reduce pea aphid population.

The alfalfa plant bug, a new alfalfa pest in the state, was on the increase during the 1943 growing season.

(Project 115. Department of Entomology. Leaders, R. C. Smith and D. A. Wilbur. State funds.)

A Study of the Biology and Control of Fruit and Vegetable Insects.—Exploratory work dealing with the biology and control of the strawberry rootworms *Paria canella* (Fab.) and *Graphops pubescens* Mels. is being carried out at the field station located at Wathena, Kansas. Cooperative work is carried on with the strawberry growers in the vicinity.

Partial life history information and some of the habits of strawberry rootworms have been observed. *Paria canella* (Fab.) overwinters as an adult and is present in the early spring. The new generation adults are present from mid-summer to fall. Eggs are laid from May 4 to June 16. The larvae are present from May 15 to August 15. The beetles chew small circular holes in the leaves and sometimes girdle the crown of the strawberry plant. The larvae in feeding remove the rootlets and roots.

A commercial poison bait and eight apple-pomace insecticide combination baits were used for the control of the adults of *Paria canella* to kill the insects

before they deposited eggs. Three of the poison baits gave significant control of the adults, namely:

- (1) Sodium fluosilicate 3/4 lb., apple pomace 15 lbs., sugar 1 lb.
- (2) Lead arsenate 3/4 lb., apple pomace 15 lbs., sugar 1 lb.
- (3) The commercial bait.

Soil fumigation for the control of the larvae of *Paria canella* was carried out but results so far are not satisfactory.

(Project 187. Department of Entomology. Leaders, R. L. Parker and P. G. Lamerson. Purnell fund.)

Biology and Control of Fruit and Vegetable Insects.—The principal research work of the biennium has consisted of codling moth control by insecticides. In addition to this, work has been carried out in the control of the strawberry sawfly and the carrot weevil all in the Wathena area in Doniphan county.

Coding moth.—When lead arsenate combinations are used to control the coding moth, *Carpocapsa pomonella* L., it has been found that zinc sulfate is a good corrective to prevent foliage injury by the arsenical and does not weaken lead arsenate as an insecticide. Good results are obtained when naphthalene acetic acid is used at the end of the season following zinc sulfate treatments, to prevent premature fruit drop. During 1943 a calcium arsenate bentonite mixture was found to be inferior in the control of this insect.

Strawberry sawfly.—An outbreak of this insect, *Harpiphorus maculatus* Norton, occurred during the latter part of April, 1942, in the strawberry growing district of Doniphan county. The outbreak was controlled.

Carrot weevil.—In the Doniphan county area carrots have not been grown for truck or table use for a number of years due to the activities of this insect, *Listronotus oregonensis* (LeConte). This insect attacks parsley, carrots, celery, wild carrots and other related plants. The insect infests an increasingly greater number of the roots as the season advances. During the latter part of September or first part of October the infestation becomes serious. For early planted and harvested carrots, poison apple-pomace baits applied to the rows of carrots gave good control of the adults of the carrot weevil at the time the beetles infested the carrot field for oviposition. Cryolite 3/4 lb., apple pomace 15 lbs. gave 94 percent control.

(Northeast Kansas Experiment Fields and the Department of Entomology. Leaders, R. L. Parker and P. G. Lamerson. State funds.)

Resistance of Crop Plants to Insect Attack.—Project 164 was revised in September, 1943, and divided into three subprojects. A nursery for the study of resistance of wheat to Hessian fly was maintained at Manhattan. In coöperation with the Bureau of Entomology and Plant Quarantine another nursery is maintained at Bennington, Kansas, and another at Springfield, Missouri. Each contained more than 1000 varieties or hybrids, especially those in early generations.

Subproject No. 1, Hessian fly resistance.—In 1942-'43, among the 99 hybrids in advanced tests and involving Hessian fly resistance derived from spring wheats, at least 75 are satisfactory for resistance to fly. In the fall as well as the spring, some of these also showed high resistance to leaf rust in the

field. Most of them involve crosses of simple Marquillo hybrids back to winter wheats to secure increased winter hardiness.

Pawnee wheat which was released to farmers in 1943 and which is less infested by Hessian fly, continued to give a good record. This variety in 21 experiment station tests during the last 11 years has had only 58 percent of the infestation of Tenmarq in the same tests.

Subproject 2. The resistance of corn to insects.—In 1942 studies on resistance of corn hybrids to corn earworm were continued but the number of plots studied was less than usual. Due to the small population of this insect in 1943 no studies were made.

During this biennium experimental work was begun on the Southwestern corn borer, a new and dangerous pest of corn in Kansas. Both years methods of measuring infestation and injury by this insect were studied and in 1943 a preliminary first test on 25 strains of corn was conducted in four localities.

Subproject 3. The resistance of various crop plants to insects.—Studies were made of the literature related to resistance of plants to insect attack. Notes were taken on injury or infestation of various crop plants by insects whenever possible.

Observations were made on chinch bug resistance in corn and sorghums at the Wichita experimental field and on damage done to strains of wheat by the English grain aphid, *Macrosiphum granurium* (Kirby).

(Project 164. Departments of Entomology and Agronomy. Leaders, R. H. Painter, L. P. Reitz, and 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.—Field work on this project had to do with collections, surveys and biological studies of grassland insects. The extensive collections made in coöperation with the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine by means of sack traps located in selected grassland habitats in the vicinity of Manhattan were summarized. The study of data on leafhoppers, grasshoppers and chloropids collected from a native grass pasture and orchard and brome grass pasture, and a Kentucky bluegrass pasture was continued.

Data dealing with 24 species and 4687 specimens of cutworms collected under sack traps were published by Mr. H. H. Walkden. Data dealing with all other arthropods collected in similar habitats were summarized and prepared for publication. Of these insects the major group is the Coleopterous family Carabidae.

(Project 211. Departments of Entomology and Agronomy. Leaders, D. A. Wilbur and Kling Anderson. 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 Livestock Disease Investigations.—Two principal phases, in addition to general diagnostic service to farmers and veterinarians, were carried on during the biennium.

Diagnostic service report.—To May 14th inclusive, the following examinations have been made in the laboratory for the biennium:

Positive examinations for rabies	20
Negative examination for rabies	99
Miscellaneous specimens	82
Sets of tissues and organ examinations.. . . .	272
Feed examinations	4
Bacteriological examinations	17
Urine specimens	7
Autopsies	1,032
Agglutination tests for brucellosis.. . . .	28,452

Evidence seems to be accumulating from this diagnostic service that leptospira infections in various animals including man, dog, and possibly cattle and hogs, may be responsible for some of the puzzling conditions that come to the attention of this laboratory. One investigation of an outbreak of malignant catarrhal fever, a rather uncommon disease, was made for the Livestock Sanitary Commissioner. Aid was rendered the commissioner through the co-operation of the brucellosis committee of the Kansas Veterinary Medical Association in formulating a program for handling the disease.

Investigation of fistulous withers of horses.—Primarily this work is a bacteriological project, consisting of an extensive investigation of the anaerobic bacteria or fungi present in fistulous withers and poll evil of horses. So far 57 cases of fistulous withers and poll evil have been investigated. We are obtaining a high percent isolation of an extremely anaerobic organism which we believe could have an important bearing on this disease.

Studies on bovine lymphogenous leukemia.—The work on this phase of the project, has consisted of studies on the laboratory diagnosis of the disease, the clinical symptoms and gross and microscopic studies of the pathology in all cases that could be secured for post-mortem examination. One attempt at transmission of the disease has been made.

(Project 102. Department of Veterinary Medicine. Leaders, E. R. Frank, Alice D. Kimball, L. M. Roderick, R. R. Dykstra, and W. W. Thompson. State funds.)

Anaplasmosis Investigations.—Work on anaplasmosis has consisted of making field investigations for diagnostic purposes and to determine the spread of the disease to other parts of the state. Studies are made in an attempt to find a satisfactory method of treatment in the acute and carrier state, a means of diagnosis in the carrier state, and a method of immunization of susceptible cattle.

Ten field investigations have been made, in five of which anaplasmosis was diagnosed. Three animals purchased locally for experimental purposes were already carriers of the disease.

Large doses of nearsphenamine, sodium iodide and quinine sulphate administered intravenously apparently checked the course of anaplasmosis in two cows treated but a third cow died in spite of treatment.

Sodium sulfathiazole had no marked effect on the course of the disease in one cow although she recovered and carried her calf.

Large doses of sulfapyridine given orally had no effect on the course of the disease in one cow.

One cow which has been a carrier for 12 years is no longer a carrier and will not contract anaplasmosis following intravenous injection.

A serum prepared from blood of the above cow did not show protective properties.

Three splenectomized calves developed acute anaplasmosis following inoculation and two recovered.

Embryonated chick eggs, when inoculated with anaplasma infected blood, hatched after the usual incubation period.

One calf born to a carrier was proved not to have acquired anaplasmosis in utero.

Infective blood passed through two sheep in a series failed to produce the disease in a susceptible cow.

Five cows were infected with anaplasmosis in order to study the disease in the untreated form.

A disease of cattle, believed by some to be anaplasmosis characterized by a marked hemoglobinuria, has been prevalent in Kansas. Five cows were inoculated with blood tissues from cases of the disease but the disease could not be reproduced. It therefore is not anaplasmosis.

Anaplasmosis-like disease of swine was diagnosed in three herds of swine. The disease could not be reproduced in healthy hogs by subcutaneous, intravenous or intraperitoneal injection of blood from diseased animals.

The blood picture was found to be typical of a severe anemia but inclusion bodies characteristic of anaplasma could not be demonstrated.

Serological diagnosis.—These studies have been directed toward determining a type of serological diagnosis that may be employed routinely and accurately to determine both carrier infection and acutely infected anaplasmosis cattle. While it is impossible to arrive at any conclusions from tests so far made, it is felt that leads obtained from using chicken liver antigen and dog red blood corpuscles are promising.

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

Feeder Cattle Disease Investigations.—The cattle diseases included in this project are ensilage poisoning, "shipping fever," anaerobic infections, mineral deficiencies, cornstalk disease and keratitis. The work with keratitis has included attempts to isolate the causative agent of this important disease to determine the manner of spread in nature, and develop satisfactory treatment and preventive measures.

Twenty-one field trips were made during the biennium to investigate disease conditions among livestock. Among these conditions were malnutrition, *Actinomyces necrophorus* infection, "shipping fever" and keratitis.

Thirteen specimens have been submitted for examination for anaerobic organisms. Among the tissues examined were those from two cases of clinical blackleg from which *Clostridium septicum* alone was isolated.

Ten steers were vaccinated with commercial mixed bacterin and exposed to natural cases of keratitis 14 days later. Within three weeks nine of these calves had developed keratitis. Numerous other tests and exposures were tried together with vaccines and other possible preventives. Nothing has so far been discovered which will protect animals against direct exposures to other diseased animals.

