AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE
MANHATTAN, KANSAS

ELEVENTH BIENNIAL REPORT OF THE DIRECTOR 1940-1942

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KANSAS AGRICULTURAL EXPERIMENT STATION

MANHATTAN, KANSAS

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TABLE OF CONTENTS

LETTER OF TRANSMITTAL

OFFICE OF DIRECTOR,
June 30, 1942

To His Excellency, Payne H. Ratner, 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, 1942. 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 REPORT [1]

INTRODUCTION

This report contains a brief statement of the work of the Kansas Agricultural Experiment Station for the biennium ending June 30, 1942. The station is both a state and federal agency. It was authorized by act by Congress and was organized following the acceptance of this act by the Kansas Legislature on March 4, 1887. It is supported by both state and federal funds which were about equal in amount during the biennium. The work is conducted at the central station at Manhattan, at four branch stations located at Hays, Colby, Garden City, and Tribune, and on numerous outlying farms and experiment fields.

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

COOPERATION WITH OTHER AGENCIES

The station has cooperated actively during the biennium with a number of agencies working in the same or closely related fields. This cooperative work has been upon the whole highly advantageous to this station and has made possible much greater service to the agricultural and rural life interests of Kansas than would have been possible without this cooperation. Agencies with whom cooperative relations have been maintained include other state agricultural experiment stations, the United States Department of Agriculture, other institutions and departments of the state of Kansas, other research agencies, and farmers.

THE STATION AND THE WAR

A major objective during the biennium has been to give all possible assistance in the war effort. Certain adjustments of the work of the station have been made to this end: (1) A special effort has been made to make available to the public facts accumulated from the investigational work of the past that were considered especially useful at this time; (2) information from the station has been drawn upon extensively in agricultural program planning and in setting up the state production goals; (3) adjustments have been made in the research program to help provide additional information needed urgently in the war effort; and (4) certain members of the station staff have been released wholly or in part from regular duties to assist with war work.

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[1] Contribution No. 74 from office of the Director.

Much information has been accumulated from the research work of the station through the past 50 years that is exceedingly helpful in the production of an abundance of food and other material needed by the nation. While this information has been made available in the past through regular publications of the station, a special effort has been made during the biennium to assemble this information in readily usable condition, and through the Extension Service, through correspondence by station workers, and in other ways, to make it available to the farmers of the state.

The data compiled through the past years as a part of the research in farm management and farm operation have provided the basic data in planning the farm production goals. These data have

This photograph shows one of the laboratories and two research workers at the central station at Manhattan where research work is being conducted on the commercial utilization of sorghum grain.

provided information on labor and material requirements for crop and livestock production in the different parts of the state. By taking stock of the resources of each type-of-farming area and their present organization by type and size of farm, it is possible to appraise the ability of each type-of-farming area to increase its production of needed farm products. The 1942 production goals were determined, in part, on this basis, but the limited time available for setting up these goals prevented full use of these materials for this purpose. Much greater use is being made of these materials in setting up the production goals for 1943, and it is believed that a much better job is being done. In the same manner, basic information of the station accumulated in the past is being used in all phases of agricultural program planning work.

Since the chief objective of station work has been efficiency and economy in production and in processing of agricultural products, and since these are the objectives of greatest, value in the war effort, no material change in emphasis has been made when the project work of the station as a whole is considered. However, the war has presented many new problems and has required minor changes in emphasis on old problems. Adjustments in the projects have been made to meet these changes. Special emphasis has been given to the researches on sorghum grain starches. Attempts are being made to prepare a starch from sorghum that may be substituted for imported tropical starches. Leoti and hybrids of this variety of sorghum produced at the Fort Hays Branch Station show promise of containing starches useful for this purpose. A study is being made of native and introduced plants that may be used for growing for medicinal purposes or that give promise from the standpoint of rubber production. Several species of wild milkweed and other wild plants are being grown and will be analyzed for rubber. Guayule plants have been obtained and trial plantings made in several sections of the state. Russian dandelion, *Taraxacum koksaghyz*, seedlings have been made at different times in several localities in the state. Special emphasis has been placed on the experimental work with flax and soybeans in an effort to obtain better varieties for oil-production purposes and those that can be harvested successfully with the combine, thus reducing labor costs.

Much of the time of the station staff has been devoted to work of an emergency character related to the war. The victory garden and nutrition work has utilized much of the time of members of the staff of the Departments of Horticulture, Home Economics, Chemistry, and the animal industry departments as well as the Departments of Entomology and Botany. Nearly all of the departments of the central station as well as those of the branch stations have assisted with work relating to the agricultural production goals. Staff members have taken the leadership as chairmen and members of important state committees dealing with various war activities, and a few of the projects leaders have been granted leave of absence to enter the armed forces.

BUILDING, EQUIPMENT, AND LAND

The station lost by fire on March 15, 1941, a two-story frame structure, 42 by 185 feet, built in 1918 and used during the following 21 years as a small-animal laboratory and field crop nursery building. Requests were made of the legislature which was then in session for appropriations with which to restore this loss. The legislature appropriated $9,000 for replacing the equipment lost in the fire and an appropriation of $3,000 for the construction af a field crop nursery building. This money was available immediately and the equipment was replaced promptly.

A two-story crop nursery building of frame construction, 30 by 60 feet in size, was completed in time for the harvest of 1941. The

legislature also appropriated $50,000 for the construction of a fireproof small-animal laboratory building, this money to be available in 1943.

An old one-story building, 26 by 32 feet, used as an apiary laboratory, was moved to a new location, placed upon a well-constructed basement, and completely remodeled. This building was completed at a cost of $3,300.

A subterranean insectary, 16 by 22 feet, was constructed for the Department of Entomology at a cost of $900.

Buildings constructed at the branch stations are the following:

The building in the foreground, a concrete and brick seedhouse, was built at the Fort Hays Branch Station during the biennium at a cost of about $15,000. The building is fireproof.

1. A fire-proof seed house of reinforced concrete with brick construction and tile roof was completed at the Fort Hays Branch Experiment Station in 1942 at a cost of $15,000. The building is two stories with partial basement, 65 feet by 42 feet, with a height of ceiling on each floor of 13 feet 6 inches. It is estimated that the building can store safely 20,000 bushels of seed in bags. The building is conveniently wired on both floors with 110-volt current and 220-volt three-phase power circuits, and is equipped with platform elevator for the handling of bagged seed.

2. At the Garden City Branch Station a cottage was built for the use of the station agronomist and family. The structure is of wood frame design and completely modern. It has a full concrete basement, four rooms and bath, with hardwood floors and plastered

walls. The house was built with a special appropriation by the legislature of $2,500.

Also at the Garden City station, a cattle shed, 20 by 104 feet, was built to accommodate the expanding herd of dairy cattle. The structure is of open front design and cost approximately $800.

3. New construction at the Colby Branch Station consists of a pit silo, 12 by 33 feet, built with regular station labor at a cost of $138 and the enlargement and rearrangement of the milk house at a cost of $508.

The legislature of 1941 appropriated $8,000 for the purchase of 320 acres of land adjoining the Colby station on the south that had been rented by the station for a number of years. This land was purchased from Mr. Ike W. Crumly in July, 1941.

PERSONNEL CHANGES

Dr. W. H. Metzger, member of the staff in soils of the Department of Agronomy, has been granted indefinite leave of absence because of sickness.

Leaves of absence have been granted the following members of the staff to enter the armed forces or engage in defense work.

D. L. Mackintosh, meat investigations.
R. B. Cathcart, horse investigations.
M. J. Twiehaus, poultry disease investigations.
J. W. Greene, chemical engineering investigations.
C. H. Kitselman, animal disease investigations.
Leo Petri, zoological technician.

Appointments.–The average number of persons regularly employed on the scientific staff of the station during the biennium was 148. Seventeen appointments were made during the biennium as follows:

R. W. Hoecker, fruit and vegetable marketing.
R. F. Sloan, assistant, North Central Kansas Experiment Fields.
Don E. Crumbaker, assistant, Bindweed Experiment Field.
Helen Mertz, assistant, animal husbandry.
Howard V. Vernon, supervisor, State Institutional Dairy Herds
Richard C. Johnson, forestry.
Donald P. Duncan, forestry.
John A. Johnson, Jr., baking research.
Warren F. Keller, research miller.
Don E. Fleming, milling chemist.
A. E. Schumacher, poultry production.
Wilbert Greer, superintendent, poultry farm.
L. H. Schoenleber, agricultural engineering.
James W. Martin, agricultural engineering.
Leah Ascham, food economics and nutrition.
Leo Petri, zoological technician.
John C. Crupper, Jr., forest nurseryman, Fort Hays.

Resignations.–Nineteen of the staff resigned during the biennium. Those resigning were:

R. J. Eggert, livestock marketing.
John H. McCoy, land economics.
R. F. Sloan, assistant in agronomy.
Julia Bradley, assistant, animal husbandry.
C. E. Arndt, supervisor of State Institutional Dairy Herds.
Alfred O. Shaw, dairy production.
Lloyd F. Smith, forestry.
Richard C. Johnson, forestry.
Donald P. Duncan, forestry.
Don E. Fleming, milling chemist.
Clarence L. Gish, superintendent, poultry farm.
H. M. Scott, poultry physiology.
Charles K. Otis, farm machinery.
E. L. Barger, agricultural engineering.
B. W. Beadle, analytical chemist.
W. J. Peterson, nutrition chemist.
Pauline Nutter, food economics and nutrition.
Bernice Kunerth, food economics and nutrition.
Allen Edgar, zoological technician.

SCOPE OF THE STATION WORK JULY 1, 1940, TO JUNE 30, 1942

STUDIES IN THE ECONOMICS OF AGRICULTURE

Ten principal lines of research were conducted during the biennium in the economics of agriculture. Brief reports of the progress made in these projects are printed on this and the following pages.

Studies of Factors Affecting the Organization and Operation of Kansas Farms.–The work for the biennium ending July 1, 1942, consisted of several phases, including:

1. *Type of farming and related problems*.–Census data indicate a continuing trend toward larger-sized farms with greatest increases in the western part of Kansas. Wheat acreage is down in the eastern part of the state. Corn acreage tends to be inverse to that of wheat in that section, also. Forage and grain sorghum acreages approximate those of 1935. The increase of all types of livestock, except horses and mules, since 1938, has been rapid.

2. *Factors affecting farm income and other account book work*.–Farm records have emphasized the importance of the quality of the livestock enterprises rather than were size of enterprise.The increasing numbers of livestock have tended to cause some shifts in type of farming from general and cash grain to livestock specialty. On these groups of farms good management was a more important factor affecting income than was tenure. Incomes during 1941 were substantially higher than in recent years.

3. *The study of farm organization and management through farm budgeting*.–Those systems of handling beef cattle offering the highest returns require the highest degree of managerial ability on the part of the farmer.The budget method of planning enables the farmer to determine in advance the effect of following certain production and marketing techniques. Systems of producing beef in the Bluestem Belt of Kansas that have proved the most profitable are deferred feeding, creep feeding, and wintering and grazing.

4. *Farm practices and related problems*.–The labor and feed requirements for handling cattle by different methods under farm conditions were determined. Since 1933 the use of tractors has increased relatively more rapidly

in eastern Kansas than in other sections of the state and additional information was needed on requirements for crop production.

5. The effect of policies of the AAA and/or other agencies upon the management and income of Kansas farms.–Work upon this phase of the project during the biennium consisted principally of summarizing studies formerly made in four representative areas in Kansas. This work was carried on in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture.Two of the eight summary reports have been mimeographed.

6.The relation between the organization of resources on farms and the systems of farming followed in a community.–A survey was made of an area extending outward from Frankfort, Marshall county, in a radius of about eight miles comprising most of the nine townships in the southeast corner of the county. Data included 96 detailed and 81 short-form farm records in addition to about 20 landlord records, supplemented with information collected from other sources. Data were analyzed on the basis of size and type of farm for the distribution of farms, farm organization, and inter-farm relationships. At least 75 percent of the farms were less than 300 acres in size. The modal size farm in the Frankfort community was 160 acres. The percent of tenancy for the community was 4 percent less than that for the state as a whole. There were nine types of farms, 42 percent of which were cash-grain farms. The average return on farm capital for farms less than 100 acres in size was 2.3 percent, while the average for all farms over 100 acres was about 5 percent. Cash-grain farms had the highest percentage return on farm capital, averaging 10.6 percent. More of the middle-sized farms, those from 100 to 400 acres in size, exchanged labor than either the smallest- or the largest-sized farms. More of the operators on small farms did work off the farm, but the operators on the larger farms received a higher average return due to the type of work performed. The operators on small farms did mostly farm work, while the larger farm operators did road work, AAA work, or other public service work. Most of the man-labor and the machine work hired by operators was supplied from other operators or persons within the community. There was considerable cooperation among the various farm units within the Frankfort community.

(Project 95, Department of Agricultural Economics. Leaders, W. E. Grimes, J. A. Hodges, W. H. Pine, R. J. Doll, H. J. Meenen; Purnell and state funds.)

The Development of an Agricultural Land-use program for the State of Kansas.–Investigations were conducted in conjunction with the land-use planning agreement between the Kansas Agricultural Experiment Station, the Division of College Extension, Kansas State College, and the Bureau of Agricultural Economics, and the Soil Conservation Service, United States Department of Agriculture.

The area analysis of Nemaha county was completed during the biennium and is reported in detail in Bulletin No. 305, published by this station.

A similar analysis of Chase county was completed, using the same technique employed in Nemaha county. The analysis showed 17 agricultural areas, several of which were similar but were separated by other areas. The county is in the center of the Bluestem Belt and the areas varied from about one-third to entirely pasture land with an average of four-fifths in pasture. Adjustments to be recommended were determined, giving more consideration to the use of a pasture and livestock program than was given in Nemaha county.