Ointments prepared from sulfapyridine and sulfanilamide proved effective in checking early cases of keratitis but apparently had no effect on more advanced cases.

(Project 194. Department of Veterinary Medicine. Leaders, H. F. Farley and V. K. McMahon. State funds.)

Studies on mastitis control.—The use of blood agar media is of importance in the study of mastitis. It is well known that the major cause of mastitis in cattle is *Streptococcus agalactiae*, an organism which does not cause Beta-hemolysis of red blood cells but may be detected in milk by the use of blood agar. The routine ex-

amination of many samples from over the state indicates that the Beta-streptococci are not common inhabitants of the udder of the cow normally, or when infected with mastitis streptococci.

To date it has been found that mastitis streptococci can be regularly demonstrated in the teat cups of milking machines used on infected animals. These streptococci remain alive in the teat cups until the next milking period if they are not thoroughly cleaned. By the use of chlorine with the proper procedure it through removal of streptococci may be affected. Accidental transmission of mastitis from infected cows to uninfected cows has occurred frequently enough to make transmission experiments unnecessary.

It has been shown that mastitis streptococci may be demonstrated on the hands of workers, dairy equipment used in the milking operations and about the premises generally. Arrangements are being made to continue this line of investigation and to work out methods of satisfactory control.

It has been shown that mastitis streptococci may be destroyed on the teats of animals by the use of liquid soap. Studies are being made to find a material to replace chlorine which, many times, causes chapping and cracking of teats, therefore giving an opportunity for reinfection.

Examination of milk samples from dairy cattle for mastitis survey.—During the past biennium over two thousand milk samples have arrived at this laboratory for examination. This has given an excellent opportunity to contact dairymen and farmers who are anxious to control, and eventually eradicate, mastitis from their herds.

From our records it is evident that there is ample room for much work and training among dairymen on the subject of mastitis control and eradication.

(Department of Bacteriology and Dairy Husbandry. Leaders, V. D. Foltz and F. W. Atkeson. State funds.)

Tuberculosis Investigations.—The cellular response, in the circulating blood, to injections of tuberculin as noted by Hendershott, has been studied on four tuberculous cows and three tuberculosis free cows. Observations failed to reveal any diagnostic differences between the blood pictures of these two groups of animals.

Some work has been done and work will be continued toward extracting specific proteins from the tuberculosis and other acid-fast organisms for use as antigens in precipitin tests for diagnosis of the disease.

(Project. 224. Department of Veterinary Medicine. Leader, W. W. Thompson. State funds.)

Sleeping Sickness Disease.—Work on the various coöperative phases of this project are now inactive. It seems improbable that any further work on it will be undertaken in the near future. The work represented a coöperative project between the Departments of Entomology and Pathology, the State Board of Health and a committee of the Kansas Medical Association. Part of the experimental work was financed by the Horse and Mule Association of America. The following notes and publications cover the final results of the work on the project:

“Studies on the Transmission of the Western Strain Virus of Equine Encephalomyelitis by the American Dog Tick *Dermacentor variabilis* (Say) and by *Triatoma sanguisuga* (Le Conte)” by A. W. Grundmann, C. H. Kitselman, L. W. Roderick and R. C. Smith. Jour. Inf. Dis. 72, 1943, pp. 163-171.

"Human and Animal Encephalitides in Kansas." Morris S. Cover. Abstract of Master's Thesis. Jour. Amer. Vet. Med. Assoc. 103, 1943, p. 300.

"Western Equine Encephalitis Occurring among Human Beings in Kansas During the Summer of 1941." J. A. Wheeler, Jour. Amer. Med. Assoc. 117, 1941, p. 1972.

(Project 226. Department of Veterinary Medicine. Leader, L. M. Roderick. State funds.)

Anthelmintic Investigations.—In vitro work with *Nippostrongylus muris* injection in albino rat using standard technic tests have been made with many compounds, too numerous to describe here.

Field tests with anthelmintics.—Field tests with emulsified hexane as an adjuvant to tetrachorethylene have been successful.

Phenothiazine salt mixtures failed to control an outbreak of haemonchosis.

An instrument for the administration of phenothiazine suspensions has been developed.

(Project 225. Department of Veterinary Medicine. Leader, J. H. Whitlock. State funds.)

Poultry Disease Investigations.—Four phases of this general project received major consideration during the biennium, in addition to maintenance of a general laboratory service for poultrymen and the preparation and distribution of vaccines.

Several tests with use of a solution of copper sulphate instead of drinking water have given satisfactory results with the *Trichomonas* but no such benefits result with the *Hexamita*. These tests conducted only on a small scale due to lack of adequate facilities.

Study of protozoan parasites in poultry.—Studies were continued on the use of Mapharsen (Metarsen) as a treatment of blackhead in turkeys. Livers of some 30 birds were examined by means of an opening through the peritoneal wall for evidence of blackhead. These birds were then injected intravenously with 0.006 gram doses of Metarsen.

Three weeks later the birds were again examined. Six of the birds had died. In all the remaining birds the lesions were healed or greatly reduced in size. It appears that the drug will cure about 90 percent of those treated. It is expensive and must be injected intravenously to avoid serious injury to the tissues.

Study on leucosis (fowl paralysis).—This subproject has been continued on whatever material was delivered to the laboratory. The larger study had to be abandoned because of lack of space in which to keep experimental birds.

Blood examinations have been made on 25 adult birds with various types of leucosis. Blood counts on chickens are of little value as an early aid to diagnosis. Marked changes are observed only after the birds have developed symptoms.

Precipitin tests have been made on some 50 birds but the results are variable and do not run parallel with the clinical appearance and post-mortem findings. It is hoped that work may be continued on serological methods of diagnosis on early cases of this disease.

The disease appears to be on the decline in Kansas. This is probably due to the system of breeding from resistant birds over a period of several years.

Study of pullorum disease in turkeys.—Last winter blood samples were sent to the Department of Bacteriology from a nearby town. The station laboratory tested 1,789 samples and 110 were reported as reactors. The hatchery believed this was too many. The birds were again bled and blood sent to a

commercial laboratory This laboratory reported 10 reactors. The owner of the birds was dissatisfied and an investigation was then made to find why there was such a marked difference. It developed that the station laboratory condemned the birds on the basis of a 1-25 dilution of the serum while the second laboratory used a 1-50 dilution. The difference in dilution explained the difference in reports but did not determine which was the better dilution to use.

Another point came up about the use of the stained antigen for rapid whole-blood testing of turkeys in the field. The method is now widely used in the middle west. All reports to date indicate that it is not satisfactory for turkeys. However, the Bureau of Animal Industry has brought out a new antigen (K-antigen) designed for use on turkeys.

As a result of experience to date it is believed that the 1-25 dilution of serum is too low for practical purposes; also that the whole-blood test, using stained antigen, is not satisfactory for control of the disease in turkeys. The ordinary chicken antigen is about as satisfactory as the K-antigen except for an occasional sample, probably not enough difference to be of much value. This is an important experiment and probably the most extensive of its type to date. It will be repeated.

General report on poultry diseases.—There has been somewhat less use of this laboratory than usual during the past biennium, probably due to difficulty of transportation. There is also a slight increase in vitamin deficiencies, probably due to the difficulty of obtaining proper feeds and vitamins.

Coryza has about doubled in incidence during the past year. This again may be due to shortage of green feeds. The numbers showing parasitism generally decreased during the past year. Pullorum disease showed a fairly heavy increase. This increase was most marked in turkeys.

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

Parasitological Investigations.—During the past biennium, the work has been upon the following phases: (a) Studies on effects of tapeworms upon growing chickens; (b) Studies on the effects of host starvation on tapeworms; (c) Survey of important parasites of food-producing animals; and (d) Liquid skim milk as a factor in round-worm control.

Tests for effects of moderate infections of tapeworms on chickens were carried out on 44 young chickens, half of which were parasitized with the fowl tapeworm *Raillietina cesticillus*, and the balance kept as controls. All chickens were kept on the same adequate ration. Results indicate that if all of the ingredients required by growing chickens are supplied, the young fowls can tolerate considerable numbers of tapeworms without serious effects.

(b) Results from numerous tests show that the tapeworm body, except the head or scolex, may be removed from infected fowls by removing the feed hopper over night and until 2:00 p.m. next day or a period of 20 to 24 hours. Additional work on host starvation, however, showed that the tapeworm head or scolex which regenerates the tapeworm segments cannot be removed by host starvation.

(c) The results of nation-wide inquiries made of active workers in veterinary parasitology show that the meat supply for the armed forces and civilian population was considerably reduced in quantity by internal and external parasites of food-producing animals in this country. Practical control measures are available.

(d) Preliminary tests on chickens infected with the round-worm *Ascaridia galli* indicate that liquid skim milk given in addition to an adequate ration may result in removing a considerable percentage of the worms present. In some

tests the controls which received no skim milk harbored twice as many worms as did the chickens which received the skim milk.

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

Resistance of Animals to Parasitism.—During the biennium work on the factors in the resistance of chickens to the nematode *Ascaridia galli* has centered upon protein supplements as a factor.

In previous experiments it was found that when peanut meal was used as a protein supplement to a basal cereal ration the resistance of chickens to the viability and growth of the fowl ascarid *Ascaridia galli* was lowered in comparison with that of fowls whose basal cereal ration was supplemented with meat scraps or meat scraps and milk.

Similar tests on 304 growing chickens parasitized with *A. galli* have been made with a soybean oil meal supplement in place of the peanut meal. Other groups of chicks of the same age were given meat scraps, or meat scraps and powdered skim milk as supplements to the otherwise adequate cereal basal ration. The soybean oil meal group, instead of having more worms and longer ones as in the case of the peanut meal group, had *A. galli* in approximately the same average number and length as those in the meat scraps, or in the meat scraps and milk supplement groups.

The explanation of the success of this all-plant (soybean supplement) ration in producing host resistance probably lies in the high percentage of protein digestibility of soybean oil meal in growing fowls. Results indicate that soybean oil meal as a protein supplement to a cereal basal ration may be substituted for meat scrap or meat scrap and powdered milk, in efforts to maintain the resistance of growing chickens to the nematode, *Ascaridia galli*.

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

STUDIES IN HOME ECONOMICS AND FOOD RESEARCH

The Department of Home Economics conducts several lines of research, all of which have for their objective the improvement of farm life and living. Since the beginning of the war added emphasis has been given to many studies in the field of food research, some of which are carried on in this department and some in other departments of the station. All are reported together in this section of the biennial report.

The Nutritional Status of College Women.—A study was made of the basal metabolism of women and girls of varying ages in Kansas. The work this biennium has been, (a) to add to numbers of subjects in upper and lower age brackets, (b) to follow the basal metabolic rates of two college women by means of frequent tests, (c) to follow the basal metabolic rate of a child through the twelfth and thirteenth years by means of frequent tests.

The data are not sufficient on single test subjects to evaluate. Repeat subjects show great variation from test to test and little or no correlation with temperature, season, sunshine, or humidity.

The basal metabolism of midwestern college women. The Am. J. of Physiol. 140, 33-39, 1943.

The vitamin C status of college women.—Minnesota, Iowa, Kansas and Oklahoma have been coöperating on a study during 1942-'44 to determine whether the metabolism of vitamin C is influenced by controlled exercise superimposed upon the normal daily routine of a college girl and if so, to what extent.

There is a wide variation in the vitamin C status of college women as interpreted from their blood picture. Whether extra vitamin C is needed in increased exertion is still in question.

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

A Study of Factors Affecting the Service Qualities of Certain Textile Fabrics.—Three phases of this project were carried on during the biennium.

1. *A comparison of service qualities of certain fabrics and mixed synthetic fabrics.*—Wear tests and laboratory analyses have been made on viscose, cellulose acetate and cuprammonium rayon hose. The results were compared to those with silk and nylon hose. Statistical analyses of the data showed significant differences in the wearing qualities of the silk, nylon, and rayon hose. There was no significant difference in the length of wear for the three kinds of rayon hose. The nylon hose wore longer than either the silk or rayon, and the rayon wore longer than the silk. The acetate hose did not wear as long as the viscose or cuprammonium, but there were no significant differences in the number of hours worn for the three kinds as shown by the statistical analysis.

A study was made on shrinkage of cotton, linen, and rayon fabrics due to laundering, pressed under controlled tensions. These included cotton, linen, continuous filament viscose, continuous filament cellulose acetate, and spun viscose rayon. The continuous filament, viscose and acetate shrank less than the cotton and linen. Spun viscose shrank more than the cotton. Successive launderings did not significant increase the shrinkage.

2. *The absorptive qualities of treated and untreated fabrics.*—Fabrics with water repellent finishes were tested for their resistance to absorption and the effect of repeated dry cleaning and laundering on this property. Results of tests showed that five dry cleanings destroyed the water repellent qualities of all treated fabrics studied including those advertised as permanent to all types of cleaning. Ten launderings by a commercial laundry did not remove the water repellent qualities of the fabrics treated with one "permanent" finish but did remove the water repellent properties of fabrics treated with a finish which is not advertised as permanent.

3. *Thermal conductivity and relative durability of blankets woven from various fibers.*—Blankets of all wool, wool and cotton, wool and aralac, wool and rayon, cotton and rayon and all cotton are being tested to determine their thermal conductivity and resiliency and the effect of laundering, dry cleaning and storage on these properties. Conductivity, thickness, and resilience measurements are being made.

(Project 161. Department of Home Economics. Leader, K. Hess. Purnell funds.)

Studies of Factors Affecting the Expenditures for Family Living Among Kansas Farm Families.—A final report on data collected from 802 Farm Management Association account books kept during the 7-year period 1934 through 1940 is near completion.

The average value of goods consumed each year was \$1,266 of which 36 percent was supplied by the farm. Thirty-eight percent went for food. Cloth-

ing averaged \$124 and household operating expenses averaged \$114. In addition \$100 was allocated to nonfarm investments including insurance. Limited space does not permit listing of all expenditures here.

(Project 196. Departments of Home Economics and Agricultural Economics. Leaders, M. A. Gunselman and W. E. Grimes. 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, and (c) histology of the blood.

Muscles.—Guinea pigs varying in age were kept under as nearly the same conditions as possible and fed the same adequate basic diet except for vitamin C. Some animals of each age group either had no vitamin C or a limited, measured amount. Others of corresponding ages were given an adequate supplement of vitamin C. At stated times, experimental and control animals were killed and the muscles studied. The muscles of the vitamin-deficient, experimental animals appeared “shriveled.” They showed a gradual degeneration of muscle fibers. In extreme cases, the cross striations disappeared. The nuclei were closer together due to the degeneration. The muscles of animals having a little vitamin C did not show as much degeneration as those completely devoid of vitamin C.

Blood.—There was a great variation in the red and white corpuscle count. There was a general decrease in the haemoglobin content of the blood of animals deficient in vitamin C. Although not definitely measured, there was an appreciable decrease in the amount of blood in the large blood vessels of these animals.

(Project 188. Departments of Home Economics and Zoölogy. Leaders, L. Ascham and M. T. Harman. Purnell funds.)

Vitamin Content of Food in Relation to Human Nutrition.—The work on this project during the biennium consisted of determining the thiamin and riboflavin content of certain varieties of Kansas-grown wheat and flour milled from the wheat. Growth studies were conducted using specially milled high-vitamin flour as compared to ordinary patent flour, enriched patent flour, and whole wheat.

Of the varieties analyzed, the 1942 wheat showed higher thiamin values than the 1941. Thiamin retained in the flour ranged from 17.7 to 34.9 percent. There was slight variation in riboflavin values between the 1941 and 1942 samples of wheat of the same variety, while the 1943 crop showed a reduction in riboflavin content for all varieties. The percent of riboflavin retained in the flour varied from 42.6 to 77.6.

The growth studies showed an equal or slightly greater gain in weight for the animals fed the enriched flour than for those fed the whole wheat or the specially milled flours.

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

Meat Investigations.—This project has been under way for a number of years and has been of great interest and importance to the meat industries. Four aims originally dominated the work: (1) A study of the mineral constituents of blood, muscle tissue, and fat tissue of beef animals, and their relation to keeping quality; (2) effect of dietary phosphorus deficiency on quality of beef; (3) effect of feeding limestone supplement on quality of beef; and (4) characteristics of dark-cutting beef. These studies have been completed and are reported in Technical Bulletin 58.

During the past biennium work in meat investigations has been continued to include a study of the effect of the method of handling frozen meat after removal from the locker on the quality and palatability of meat, and the distribution of thiamin and riboflavin pork carcasses.

Methods of handling frozen meat and effect on quality and palatability.—The results obtained when 96 frozen pork roasts and 66 frozen beef steaks were thawed either at room temperature, in the refrigerator, or in the oven were tabulated and analyzed statistically.

Thawing beef steaks and pork roasts at room temperature, at refrigerator temperature, and in the oven gave similar results. However, both steaks and roasts thawed at oven temperature were slightly less tender and required a longer cooking time than those thawed by the other two methods. Steaks and roasts thawed at room temperature yielded the least press fluid and the roasts thawed at room temperature had the highest percentage total loss.

The distribution of thiamin and riboflavin in two pork carcasses was studied. Thiamin and riboflavin determinations were made on 12 pairs of pork chops, one of each pair raw and the other braised. Similar determinations were made on loin roasts immediately after cooking, after being cooked and held over steam and after being held over night both cold and reheated.

The thiamin content of the different cuts from one carcass varied up to 169 percent, calculated on the moisture-free basis and from the other, 146 percent. The data from the other determinations have not been tabulated and analyzed,

(Project 217. Departments of Chemistry, Animal Husbandry, and Home Economics. Leaders, J. L. Hall, D. L. Mackintosh, G. E. Vail and B. D. Westerman. Purnell funds.)

Cooking and Baking Quality of Dried Egg Products.—Both chemical and cooking tests have been developed for evaluating the quality of dried egg products. These methods have been applied to many samples of experimentally prepared dried eggs.

Cream puffs, pop overs, sponge cakes, and baked custards were found to be satisfactory products for testing the quality of dried eggs. High quality fresh dried eggs performed well in these products. As the eggs aged in storage, their ability to make any of these products well decreased. Low storage temperatures extended the useful life of the eggs. None of the chemical tests has shown a good correlation with the measures of cooking quality, perhaps because of storage changes between the times of the cooking and chemical testing. This difficulty is now being corrected.

(Project, Commercial No. 6. Departments of Chemistry and Home Economics. Leaders, R. M. Conrad, G. E. Vail and G. Tinklin. Seymour Packing Company funds.)

Improving the Quality of Dressed Poultry.—The changes in flavor, aroma, and chemistry of the fat which occur during storage of poultry, particularly broilers, have been investigated. The effect on storage stability of diet and type of package has been the principal object of study.

In the birds prepared in 1941, the dietary differences produced great differences in stability of the fat extracted from freshly killed birds, but this difference was not observed in the storage stability of the carcasses. All birds in this series were acceptable to the tasting committee after 18 months storage at 10° F.

To investigate this apparent discrepancy further, a second series of birds was prepared in 1942, fed a basal diet supplemented with sardine oil, wheat germ oil, alfalfa leaf meal, and vitamin "C" respectively. All supplements decreased the stability of the fat extracted from fresh-killed birds, the sardine oil to the greatest extent, followed in order by wheat germ oil, vitamin "C" and alfalfa leaf meal. The birds fed sardine oil, and containing the least stable body fat, were found also to have fat which oxidized rapidly when the carcass was stored, as might be expected.

Vitamin "C" in the diet increased the free-fat acids after storage, but did not affect the storage stability of the carcass as measured by oxidation of the fat. The palatability of these birds was inferior to that of the controls, probably because of the presence of excess fat acids.

(Project, Commercial No. 2. Departments of Chemistry, Poultry Husbandry, and Home Economics. Leaders, R. M. Conrad, A. E. Schumacher and G. E. Vail. Poultry Institute funds.)

Food Bacteriology.—This project has been concerned with two phases of work.

During the first year of the biennium a number of samples of meat were examined bacteriologically for quality. When it was found that many samples of both packing-house ground and locally-ground meats were bacteriologically unsatisfactory, an attempt was made to determine the cause.

During the study a method has been developed for measuring the amount of contamination added to meat during the grinding process. By the use of this method it has been shown that meat grinders are an important source of the organisms found in ground meat.

A satisfactory method has been worked out for sanitizing meat grinders and when this is done daily the sanitary quality of the ground meat is markedly improved.

During the past year four outbreaks of food poisoning were studied. Three of the outbreaks were in the Kansas State College army mess hall where some 150 men were involved. It was demonstrated that the food involved in the outbreak was held too long under inadequate refrigeration and that if the food in question had been properly reheated before serving, the trouble would have been avoided. In each case the food was of the macerated type. Recommendations were made and followed and no further trouble resulted.

Studies on eggs.—This has been a study of the effect of treatment of shell eggs as measured by the quality of the eggs after storage. Bacteriological examination was made of approximately 700 samples collected during the breaking of 180 cases of eggs studied during this experiment. Conclusions from this study are as follows:

1. If they are to be stored, eggs should not be washed.
2. Eggs rejected by the candlers are in many cases bacteriologically satisfactory.
3. Many eggs not rejected by candlers are bacteriologically unsatisfactory.