A survey was made of 174 farms in the vicinity of Holton, Jackson county, nearly one-half of which were general farms of 120 acres or more. The remainder of the farms were divided into two groups–1 to 80 acres and 81 to

120 acres. One-fourth of the smaller farms were "part-time" and one-third were dairy farms. By the use of budgets and case studies it was found that by reorganization the incomes of the smaller farms could be increased somewhat, but more improvement was found possible by greater efficiency. Of the smaller farms only the part-time farmers had an average income adequate for a reasonable standard of living.

To provide background material for county agricultural planning, a graphic summary of Decatur county was prepared from data obtained from secondary sources.

A reconnaissance soil survey was made in cooperation with the Soil Conservation Service of 80 Kansas counties. The survey showed soil groups, parent soil material, slope, degree of erosion and land use capability of each soil group in each of the counties. This survey provides, for the first time in many of the counties, information and maps concerning the basic resource in agriculture. A shortage of draftsmen has delayed the preparation of the maps by the Soil Concervation Service. A similar type of survey has been started in the remaining 25 counties of the state.

(Project 215, Departments of Agricultural Economics and Agronomy. Leaders, W. E. Grimes, W. H. Pine, M. L. Otto, H. E. Myers. Bankhead-Jones fund.)

Studies in Land Tenure and Related Problems–Most of the work on this project during the biennium has been in the field of land tenure and was in cooperation with the Bureau of Agricultural Economics.

Schedules that had been completed by about 6,600 Kansas landlords and tenants have been summarized. This information will be presented, in detail, on landlord, tenant, and lease conditions in each tenancy area in Kansas.

A review of the legal aspects of tenancy in Kansas shows state laws governing landlord-tenant relationships are reasonable and that the courts have been liberal in their interpretations. A station publication, Bulletin 303, Farm Tenure in Kansas, reviews tenancy in detail and offers some suggestions for improvement of landlord-tenant relations.

The budget approach has been employed in a study of leases and it was found that the customary arrangement of the stock-share lease, which was developed in the pre-tractor era, tends to work to the disadvantage of the tenant. A station publication, Circular 213, points out in detail the merits of the stock-share type of farm lease and makes recommendations for application of that type of lease to different conditions.

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

The Marketing of Kansas Grain.–The major phases of this project are continuous studies. The following work was carried on during the biennium:

1. The established statistical series on prices, receipts, stocks, movement and storage of Kansas grains were continued. Governmental agricultural programs and the influence of the war have introduced many new factors into forecasting of grain prices.

2. Operating and financial ratios were determined for 126 cooperative elevators and 80 cooperative oil associations.For 21 elevators continuous records for 10-year periods have been completed.

3. It has been found over a period of years that fall precipitation in some areas in Kansas is a reliable indicator of probable wheat yield. Official yield and precipitation records for the 1942 season will add validity to the relationship between rainfall and wheat yield because the 1942 statistics, when added

to the charts, will tend to determine the upper extremity of the line of relationship between precipitation and yield.

(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 consisted of the following three phases:

1. Livestock marketing channels used by Kansas farmers.–A rather complete enumeration of the various types of livestock marketing agencies in Kansas was made from mail questionnaires returned by county agents, chambers of commerce, and local bankers. A sample survey of farmers disclosed the relative proportions of the different classes of livestock that were bought and sold through the various marketing agencies. Information on the methods of operation of these agencies was obtained from persons closely associated with them.

2. A study of livestock trucking.–The Missouri and Kansas stations cooperated in a study of the livestock trucking situation at the Kansas City terminal market. One-fourth of the trucks returned from the market, with a 75 to 120 percent capacity load; two-fifths of the trucks returned empty.

3. Current market interpretations and livestock price forecasting.–Current market trends are disseminated in the annual Kansas *Agricultural Outlook*, the monthly *Kansas Agricultural Situation*, the weekly *Trend of the Markets* and *Picking Profitable Projects*, a monthly service. In addition, the *Cattle Outlook* is prepared twice yearly and the *Hog Outlook* and *Sheep Outlook* are each issued yearly.

(Project 149, Department of Agricultural Economics. Leader, Peairs Wilson. Purnell funds.)

The Economics of the Poultry Industry in Kansas.–Three phases of work have been carried under this project during the biennium:

1. Market forecasts and comments.–Statistical series are maintained on the poultry and egg markets and market forecasts published in all special service publications of the Department of Agricultural Economics. Market information is also prepared for use by radio stations and the Kansas press.

2. Farm poultry enterprises.–A study of the poultry enterprise on Kansas farms shows that for 1941 the average poultry labor income per 100 hens for 38 producers with general-purpose breeds was $183.20; for 33 producers with egg breeds it was $155.75. Factors affecting labor income were size of flock, egg production per hen and the percentage of eggs sold to hatcheries. Factors influencing the prices received from poultry and eggs were analyzed.

3. *Economics of turkey enterprises*.–Work has been started, in cooperation with the Farm Credit Administration, on a study of the economics of the turkey enterprise in Kansas.

(Project 144, Department of Agricultural Economics. Leader, R. W. Hoecker, Purnell funds.)

The Marketing of Kansas Fruits and Vegetables.–The economics of marketing products from Kansas commercial orchards and vegetable gardens constituted the major portion of study of this project.

Statistical information was compiled or brought up to date for use in preparation of market outlook reports, radio discussions, and in supplying economic information to inquirers.

A retail potato marketing survey determined retailer and consumer preferences for Kansas-grown potatoes compared with shipped-in potatoes.

A study was completed of the Kansas City produce terminal market. The number of farmers who patronized the market varied considerably throughout the year. Sixty-one percent of the stall rentals were during July, August, September and October. Jobbers and wholesalers purchased about three-fourths of the farmers' products. The selling time averaged about 6 hours per load. Labor and container costs were the most important variable costs.

(Project 177, Department of Agricultural Economics. Leader, R. W. Hoecker; Purnell funds.)

Production and Marketing of Kansas Potatoes.–The Departments of Agricultural Economics and Horticulture have cooperated in this study which was conducted in two general lines.

1. *Economic phases of production and marketing.*–Shrinkage on U. S. No. 1 potatoes in storage averaged from 5 to 8 percent with very little deterioration during a six-months period. Potatoes grading U. S. No. 2 and lower averaged from 15 to 25 percent deterioration. Preliminary investigations with ultra-violet ray treatment to improve keeping quality produced negative results. The shrink that may be expected of a given variety and grade of potatoes in cold storage was determined in the 1941 season. Factors affecting shrink were type of bag, humidity, and temperatures.There was little difference in shrink between varieties or between washed and unwashed potatoes of the higher grades.

2. *Factors affecting market quality of Kansas potatoes.*–Fertilizer studies were carried on in three sections of the potato producing area. The results indicate that heavy rates of fertilizer application are not practical and that soils differ greatly as to the fertilizer needs. Warba and Red Warba averaged higher yields than Cobbler or Triumph, but the quality was inferior due to growth cracks, second growth and ill-shaped potatoes.

A study showed that Kansas potatoes were shipped to 22 states during the 1941 season. Eight of the states to the south took 18 carloads. Six states to the north received 228 carloads and 772 carloads were shipped east.

(Project 214, Departments of Agricultural Economics and Horticulture. Leaders, R. W. Hoecker and S. W. Decker; Purnell funds.)

A Study of Factors Governing the Marketing of Dairy Products in Kansas.–Work on this project during the biennium consisted principally of assembling and interpreting data pertaining to the dairy industry of Kansas.

The statistical material used in preparation of periodic market forecasts has been kept to date. These materials are also used in answering direct requests.

A survey was made of the location, size, type, etc., of dairy processing plants in Kansas. This information was used to advise various interested groups.

A study of the cooperative creameries in Kansas is under way.

(Project 185; Department of Agricultural Economics. Leader, R. W. Hoecker; Purnell funds.)

A Study of Factors Affecting the Social Well-Being of Rural People in Kansas.–The Division of Farm Population and Rural Welfare of the Bureau of Agricultural Economics has co-

operated with the Department of Agricultural Economics in this project, which has been carried on in two principal phases.

1. Population changes and movements.–Preliminaryresults of a survey conducted in 1941 indicate a decline in farm population, a decrease in the number of births and in the number of deaths, a decline in movement from farm to farm and an increase in the migration from farms to cities.

2. A study of health resources and facilities.–Data for this study were obtained from primary and secondary sources. Graphic diagrams have been prepared which show number and location of all physicians, dentists, pharmacists, chiropractors, osteopaths, hospitals, nurses and certain special medical equipment within the state.

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

SOIL INVESTIGATIONS

Soil problems treated from the standpoint of conservation of the soil were continued through the biennium. Descriptions of the several projects under this classification are presented herewith.

Soil Fertility Investigations.–Field experiments, which have been in continuous progress through 32 crop seasons, have been continued during the biennium with a few changes in the general plan.

A summarization of crop yield data shows progressively larger increases from the use of phosphatic fertilizer and barnyard manure as the experiments become older. The need for lime is also shown to be increasing, although the need for lime is not now so great as the need for phosphorus. Potash fertilizers have not given increases in crop yields. The superiority of the alfalfa rotation over rotations containing soybeans or no legume emphasizes the fact that nitrogen and organic matter soon become limiting factors on this soil when legume cropping is omitted.

Laboratory studies showed that the quantity of phosphorus fixed by a prairie soil is more closely related to the total iron and aluminum of the soil mass than to the quantity of these elements dissolved by a weak solution of a strong acid. Aluminum appears to be appreciably less active in the process of phosphorus fixation than is iron.

(Project 17; Department of Agronomy. Leader, W. H. Metzger; Hatch funds.)

Influence of the Absolute Reaction of the Soil Solution Upon the Growth and Activity of Azotobacter.–This project has been continued through the biennium, in two principal phases.

1. *Changes in Azotobacter and nitrogen content of soils.*–Variously treated soils in field cylinders have been observed. *Azotobacter* introduced into the soils receiving certain treatments 19 years ago are still abundant, whereas they have not become established following other treatments in spite of repeated introductions. The presence of *Azotobacter* has not significantly influenced plant growth.

2. *Effect of H^+ concentration upon various physiological activities of Azotobacter.*–Special attention in this phase has been given to reproduction and respiration studies. The minimum pH level compatible with reproduction varies somewhat for different strains of the organism and conditions but in general appears to be in the vicinity of 5.8. The presence of combined nitrogen in the medium influenced but little, if any, the critical pH for reproduction.

The major outgrowth of the respiratory studies is a strong indication that

calcium plays an important role in the respiration of *Azotobacter*. This observation furnishes a possible explanation for the absence of *Azotobacter* from soils and their failure to grow in the conventional media when the pH falls much below 6.0, in that with the relatively high H^+ concentration and low calcium concentration the cell may not be able to adsorb sufficient calcium ions to enable it to carry on normal respiration.

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

The Influence of Legumes and Free-Living Organisms on the Growth of Plants and on the Nitrogen Balance of Kansas Soils.–This project was continued in two branches–field and laboratory–during the biennium.

Field plot results indicate that the harmful effect of a sorghum crop on succeeding crops can be overcome by the use of either alfalfa or sweet clover in the rotation.

A summary of soil nitrogen and carbon changes over a 22-year period at Hays, Colby and Garden City shows that continuous small grain cropping has caused the least loss of these elements in comparison to other cropping systems. Alternate small grain and fallow caused only a slightly greater loss than small grain grown continuously. The greatest loss occurred under the alternate row crop and fallow cropping system. This not only resulted from the cropping system used but was influenced also by the total yield of crops produced during the period and by the original nitrogen and carbon content of the soil.

The stability of soil aggregates is related to the biological activity in the soil. The cause of the favorable effect of increased bacterial numbers seems to be more one of changing the quality of the organic matter and not one of actual binding of soil particles by the organisms.

Greatly improved growth of barley and strawberries were obtained on an old orchard soil from Doniphan county by the application of 20 tons of barnyard manure per acre under greenhouse conditions. Other treatments were ineffective. The productivity was low, due in part to spray residues.

Ammonium sulfate, 200 pounds per acre, corrected a "sod-bound" condition that had developed in a bromegrass field. The fertilized grasses were larger than grasses growing on a similar unfertilized soil that had not grown bromegrass.

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

The Storage, Utilization and Evaporation of Soil Moisture. –The lysimeter study of moisture utilization by crop plants conducted cooperatively with the Soil Conservation Service, United States Department of Agriculture was continued through the biennium with only minor changes. This work has been extended to include a more detailed study of the nature of moisture losses through evaporation.

Grain crops make their heaviest draft on water during the active growing period previous to the fertilization of the seed. For winter wheat under conditions at Manhattan as much as one-half of the total water used for growth purposes may be used during May.During warm, dry weather a previously moistened soil loses up to about one-half inch of moisture quite rapidly, after which evaporation losses decrease rapidly.

Evaporation takes place from a relatively thin layer of surface soil, the surface inch being almost completely dried before an appreciable amount of water is lost from the second inch.Once the surface layer has become air dry its moisture content fluctuates with atmospheric conditions, particularly from

day to night. Part of the moisture which during the night accumulates in the relatively dry surface soil is lost to the atmosphere when the temperature rises in the morning but since the second section gains in weight at this time part of the moisture evidently moves downward. Moisture is lost from the relatively thin upper section of the moist zone during the day but any loss which takes place from the lower part of the moist zone occurs during the night. These moisture changes are associated with changes in soil temperature. A year long continuous record of soil temperatures under a fallowed surface at depths of 1/2 inch, 2, 6, and 12 inches is now available.

Distillation of moisture as a result of temperature differences in the soil is not rapid but appears to be significant. It may have seasonal importance and account for the gradual wetting of subsoil after it has been dried by a deep rooted crop as alfalfa.

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

A Study of the Soil Solution as Governed by the H-ion Concentration and Other Factors.–The effect of treating soil separates and fractions with different acids at a pH value of approximately 2.0 and with hydrochloric acid at pH values of 3.5, 5.5, 7.0 and 9.0 constituted the major portion of the work on this project during the biennium.