4. The organisms most frequently recovered from unsatisfactory eggs are of soil and water types.

5 Eggs at usual storage temperatures are an excellent medium for the growth and development of certain microorganisms.

(Departments of Bacteriology, Chemistry and Poultry Husbandry. Leaders, V. D. Foltz, A. E. Schumacher and R. M. Conrad. State funds.)

Study of Flavor of Eggs Held in Cold Storage.—One hundred and seventy-six cases of eggs were treated in various ways designed to sterilize and seal the shells. After seven months in commercial storage, the eggs were candled and broken out. Bacteriological studies of the eggs rejected in the candling and breaking operations, and of the eggs passed as edible, were made.

After receipt at the produce house, no treatment was found capable of reducing the final loss. Washing on the farm, even in a supposedly disinfectant solution, greatly increased the loss. Some evidence was obtained that the characteristic flavor of cold storage eggs is due to the absorption of the odor given off by an occasional "musty" egg.

(Industrial Research Fellowship No. 7. Departments of Chemistry, Poultry Husbandry, and Bacteriology. Leaders, R. M. Conrad, L. F. Payne, and V. D. Foltz. State fund.)

Coördinated Dried Egg Research Program.—The project is aimed at finding remedies for the faults of dried egg as it is being used during the emergency, especially by the army. The principal fault is poor flavor stability. This is being studied from the point of view that it might be corrected by low moisture content and by protective packaging, including various gas-packs. This work is part of a nation-wide program, in which the station is primarily interested in fat changes and in methods of producing egg powder of low moisture content.

Results so far indicate that the lower the moisture content, the better eggs keep their flavor, and that packing under inert gas tends to retard fat oxidation and vitamin A destruction. The addition of acid to the egg before drying increases the rate of vitamin A destruction. A method for the spectrographic determination of vitamin A in eggs has been developed as one of the tools necessary for this work. Practical methods for producing egg powder containing less than 2 percent moisture on a commercial scale were developed, tested, and are now in commercial use.

(Commercial Project No. 9. Department of Chemistry cooperating with National Egg Products Association. Leader, R. M. Conrad.)

Factors Affecting the Quality and Nutritive Value of Fruits and Vegetables Preserved by Freezing and Dehydration.—Although this project was not officially approved until July, 1943, some strawberries, peas, spinach, beans and sweet corn were grown and prepared for freezing and some vegetables were prepared for dehydration.

The production and preparation of small fruits and vegetables for preservation by freezing and dehydration.—Four varieties of strawberries were used in the studies. One part sugar added to four parts berries was used as a standard when judging other treatments. Substitutes for sugar studied were honey, corn syrup and saccharin. None of these substitutes when used alone was as good as sugar or sugar syrup. Honey and granulated sugar syrup, equal parts, was satisfactory. Corn syrup and granulated sugar syrup, equal parts, was better than corn syrup alone. Saccharin was not satisfactory because the berries softened and the liquid froze into a hard mass.

The flavor was fair. Grape juice preserved by freezing was excellent.

Vegetables preserved by freezing were two varieties of spinach, twelve varieties of beans, eight varieties of sweet corn, three varieties of soybeans, two varieties of peas, and tomato juice from three varieties of tomatoes.

The vegetables were judged taking into consideration color, texture, flavor, odor and cooking qualities. The tomato juice was judged on color, suspension of solids and flavor.

The following conclusions may be drawn from the studies: (1) Most vegetables should be slightly less mature than optimum for fresh market when processed, (2) sufficient blanching is essential, (3) containers should be practically air-tight and vapor proof, (4) brine may increase toughness of some vegetables, (5) tomato juice pressed from fruits that had been simmered is more palatable than juice from raw tomatoes. The juice is more easily extracted from simmered fruits.

The mechanics of freezing and dehydration of fruits and vegetables.—A tray-type dehydrator with ample heat, air circulation and thermostat control was the most successful unit for drying.

The most successful foods which were dried were sweet corn, peas, and green soybeans. Partially successful for drying were carrots, beets, green beans, spinach, and potatoes.

The flavor and palatability of all dried vegetables were inferior to the frozen products. Dehydrated foods would be more acceptable if they were not in competition with frozen foods.

The farm freezer storage cabinet has given good service for two years. The cost of operation is reasonable and the capacity (30 cubic feet) would take care of an active program of food preservation.

A home-made cabinet is practical for those who have reasonable skill in construction and an understanding of the requirements.

(Project 233. Departments of Horticulture, Home Economics, and Agricultural Engineering. Leaders, Geo. A. Filinger, L. Ascham, and F. C. Fenton. State funds.)

Nutritive Value of Dried Eggs.—Samples of eggs from the college farm were dried under different conditions and to different moisture contents. The amounts of thiamin, riboflavin, pantothenic acid, and vitamin A were determined in these samples after drying and after storage.

Vitamin A was found in amounts from 28 to 38 units per gram of dry matter. No loss during drying was observed. After storage in a temperature of 80° to 90° F. for nine months, in one-pound paperboard cartons dipped in thermoplastic sealing compound, no loss was observed greater than the expected error in the method of assay.

Riboflavin in the original eggs was 10.6 micrograms per gram of dry matter. No loss during drying was observed. After 15 months' storage at room temperature, losses of 25 to 50 percent were observed.

The pantothenic acid content of the original egg was 25 micrograms per gram of dry matter. None was destroyed in drying, and after 15 months at room temperature, losses from 25 to 60 percent were found.

Thiamin, although not destroyed during drying, was by far the most un-

stable of the vitamins studied. Original values were 3.6 to 4.0 micrograms per gram of dry matter. At room temperature, the destruction ranged from 30 to 90 percent in six weeks. The rate of destruction was closely related to moisture content, with the least destruction in a sample containing 4.4 percent water, and the most in one with 7.7 percent.

(Commercial Project No. 3. Departments of Chemistry and Poultry Husbandry cooperating with Swift and Company. Leaders, R. M. Conrad and A. E. Sehumacher. Swift research fund.)

Factors Affecting the Composition and Quality of Dairy Products.—Two phases of study have been under way during the year: (1) Variations in composition of milk as a result of environmental and genetic factors; and, (2) Vitamin A potency of butter.

Variations in the composition of milk has been continued as a study with two primary objectives in mind. First, to secure data on a larger number of complete lactation records; 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 May 1, 1942, to June 1, 1944, a total of 411 three-day composite milk samples from 51 different cows taken at approximately monthly intervals have been analyzed for total solids and butterfat, and the solids-not-fat content of the samples computed by difference. The data obtained during this period have made it possible to secure complete lactation records on each of 28 cows distributed by breeds as follows: Ayrshire 6; Holstein 11; Guernsey 5; and Jersey 6.

Vitamin A potency of butter.—This study was started in January, 1943, as a part of a national cooperative project on the vitamin A potency of butter. Samples of butter have been obtained from seven creameries at approximately monthly intervals since the work was started. A total of 77 butter samples were received. During the period January through April a total of 28 samples were received.

Each butter sample has been analyzed for vitamin A and carotene. In addition each sample was graded, the color measured by means of a Nafis color standard rod and the chemical composition determined.

Since the results obtained early in the year 1944 are incomplete, no attempt will be made to present them in this report.

The average vitamin A potency varied from a low of 2.16 micrograms in February to a high of 6.08 micrograms per gram of butter in September, 1943. Similarly the average carotene content varied from a low of 1.3 micrograms in February to a high of 5.9 micrograms per gram of butter in June, 1943.

The weighted mean total vitamin A potency for all samples examined during the year 1943 was found to be 12,140 I. U. per pound. The monthly average values for vitamin A potency ranged from a low of 5,200 I. U. in February to a high of 15,400 I. U. per pound of butter in July.

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

Dairy Technology Investigations.—Seven subprojects of this general project are reported for the biennium. Each is in the field of food research.

Cheese investigations.—This has been an effort to improve the quality of Kansas cheese and to obtain information which might serve as a useful guide to plants desiring to engage in the production of cheddar cheese. The investi-

gation was undertaken in cooperation with six commercial cheese factories in Kansas. The coverage and the detail is too extensive to be included in this brief report.

Ice cream investigations.—Two phases of this subproject have been active during the biennium. One phase has been concerned with the use of sweeteners in ice cream and the second phase of the study has been concerned with an evaluation of several different stabilizing agents for ice cream.

Reduction in the sugar content of ice cream mix from 15 to 12 or 13 percent resulted in ice cream of very acceptable quality when fresh, provided there was a corresponding increase in the serum solids content to maintain the total solids of the mix approximately 37 percent. In two of the four trials conducted in this phase of the study the ice cream containing the increased amounts of serum solids became sandy during a storage period of two weeks in an ice cream hardening room.

Sherbet investigations.—This study has been concerned with the following phases: (1) Determination of the basic composition of a suitable sherbet mix; (2) the possible replacement of sucrose with sweeteners made from corn; (3) possible substitution of citric acid in ices and sherbets with lactic, tartaric, or phosphoric acid; (4) determination of the relative merits of several different stabilizers proposed for ices and sherbets.

Data obtained indicate that a basic sherbet mix for best results should contain not less than 30 percent of sugar solids, 9 percent ice cream mix, 0.36 percent of 250 Bloom strength gelatin and approximately 60 percent water.

This basic sherbet formula has been used successfully in the preparation of a large number of sherbets during the past year.

The replacement of 25 percent of the cane sugar solids with corn sugar, corn syrup, or corn syrup solids did not adversely affect the quality of the finished sherbet.

Of the corn sweeteners used Sweetose or high conversion corn syrup was found to be somewhat superior to the others.

Preliminary data indicate that none of the other stabilizers compared is superior to gelatin. The project will be continued.

Evaluation of the phosphatase test as a measure of pasteurization efficiency of dairy products.—During the biennium the work on this subproject has dealt primarily with the applicability of the New York Field or Scharer phosphatase test to cheddar cheese. Phosphatase activity of fresh cheddar cheese curd made from pasteurized milk to which varying amounts of raw milk had been added was measured in a series of three independent trials under laboratory controlled conditions. In addition, the phosphatase test was applied to five lots of cheese made on a semi-commercial scale in the college creamery and to 120 lots of cheese obtained from six different commercial plants in Kansas.

The high percentage of commercial cheese samples giving positive phosphatase reactions indicate that present methods of pasteurizing milk in many commercial cheese plants is highly unsatisfactory.

Determination of total solids in milk by means of the lactometer.—The standing committee on milk and cream of the American Dairy Science Association appointed a special subcommittee to work out a suitable procedure for the determination of total solids in milk by means of the lactometer. The Kansas, Vermont, and Ohio agricultural experiment stations are cooperating in conducting this study.

Incomplete data have been obtained with five different procedures for the determination of total milk solids by means of the lactometer.