Results obtained indicate that the acid treatment tends to increase the base exchange capacity of the sandy separates of a soil but has little effect on the colloidal separates. Chemical studies indicate that the SiO_2/R_2O_3 ratio, after acid treatment, is about the same as before the treatment. It is, therefore, assumed that any mineralogical change caused is associated with the minerals high in SiO_2 content and does not alter the composition but rather the structure.

(Project 155; Department of Chemistry. Leader, A. T. Perkins; Purnell funds.)

A Study of Replaceable Cations and Anions in Some Kansas Soils.–Work on this project during the biennium has been devoted to a study of phosphate fixation in soils, soil separates and soil fractions.

The results secured show that acid treatment of a soil decreases phosphate fixation on the coarse sandy particles from 79 percent to 61 percent on a 1,000-pound application per acre of CaH_4 $(PO_4)_2$ but increases phosphate fixation from 61 percent to 89 percent, on the silt separates. With a 5,000-pound application the phosphate fixation was increased from 91 percent to 99 percent by acid treatment of the colloid particles. The changes obtained give similar curves to the changes noted in base exchange capacity in Project No. 155. It is quite evident that mineralogically the sands differ from the clays and col loids and this has been substantiated by chemical analysis.

Project 179; Department of Chemistry. Leader, A. T. Perkins; Purnell funds.)

Soil and Crop Experiment Fields.–A group of two outlying experimental fields, one at Belleville and one at Smith Center, were added to the four existing groups during the biennium. Both fields were established in the spring of 1942 after the state legislature appropriated funds for their maintenance. Work carried on at

the new fields will be similar to that carried on at other fields. The fields have been designated as the North Central Kansas Experiment Fields.

The addition of a bindweed experimental field was also made possible by action of the 1941 session of the Kansas legislature, which appropriated $5,000 for this purpose. The field selected consists of 80 acres near Canton, Kansas, uniformly infested with bindweed. Various cropping, cultivating and chemical treatment experiments will be conducted. Work was started in the spring of 1942.

Southwest Kansas Experiment Fields.–Basin listing as a method of seedbed preparation and planting sorghums produced 29.3 bushels of grain and 4.6 tons of dry forage per acre on continuously cropped land while ordinary listing yielded 23.9 bushels of grain and 3.6 tons of forage per acre.

The average yield of wheat on fallowed land at the Meade field was 18.2 bushels per acre compared with an average of 11.7 bushels on continuously cropped land.

Contour fallowing and seeding on an area at the Dodge field with a slope of 0.21 percent produced an average wheat yield of 15.5 bushels during the biennium, while noncontouring has produced an average yield of 16.4 bushels per acre.

Mowing of newly seeded grasses, even during the second year, after the plants have become fully established, has shown a marked beneficial effect, principally through weed eradication. Plots of buffalo and blue grama maintained nearly perfect stands as compared with a stand of about one-third optimum for the areas not mowed.

(Department of Agronomy. Leaders, A. B. Erhart and R. I. Throckmorton; State funds.)

Southeast Kansas Fields.–The work at these fields during the past biennium has consisted chiefly of fertility and variety tests of farm crops. In general, the data obtained substantiate previous results, giving more reliable crop yield averages.

Soybean yields were exceptionally high in both years, but no significant increases were obtained through the use of any fertilizer treatment.

Phosphate fertilizers plus barnyard manure continued to give definite increases in wheat yields at the Columbus and Thayer fields.

Reno and Ward winter barley survived 90 percent in a winter-hardiness test, while Missouri Early Beardless had about 20 percent survival.

Legumes in the crop rotation produced an increase of about 6 bushels in wheat yield at the Columbus field. Addition of a treatment of 20 percent superphosphate has been about twice as effective in increasing wheat yields as a comparable application of rock phosphate. Superphosphate also increased the test weight and size of kernel of wheat.

(Department of Agronomy. Leaders, F. E. Davidson and R. I. Throckmorton; State funds.)

South Central Fields.–The Kingman field was relocated in the fall of 1941. The new field is located 7 miles south of Kingman on Kansas highway No. 14.

Variety tests of wheat conducted have given Comanche and Pawnee wheats a considerable advantage in yields. (For a report on these two new varieties see Project No. 67, Small Grain Improvement.)

In the corn tests it was found that the early hybrids have yielded higher than later-maturing hybrids. Hays Golden has been the outstanding open-pollinated variety and has compared favorably with hybrid yields. Corn has yielded only about 55 percent as much as grain sorghums over a 10-year period.

Grain sorghums that have proved their adaptability to south central Kansas include Pink kafir, Red kafir, Western Blackhull and Club kafir. A natural hybrid selection known as Pierce has been outstanding in yield at the Hutchinson field. West of Kingman county Western Blackhull is better adapted than Standard Blackhull. Atlas and Kansas Orange continue to be the outstanding forage varieties, with Atlas having the preference because of its stiffer stalk and kafir type white grain.

Application of commercial fertilizers on small grains in the Kingman area did not produce any significant increase in yield. There has been more response to commercial fertilizers in the Wichita area, however, but it is questionable whether fertilizing is profitable except on certain soils.

(Department of Agronomy. Leaders, Clare R. Porter and R. I. Throckmorton; State funds.)

Northeast Kansas Fields.–Phosphatic fertilizers caused wheat to mature two to three days earlier than unfertilized wheat and the grain averaged a pound or more per bushel in test weight.

In a two-year rotation of oats and corn, manure was somewhat more effective in increasing the yields of both oats and corn than sweet clover seeded with the oats and turned under in the spring. The addition of phosphorus to the sweet clover made this treatment equal to manure.

Fulton oats continued to be the high-yielding variety.

Clarkan yielded 43.6 bushels in the 1940 wheat variety tests, followed by Kawvale X Tenmarq 2723 with a yield of 42.4 and Kawvale, 40.6. Clarkan was also more winterhardy than the other varieties.

In the barley variety tests Missouri Early Beardless and Ward were inferior in yield to Reno and the Southeast Kansas strain. All varieties winterkilled in the November, 1940, freeze and yields were not obtained in 1941.

Pride of Saline was the only open-pollinated variety of corn to compare favorably with hybrids tested. Practically all hybrids outyielded Reid's Yellow Dent.

Atlas sorgo and Kansas Orange produced an average forage yield of 11 1/2 tons and 10 tons, respectively. Yields of other varieties tested were much lower. Grain yields for the two-year period were not consistent.

Soybeans drilled in 7-inch rows have yielded better in hay and grain than when planted in 40-inch rows.

Mulched fruit trees in the Atchison experiment orchard made more rapid growth and higher yields than did trees under different cultural treatments. The fruit from mulched trees was slightly larger. Yield was materially reduced by thinning; size of the individual fruits was increased slightly but not enough to compensate in pounds of fruit per tree for removal for part of the crop. The only apparent advantage from thinning is prevention of branch breakage and on this basis thinning might prove beneficial over a long period.

The freeze of November, 1940, killed most of the trees in the Atchison orchard, and it was abandoned. For a complete report on the orchard, readers are referred to Bulletin No. 301, The Atchison Experiment Orchard, published by this station.

Liquid lime sulfur was the only spray material to give satisfactory control of apple scab on both fruit and foliage during the 1941 season at the Blair orchard. Fruit and foliage on unsprayed trees were 100 percent infected.

Use of harvest sprays, designed to prevent premature dropping of the fruit, reduced the number of drops on Jonathan trees by 19 percent in 1940. Twenty days after this spray was applied, 58 percent of the crop remained on the unsprayed trees, and 77 percent on the sprayed trees. When picking was delayed

until 30 days had elapsed between spraying and harvest, a second spray applied two weeks after the first was effective.

Mulched strawberries produced an average yield of 2,756 quarts per acre compared with 2,036 quarts per acre for the unmulched which came into production and reached their peak a few days earlier than the mulched plants. The fruit from the mulched plots was much cleaner and more attractive.

The entomological work at these fields is given in this report in the plant disease and insect section. See page 55.

(Departments of Agronomy, Horticulture and Entomology. Leaders, Erwin Abmeyer, R. I. Throckmorton, W. F. Pickett, and G. A. Dean; State fund.)

INVESTIGATIONS IN THE PLANT INDUSTRIES

Much of the work of the station is devoted to increasing the efficiency of plant production and of improving existing crop varieties. The following pages contain brief reports of the projects conducted during the biennium in this phase of agriculture.

Temperature Relations of Crop Plants.–Work under this project dealt mainly with the study of conditions that would induce heat resistance in corn, wheat and sorghums.

It was found that the character and quantity of growth of young wheat plants were influenced more by variations in temperature than by differences in moisture. Interrelations of varying temperature and moisture significantly influenced the photosynthesis-respiration ratio and the top-root ratio.

Plants of corn, sorghum and wheat developed heat resistance when exposed to both natural and artificial light. The amount of resistance acquired increased with increased intensity of light, the greatest being developed in plants that were exposed to direct sunlight.

Winter-hardened wheat plants that had been in the greenhouse for varying lengths of time possessed varying degrees of heat resistance, the highest being in the plants that were most cold hardy.

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

Crop-Weather Studies.–These investigations conducted cooperatively with the Division of Cereal Crops and Diseases, and the Agricultural Marketing Service, United States Department of Agriculture, are for the purpose of determining the influence of environmental conditions on the growth and development of wheat, particularly as these influences might ultimately affect the yield or quality of the crop. Similar but less extensive investigations were made cooperatively by the Bureau of Plant Industry at five other experiment stations in the hard red winter wheat region.

Environments which were favorable for large growth of the crop during the fall and early spring, for the development of large plants, large tillers, and high numbers of tillers per acre and per plant were in general favorable for high yields. The correlations between these plant characters at the end of the fall growing period and yield of the crop at maturity indicated that about 25 percent of the yield variation was associated with variations in the growth characters of the plants as measured at the end of the fall growing period. Similar plant measurements made during the spring showed somewhat less association with yield. In samples taken between the full head and mature

stages the number of heads per acre was highly associated with the yield of grain, the correlation ranging from 0.72 to 0.81. It would appear, therefore, that one-half to two-thirds of the yield variation was associated with variations in the number of heads per acre. As the crop approached maturity the size of kernel and the weight per volume of the grain were positively and significantly associated with yield.

(Department of Agronomy. Leader, H. H. Laude; State fund.)

Small Grain and Sorghum Improvement.–The work of this project is in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture. Research on the project is supplemented by cooperative projects involving the Departments of Botany, Entomology and Milling Industry.

Winter Wheat.–Two new varieties developed in part with support from this project and named during the past biennium are Comanche and Pawnee. Pawnee has not been approved for distribution but is being increased for commercial production.

Comanche (C. I. 11673) was selected from a hybrid population resulting from the cross of Oro X Tenmarq. Its superior characteristics are high yield, good test weight, earliness, stiff straw, milling and making quality equal to the parents, high resistance to leaf rust and tolerance to stem rust. It is a bearded hard red winter wheat adapted to central Kansas and the southern Great Plains.

Pawnee (C. I. 11669) resulted from a cross of Kawvale X Tenmarq. The original hybrid and resulting segregating populations were carried under this project until in the F_3 generation. Final selection was made at the Nebraska Agricultural experiment Station. Pawnee is a promising variety of hard red winter wheat and tests are being continued to determine its suitability for this area and its milling quality.

Selection and testing of other superior strains of winter wheat was continued in the 1941 season at Manhattan and Thayer. An intra-state nursery was established at seven points in Kansas.

Flax.–New strains grown at the Thayer field show an average of 2.0 bushels per acre higher yield than Linota, the leading variety in the flax area of Kansas.

Winter Barley.–Hardiness nurseries were maintained at Manhattan and Columbus. Differential killing at Columbus indicated Reno, Admire, Purdue 21, Purdue 1101 and Ward were most hardy. The first two named varieties are grown commercially in Kansas.

Oats.–Thirty-four new strains of oats resistant to crown rust were tested for the first time and all yielded more than Kanota and 13 yielded more than the highest Fulton check. The new strains have disease resistance, stiff straw and good test weight. They are selections from the crosses Fulghum-Markton X Victoria-Richland and Fulton X Victoria-Richland.

Sorghums.–A heavy infestation of chinch bugs in 1941 made possible the selection of strains resistant to that insect pest. Selections from the Weskan X Greeley cross proved to have high yield and adaptation to western Kansas. Five selections tested for the first time ranked first, second, third, sixth and thirteenth in yield test plots at, Tribune, 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 cooperatively between the Departments of Agronomy and Milling Industry. Wheat varieties tested are produced largely in the work on Project 67, Small Grain Improvement.

Milling and baking research on the 1940 crop indicated that of 18 strains tested, all would make acceptable bread. Wheat meal time fermentation tests on F_4 selections from different F_3 families in the cross Cheyenne X Chiefkan gave readings of 51, 57, 56, and 48 for one family while readings of 163, 120, 137 and 111 were obtained on selections descending from a different F_3 row. Segregating families also were found.

It is in the public interest that new varieties of wheat shall not deviate appreciably from present standard varieties in quality. The work of this project helps reduce this danger as new varieties are bred having superior agronomic characteristics.

(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 project is a companion project to No. 67, Small Grain and Sorghum Improvement. The varieties of wheat tested are discussed in the report of that project.

The results of variety tests of sorghums are reported in Bulletin 304, "Sorghums for Kansas," published by this station.

Other observations made on the project are reported in detail as follows:

1. Seasonal Distribution of Rainfall in Relation to Yield of Winter Wheat. *U. S. Dept. Agr. Tech. Bul.* 761; January, 1941.
2. Natural Selection in Varietal Mixtures of Winter Wheat. *Jour. Amer. Soc. Agron.* 34:(3)270-274; March, 1942.

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

Varietal and Cultural Tests of Soybeans and Cowpeas.– Varieties and strains of cowpeas and soybeans and rates and methods of planting of soybeans have been studied as the work of this project. Thirteen varieties and 30 selections and introductions of soybeans were grown in 1940 and 14 varieties in 1941.