Results reported by the three cooperating laboratories show a marked lack of agreement when using the same lactometer procedure. The data obtained to date indicate that there may be greater differences in results between different laboratories using the same lactometer procedure than there is between the different lactometer procedures compared.

The data indicate that the lactometer procedures as used in this investigation leave much to be desired for accurately determining the total solids content of whole milk.

Factors influencing the quality of cream and butter.—The visual mold test for cream has been the subject of two investigations completed under this subproject during the biennium. In one of these investigations, data on 870 cream samples from eight different creameries at different seasons of the year were obtained. In a second investigation, data were obtained on 1,380 samples of cream from two local cream stations. In the latter study each cream sample was examined for: (1) Visual mold by the Parsons Modification of the Wildman test, (2) mold plate count, (3) yeast plate count, (4) titratable acidity and (5) organoleptic grade. The age of the cream at the time of delivery together with certain pertinent information relative to the methods used in the production and handling of the cream prior to delivery was obtained and recorded.

A study of certain factors affecting the acidity and pH of ice cream mixes.—This study was started as a result of data obtained in connection with two recent statewide ice cream surveys. The results of acidity and pH measurements on 629 commercial ice cream samples submitted for these surveys indicated that a large number of the samples had lower titratable acidities (33 percent of the samples were below 0.17 percent acid expressed as lactic acid) and higher pH values (51.8 percent of the samples had a pH value of 6.6 or over) than are typical for commercial ice cream made from normal fresh dairy products.

The recent controversy, relative to the use of mineral salts and the use of certain ingredients with an alkaline reaction, in connection with the proposed federal standard for ice cream has also stimulated interest in the study.

Methods of determining microorganisms in dairy products.—Activity on this project during the past year has been confined to further accumulation of material for a review on the subject of "Evaluation of methods for determining the bacteriological quality of milk" for the journal of Dairy Science. Considerable progress has been made and early preparation of the manuscript is anticipated. Since Dr. Nelson has left the institution this report will not come out from this station.

Factors influencing heat resistance of microorganisms.—Previous studies have been extended to show that addition of peptone to a synthetic basal medium increases the apparent number of bacteria which survive heat shock. Increasing quantities of peptone, up to the maximum studied which is 0.5 percent, increases the apparent survival of the heat-treated organisms but have no effect on the counts of the unheated control organisms.

This study will be continued as soon as arrangements can be made.

(Project 124. Departments of Dairy Husbandry and Bacteriology. Leaders, W. H. Martin, W. J. Caulfield, and F. E. Nelson. State funds.)

BRANCH EXPERIMENT STATIONS

The work of the central station at Manhattan is supplemented by work at four branch experiment stations, all in the western part of the state located at Hays, Garden City, Colby, and Tribune. The work at each of these 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 was established on the old Fort Hays Military Reservation by legislative enactment in 1901. At the present time, 3,264 acres comprise the station property, approximately 1,800 acres of which is under cultivation and 1,375 in native grass pasture. The balance is in building sites, feed lots, creek bed and roads. In addition about 410 acres of land infested with bindweed is leased from the Fort Hays Kansas State College for experimental studies in eradication of this serious weed pest.

The station is equipped to conduct experimental work with soils, crops, livestock, horticulture and forestry. All of the soils and crops work is in coöperation with the Bureau of Plant Industry or the Soil Conservation Service, United States Department of Agriculture. Brief statements about the more important projects follow:

Cereal Investigations.—Tests with sorghums, winter wheat, winter and spring barley, oats, and corn are conducted to determine the better varieties to use in the Plains Region. Plant breeding work is extensively conducted with sorghums.

The waxy endosperm selection of grain sorghum from the Leoti X Club cross mentioned in the last biennial report has been given the name of Cody and released for commercial production. During the winter of 1943-1944, 800,000 pounds of commercial grain of Cody was processed for starch by a large industrial food concern. The starch so produced compares favorably with and replaces that formerly imported. Approximately 19,000 acres of the new Cody was grown under contract for the season 1944 and a much larger acreage is planned for 1945. Cody has a sweet stalk. It can be cut with a combine and has about the same yielding ability as other grain sorghums of like maturity. (A. F. SWANSON, *in charge.*)

Dry Land Agriculture.—Total precipitation for 1942 and 1943 were just the opposite in extremes, the former having an annual precipitation of 29.61, or 7 inches above normal and the latter 16.19 inches, or almost 7 inches below normal. Because of the distribution of the rainfall in 1942 the expected result in high crop production did not materialize. Drouth in May and hail in June of that year were two destructive features bringing about reduced yields. Winter wheat averaged 9 bushels on cropped land and 18 bushels on fallow. Sorghum grain and forage yields were only fair.

The low yields of winter wheat in 1943, 9 bushels on cropped land and 18 bushels on fallow, cannot all be attributed to a lack of moisture because there was a large carryover in the soil from the precipitation of the previous year. The mid-April freezes following early warm spring weather were responsible for much of the reduction. Yields of grain sorghums were low, in fact many of the varieties did not succeed in making gram. Tonnage on forage sorghums varied from 1.5 tons on cropped land to 2.5 tons on fallow. The heavy infestation of the Southwestern corn borer reduced corn yields in both years. (A. L. HALLSTED, *in charge.*)

Forage Crops Investigations.—The forage crops studies at this station include investigational work on grass, sweet clover, and alfalfa, with special emphasis on the grass work. Buffalo grass and blue grama receive the greatest attention because of their importance in this region.

Investigations have shown that the germination of buffalo grass seed can be increased from 5 to 10 percent up to approximately 75 percent of its germinating capacity by soaking in a 0.5 percent solution of saltpetre for 24 hours, immediately followed by storage at 41° F. for 6 weeks, then drying. A very desirable feature of treated seed is that it will maintain or even improve its viability for at least two to three years after treatment. Treated seed has proved an invaluable aid to the use and success of buffalo grass in the revegetation program. Approximately 110,000 pounds of buffalo grass seed was treated at this station during the spring of 1944 for the army, seed companies and private individuals.

The breeding and selection work with buffalo grass is being continued on a rather extensive scale. One of the improved selections has been named Hays buffalo grass and was approved for certification by the Kansas Agricultural Experiment Station in the spring of 1944. Other selections which appear to be even more promising than Hays buffalo grass have been advanced from the nursery to increase plots for further testing.

The possibilities of buffalo grass seed production under irrigation are being thoroughly explored. The 10-acre block of Hays buffalo grass established by rod in 1941 produced 450 pounds of seed in 1942 and 4,600 pounds in 1943.

Studies to determine the most satisfactory dates, rates and methods of seeding grasses and various mixtures of grasses have been and are being conducted. Nearly 200 acres of station pasture land were successfully reseeded to grass during the biennium, which makes a total of approximately 400 acres reseeded to grass during the past five years. Most of the area reseeded during this biennium was seeded with a mixture of buffalo grass, blue grama, side oat grama, and western wheatgrass. (R. E. WAGNER, *in charge*.)

Noxious Weed Control Investigations.—Experiments were continued during the biennium on all phases of the eradication of bindweed and the control of bindweed seedlings. Intensive clean cultivation every two to three weeks over a full season or a shorter period between close-drilled competitive crops of wheat, rye, sorgo, or Sudan grass continued to be the most practical method of eradication. Competitive crops were much more effective in eradicating bindweed during the unusually wet year of 1942, than in the abnormally dry year of 1943.

Thus far the best method discovered for controlling bindweed seedlings after the old stand has been eradicated is ordinary good farming practices using only close-drilled small grain or sorghum crops.

Sodium chlorate applied in August, September, or October at 3 to 4 pounds per square rod continued to be the most effective and economical method of eradicating bindweed with chemicals. Russian knapweed was more easily eradicated by chemical treatment than bindweed, but dogbane required nearly twice as much sodium chlorate and hoary cress about three times as much for a complete kill (F. L. TIMMONS, *in charge*.)

Beef Cattle Feeding Investigations.—Part of the feeding trials conducted during the biennium concerned the value of different amounts of bran fed with silage compared with alfalfa hay in different amounts and of cottonseed cake fed with silage as a basal ration. This completes the series of the protein supplement investigations begun in 1939. A series of investigations the influence of different levels of nutrition upon ultimate development of stock calves was begun in 1942. A detailed report of the results of these investigations is contained in Progress Reports B-43 and B-44. (L. C. AICHER and C. W. McCAMPBELL, *in charge*.)

State Forest Nursery.—The sale of seedling trees in 92 counties of the state for 1943 and 1944 for windbreaks, shelter belts, and woodlots remains practically the same as for the last biennium. Red cedars continue to be far in the lead in demand in Kansas. Chinese elm and Osage orange are also popular. (J. G. HARRISON, *in charge*.)

Pure Seed Distribution.—Sales of certified seed of adapted and approved farm crops continued good during the biennium. Sorghum seed sales reached 233,898 pounds in 1943 and 255,106 pounds in 1944. The first release of the new Comanche seed wheat was made in 1943, 23,000 pounds being distributed. The sale of 312,000 pounds of Tenmarq seed wheat was also made. This year also marked the first release of seed of a new selection of buffalo grass and side oat grama. A 10-acre field of the new buffalo grass selection produced 460 pounds of seed to the acre, 4,512 pounds of this seed was sold for seeding on army air bases and to farmers. A 10-acre field of the new side oat grama selection averaged 440 pounds of seed per acre. Both the buffalo and the side oat grama grass crops were produced under irrigation. The year of 1943 marked the first release of the new wilt-resistant Buffalo alfalfa when 4,530 pounds of seed were allocated to Kansas farmers for seed production. (L. C. AICHER, *in charge.*)

Soil Erosion and Water Conservation.—These investigations have been continued with special emphasis on the reestablishment of native grasses on 4 to 10 percent slopes and the development of grass outlets for terraces and waterways. Annual reports on the water and soil losses from 5 percent slopes and other investigations under way are supplied the coöperative agencies in these investigations. (L. C. AICHER, *in charge.*)

GARDEN CITY BRANCH EXPERIMENT STATION

The Garden City Branch Station of 556 acres is located five miles northeast of Garden City, Kan. Approximately 350 acres are under cultivation, 80 in grass and the balance in building sites, roadways and corrals.

The station carried major projects in livestock feeding, crop improvement, dry-land agriculture investigations, soil and water conservation and entomological investigations.

Dry-Land Agriculture.—The Bureau of Plant Industry, United States Department of Agriculture, and the Kansas Agricultural Experiment Station continued joint investigations of dry-land agriculture practices at Garden City during the biennium. Two major changes were made in the cropping practices. Western Blackhull, a binder type sorghum, was replaced by Westland milo, and hill-dropping method of planting Finney milo, 42 inches apart in the row, replaced the old method of drilling.

Above average precipitation in 1942 resulted in excellent growth of sorghums, but yields were very poor due to a killing frost on September 25. Sorghum yields in 1943 were good in spite of only 14.5 inches of precipitation. The high yields were due largely to the abundant supply of soil moisture at planting time, the penetration on fallow being six feet and deeper.

Wheat yields in 1942 were good ranging up to 38 bushels, but marked differences occurred on various plots. The lowest yield was 2 bushels per acre. Yields in 1943 were above average, but were adversely affected by May drought. The best yields were on summer fallow, around 22 bushels per acre. (H. G. MYERS, A. E. LOWE and L. M. SLOAN, *in charge.*)

Soil Conservation Investigation.—This work was continued coöperatively with the Soil Conservation Service and Bureau of Plant Industry. Yield performance of crops on the project generally followed the results of former years. Contour cultivation has given slight increase over up-and-down-hill seedbed preparation for wheat, but no advantage has appeared for basin listing on the contour. Ordinary listing of sorghums on the contour performed equally as well as basin listing on the contour, both of which were far superior to up-and-down-hill listing, but basin listing sorghums up-and-down-hill was a markedly superior method to ordinary listing up-and-down-hill.

Subsurface tillage results have been limited but indications are that yields will compare favorably to other good methods of seedbed preparation for wheat. (H. G. MYERS, A. E. LOWE and L. M. SLOAN, *in charge.*)

Field Trials of Summer Fallow Cropping.—A 136-acre field is utilized for this field scale experiment wherein recommendations derived from plot experiments are applied on a field scale. Results from three crop years subsequent to purchase indicate that in this section planting of wheat and sorghums only on summer fallow land is an economically sound practice. (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, barley, oats, corn, winter barley and soybeans. Intensive work is carried on in testing varieties of sorghum for resistance to milo disease, a soil-borne organism prevalent in western Kansas which attacks many sorghum varieties. Flax and spring wheat were compared with spring barley and oats for adaptation to southwest Kansas and have given very inferior yields. In 1942 a test, comparing five rates on five dates of planting, was started with winter wheat. The rates range from 10 to 60 pounds per acre and the dates are by 15-day intervals from August 15 to October 15. Wheat variety data secured were valuable in the designation of two new wheat varieties, Comanche and Wichita, both specifically recommended for southwestern Kansas.

Alfalfa strains were tested and selections made for resistance to bacterial wilt. This was done in coöperation with the Office of Forage Investigations, United States Department of Agriculture.

Adaptation plantings of Russian dandelion were made in 1942 but all plantings were near failure due to inability to secure stands. Plants of guayule were set out in 1942 and 1943 and both years they did well on dry land and under irrigation. However, not a single plant survived the first winter after being set out. So both the rubber-producing plants tried proved poorly adapted to this territory.

In 1942 and again in 1943, a test was conducted on control of covered kernel smut of sorghum, in cooperation with the Office of Cereal Crop and Diseases, United States Department of Agriculture. Arasan and Spergon are two of several new fungicides not composed of critical war material which proved to be as effective in control of covered kernel smut of sorghum as is copper carbonate.

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 Investigation.—The Brown Swiss herd has been increased and preliminary information gathered on pasture management. It has been found that a combination of pasture, consisting of brome grass, Sudan grass, sweet clover and Balboa rye, will furnish green pasture approximately 8 months of the year. (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 four major projects: (1) Dry-land agriculture investigations, (2) general crop investigations, (3) dairy investigations, and (4) horticulture investigations.

Dry-Land Agriculture.—The experiments in cultural practices and soil management studies together with the securing of climatic data in cooperation with the Division of Dry Land Agriculture, United States Department of Agriculture, were continued as in the previous biennium. The year 1942 was the most productive year on record. The precipitation was 21.10 inches, which is nearly 3 inches above normal. There was an abundance of moisture in the soil in the fall of 1941 so winter wheat got an excellent start. The weather continued favorable throughout the growing season, and a record crop was harvested. High yields were obtained on all methods of seedbed preparation, including fields of volunteer. On the dry-land agriculture plots, winter wheat averaged 24.7 bushels to the acre on fallow and the same on cropped land. Barley averaged 28.1 bushels on fallow and 15.5 bushels on cropped land. Corn yielded 30.9 bushels on fallow and 29.0 on cropped land. Milo averaged 30.7 bushels on fallow, and 22.3 bushels on cropped land.

The year 1943 was another productive year, although comparatively dry. The precipitation was 14.35 inches which is more than 4 inches below normal. Due to the abundance of moisture in the fall of 1942 winter wheat again got off to a good start. For the second year in succession practically all wheat fields came up to thick stands of volunteer wheat after harvest. The weather continued fairly favorable most of the season, and another large crop of wheat was produced. In contrast to 1942, however, the yields on most volunteer fields were very low, and those on fallow were uniformly high.

On the dry-land project, winter wheat averaged 27.4 bushels on fallow and 10.3, on cropped land. Barley yielded 24.2 bushels on fallow and 16.4 on cropped land. Corn yielded 17.7 bushels on fallow and 4.6 on cropped land. Milo averaged 30.3 bushels on fallow, and 9.0 bushels on cropped land. The year 1943 was not very favorable for storing moisture by fallow. At winter-wheat-seeding time the soil was wet less than 4 feet deep. (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. Growing conditions were favorable for the production of most crops during both seasons.

Winter wheat yields were excellent, while the yields of the spring small grains were only fair.

Comanche and Pawnee were the two highest yielding varieties in the winter wheat test. Beecher barley has produced a somewhat higher yield than Flynn. There is practically no difference in the yield of Kanota and Fulton oats. The early maturing sorghums such as Colby and Day milos, and Coes, remain at the top of the grain sorghum yield table. Early Sumac is the favored sorgo, not from total yield, but from a quality standpoint.

Corn produced excellent yields in 1942 with several of the hybrids yielding as high as the open-pollinated varieties. In 1943 the yields were all much lower and all hybrids yielded less than the open-pollinated varieties.

In the date-of-planting test with winter wheat, duplicate fiftieth-acre plots of fallowed land have been drilled to Kanred at 10-day intervals from August 20 to November 10. In no season has the highest yield been harvested from plots seeded before September 10 nor after October 10. (E. H. COLES, *in charge.*)

Dairy Herd Improvement.—A new phase of the study of dairy herd improvement was started in 1941 with the purchase of six red farm milk cows. A purebred Ayrshire sire will be used on these cows and their female offspring. The daughters from this and succeeding generations will be tested for milk and butterfat production and the males will be sold for baby beef. Records are being kept on daily gains, feed requirements, dressing percentages, and quality of meat produced by these steers. (E. H. COLES, *in charge.*)

Horticulture Investigations.—Practically no fruit was produced in the young orchard in either year of the biennium. Some of the Hanson hybrid plums produced small amounts of fruit in 1942, but their blossoms were killed by frost in 1943. Most of the young trees have made a satisfactory growth. (E. H. COLES, *in charge.*)

TRIBUNE BRANCH EXPERIMENT STATION

The Tribune Branch Experiment station is located near Tribune, Greeley county. Experimental work is planned to determine the better crops, crop varieties and soil management methods for the High Plains area of western Kansas. Crop yields in the area are variable from year to year because of great differences in rainfall.

Seedbed preparation for winter wheat, continues to favor early plowing, early listing, and early one-waying in the order named.

Among wheat varieties, Early Blackhull leads in average production at the end of 15 years, with Tenmarq only 0.7 bushel behind. The new variety, Comanche, after only five years under test at Tribune has averaged yields a trifle higher than Early Blackhull. Optimum planting date for wheat is about September 15; rate, 30 pounds per acre.

Comparing the use of the common drill with the furrow drill, the yields for seven comparable years favor the common drill.

Tests at Tribune comparing best Kansas corn hybrids with highest-yielding open-pollinated varieties. Cassel white and Freeds, indicate it is doubtful if hybrid corn yields will offset the higher prices for hybrid seed. June 1 seems to be the optimum corn-planting date. The pattern of planting two rows and skipping one favors maximum yields.

Hybrid popcorn, after tests for only two years when neither year was particularly adverse to corn, has made very satisfactory yields. In 1942, Kansas hybrid popcorn yielded 35.7 bushels per acre; the open pollinated popcorn variety, Supergold, yielded 17 bushels per acre. In 1943, hybrid popcorn yielded 25.8 bushels per acre; Supergold 16.1 bushels per acre.

Long-time yields of gram sorghums favor the variety Greeley. A new hybrid (Weskan X Greeley) is showing promise.

Among forage types of sorghum, Early Sumac continued to lead in tonnage production, with Leoti Red and Norkan close behind.

A practice to provide maximum green pasture throughout the year has been established at Tribune, as follows: Summer fallow, plant to winter wheat for fall and spring pasture. On another field, summer fallow, plant to Sudan grass the following spring for midsummer pasture. Under this practice a field of 4.4 acres has provided 50 to 100 days of wheat pasture and 45 to 80 days of midsummer Sudan grass pasture for two or three cows and two horses each year beginning with 1936. Under this practice, native pasture is rested while wheat and Sudan grass are being grazed, and the native pasture carries the load much of the time when wheat and Sudan grass pasture are not available.

Treatment with manure of wheat, barley, oats and sorghums at rates of five tons, and 10 tons per acre, do not show increased yields to warrant the time and labor of application.

Potato varieties Irish Cobbler and Red River Ohio have been under comparable tests for 23 seasons. Average yield for Irish Cobbler, 70 bushels per acre; for Red River Ohio, 61 bushels. (T. B. STINSON, *in charge*.)

STATION PUBLICATIONS

The results of investigations by the Agricultural Experiment Station are reported in four series of publications: Biennial reports, technical bulletins, bulletins, and circulars.