Soybeans.–Higher yields can be obtained in eastern Kansas by drilling with a grain drill than by planting in rows provided the ground is free from weeds or weeds are controlled by a harrow or weeder or by hand pulling. The rate of planting by this method had little influence upon yield within the limits of 58 to 102 pounds planted per acre. On the average, 70 to 90 pounds per acre should be used.

High ranking varieties in seed production in order were Hongkong, Mt. Carmel, Mansoy, AK and Dunfield with a range of 22.1 to 16.0.

Cowpeas.–New Era, Whippoorwill, Victor, Blackeye R-12 and California No. 1 were the high ranking varieties in order in hay production. For seed production, Blackeye R-12, Calva No. 6 and Blackeye R-51 ranked in that order. The highest yield was 13.8 bushels per acre.

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

Sweet Clover and Miscellaneous Crops.–The work with sweet clover during the period covered by this report has consisted of tests to determine yields and to study growth habits of 22 varieties of clover. As a part of the war emergency effort, a number of miscellaneous crops, mainly oil-producing, were planted in 1941.

Sweet Clover.–Highest forage yields were produced by Evergreen, an Ohio strain that grows late and rank, with a yield of 4.6 tons per acre. Common

white produced 3.8 tons of forage and 5.6 bushels of seed per acre. Madrid has averaged 2.9 tons of forage and 10 bushels of seed per acre for the past two years. Detailed results of tests on sweet clover will be available in a bulletin to be published soon by this station.

Miscellaneous Crops.–Among the oil-producing crops tested were sesame, perilla, safflower and castor beans. A yield of 750 pounds of sesame seed per acre was obtained and the crop is regarded as worthy of further tests. The seed is about 50 percent oil which is of high quality and may be used in place of olive or other edible oils. Perilla, also a producer of edible oil, shows some promise. In spite of a poor stand and loss from shattering, 192 pounds of seed per acre was harvested. Yields of double that amount may be expected.

Safflower seed is high in content of drying oil. This crop, however, has failed to show promise for this section.

Three varieties of castor beans were grown, the earliest variety producing 15 bushels of seed per acre.

Investigations with rubber-producing plants were started in the spring of 1942. Plants under test include Russian dandelion *(Taraxacum kok-saghyz),* the desert shrub Guayule *(Parthenium argentatum),* common milkweed and two species of *Apocyanum.* An attempt will be made to determine the adaptability, rubber content and methods of culture of introduced plants. The rubber content and production of native plants under cultivation will also be studied.

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

Corn Production and Improvement.–This project is conducted cooperatively with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture. The primary objective is to develop adapted white and yellow dent hybrids and popcorn hybrids. The work is divided into three phases:

1. Development of Kansas Hybrids.–Kansas-2234, Kansas-2216, both white dent hybrids, Kansas-1583 and Kansas-1585, yellow dent hybrids, and Kansas-24 X 30A and Kansas-18 X 24, popcorn hybirds have consistently outperformed the better open-pollinated varieties and out-of-state hybrids. These new hybrids are full season strains, better able to take advantage of the long growing season.

White hybrids will provide a source of white corn for commercial utilization in industrial plants. Few, if any, desirable white dent or popcorn hybrids are commercially available in the Corn Belt at the present time. Seed supplies of the parent inbred lines and single-crosses of the above-mentioned hybrids are being increased.

2. *Testing of Corn Hybrids Developed Outside Kansas.*–An extensive corn testing program is conducted to determine the out-of-state hybrids best suited for Kansas. Four of these, U. S. 13, U. S. 35, Ill. 200, and K. I. H. 38, have been approved and are now in commercial production in Kansas. As an average of two years and when planted on fields in the three eastern sections of Kansas differing in fertility, topography, heat and rainfall, U. S. 13, U. S. 35 and Ill. 200 produced 25 percent more corn and had 29 percent less lodged plants than the average of the adapted open-pollinated varieties.

Complete results of the tests for the 1940 and 1941 seasons are reported in Bulletins 292 and 299, respectively, published by this station.

3. *Fundamental Research in Corn Breeding,*–Breeding for drought resistance has been given major attention since drought seems to be the primary limiting factor for corn production in Kansas. These investigations included: (1) Determination of resistance to leaf firing, (2) association of leaf firing and

grain yield, (3) receptivity of silks to pollen, (4) differential fertilizing ability of pollen and (5) success of pollination.

Vitamin B_1 treatment on corn grown in the field did not affect tillering, lodging, plant height, maturity, yield of grain or stover significantly. Treatment with "Graino" had no apparent effect on yield, maturity, tillering, stand, or resistance to lodging, firing, smut, or grasshoppers.

Work during the biennium has demonstrated outstanding differences among inbred lines and hybrids for resistance to corn ear worm, grasshoppers, chinch bugs, aphids, grub worms, Southwestern corn stalk borer and rabbits. Breeding for resistance to insects is being continued. An experiment started in 1938 and expanded in the greenhouse during the winter of 1941-'42 indicated that corn strains can be tested in the seedling stage for relative resistance to grasshopper feeding.

Other research included the effect on yield of time and method of thinning corn; rate and date of planting; weather influences on growth and yield; determination and nature of resistance to Diplodia stalk rot, corn smut, corn ear worm, grasshoppers, and chinch bugs; and taxonomic studies.

Detailed reports on the several phases of work conducted during the biennium are contained in the following publications:

Kansas corn tests, 1941. *Kan. Agr. Expt. Sta. Bul. 299.*

Genetic studies of heat and drought tolerance in maize. *Jour. Amer. Soc. Agron*. 32:803-814. 1940.

An association of root injury by white grubs, *Phyllophaga* Spp., and lodging of cross bred strains of corn. *Jour. Amer. Soc. Agron.* 33:1100-1107. 1941.

Resistance to Diplodia stalk rot in inbred lines and hybrids of maize. Submitted for publication in *Jour. Agr. Res.*

Kansas corn tests, 1940. *Kan. Agr. Expt. Sta. Bul. 292.* 1941.

Vitamin B_1 (Thiamin chloride) and the yield of corn and sorghum under field conditions. *Jour. Amer. Soc. Agron.* 33:474-475. 1941.

Differential injury within varieties, inbred lines and hybrids of field corn caused by the corn ear worm. *Jour. Agr. Res.* 61:81-100. 1940.

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

Alfalfa Investigations.–This project is conducted in cooperation with the Bureau of Plant Industry, 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.

Effect of Cutting Practices on Root Reserves.–Proper cutting practices promote high food reserves stored in the fall. Without some top growth on the plants through the fall dormant period there will be only a small number of crown buds. A limited amount of top growth will not be able to stimulate crown bud development or store food reserves in the roots to aid in building up cold resistance.

Environmental Factors Affecting Seed Production.–Two years' results indicate that high food reserves will increase seed production. Almost three times as much seed was produced on plants high in food reserves, compared with plants low in food reserves.

Breeding and Improvement.–The six high-yielding varieties and strains in variety plots during the biennium were Kansas selection A-8, Kansas Selection A-11, Hardistan, Ladak, Argentine and Kansas Common. A-8 showed only 8 percent bacterial wilt symptoms while some varieties showed as high as 90 percent wilt.

Disease Investigations.–Recent work shows that resistance to black stem *(Aschocyta imperfecta* Peck) is inherited. Hybridization is being done to determine the mode of resistance and to obtain resistant plants.

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

Pasture Improvement Investigations.–This project is conducted cooperatively with the Division of Forage Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture. It is concerned with agronomic problems in pasture improvement and with the improvement of pasture plants by breeding. Agronomic studies include grazing practices, burning, fertilization and methods of seeding grasses.

Deferred pastures continue to outyield those grazed continuously in beef produced per acre. The deferred pasture area on the Casement ranch averaged 42 percent more big bluestem, 239 percent more little bluestem and 16 percent more side-oats grama than the average of three season-long pastures. The latter pastures had 52 percent more weeds and 11 times more annual grass than the deferred pastures.

Late-spring burned plots continue to outyield areas burned earlier, and are outyielded only by the unburned areas. Late-spring burnings have decreased the weed population.

Fertilization of native pastures has not been shown to be practical, although considerable increase in production may be obtained from the use of nitrogenous fertilizers.

Fall seedings of native grasses are not generally so successful as spring seedings. Drilling or broadcasting is less successful than scattering native grass hay containing seed and pressing it into the seedbed.

Two strains of big bluestem, three of little bluestem and one of Kentucky bluegrass are being increased for testing.

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

Weed Eradication.–The work of this project has consisted almost wholly of tests of various chemicals as herbicides. The following lines were pursued during the biennium:

Sodium Chlorate Treatments.–Repeated light applications are more effective than a single application when equal amounts of the chemical are used.

Comparison of Dry and Liquid Sodium Chlorate.–The liquid, applied as a spray is more effective than when applied in the dry form in rates up to 4 pounds per square rod. It is, therefore, possible to kill bindweed with less chlorate by the spray method than by dry applications.

Comparison of Different Commercial Sprays–Chemicote, Pentox, Triox, Bentonite, Barteldes and Dixie weed killer had little or no value for killing bindweed. Acid arsenical is an effective and cheap treatment for annual weeds and has considerable effect on bindweed. The New Atlacide is apparently slightly more effective than the old formula but is still less effective than an equal amount of sodium chlorate.

There appears to be no advantage in applying nitrogenous fertilizers to neutralize the toxic effect of sodium chlorate.

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

Co-operative Experiments 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.

During the biennium, 1,642 tests were located in 100 Kansas counties.

The detailed results of these tests are available in printed or mimeographed form. An inquiry addressed to the Department of Agronomy, Kansas State College, will obtain the test results. Publications prepared during the biennium include:

1. Kansas Corn Tests, 1940, Bulletin No. 292.
2. Kansas Corn Tests, 1941, Bulletin No. 299.
3. Fulton Oats (mimeographed).
4. Report of Cooperative 1940 Wheat Variety Tests (mimeographed).
5. Report of Cooperative 1940 Winter Barley Variety Tests (mimeographed).
6. Report of Cooperative 1940 Oat Variety Tests (mimeographed).
7. Report of Cooperative 1940 Spring Barley Variety Tests (mimeographed).
8. Report of Cooperative 1940 Sorghum Variety Tests (mimeographed).
9. Report of Cooperative 1940 Soybean Variety Tests (mimeographed).
10. Summary of Cooperative 1941 Wheat Variety Tests (mimeographed).
11. Report of Cooperative 1941 Winter Barley Variety Tests (mimeographed).
12. Report of Cooperative 1941 Spring Barley Variety Tests (mimeographed).
13. Report of Cooperative 1941 Oat Variety Tests (mimeographed).
14. Report of Cooperative 1941 Sorghum Variety Tests (mimeographed).

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

A Study of Methods of Harvesting and Storing Grain Sorghums.–This project, conducted in the past in cooperation with the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, at the Fort Hays Branch Experiment Station, has been enlarged to include cooperation with the Bureau of Plant Industry and the Agricultural Marketing Service and to use storage facilities of the Commodity Credit Corporation at Hutchinson for the work.

At the Hays station results of storage tests show that grain sorghums can be safely stored through the winter, spring and summer months, provided they are below 13 percent in moisture content. Higher moisture content may be safe during the winter months. Winter is likely to be unfavorable for drying because grain tends to gain rather than lose moisture in winter air.

Storage bins with natural and mechanical ventilation have proved to be effective in drying the grain and preventing damage at the Hays station.

Because of the unusually wet weather at Hutchinson, Kansas, the attempts to dry sorghum during the summer of 1942 have been unsuccessful.

A study of underground storage was undertaken at the central station at Manhattan because of the wet harvest season in the fall of 1941. Sorghum has been placed in pits in three forms: Whole grain, chopped heads, and whole sorghum heads. These grains have passed through the winter without any unusual temperature changes.

(Project 181; Department of Agricultural Engineering. Leader, F. C. Fenton; Purnell funds.)

Factors Influencing the Quality of Wheat During Storage. –The need for additional storage space on the farm and the shortage of labor for the 1942 wheat harvest caused a change in emphasis on this project to be directed toward the design of farm storage structures and the design of grain elevating equipment.

A scarcity of commercial grain elevating equipment necessitated the design of home-made equipment. A canvas-belt drag-type elevator has been constructed and tested. Plans were prepared for distribution to farmers. Plans and suggestions for a home-made cup-type of elevator have been prepared. An experimental spiral auger elevator has been built, utilizing augers from junked combines and threshing machines.

Coöperation has been continued with federal agencies in wheat storage investigations, both at Hays and Hutchinson, Kansas.

The storage experiments *at* the Fort Hays branch station are in the process of being closed. Some wheat is in long-time storage and may be observed for a few more years.

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

Chemical Factors Influencing the Quality of Wheat and Flour.–Thus project was conducted in two principal phases during the biennium. (1) Effect of protein level on baking quality; (2) Effect of bleaching flour on baking quality.

Since the results of research conducted in both phases have been reported in detail, readers are referred to the following publications:

The effect of protein content on the baking behavior of some winter wheat varieties. *Cereal Chem., 18:640-654.*

Baking tests and the evaluation of new wheats. *Cereal Chem.,* 19:493-507.

The effect of bleaching agents versus bromate in baking. *Cereal Chem.,* 18:497-514.

Effectiveness of dry milk solids in preventing offer-bromation of some bleached hard winter wheat flours. *Cereal Chem,* 19:481-492.

The dry milk solids-bleaching studies were made in collaboration with Meade. C. Harris and Glen West, Fellows of the American Dry Milk Institute, Chicago.

(Project 60-A; Departments of Milling Industry and Agronomy. Leaders, E. G. Bayfield and A. L. Clapp; State funds.)

Genetic Factors That Influence the Quality of Wheat.–The work on this project was directed mainly toward the development and testing of methods to be used to evaluate small samples submitted by plant breeders.