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. Five 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. Twenty-two 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:

BIENNIAL REPORT				
<i>No.</i>	<i>Title</i>	<i>Edition</i>	<i>Page</i>	<i>Total Pages</i>
	Eleventh Biennial Report of the Director.....	1,200	79	94,800
TECHNICAL BULLETINS				
52	Crossbreeding of Poultry.....	2,500	44	110,000
53	The Influence of Some Spray Materials on the Internal Structure and Chlorophyll Content of Apple Leaves.....	2,500	54	136,000
54	Relation Between Age and Dry Weight of the Corn Plant (Zea Mays L.).....	2,000	51	102,000
55	Development of Sorghum Resistant to Milo Disease.....		24	48,000
56	Nitrogen and Carbon Changes in Soils.....	2,000	52	104,000
GENERAL BULLETINS				
302	Kansas Weather and Climate.....	5,000	108	640,000
303	Farm Tenure Law in Kansas.....		27	94,600
304	Sorghums for Kansas.....	10,000	63	630,000
305	Area Analysis and Agricultural Adjustments in Nemaha County, Kansas.....	3,000	47	141,000
306	Soybean Production in Kansas.....	10,000	31	310,000
307	Distinguishing Sex of Chicks at Hatching.....	5,000	29	145,000

No.	Title	Edition	Pages	Total pages
308	The Economics of the Poultry Enterprise on Kansas Farms	7,500	48	360,000
309	Factors Affecting Butterfat Prices in Kansas.....	3,500	28	98,000
310	Some Cold-Storage Studies of Kansas Potatoes.....	3,500	18	63,000
311	Kansas Corn Tests, 1942.....	5,000	44	220,000
312	Planning the Farm Business in South Central Kansas.....	3,000	32	96,000
313	Tomato Production in Kansas.....	20,000	30	600,000
314	Swine Production in Kansas.....	10,000	76	760,000
315	Capon Production	5,000	35	175,000
316	Sheep Production in Kansas.....	10,000	80	800,000
317	Southwestern Corn Borer in Kansas.....	5,000	32	160,000
318	Barley Production in Kansas.....	7,500	38	285,000
319	Comanche and Pawnee: New Varieties of Hard Red Winter Wheat for Kansas	7,500	16	120,000
320	Grass and Alfalfa as Silage Forage and Meal for Poultry,	3,500	46	161,000
321	Buffalo Grass	7,500	78	585,000
322	Potato Production in Kansas.....	10,000	52	520,000
323	Kansas Corn Tests, 1943.....	5,000	36	180,000

CIRCULARS

212	Control of Sheep Diseases. (Reprint).....	5,000*	19	95,000
213	The Stock-Share Lease in Kansas.....	7,500	39	292,500
214	Diseases of Feeder Cattle in Kansas.....	3,000	14	42,000
215	List of Publications	2,500	4	10,000
216	Culling Poultry	20,000	31	620,000
217	Preserving Foods in Frozen Food Lockers.....	20,000	38	760,000
218	Pruning Fruit Trees in Kansas.....	7,500	24	180,000
219	Apple Guide for Kansas Retailers.....	3,500	24	84,000
220	Diseases of Feeder Cattle	5,000	16	80,000
221	List of Publications	3,000	4	12,000
222	Brucellosis of Cattle	5,000	16	80,000
223	Swine Feeding Investigations 1930-'35.....	5,000	24	120,000
224	Developing of Early-Feathering Strains of Heavy Breeds of Poultry	2,500	4	10,000

ABSTRACTS

3	Abstracts of Publications	8,700	4	34,800
4	Abstracts of Publications	10,000	2	20,000

MISCELLANEOUS

Prog. Rpt.	Research in Milling Industry	1,500	17	25,500
	A List of Poultry Books.....	1,000	83	83,000

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
111	1941	Storage Conditions for Kansas Potatoes. Harold R. Fox. Kan. State Hort. Soc. Bien. Rpt. 46:229-234.
112	1942	Farm Tenure in Kansas. Harold Howe and Alfred H. Hockley. Kan. Agr. Expt. Sta. Bul. 303:1-27.
113	1942	Area Analysis and Agricultural Adjustments in Nemaha County, Kansas. W. H. Pine. Kan. Agr. Expt. Sta. Bul. 305:1-47.
114	1942	The Stock-Share Lease. John H. McCoy and W. E. Grimes. Kan. Agr. Expt. Sta. Cir. 213:1-39.
115	1942	Cold Storage of Kansas Potatoes. Franklin L. Parsons. Kan. State Agr. Expt. Sta. Bul. 310:1-18.
116	1942	Factors Affecting Butterfat Prices in Kansas. Geo. Montgomery and F. L. Parsons. Kan. Agr. Expt. Sta. Bul. 309:1-28.
117	1942	The Economics of the Poultry Enterprise on Kansas Farms. R. W. Hoecker. Kan. Agr. Expt. Sta. Bul. 308:1-48.
118	1943	Planning the Farm Business in South Central Kansas. R. J. Doll. Kan. Agr. Expt. Sta. Bul. 312:1-32.
119	1944	Transition Readjustments in Agriculture. Discussion. W. E. Grimes. Amer. Farm Econ. Assoc. 26(1):89-91.
120	1943	Farm Management—A Decisive Factor in Efficient Food Production. W. E. Grimes. Kan. State Bd. Agr. Quart. Rpt. 63:18-24.
121	1944	The Feed Situation. George Montgomery. Kan. State Bd. Agr. Quart. Rpt. 63:54-58.
123	1944	Kansas Farm Labor. W. H. Pine and Frank Blecha. Kan. Ext. Cir. 176:1-11.

Department of Agricultural Engineering

<i>Serial No.</i>	<i>Year of issue</i>	<i>Title, author, and publication</i>
...	1942	A Study of Engineering Problems in Garden Irrigation. L. H. Schoenleber. Agr. Engin. 24:75-78.
...	1943	Farm Storage of Wheat in Kansas. F. C. Fenton. Kan. State Bd. Agr. 33d Bien. Rpt. 38:92-104.
Department of Agronomy		
322	1941	Some Physiochemical Aspects of Soil Aggregates. H. E. Myers. Soil Science, 52:469-480.
332	1942	A Comparison of Line Transects and Permanent Quadrats in Evaluating Compositions and Density of Pasture Vegetation of the Tall Prairie Grass Type. K. L. Anderson. Jour. Amer. Soc. Agron. 34:805-822.
333	1942	Food Reserves and Their Translocation to the Crown Buds as Related to Cold and Drought Resistance in Alfalfa. C. O. Grandfield. Jour. Agr. Research. 67:33-47.
334	1942	Cause and Control of Chlorosis. H. E. Myers. Kan. Hort. Soc. Bien. Rpt. 46:263-264.
335	1942	Study of Some Factors Influencing Aggregation of a Claypan Soil. F. G. Ackerman and H. E. Myers. Soil Sci. 55:504-413.
336	1942	Brome Grass Toxicity Versus Nitrogen Starvation. H. E. Myers and K. L. Anderson. Jour. Amer. Soc. Agron. 34:370-773.
337	1942	Some Chemical Properties of Soil Organic Matter and Sesquioxides Associated with Aggregation in Soils. Thomas Weldon and J. C. Hide. Soil Sci. 54:343-352.
338	1942	Indications of Hail Resistance Among Varieties of Winter Wheat. L. P. Reitz. Trans. Kan. Acad. Sci. 45:129-137.
339	1942	Sorghums for Kansas. A. F. Swanson and H. H. Laude. Kan. Agr. Expt. Sta. Bul. 304:1-63.
340	1942	Soybean Production in Kansas. J. W. Zahnley. Kan. Agr. Expt. Sta. Bul. 306:1-31.
341	1942	Agronomic Tests of New Resistant Varieties and Hybrids of Hard Red Winter Wheat in the Presence of Stem Rust and Hessian Fly. L. P. Reitz, E. T. Jones, C. O. Johnson, R. H. Painter. Jour. Amer. Soc. Agron. 35:210-229.
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78	1941	Effectiveness of Dry Milk Solids in Preventing Overbromation of Some Bleached Hard Winter Wheat Flours. G. A. West and E. G. Bayfield. Cereal Chemistry 19:481-492.
79	1941	Baking Tests and the Evaluation of New Wheats. E. G. Bayfield and G. A. West. Cereal Chemistry 19:493-507.
80	1942	A Micro Method for Test Weight. C. O. Swanson. Cereal Chemistry 19:493-507.
81	1942	Factors Influencing the Pearling Test for Kernel Hardness in Wheat. M. E. McCluggage. Cereal Chemistry 20:585-700.
82	1942	Yeast Variability in Wheat Variety Test Baking. K. F. Finney and M. A. Barmore. Cereal Chemistry 20:194-200.
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84	1942	Effects of Moisture on the Physical and Other Properties of Wheat. II. Wetting During Harvest. C. O. Swanson. Cereal Chemistry 20:43-61.
85	1942	Micro Baking and the Milling of Small Samples of Wheat. M. E. McCluggage. Cereal Chemistry 20:185-193.
86	1942	A Simple Photoelectric Relay. E. B. Working. Science 106:281.
87	1942	The Effect of Millroom Temperature and Relative Humidity on Experimental Flour Yields and Flour Properties. E. G. Bayfield, J. E. Anderson and W. F. Geddes, Minnesota, and F. C. Hildebrand, General Mills. Cereal Chemistry. 20:149-171.
88	1942	Fractionating and Reconstituting Techniques as a Tool in Wheat Flour Research. K. F. Finney. Cereal Chemistry. 20:381-396.
89	1942	Factors Which Influence the Physical Properties of Dough. V. Gluten Protein as the Main Factor Affecting the Pattern of Mixograms. C. O. Swanson and A. C. Andrews. Cereal Chemistry. 20:-61-78.
90	1942	Studies on Treating Wheat with Ethylene I. Effect upon High Moisture Wheat. W. S. Hale and S. Schwimmer and E. G. Bayfield. Cereal Chemistry. 20:224-233.
91	1942	The Correlation of Mixograms with Baking Results. J. A. Johnson, Jr., C. O. Swanson, E. G. Bayfield. Cereal Chemistry. 20:625-644.
92	1942	Some Tests with the Entoleter. J. E. Anderson. Assn. Operative Millers Bul. 1235-1237.
93	1942	An Air Pump of Low Capacity. Earl B. Working. Plant Physiology. 18:310-312.
95	1942	Survey of Experimental Milling Methods. J. E. Anderson and E. G. Bayfield. Amer. Assoc. Cereal Chemistry. Newsletter and Transactions. 57:29-37.
96	1942	The Quality of 1942 Hutchinson, Salina, and Wichita Wheat Receipts. E. G. Bayfield. Bul. Assn. Operative Millers. pp. 1249-1252.
97	1942	The Correlation of Mixograms with Baking Results. J. A. Johnson, Jr., C. O. Swanson, E. G. Bayfield. Cereal Chemistry. 20:625-644.
98	1942	Effects of Moisture on the Physical and Other Properties of Wheat. IV. Exposure of Five Wheat Varieties to Small Rains During Harvest. C. O. Swanson. Cereal Chemistry. 20:703-714.
98a.	1943	The Sulfhydryl Groups of Wheat Flour. Homer S. Myers and Earl B. Working. Cereal Chemistry. 21:-32-37.
99	1943	Flour Blends and the Question of Complementary Effects. K. F. Finney and M. A. Barmore. Cereal Chemistry. 21:65-74.
100	1944	Factors Which Influence the Physical Properties of Dough. VI. Effect of Cysteine and Some Other Substances. C. O. Swanson and A. C. Andrews. Cereal Chemistry. 21:-140-149.
102	1943	Factors that Influence the Physical and Other Properties of Wheat. V. Effect of Frequent Rains Accompanied by Storms on Blackhull, Chiefkan, and Tenmarq. C. O. Swanson. Cereal Chemistry. 21:126-140.