A high positive correlation was found to exist between sifted wheat meal mixograms and flour mixograms from the same wheat samples. Thus it is possible to discard inferior wheat varieties with the use of small samples of grain.

The results of research completed under this project are reported in detail in the following publications:

Recording dough mixer curves from sifted wheat meals as a short method of testing. *Bulletin,* Association of Operative Millers, August, 1941, pages 1131 to 1134.

The testing of wheat quality by recording dough mixer curves obtained from sifted wheat meals. *Cereal Chem.,* 19:216-229.

(Project 60-B; Department of Milling Industry. Leaders, E. G. Bayfield and John A. Johnson, Jr.; Bankhead-Jones funds.)

The Influence of Environment Upon Wheat Varieties.– Five varieties of hard red winter wheats are grown uniformly at a number of Kansas locations each year. Grain from these plantings are used as the basis for milling and baking studies.

As complete data for only one year are available at this time, it is questionable whether any conclusive observations should be made. This project will continue for at least five years, furnishing sufficient data for observations.

(Project 60-C; Departments of Milling Industry and Agronomy. Leaders, E. G. Bayfield, H. H. Laude; Bankhead-Jones funds.)

Tempering Factors That Affect the Quantity and Quality of Wheat Flour.– The research work connected with this project was conducted in the 65-barrel commercial unit and in the experimental mill, both in the Department of Milling Industry.

A short-time W-W wheat conditioner was installed and used in preliminary work during the first part of the biennium. More extensive tests have been conducted in conjunction with the work on Project No. 219. Preliminary results indicate a rest period of at least 2 hours when a temperature of 105 F. is used, seems to be satisfactory. Higher temperatures apparently impart a yellow color to the clear flours.

The Allis-Chalmers experimental milling equipment may be used successfully for "pilot plant" work. Results obtained on this unit practically duplicates results obtained with commercial units.

An article has been prepared for publication in *Cereal Chemistry,* dealing with the effect of mill room temperature and relative humidity on experimental flour yields and flour properties. This article gives in detail some results of research on this project.

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

Factors Which Influence the Colloidal Properties of Dough. –Three principal phases of research were carried on under this project during the biennium. (1) Factors which influence the pattern of mixograms; (2) effect of weakening the gluten in flour by admixture with starch and additions of alcohol or pyridine; (3) a study of mixtures of dried, ground glutens and starches that contained approximately the same protein content as representative flours.

The results and observations of this project have been published extensively. Persons interested are referred to the following publications.

Factors which influence the physical properties of dough:

I. Effects of autolysis on the characteristics of dough mixer curves. *Cereal Chem.* 17:679-689.

II. Effects of enzymes on curve characteristics. *Cereal Chem.* 17:689-700.

III. Effects of protein content and absorptions on the pattern of curves made by the recording dough mixer. *Cereal Chem.* 18:615-627.

IV. The effects of surface active agents on the characteristics of curves made by the recording dough mixer. *Cereal Chem.* 19:102-120.

V. Gluten proteins as the main factor affecting the pattern of mixograms. (Being submitted for publication in *Cereal Chemistry.)*

Description of mixograms. (Accepted for publication in *Cereal Chemistry.)*

A simple photoelectric relay. *Science,* 96:281.

The structure of the phospholipids. *Chemical Reviews,* 29 :245-256, October, 1941.

(Project 200; Department of Milling Industry. Leaders, C. O. Swanson, Earl B. Working; Bankhead-Jones funds.)

The Influence of Some Factors Affecting the Physical Properties of Wheat.–Wheat that has been subjected to rainfall either as standing grain or as grain in the shock sells at a discount on the market because of lowered test weight and because of bleaching. This project dealt principally with the effect of wetting upon the quality of the flours milled from wheats that had been subjected to various wetting treatments.

Flour yield is computed on a weight basis, not volumetric. Wetting had no effect on flour yield.

Weathering or moisture treatments did not decrease the baking values of the flours.

The complete and detailed results of research on this project are reported in *Cereal Chemistry.* Persons interested are referred to that technical journal for the following reports:

I. The effect of low temperature in preventing damage to wheat stored with a high moisture content. *Cereal Chem.* 18:299-315.

Effects of moisture on the physical and other properties of wheat. *Cereal Chem.* 18:705-729.

II. Wetting wheat during harvest. (To be published in *Cereal Chemistry.)*

III. Duration and variation in number and degree of wetting. (Submitted for publication in *Cereal Chemistry.)*

A micro-test weight method. *Cereal Chem.* 19:468-470.

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

Conditioning Requirements of Wheat and Their Influence Upon Milling and Baking.–Work on this project, started July 1, 1941, has been carried on along two general lines: (1) Development of techniques suitable for use on the 65-barrel mill as an experimental unit for advanced variety testing or other testing that demands conditions approximating those of a commercial mill; (2) development of experimental milling methods for use with laboratory mills to adapt them for use as "pilot" mills for commercial establishments.

Because of the nature and scope of this project and the short length of time it has been conducted, conclusions or recommendation will not be made at this time. It is planned to prepare a report for issuance in the near future.

(Project 219; Department of Milling Industry. Leaders, R. O. Pence and W. F. Keller; State funds.)

The Effect of Factors Influencing the Qualities of Kansas Wheat.–This project, which became operative July 1, 1941, was established for conducting work which may be regarded as of a research-service nature. It has as its objective the increase of financial returns to the grower of Kansas wheat by providing a better product to the miller, baker and ultimate consumer.

A study comparing ICl_3 with $KBrO_3$ indicates that ICl_3 produces somewhat similar results to $KBrO_3$. A greater quantity of ICl_3 is required, however, to obtain comparable results. It is exceedingly difficult to handle, since

it volatilizes at ordinary room temperatures and is reactive to most oxidizable materials. It had little effect on the baking quality of a flour which had a high diastatic enzyme activity and low baking qualities.

The effect of ethylene gas on quality of stored wheat conducted in coöperation with the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, seems to indicate that the gas treatment enables storage of wheat with high moisture with less danger of immediate damage while awaiting drying facilities. Ethylene treated samples apparently produce a better loaf of bread, regardless. of whether the treatment was made when the grain was high in moisture content or later when the moisture content had been reduced.

Treatment of wash water with Cl_2 produces definite improvement in removing off-odors and flavors in flour milled from damaged wheat. It was noted, however, that the treatment seems to make milling more difficult, probably due to changes made in the bran coat during the washing process.

Mixograms may be correlated to baking characteristics, since mixing time on the recording dough mixer closely approximates the time required to mix a dough to optimum consistency for baking.

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

A Physiological Study of the Winter Wheat Plant.–The objective of this project is the determination of the extent to which leaves contribute the materials of which the grain is composed. It is intended to demonstrate the reason why leaf rust which affects for the most part the leaves of wheat does not cause the grain to shrivel or decrease the yields of wheat to so great an extent as does black rust, which affects the leaves, sheaths and stems of the wheat plants.

Eight varieties of red winter wheat were used in these experiments. At four stages during the life of the 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 basal defoliation removed approximately one-half of the leaf blade area at the first clipping. As the lower leaves die and cease to function in photosynthesis, the clipping of the lower leaves exerts less influence on the yield of grain so that such removal of leaves during the last two stages of the experiment had no effect at all on the yield of grain.

The data obtained during the first year are summarized in the biennial report of June 30, 1940. During 1939-'40, plants were grown and subjected to the same treatment as had been accomplished during the preceding year. The summarization and tabulation of these data will be undertaken at a later date.

Publications include the following:

Modification of diurnal transpiration in wheat by infections of *Puccinia triticina. Jour. of Agr. Res.* 61:427-444.

The influence of the awns upon the rate of transpiration from the heads of wheat. *Jour. of Agr. Res.* 61:445-458.

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

Physiological Studies of Noxious Weeds in Relation to Their Control.–Four phases of study have been conducted on this project during the biennium:

1. *Nature and general rate of development of the underground system of perennial noxious weeds.*–Undisturbed by cultivation, this system of field bindweed and hoary cress consists of five portions: The original vertical root, the lateral roots, secondary vertical roots which are vertical extensions of permanent lateral roots, vertical rhizomes which arise from buds formed on the permanent root, system (the two types of vertical roots and the permanent lateral roots), and shoots which arise from buds formed at the nodes of the rhizomes.

2. A study of the penetration of herbicides into the bindweed plant.-An attempt was made to devise a simple colorimetric test for use in determining the presence of the chlorate ion, or the form to which it is reduced in the tissues of the plant. Results thus far have been negative.

3. Food reserves of bindweed.–In general, on a dry weight basis, there is twice as much material used in producing eight days' growth of tops as was used in producing the rhizome. Thus, in a 14-day interval of cultivation, with but half the labor of two 7-day cultivations one-third more of the food reserves of the weed would have been destroyed.

4. Shade tolerance of bindweed.–Work on this phase was largely devoted to assembling equipment for the 1942 growing season and making preliminary studies of the shading effect of crop plants growing in the field at different seeding rates.

(Project 202; Department of Botany. Leaders, J. C. Frazier and E. C. Miller; Bankhead-Jones funds.)

Orchard Investigations.–Work on this project was severely curtailed by the total loss of the station orchard. The drought of the mid-30's damaged the orchard severely and the freeze of November, 1940, completed its destruction. The orchard was abandoned and a new site chosen for the establishment of an experimental orchard. Four phases of this project were conducted:

1. *Testing of spray materials.* Work on this phase was limited to nursery studies of spray materials on newly transplanted conifers. Observations indicated that nursery waxes did not prolong the lives of the conifers and in most cases caused damage.

Harvest sprays (Fruitone and Parmone) were used in a commercial orchard near Manhattan. A rain came soon after the application of the sprays so the reduction in fruit drop was not as marked as in previous seasons.

2. *Rootstock studies.* Out of about 600 French Crab seedlings, 65 survived the November, 1940, freeze without apparent injury. These have been carefully transplanted and will be mounded to get own-rooted trees for further study.

3. *Orchard soil management. Frost relations in orchard soils.* Seven different conditions of surface orchard soil were studied each year. These variations, in addition to the temperature of the air and length of the low-temperature period, are of importance in determining penetration of frost into orchard soil and its later disappearance. Both winters of the biennium were comparatively mild. No frozen soil was found under the straw mulch treatment and 20 inches was the maximum penetration under any of the other six treatments. Compacting of cultivated soil by the heavy fall rains in l941 resulted in the loss of protection against deep freezing by that treatment.

4. *Testing new varieties of tree fruits.* The last surviving trees of varieties under test were killed by the November, 1940, freeze. A summary of the 20 years' work shows that no pear highly resistant to fire blight and of good quality was found. No cherry or peach excelled the standard varieties. Helm, a southern midsummer variety of apple, was killed by the droughts of the mid-30's after it had shown high productivity and good culinary quality.

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

Small Fruit Investigations.–Weather conditions at Manhattan during the past biennium were extremely unfavorable for small fruit production. The 1940 crop was light, due to a period of moisture deficiency and high temperatures early in the season. The freeze of November, 1940, killed most of the brambles and grapes in the northern and western portions of the state. Strawberries, too, were severely damaged by the freeze.

Early mulching of strawberries produced the highest yields of those mulched and the matted rows of Howard strawberries produced 4,230 quarts per acre as compared with 2,700 for the hill system.

Grape and bramble plants were so severely damaged that no yields were recorded.

A rapid method for determination of killing of bramble canes was devised with the coöperation of the Department of Physics of the college. Resistance to electric current is reduced from 70 to 90 percent in canes killed by freezing or boiling. Resistance is measured with a standard bridge for electrolytic resistance, inserting steel needles through a section of the cane to be tested. A detailed report of the technique appears in the *Proceedings of the American Society for Horticultural Science*, 39:85-86, "A rapid method for determining when a plant is killed by extremes of temperatures."

About 250 pints of fruits and vegetables were placed in a frozen food locker plant in 1941. During the following winter these fruits were judged by the Home Economics Department and by several housewives. Some of the conclusions reached are: (1) The proper degree of maturity, careful handling and correct freezing temperatures are more important than the variety used. (2) The most satisfactory methods of packing small fruits were either packed whole with sugar, packed whole with sugar syrup or sliced or crushed and packed with sugar.

(Project 26; Department of Horticulture. Leader, G. A. Filinger; State funds.)

Vegetable Investigations.–Work on this project consists principally of variety yield tests of the different staple garden crops adapted to production in farm gardens. Some greenhouse studies are conducted also. An irrigated garden is maintained in coöperation with the Department of Agricultural Engineering and the Kansas Committee on the Relation of Electricity to Agriculture.

Tomatoes.–Forty varieties were tested and 21 were sufficiently high in yield and quality to warrant classification as market garden varieties. The remaining varieties were continued in tests to find one that will set fruit and produce under conditions common to the western two-thirds of the state.

Beans.–Eighteen varieties were tested during the past season, with plantings on May 5, June 6 and June 20. Idaho and U. S. No. 5 Refugee were the better all-season varieties tested.

Cabbage, peas and spinach were tested on a smaller scale.

Greenhouse studies.–Natural gas as commonly used as fuel for heating greenhouses was found to cause no injury to tomatoes, carnations, sweet peas, begonias, lantanas, and geraniums in concentrations up to one part to fifty parts of air for a period of twenty-four hours. Fumes from burned natural gas caused injury to tomatoes, lantanas, begonias, and geraniums, the tomato symptoms being similar to those caused by illuminating gas. Carnations and sweet peas are not sensitive to fumes of burned natural gas.

Irrigated garden.–A detailed report of the results of work on this phase is contained in a mimeographed booklet, "Garden Irrigation," which may be obtained from the Department of Horticulture.

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

Relation of Leaf Structure to Rate of Photosynthesis in Fruit Plants.–The objectives of this project for the current biennium were two-fold: (1) To study the influence of some spray materials on the internal structure of apple leaves and (2) to study the influence of these same spray materials on the chorophyll content of apple leaves.

In 1940 these studies were conducted both with trees grown in the greenhouse and in the field. The greenhouse trees were sprayed with lead arsenate lime-sulphur for six applications, lead arsenate alone for three applications, and five applications of lead arsenate and summer oil. Calculations of "R" were made where "R" is defined as the ratio of the internally exposed surface to the exterior surface of the leaves. Of the two varieties grown in the greenhouse, Wealthy had the greater "R" value; longer palisade cells; wider upper palisade cells, and fewer upper palisade cells per unit of area than the York variety. Within each variety the sprayed leaves showed a lower "R" value, shorter and narrower palisade cells, with a greater number of cells in the first palisade layer per given area than the unsprayed leaves.

The correlation coefficient between depth of palisade tissue and the "R" values for all varieties, treatment, and conditions was + .88 and the regression coefficient was 0.1122P + 1.33. Using this regression, "R" may be computed by direct measurements of the total depth of the palisade mesophyll.

The chlorophyll content of the Wealthy leaves was highly significantly greater than the York leaves and the chlorophyll content of the sprayed leaves was less than that of the unsprayed leaves. The differences were highly significant.

Within two or three days after the first new leaves began to appear in 1941 a combination spray of lime-sulphur and lead arsenate was applied at weekly intervals to the foliage on parts of some of the trees. Another group of leaves was sprayed with one-fourth of one percent summer oil emulsion and lead arsenate. Some leaves received no sprays. The Wealthy leaves had longer palisade cells than leaves of the York variety and each spray material reduced the length of the palisade cells of each variety. The spray applications prevented the normal development of the palisade tissue, gradually increasing the difference as the season progressed. Leaves which were ten weeks old before they received a spray application were checked rather severely and held at about the value of the sprayed leaves after five applications, while those which were left unsprayed continued to grow normally.

Previous studies at this station have shown that the extent of the internally exposed surface of apple leaves is one of the factors partially conditioning the rate of photosynthesis. This study indicates that milder sprays are preferable if sufficient pest control is maintained, and the longer the first spray can be postponed, the better for the foliage.

The following reports have been published:

Common spray materials alter the internal structure of apple leaves. *Proc. Amer. Soc. Hort. Sci,* 38:153-162.

Further studies on the effect of common spray materials on the internal structure of apple leaves. *Proc. Amer. Soc. Hort. Sci.,* 40:69-70.

(Project 199; Department of Horiculture, Leaders, W. F. Pickett and C. J. Birkeland; Bankhead-Jones funds.)

Investigations With Ornamental Plants.–Work of the past biennium covers five phases of investigations with ornamental trees, shrubs and flowers.

1. *Varietal tests of herbaceous perennials*.–Fifty-one varieties of peony were planted in October, 1940. They will be well established in another year.

All of the 374 varieties of iris have proved to be well adapted to Kansas climatic conditions. The fall blooming irises require considerable care to get them to bloom well.

There are 135 varieties and species of hardy herbaceous perennials under observation. All kinds have done well with the exception of those that bloom in midsummer. These are injured by high temperatures.

2. *Adaptability of trees and shrubs*.–Fairly good results have been obtained in growing trees and shrubs from seed, a method which apparently is the best way of testing for adaptability.

3. *Varietal tests of Climbing Clematis*.–Some difficulty has been experienced in getting all varieties and species established.

4. *Effects of the November, 1940, freeze on campus trees and shurbs*.–Ornamental trees showing most severe damage are as follows: Ulmus pumila, Populus italica, Thuja orientalis, and Amygdalus perisa floreplena. Shrubs showing most severe damage were: Vanhoutte Spirea, Spiraea bumalda, Weigela rosea, Hibiscus syriacus, Hybrid Tea, Hybrid Perpetual, Polyantha, and Climbing roses.

5. *Lawn and grass studies*.–It was definitely proved that nine species of grass would grow through a special asphalt that had been applied to the soil after seeding.

Good results have been obtained by "spot spraying" of dandelions with kerosene by means of a knapsack sprayer. Comparative tests with sodium chloride, sodium chlorate, and kerosene showed that kerosene gave a much better percent kill.

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

Factors Affecting Survival and Growth in Forest Plantations.–This project was approved in October, 1941. Plantings were made in the spring of 1942 and no data are available regarding results.

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

(Project 221; Department of Horticulture. Leader, W. F. Pickett; 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.–Because of the reactivity of organic chlorides in general, chlorination of the starch molecule has received most emphasis. Three different methods are being employed for this purpose. Two of them give quite similar products of high chlorine content and of high solubilities in organic solvents. The third method gives products of low chlorine content and low

solubility in organic solvents. All the chlorides may be condensed with phenols yielding compounds which form colored substances when coupled with diazotized amines.

The water-soluble plastic obtained contains from 2 to 3 percent nitrogen and may be used to form thin transparent films resembling cellophane.

The pyrolysis of starch first proceeds at an appreciable velocity at about 200 to 210°C. A black granular substance (which is not carbon) and acetic acid are the products of the reaction.

The dibasic acid esters which have thus far been prepared from starch vary with respect to their solubilities in organic solvents. None of them is soluble in water. Some of them dissolve in organic solvents to the extent that translucent films may be formed from their solutions.

Physical Phase.–Of the sorghum grain starches which have been tested the majority closely resemble corn starch in their behavior. The starchy varieties yield starches which give the same general type of viscosity curves; differences shown are of degree rather than kind. Leoti Red sorgo, which carries the waxy endosperm, yields starch the viscosity of which responds slowly and regularly to temperature changes. This is in contrast to starch from sorghums having starchy endosperms which show sharp discontinuities in the viscosities of pastes which are being cooled. The behavior of Leoti Red sorgo starch closely resembles that of Caasava starch (tapioca) which formerly was imported. Importations have been reduced because of the war in the Pacific.

Fourteen varieties of sorghum adapted to Kansas weather and climatic conditions have been studied. Measured by the results obtained in the processing of 5-pound batches of grain, the starch yields between varieties varied between 45 and 58 percent on a dry basis. Finney and Wheatland milo and Club kafir gave the highest yields, while Leoti Red, Schrock, Blackhull and Feterita gave the lowest yields. With Standard Blackhull kafir the yield was increased by increasing the size of the batch being processed.

The presence of finely ground dark fibrous material which settled out with the starch during the final washing operation on the starch tables was found to be the cause of undesirable color in the starch. This has been remedied by careful screening and by washing in the hydraulic separator before the material is passed through the buhr mill. Starches of an excellent color have been produced from all varieties of sorghum tested with the exceptions of Leoti Red, Schrock and Early Sumac.

(Project 208; Departments of Chemistry and Chemical Engineering. Leaders, H. N. Barham, J. W. Greene; State 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.

Nutritive Requirements of Swine.–The work during the past biennium has been a continuation of experiments designed to determine the minimum amount of calcium in the ration of growing pigs which will produce normal growth and development when the ration contains 0.3 phosphorus and an adequate amount of vitamin D. Two series of feeding tests were conducted.

During the first year the calcium levels in different lots of pigs were held at 0.2, 0.25, 0.3 and 0.35 percent. During the second year the calcium levels in the different lots were 0.3, 0.35 and 0.4 percent.

The pigs that received 0.3 and 0.35 percent calcium did better in gains and bone development than those fed lesser amounts of calcium but it could not be concluded that 0.35 percent calcium was adequate.

The second feeding trial demonstrated that levels of calcium of 0.3 and 0.35

percent are definitely below minimum requirements for young pigs. Pigs in the lot receiving 0.4 percent calcium did well, indicating that this level was near optimum.

The following reports have been published:

The minimum calcium and phosphorus requirements of growing pigs. 1940 Proceedings American Society of Animal Production, pages 311-315.

Calcium requirements of growing pigs. *Jour. Agri. Res.*, 62, No. 9, pp. 531-542.

(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.–This project was conducted in three phases during the biennium: (1) A study of protein supplements in fattening rations of swine on alfalfa pasture; (2) a comparison of shelled corn, ground Colby milo and whole and ground Wheatland milo for fattening pigs in the dry lot, and (3) a comparison of shelled corn, whole and ground Colby milo and whole and ground Wheatland milo for fattening pigs that have access to alfalfa pasture.

Protein supplements.–Supplements tested were tankage, soybean oil meal, fish meal and cottonseed meal and combinations of those supplements. The largest daily gains were made by the lot receiving a combination of soybean oil meal, tankage and cottonseed meal. This lot also had lowest cost of gains.

Milo with alfalfa hay.–The milo grains fed in this trial were fully as palatable as the shelled corn and the pigs fed the milos were apparently the equal of the corn-fed pigs in finish. Less milo grain was required per hundred pounds of gain than of corn.

Milo with alfalfa pasture.–The finish of the pigs fed whole milo was fully the equal of the pigs fed on shelled corn and the pigs fed ground milo were better finished than the shelled corn-fed pigs. Grinding the milo grain increased the feeding efficiency.

Detailed reports of the above-mentioned feeding trials are contained in circulars prepared by the Department of Animal Husbandry. A summary of swine feeding trials, 1936-1940, is contained in Circular No. 207.

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

Investigations in the Use of Silage for Fattening Beef Cattle.–The work conducted during the biennium has consisted of two feeding trials in which studies have been made of the comparative value of ground Colby milo, ground Wheatland milo, and ground shelled corn as cattle fattening feeds when fed with Atlas sorgo silage as the entire roughage portion of the ration. The second trial was extended to include ground Blackhull kafir.

The grains were ground and fed in self-feeders in both trials after the steers were receiving all the grain they would clean up readily. Cottonseed meal was the protein supplement used, and finely ground limestone was fed to all lots at the rate of one-tenth pound per steer daily.

Satisfactory gains were made by all lots. The results of the feeding trials indicate that either ground Colby milo or ground wheatland milo will give results at least equal to those obtained when ground shelled corn is fed. Ground Blackhull kafir produced satisfactory results in the second trial. This trial will be repeated to check the results.

Detailed reports of both trials have been published in Circular 41-B-4, The Comparative Value of Colby Milo, Wheatland Milo and Corn as Cattle Fattening Feeds; and Circular 42-B-2, The Comparative Value of Colby Milo, Wheatland Milo, Blackhull Kafir and Corn as Cattle Fattening Feeds.

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

Method of Utilizing Native Pasture in Beef-cattle Feeding. –The work on this project during the biennium was divided into three phases. Phase 1 consisted of the last in a series of three tests to determine how a feeding system satisfactory for steer calves should be modified for heifer calves. Phase 2 consisted of a comparison of the method that proved most satisfactory in Phase 1 with a method followed by several Kansas cattlemen. Phase 3 consists of wintering good quality steer calves, grazing them during the following season and selling in the fall as feeder yearlings.

Phase 1.–Results indicate that grain need not be included in the wintering ration of heifer calves. Good quality heifers should gain approximately 200 pounds without feeding grain as compared to steer calves which should gain approximately 250 pounds with the feeding of some grain. Experience has indicated that a given amount of grain produces more fat on a heifer than on a steer.

Phase 2.–Wintering heifer calves without, grain, grazing to August 1 and then full feeding 100 days in a dry lot proved to be more profitable than including 4 pounds of grain per day during the wintering period, grazing until July 1, then feeding grain on grass until August 1, and finally full-feeding in a dry lot until finished.

Phase 3.–The work on this phase has not been completed, so no conclusions can be stated at this time.

Results of Phase 1 have been published in detail in Circular 41-B-2. The results of Phase 2 are contained in Circular 41-B-5.

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

Lamb-Feeding Investigations.–Three feeding trials were conducted under this project during the biennium. Trial 1 consisted of a study of comparative values of expeller process soybean oil meal and cottonseed meal as protein supplements for fattening lambs. Trial 2 consisted of a further study of the above-mentioned supplements in addition to a test of solvent process soybean oil meal. Included in this trial was a study of physical balance in the ration as a factor affecting its productive energy value. Trial 3, a continuation of the second phase of Trial 2, now is in progress.

Trial 1.–Soybean oil meal placed slightly better than cottonseed meal. In previous tests cottonseed meal was found to be superior to soybean oil meal.

Trial 2.–Lambs fed rations composed of 45 percent concentrates to 55 percent roughage made significantly greater gains than lambs fed rations which contained lesser or greater percentages of concentrates. There appears to be strong evidence in these results of feeding trials to indicate that physical balance in the ration is in itself an important factor in determining the productive energy value of rations for fattening lambs.

At the time of this report, Trial 3 is in progress. Preliminary weighings indicate, however, that the lambs receiving 45 percent concentrates will produce the most efficient and economical gains.

(Project 111; Department of Animal Husbandry. Leader, R. F. Cox; State funds.)

Co-operative Studies in Lamb Feeding.–Twelve lots of range lambs (549 head) were used at the Garden City Branch Experiment Station during the winter of 1941-'42 in the investigation of four lamb-feeding problems.

1. *Varying proportions of concentrates and roughages and the effect on the productive energy value of the ration*.–Results of these tests indicate that the most desirable concentrate content of the ration lies within the range of 45 percent to 55 percent. The efficiency of feed utilization as determined by gains made per pound of nutrients consumed was decidedly in favor of those fed only 45 percent concentrates. The cost of gains was also lower.

2. *Deferred grain feeding versus full grain feeding*.–Deferring grain feeding did not prove advantageous in this test so far as rate of gain was concerned, but produced economical gains.

3. *Wheat pasture versus wheat pasture plus milo stalk field*.–Wheat pasture plus dry roughage produced greater gains than wheat pasture alone.

4. *Relative productive energy values of different roughages*.–Alfalfa hay and threshed alfalfa straw proved to be equal in value as roughages in these trials. It is obvious, however, that as a rule alfalfa hay would be superior to the straw. Both alfalfa roughages produced faster gains than either Sumac or Finney milo stover.

A detailed report of the results of this project is contained in Circular GC-S-42.