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
105	1944	The Quality of Bread as Influenced by Varying the Mixing Time with the Use of Some Wetting and Reducing Agents. C. O. Swanson, John A. Johnson. <i>Cereal Chem.</i> 21:140-170.
106	1943	Effect of Hydrocyanic Acid on the Baking Quality of Flour. H. D. Young and E. G. Bayfield. <i>Cereal Chemistry.</i> 21:-179-184.
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139	1942	Fat Absorption in the Laying Hen. R. M. Conrad and H. M. Scott. <i>Poul. Sci.</i> 21:407-409.
140	1941	Time of Pigment Deposition in Brown Shelled Hen Eggs. D. C. Warren, R. M. Conrad. <i>Poul. Sci.</i> 21:77-80.
141	1942	The Cross-breeding of Poultry. D. C. Warren. <i>Kan. Agr. Expt. Sta. Tech. Bul.</i> 52:1-44.
145	1942	Distinguishing Sex of Chicks at Hatching. D. C. Warren. <i>Kan. Agr. Expt. Sta. Bul.</i> 307:1-29.
146	1942	The Value of Artificial Insemination in Poultry Breeding Work. D. C. Warren and C. L. Gish. <i>Poul. Sci.</i> 22:108-117.
147	1942	Bibliography of Poultry Books. L. F. Payne, pp. 1-83.
148	1943	The Inheritance of Plumage Color in the Turkey. W. R. B. Robertson, B. B. Bohren, D. C. Warren. <i>Jour. Heredity</i> 34:247-256.
150	1943	A Chemical and Histological Study of Feather Pigments of the Domestic Fowl. B. B. Bohren, R. M. Conrad, D. C. Warren. <i>Amer. Naturalist</i> 77:481-518.
151	1943	Capon Production. L. F. Payne. <i>Kan. Agr. Expt. Sta. Bul.</i> 315:1-35.
152	1943	Inheritance of Ragged Wing in the Fowl. D. C. Warren, and F. B. Hutt and C. D. Mueller. <i>Cornell Univ. Jour. Heredity</i> 35:27-32.
153	1943	Culling Poultry. L. F. Payne. <i>Kan. Agr. Expt. Sta. Circ.</i> 216:1-37.
154	1943	Grass, Grass Silage, and Alfalfa for Poultry. L. F. Payne and C. L. Gish. <i>Kan. Agr. Expt. Sta. Bul.</i> 320:1-46.
155	1943	Inheritance of Polydactylism in the Fowl. D. C. Warren. <i>Genetics</i> 29:217-231.
156	1943	The Influence of Age on Expression of Genes Controlling Rate of Chick Feathering. M. I. Darrow and D. C. Warren. <i>Poul. Sci.</i> 23:199-212.
158	1944	Poultry Thesis, A List of. L. F. Payne. <i>Dept. of Poul. Husb. K. S. C. Jan., 1944,</i> pp. 1-29.
159	1944	Developing of Early Feathering Strains of Heavy Breeds. D. C. Warren. <i>Kan. Agr. Expt. Sta. Circ.</i> 224:1-4.
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79	1939	Diseases of Feeder Cattle in Kansas. Herman Farley. <i>Kan. Agr. Expt. Sta. Cir.</i> 214:1-14.
88	1941	Characteristics of the Population Available for Bioassay of Anthelmintics in <i>Nippostrongylus Muris</i> Infection in Albino Rats. J. H. Whitlock. <i>Jour. Parasitol.</i> 29:42-47.
89	1941	Studies Upon <i>Strongylus Vulgaris</i> . VI Tests with Organic Copper Salts. J. H. Whitlock. <i>Jour. Parasitol.</i> 28:168-169.
91	1942	Bioassay Technique for Anthelmintics. J. H. Whitlock and C. J. Bliss. <i>Jour. Parasitol.</i> 29:48-58.
93	1942	Field Test of Various Anthelmintics Used for the Treatment of Haemonchosis. J. H. Whitlock. <i>Amer. Jour. Vet. Research</i> 3:386-391.
...	1943	The Relationship of Diet to the Development of Haemonchosis in Sheep. J. H. Whitlock et al. <i>Jour. Amer. Vet. Med. Assn.</i> 102:34-35.
96	1944	Diseases of Feeder Cattle. Staff of Dept. Vet. Med., <i>Kan. Agr. Expt. Sta. Cir.</i> 220:1-161.
97	1944	Brucellosis of Cattle. V. K. McMahan. <i>Kan. Agr. Expt. Sta. Cir.</i> 222:1-16.
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100	1941	The Influence of Certain Genetic Factors Upon Eye Color in the Guinea Pig. Mary T. Herman and Annette Alsop. <i>Case. Trans. Kan. Acad. Sci.</i> 45:344-357.
101	1942	The Removal of the Fowl Tape Worm <i>Railletina cesticillus</i> by Short Periods of Starvation. W. M. Reid. <i>Poul. Sci.</i> 21:220-229.

AGRICULTURAL EXPERIMENT STATION

<i>Serial No.</i>	<i>Year of issue</i>	<i>Title, author, and publication</i>
192	1941	Certain Nutritional Requirements of the Fowl Cestode <i>Raillietina cesticillus</i> (Mohn) as Demonstrated by Short Periods of Starvation of the Host. W. M. Reid. <i>Jour. Parasitol.</i> 28:319-340.
194	1942	Kansas Fish in the Kansas State College Museum. Dolf Jennings. <i>Trans. Kan. Acad. Sci.</i> 45:363-366.
195	1942	Important Internal Parasites of Food-producing Animals in the United States. J. E. Ackert and Members of the Committee on Parasitic Diseases. <i>Proc. 46th Ann. Meet. U. S. Livestock San. Assoc., Chicago 1942.</i> pp. 163-172.
196	1943	Some Influences of Stilbestrol Estrone and Testosterone Propionate on the Genital Tract of Young Female Fowls. E. H. Herrick. <i>Poul. Sci.</i> 23:65-66.
197	1943	Important External Parasites of Food-producing Animals. J. E. Ackert and Members of the Committee on Parasitic Diseases. <i>Proc. 47th Ann. Meet. U. S. Livestock San. Assoc., Chicago. 1943.</i>

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73	1912	Kansas Weather and Climate. A. B. Cardwell and S. D. Flora. <i>Kan. Agr. Expt. Sta. Bul.</i> 302:1-108.
74	1942	Eleventh Biennial Report of the Director of the Kan. Agr. Expt. Sta. L. E. Call. <i>Kan. Agr. Expt. Sta. 11th Bien. Rpt., 1940-1942.</i> pp. 1-79.
75	1942	War-time Farming in Kansas. L. E. Call. <i>Kan. State Bd. Agr. Quart. Rpt.</i> 62:67-76.
76	1943	Food in the War Effort. L. E. Call. <i>Trans. Kan. Acad. Sci.</i> 46:267-271.
77	1943	The Development of Sorghums Resistant to Milo Disease. L. E. Melchers and Alvin E. Lowe. <i>Kan. Agr. Expt. Sta. Tech. Bul.</i> 55:1-24.
78	1943	Nitrogen and Carbon Changes in Soils. H. E. Myers, A. L. Hallsted, J. B. Kuska, and H. J. Haas. <i>Kan. Agr. Expt. Sta. Tech. Bul.</i> 56:1-52.

Fort Hays Branch Experiment Station

35	1942	Sorghums for Kansas. L. E. Wenger. <i>Kan. Agr. Expt. Sta. Bul.</i> 321:1-78.
36	1942	The Rise and Decline of Cactus in Kansas. F. L. Timmons. 33d <i>Bien. Rpt. Kan. State Bd. Agr.</i> 38:37-46.
37	1942	The Comparative Effects of Corn and Sorghums on the Yield of Succeeding Crops. H. E. Myers and A. L. Hallsted. <i>Soil Science.</i> 7:316-321.
38	1943	Nitrogen and Carbon Changes in Soils. H. E. Myers, A. L. Hallsted, J. B. Kuska, and H. J. Haas. <i>Kan. Agr. Expt. Sta. Tech. Bul.</i> 56:1-52.
39	1943	Barley Production in Kansas. A. F. Swanson and H. H. Laude. <i>Kan. Agr. Expt. Sta. Bul.</i> 318:1-38.
40	1943	Buffalo Grass. L. E. Wenger. <i>Kan. Agr. Expt. Sta. Bul.</i> 321:1-78.

BIENNIAL REPORT OF DIRECTOR

99

FINANCIAL STATEMENT, 1942-'43

(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	\$59,485.73	\$199,536.69
Branch stations		82,504.03	82,504.03
Main and branch stations, fees.....		134,026.30	134,026.30
Balance, June 30, 1942, all sources less amount reverted		22,186.44	22,186.44
Totals	\$140,050.96	\$298,202.50	\$438,253.46
Personal services	\$126,536.52	\$139,120.97	\$265,657.49
Travel	992.68	4,245.69	5,238.37
Transportation of things	130.88	1,090.68	1,221.56
Communication service	16.30	2,153.68	2,169.98
Rent and utility services.....	228.00	6,640.45	6,868.45
Printing and binding	258.49	2,309.19	2,567.68
Other contractual services	357.31	7,186.79	7,544.10
(Repairs and alterations to equipment and buildings)			
Supplies and materials	8,662.53	40,023.34	48,685.87
Equipment	2,335.24	15,059.97	17,395.21
Land and structures	533.01	6,096.73	6,629.74
Contributions to retirement			
Unexpended balances June 30, 1943.....		74,275.01	74,275.01
Totals	\$140,050.96	\$298,202.50	\$438,253.46

FINANCIAL STATEMENT, 1943-'44

(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	\$61,810.00	\$201,860.96
Branch stations		79,800.00	79,800.00
Main and branch stations, fees.....		178,702.46	178,702.46
Balance, June 30, 1943, all sources less amount reverted		74,273.18	74,273.18
Totals	\$140,050.96	\$394,585.64	\$534,636.60
Personal services	\$127,913.91	\$173,499.74	\$301,413.65
Travel	964.78	4,944.38	5,909.16
Transportation of things	2.00	2,048.99	2,050.99
Communication service	52.13	2,314.42	2,366.55
Rent and utility services.....	18.50	7,113.50	7,132.00
Printing and binding	110.81	973.61	1,084.42
Other contractual services	909.99	12,361.38	13,271.37
(Repairs and alterations to equipment and buildings)			
Supplies and materials	7,707.43	55,878.56	63,585.99
Equipment	2,318.94	19,260.04	21,578.98
Land and structures	52.47	480.00	532.47
Contributions to retirement			
Unexpended balances, June 30, 1944.....		115,711.02	115,711.02
Totals	\$140,050.96	\$394,585.64	\$534,636.60