(Department of Animal Husbandry and the Garden City Branch Experiment Station. Leaders, R. F. Cox and L. M. Sloan; State funds.)

The Mineral Requirements of Fattening Cattle.–This project was completed during the first year of the biennium with a study of the importance of mineral elements other than calcium and phosphorus in the cottonseed meal used as the protein supplement in the fattening ration. Since urea was used in some of the rations, the study also afforded an opportunity to evaluate this chemical as a source of nitrogen for fattening calves.

Four groups of three steers each were fed individually for 168 days. One animal in each group received a check ration. A second animal received urea instead of cottonseed meal as a source of supplemental nitrogen with the energy value of the ration maintained at the same level as the check ration with the addition of corn sugar. The third steer in each group received urea plus cottonseed meal ash in place of cottonseed meal. The energy level of this ration also was maintained with corn sugar.

The average daily gains per steer were as follows: No. 1 steers (checks), 1.59 pounds; No. 2 steers (urea), 1.59 pounds; No. 3 steers (urea plus c.s.m. ash), 1.63 pounds. There was no significant advantage gained from adding the cottonseed meal ash to the urea. Furthermore, both supplements containing urea were equally as palatable and produced as large gains as cottonseed meal containing the same amount of nitrogen.

Balance studies were conducted with two of the four groups of steers for a 10-day period. No apparent advantages were observed from the use of cottonseed meal ash insofar as the retention of calcium and phosphorus was concerned. There appeared to be no significant differences in the digestibility of the various nutrients irrespective of the mineral supplement included in the ration.

The nitrogen balance revealed that the percentage retention of urea nitrogen was fully equal to that of cottonseed meal nitrogen, The nutrients in the rations containing urea were digested as well as those in rations including cottonseed meal as the source of supplementa1 nitrogen.

All 12 steers used in these studies were continued on experimental rations for 136 days following the balance studies, but were fed in two groups. The group receiving cottonseed meal had somewhat better appetites, made larger gains and required less feed per 100 pounds of gain than did those fed urea.

The results of studies on calcium were completed and published in Technical Bulletin No. 51, "Calcium in the Nutrition of the Fattening Calf."

{Project 203; Departments of Animal Husbandry and Chemistry. Leaders, A. D. Weber and J. S. Hughes; Bankhead-Jones funds.)

Studies of Sorghum Roughages and Grains in the Cattle-Fattening Ration.–This project was initiated in November, 1941, and its objective is the determination of coefficients of digestibility of sorghum grains when fed whole and ground and in conjunction with Atlas sorgo stover silage, cottonseed meal and calcium carbonate.

Ground Colby milo and ground and whole Wheatland milo grain are being compared with ground shelled corn. Twelve range-bred steers were used in these studies. Chemical analyses and computations have not been completed at this time. It is planned to publish the results of this study in a departmental circular.

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

The Effects of Inbreeding and Line Breeding on Sheep.– The year 1941-'42 completed four years of work on this project. Shropshire and Rambouillet sheep have been mated by various degrees of inbreeding and line breeding. It has been necessary to curtail the work to a considerable extent because of disposal of experimental breeding stock.

Measurements have been made on 177 animals. Some outstanding individuals have been produced, while a few very poor ones also have resulted. General speaking, inbreeding has produced favorable results, especially with one strain of Shropshires.

A report, "Inheritance of horns and scurs in sheep," published in the Journal of *Heredity*, July, 1940, was based partially on this project.

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

Meat Investigations–Four aims have dominated the research on this project during the past biennium: (1) Attempts to determine the cause of "dark-cutting" beef; (2) to improve the keeping qualities of meat; (3) to decrease shrinkage losses of meat in storage; (4) to improve palatability of meat.

Phosphorus deficiency in the ration did not cause dark cutters but did prevent the acquisition of a normal finish on steers. The color of what fat existed over the outside was in all instances distinctly white. Carcass analyses of steers fed urea indicate that urea did not impair the ability of the cattle to produce carcasses grading choice, and that there were no features of the beef, physical, chemical or subjective, by means of which the beef produced could

be identified from that of beef produced on standard fattening rations. Rib cuts from phosphorus deficient steers ripened with more spoilage and shrinkage than did rib cuts from animals that received normal rations.

Studies with pork during the past year confirmed the findings of previous studies, in that acid number and peroxide number increase as the period of storage is lengthened. Contrary to previous observations, sausage seasoned prior to freezing kept better than sausage not seasoned. This probably was due to the fact that in later studies, lower storage temperatures were maintained. Freezing does not have a signficant influence upon tenderness in pork. There was no apparent difference in tenderness of cuts from left or right side of the carcasses.

Freezing had little or no influence upon tenderness of beef aged 40 days prior to freezing.

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

Deficiencies of Sorghum Crops as Feed for Dairy Cows.– These long-time feeding studies with dairy cows, started in 1938 were continued as planned. Several animals left the experiment because of death, sterility or completion of their test periods.

Data from the project indicate that digestibility coefficients are highest in cows that receive alfalfa hay in their rations. Cows that were previously fed normal rations digested an all-sorgo ration better than experimental cows which had been receiving the all-sorgo ration for a long period of time.

Cows showed a rapid improvement when shifted from a ration of sorgo grain, sorgo silage and sorgo stover to a ration in which alfalfa hay replaced sorgo stover and to which cottonseed meal, bone meal and wheat bran were added. Cottonseed meal and bone meal were beneficial as supplements for the sorgo ration but distinctly failed to effect optimum improvements in feeding value. When alfalfa hay and wheat bran were also included, satisfactory results were obtained without exception. Studies in progress indicate that wheat bran was an unnecessary accessory and that the alfalfa hay fulfilled some essential role not met by the use of cottonseed meal and bone meal. Other observations, with calves as well as with cows, suggest that the value of the alfalfa hay may have been due to constituents other than nitrogen and carotene.

Studies of the microflora of several rumen liquid samples from typical cows showed that the concentration of nonprotein nitrogen decreased during incubation regardless of the ration of the animal from which the sample was obtained. Some of the differences in yeast counts were suggestive of yeast infestations in the rumens of cows on the deficient rations, indicating that disturbed nutritive conditions may have affected the development of microorganisms in the paunches of these cows.

Bio-assays, using rats, have shown that rations high in Atlas sorgo grain are improved by the inclusion of 10 percent casein, that Atlas sorgo grain contains approximately 11 to 16 gamma of vitamin B_6 per gram of grain, and that Atlas fodder butts possessed a potency of about 75 U. S. P. vitamin D units per pound of stover.

(Project 206; Departments of Dairy Husbandry and Chemistry. Leaders, H. E. Bechtel, F. W. Atkeson, and J. S. Hughes; Bankhead-Jones funds.)

Calf-Feeding Investigations.–Work on this project during the biennium was conducted in two phases: (1) Use of the Coyner nipple pail; (2) production of vealer calves.

1. *Use of Coyer nipple pail*–Seven calves have been raised on the nipple pail and a similar number by bucket in this phase of the project. Observations to date indicate little difference in results.

2. *Production of vealer calves*.–Six dairy calves have been fed whole milk in varying quantities to determine how much milk was necessary for production of top-grade veal. Seven calves have been fed to about 160-pound weights with an average requirement of about 11.2 pounds of milk per pound of gain. No grain or hay was fed.

(Project 154; Department of Dairy Husbandry. Leaders, A. O. Shaw, F. W. Atkeson; State funds.)

Factors Affecting the Composition of Milk.–The work on this project has been conducted in two phases during the biennium.

1. *Digestibility and quality of milk protein*.–Samples of raw milk experimental and market samples of evaporated milk were tested by Mitchell's biological method. It was found that the protein quality in all raw milk samples was uniform, and that the biological value of the protein in milk is not impaired by evaporation, irradiation, sterilization or storage in sealed containers.

2. *Differences between breeds in milk composition.*–This phase consisted of routine analyses of milk samples from different breeds at different seasons and lactations. The data accumulated under this phase will make possible the establishment or norms for the solids-not-fat content of milk produced by different breeds at different seasons.

(Project 209; Departments of Dairy Husbandry and Chemistry. Leaders, W. J. Caulfield, C. H. Whitnah; Bankhead-Jones funds.)

Dairy Production Investigations.–Five general lines of research were conducted on this project during the biennium. The college dairy herd and dairy farm were used principally in this research. The five lines investigated were: (1) Fly control; (2) nutritional and other chemical studies; (3) physiological studies; (4) pasture studies; (5) silage studies.

1. *Fly control*.–Field and barn tests were conducted on the efficacy of various fly spray constituents. Some commercial sprays also were tested. A second phase consisted of a study of the effect of spraying cows with repellent type sprays as measured by milk production. All fly spray tests were conducted in coöperation with the Department of Entomology.

Detailed reports of these investigations have been prepared and will be published in current issues of the *Journal of Economic Entomology* and the *Journal of Dairy Science*.

2. *Biochemistry*.–Nitrogen digestibility was depressed consistently in brown alfalfa hay samples fed in a digestion trial and was found inferior to normal hay under practical farm feeding conditions.

A consistent and marked depression in the apparent digestibility of nitrogen also was observed in the results of feeding trials conducted with browned silage.

Brown silage occurred more uniformly in tower silos made with baled straw and with sorgo bundles. Chopped sorgo silage remained in good condition for more than a year when stored in a wire and roofing paper silo. Spoilage occurred in small areas where air leaked through tears and holes in the paper. Bundle silage in trenches was satisfactory for feeding but required too much time for its removal.

Killing frosts may accelerate the loss of carotene from Atlas sorgo plants approaching maturity. About 80 percent of the total carotene content of the plant was in the leaves when sampling occurred within a few hours after the

first killing frost. Carotene decreased rapidly thereafter, particularly in the leaves, so that the stalks contained more than one-half of the total carotene in the plant within 19 days after the first killing frost. The ultimate distribution of residual carotene in the several parts of the plant may be influenced considerably by the manner in which the dead fodder is handled.

The advantage of grinding Atlas sorgo grain for dairy cows is reported in an article under that title in the *Journal of Dairy Science,* 25(3):211-220. The Department of Agricultural Engineering coöperated in the study.

3. *Physiological studies.*–Four Holstein cows from a farm dairy herd were given large oral administrations of wheat germ oil. This was followed by the appearance of estrum and the cows were served, normal pregnancy resulting.

Calves from cows in extremely poor flesh in a farm beef breeding herd were normal at birth in every respect. The cows had been confined for several months prior to parturition in a dry lot with access to sorgo and kafir fodder, supplemented only by salt and some ground limestone. Difficulties at parturition were common, some deaths occurring. Blood serum analyses indicated the total calcium and inorganic phosphorus were moderately low in some animals. A post mortem examination of one cow disclosed the bones well supplied with trabeculae in spite of decreased concentrations of blood serum calcium and inorganic phosphorus.

Maximum efficiency in artificial insemination of dairy cattle was achieved when the cows were inseminated from the tenth to nineteenth hour after onset of estrum, when 1.65 services were required per conception. A total of 167 services were made by artificial breeding in the complete study, resulting in 46 percent efficiency as compared with 44 percent efficiency for normal services.

4. *Pasture Studies.*–Palatability tests were conducted with two varieties of rye, one of wheat and one of barley, using two cows from each of three dairy breeds. The results of this study are reported in an article prepared for publication in the *Journal of Dairy Science.*

Observations were taken on the time spent in grazing by milking cows during three consecutive days. Four different pairs of cows on four different good pastures were used in this test, the results of which are reported in a current issue of the *Journal of Dairy Science.*

A chemical analysis of different pasture plants, all sampled April 22 at an average height of 7 inches showed that oats was highest in protein content. Other plants in descending order of protein content were: Bromegrass, bromegrass and alfalfa mixture, common rye, barley, Kawvale wheat, Cerophyll rye.

5. *Silage studies.*–Four rates of seeding Atlas sorgo for silage production were compared. Ten and one-half pounds of seed per acre produced the highest silage yield, 11.75 tons, with an average of 572 stalks per 100 lineal feet of row. The general appearance of the sorgo, with respect to stage of maturity and head development at ensiling time, was similar in all test plots.

The use of not more than 5 percent hydrated lime or trisodium phosphate as a preservative in silages appeared to have caused a retention of more green color and more carotene in silages made from sweet clover, green alfalfa or Balbo rye. These silages, however, were unpalatable to dairy cattle, probably because of the high butyric acid content.

(Project 34; Departments of Dairy Husbandry, Veterinary Medicine, Chemistry, and Entomology. Leaders, F. W. Atkeson, H. E. Bechtel, A. O. Shaw, G. H. Beck, W. M. McLeod, J. S. Hughes, and R. C. Smith; State funds.)

Dairy Technology Investigations.–This project, coöperative between the Departments of Dairy Husbandry and Bacteriology, has been conducted in seven phases during the biennium: (1) Bacteriological studies of ice cream; (2) factors influencing the quality of cream and butter; (3) methods of determining micro-

organisms in dairy products; (4) factors influencing heat resistance of microörganisms; (5) methods of chemical analysis of dairy products; (6) studies of manufacturing processes for dairy products; (7) studies of nondairy ingredients used in dairy products.

1. *Bacteriological studies of ice cream*.–Bacterial development due to either extended holding or holding at temperatures which are too high probably is responsible for some of the high counts frequently found in Kansas ice cream, a study of the problem disclosed. Temperatures of 46° to 50° F. permitted considerable development of bacteria in 4 days and doubling or quadrupling of populations occurred in 10 days. A preliminary report on some of the work conducted under this phase was presented at the 1941 meeting of the Kansas Association of Ice Cream Manufacturers.

2. *Factors influencing the quality of cream and butter*.–Since laboratory studies on more than one thousand samples of cream have shown that the methylene blue–borax visual mold test is a reasonably accurate index of the mold content of cream, the value of this test depends upon the validity of the assumption that the mold content is an accurate index of the total microbial content and of changes caused by microorganisms in cream. It was found in this study, however, that many samples showed low mold counts and high yeast counts. One may conclude that the mold content of cream frequently is not an accurate index of the development of other microrganisms.

Visual mold score and organoleptic grade were related to some degree, but numerous exceptions to the general relationship were encountered. For the majority of samples titratable acidity and visual mold score showed no apparent relationship. "The Visual Mold Test Under Kansas Conditions" is the title of a detailed report of this phase and the article appears in a current issue of the *National Butter and Cheese Journal.*

3. *Methods of determining microörganisms in dairy products*.–The major activity under this phase has been the preparation of a review of literature on the evaluation of the various methods of determining the bacterial quality of milk, for the *Journal of Dairy Science.*

A preliminary study of the resazurin reduction test indicated that it probably could be used as a screen test for the separation of most bacteriologically satisfactory ice cream samples from most of the unsatisfactory samples.

4. *Factors influencing heat resistance of microörganisms*.–Bacteria which have been heat-treated to the point where many of the cells have been seriously injured are much more sensitive in their requirements for growth than are unheated bacteria. This fact should be considered in choosing conditions for the enumeration of heat-treated bacteria. An abstract of this work appears in a current issue of the *Journal of Bacteriology***.**

5. *Methods of chemical analysis of dairy products*.–There was no tendency for milk, cream or skim-milk samples which were negative to the phosphatase test immediately after pasteurization to become positive during storage.

Data on 10 laboratory pasteurized ice cream mix samples and 20 commercial ice cream mix samples gave no indication that storage for a period up to 10 days at 50º F. would affect the results of the phosphatase test.

6. *A study of manufacturing processes of dairy products*.–Two reports on the effect of salt on the keeping quality of cream have been published in the *Journal of Dairy Science,* 23: 1215-1227, and 25:59-70.

7. *Studies of nondairy ingredients used in dairy products***.–**A comparison was made of four ice cream stabilizers. A detailed report of the findings is contained in the proceedings of the 41st annual convention of the International Association of Ice Cream Manufacturers, Volume II.

(Project 124; Departments of Dairy Husbandary and Bacteriology. Lenders, W. H. Martin, W. J. Caulfield, and F. E. Nelson; State funds.)

Improvement and Conservation of Farm Poultry.–The work on this project deals with breeding, feeding and management studies with chickens. Four phases were conducted during the biennium.

1. *A study of grass silage for poultry.*–The work begun in 1934, dealing with preservation of silage for poultry, has been continued. Oat grass, cut soon after the first joint appeared, and young alfalfa cut at the same time, have been used. Preservatives were 4 percent molasses and 4 percent added water. The silage did not produce any typical "grassy" or olive-colored yolks in eggs. Both chickens and turkeys ate oat plant and alfalfa silage about as readily as they did freshly chopped grass. It was fed at the rate of 4 pounds daily per 100 birds.

A comparison of grass silage, dehydrated alfalfa meal and sun-cured alfalfa hay as sources of vitamin A and G in the laying ration disclosed that 10 percent of sun-cured alfalfa meal in the mash mixture does not provide an adequate supply of carotene for laying hens.

2. *Broiler production.*–An average weight of 2.9 pounds at 12 weeks of age might be expected with White Plymouth Rock cockerels and pullets fed the College all-purpose ration. About 3.6 pounds of feed were consumed per pound of gain. A profit of 6 cents per pound was realized after all costs had been charged.

3. *Use of artificial insemination for development of a more critical progeny test.*–Preliminary results indicate that by the use of artificial insemination it is possible to exchange males in the breeding pens during the season with no loss of time and with only about 5 percent error in identification of the sire of the resulting chicks. The suggested exchange of males makes for a more critical progeny test.

4. *Modifications of the K. S. C. all-purpose ration.*–Dried buttermilk or dried brewer's yeast, added to the K. S. C. all-purpose ration, increased hatchability of eggs produced by about 20 percent. A ration in which fish meal was replaced by meat scraps and soybean oil meal plus 2 percent dry milk increased the hatchability of eggs 18.5 percent over the control lot which received the standard ration.

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

Turkey Production.–The work of this project was carried on in five phases during the biennium.A 20' by 70' combination breeding and brooding house for turkeys was built at the Poultry Farm and was first used during the spring of 1941.

1. *Effect of rations and management on hatchability.–*The addition of 5 percent dried milk or 30 percent alfalfa leaf meal to the K. S. C. all-purpose ration did not increase the hatchability.

2. *Dried buttermilk and dried brewer's yeast as supplements to the K. S. C. all-purpose ration.*–The lowest and highest hatchability rates were in the lots that received the unsupplemented ration. The low fertility was due in part to preferential mating, since a number of the high-producing females laid all infertile eggs early in the season. It is planned to repeat this study.

3. *Comparison of large and small type turkeys.*–A premium of more than 5 cents per pound for small turkeys would be necessary to return the producer as much net income per bird as received for the larger birds. Broad-breasted bronze and small-type white turkeys were used in this study. At 28 weeks the bronze birds averaged 17 pounds in weight, compared with 11.3 pounds for the white birds.

4. *Rate of feathering of young turkeys.–*Six weeks was required for small-type white turkeys to grow a full set of wing feathers. The whites started

their first molt about two weeks earlier than did the Bronze. All whites had molted the No. 1 Primary feather at 6 weeks, while none of the bronze had molted this feather.

5. *Effect of altitude and climate on molt*.–A flock of 80 Bronze poults from the station poultry flock was compared with a like number of poults from the same flock but hatched and reared by a commercial producer at Fort Collins, Col. At 26 weeks of age both groups were examined and scored for wing, tail and body molt.

There was no significant reduction in the number of pin feathers over the body, in the wings, or on the tail among the turkeys reared in Colorado. The Colorado birds averaged 12¼ pounds, compared with 16¾ pounds for the Kansas birds.

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

Factors Influencing the Color of Yolks of Eggs.–Three phases of this project were conducted during the biennium.

1. *Factors influencing egg yolk color*.—Seven of the nine laying hens that were fed pigments extracted from grass silage produced olive-colored yolks. The pigment responsible for "off-colored" eggs was found in the ether soluble fraction of the alcohol extract of grass silage and appears to be a decomposition product of chlorophyll. Further studies will be necessary to determine its identity.

2. *The role of xanthophylls in poultry nutrition*.–Chicks on a colorless ration, when supplemented with amounts of vitamin A grew as well as chicks on a normal ration. The addition of xanthophyll to this ration had no influence on growth or general appearance of the birds except for pigmentation. The average fertility of 17 males developed on the colorless ration was 82.2 percent. This is about the average when normal males are used for artificial insemination studies, indicating that xanthophyll is not essential in the development of normal sperm.

3. *Influencing of vitamin E on the utilization of vitamin A*.–The addition of vitamin E to a ration containing varying levels of vitamin A does not aid in the utilization of vitamin A by the chick.

(Project 193; Departments of Poultry Husbandry and Chemistry. Leaders, L. F. Payne, A. E. Schumacher, W. J. Peterson, and J. S. Hughes; Adams funds.)

The Mechanism of Egg Formation.–Two phases of this project were conducted during the biennium. Techniques were devised for determining the nature of pigment deposition on the egg shell and for the measuring of shell thickness of eggs.

1. *Development of pigment in brown-shelled hen and turkey eggs*.–One method of studying the development of pigment consisted of prematurely expelling eggs in varying stages of development from hens during anesthesia. Rate of deposition was determined by comparing the different eggs. Measurement of color was made with a colorimeter. Another technique followed was to dissolve off varying portions of the outside of the shell and determine the relationship between the percentages of shell and shell pigment thus removed. The two techniques agree closely in indicating that pigment is deposited during most of the period of shell formation, but that the rate of deposition is greatly accelerated in the last three or four hours. A series of prematurely expelled turkey eggs showed the same regarding the putting down of speckles.

2. *Relationship of specific gravity of the whole egg to its shell thickness*.—A series of salt solutions were made up, ranging in specific gravity from 1.000 to 1.018 and eggs were tested in them to determine the highest concentration

in which the egg would sink. This was taken as a measure of the egg's specific gravity and the shells were broken and measured. The two measures of shell thickness were in close agreement and indicated that specific gravity of the whole egg is a reliable measure of shell thickness.

(Project 198; Department of Poultry Husbandry. Leaders, D. C. Warren and R. M. Conrad; Bankhead-Jones funds.)

The Chemistry of Egg Formation.–The ability of pullets to withdraw calcium from the skeleton for egg formation has been further studied. The ability of avian and mammalian adrenal extracts to lower the blood calcium level of the laying hen has been studied.

1. *Calcium withdrawal from the skeleton*.–It was found that birds which had been laying steadily for six months on a diet containing 2.28 percent calcium still possessed approximately the same amount of skeletal calcium as when they commenced laying, and were able to utilize about 30 percent of the total skeletal calcium for egg formation. It was also found that when fed a diet containing 3.17 percent calcium they could slightly increase this store, or when fed a diet containing only 0.496 percent calcium, they were able to utilize 25 percent of their total skeletal calcium in 12 days.

It was found that in laying hens, the injection of a saline extract corresponding to 0.02 gm. to 0.1 gm. of the adrenal tissue from immature chickens, hogs, or cattle lowered the blood calcium 30 percent. The corresponding extract from sheep was found to be less potent. There were indications that the hens developed a resistance to the effect of the mammalian gland when repeatedly injected. A standard assay method has not been developed because of large individual variations. The response shows a striking similarity to the response to high air temperatures.

2. *Lipid metabolism*.–The mechanism of absorption of lipids from the intestine has been studied by means of analyzing the portal vein blood and heart blood for total fatty acids. A large part, and perhaps all, of the fatty acids absorbed by the hen may enter the body by way of the portal vein rather than the thoracic duct, as is the case in mammals. This means that the fats, and probably the fat soluble vitamins, pass through the liver before reaching the rest of the body, and suggests that the metabolism of fat soluble vitamins may be different in fowl and mammal.

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

Chromosome Mapping of the Genes of the Fowl.--This project has been carried on in two phases during the biennium: (1) Linkage groups and genetics of new factors; (2) Physiological basis of color variations.

1. To date, over 180 character combinations have been tested at this institution and some of the characters have been shown to belong to the six known autosomal linkage groups, while several seem to be inherited independently of these groups. Recently emphasis has been placed upon tests of albinism and pinkeye, neither of which has as yet been located on the chromosome map. Duplicate, a new type of polydactyly, has been studied as to linkage relations and other genetic behavior. It now appears to belong to a multiple allelomorphic series along with the usual type of polydactyly. New genes being given special study are double spur, defective toenails, short flights, syndactyly, recessive leg feathering, ropy plumage, and green legs.

2. The spectrophotometric studies of pigment indicate that red and black are different and also that red and buff differ. The latter two are differentiated in the acid-insoluble fraction but not in the acid-soluble. Blue and black seem to be identical chemically but may be differentiated histologically by

both the shape and distribution of the pigment granules. Attempts to further differentiate between the various pigments by the use of the quartz spectrograph in the ultraviolet light range were unsuccessful.

(Project 197; Department of Poultry Husbandry. Leaders, D. C. Warren, B.B. Bohren; Bankhead-Jones funds.)

Development of Strains of General Purpose Breeds Possessing High Egg Production and Early Feathering Tendencies.–Major emphasis on this project has been placed on the development of early feathering strains of White Plymouth Rocks although both Barred Plymouth Rocks and Rhode Island Reds have been included in the project.

Early feathering genes were brought into these breeds from the New Hampshire and repeated back crosses to the stocks under improvement has reestablished other desired breed and varietal characteristics. During the present season several breeding birds homozygous for both early feathering and white plumage were available as White Rock parent stock. During this season approximately one thousand early feathering birds were produced from eight individual breeding pens and the pullets are to be housed and progeny tested for laying qualities. Growth and color qualities of this stock are good. Green leg is the major standard defect and study is being made of the genetics of this color in the legs. Early feathering Barred Plymouth Rocks have also been developed in smaller numbers but their growth and egg production is superior to the white variety. The barring pattern of the Barred Plymouth Rock is not so good as desired.

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

Poultry Research Fellowships.—Three lines of research in poultry products were conducted during the biennium through research grants made by Swift and Company, the Poultry Institute and the H. J. Keith Fund.

1. The nutritive value of dried eggs. (Swift and Company)–This project was started in February, 1942, and the work to date has included only the construction of a laboratory egg drier and the establishment of conditions of its operation. Eggs will be dried at temperatures from 60° C. to 250° C. and to moisture contents from 3 to 10 percent. After drying, the eggs will be assayed at different storage periods for different vitamin contents. Studies also will be made on the effect of different rations upon the storage stability of the dried product.

2. Storage changes in poultry fat. (Poultry Institute)–The inclusion of the fat of fish meal, meat meal, and soybean oil meal in the diet increase the rate of oxidation of body fat but at the same time increase the desirability of the flavor and aroma of the cooked birds. Birds dressed New York style oxidize more slowly but are markedly inferior in flavor and aroma to eviscerated birds. Internal scratching of birds during evisceration increases considerably the rate of fat oxidation.

3. *Shell treatment of eggs.* (Keith Fellowship)–To seal egg shells against water and CO_2 loss it is necessary to cover the shell surface with a water repellent film rather than simply to seal the pores against vapor loss. An emulsion containing 2 percent mineral oil in water with a suitable emulsifying and stabilizing agent was used. This emulsion can be made at a cost of 3 to 4 cents per gallon and has a number of advantages in use over pure oil.

It is adaptable to use on the farm because of its inexpensiveness and ease of application. It deposits only a thin film of oil on the eggs, with the result that no damage from excess oil occurs in the flats and fillers of the egg case.

It was demonstrated that if eggs are treated on the farm, either with or without previous washing, their interior quality is as high after 14 days in a farm cave as that of untreated eggs after only three days, and as high after six weeks as that of untreated eggs after seven days. Since most fresh eggs do not reach the consumer until they are three to ten days old, the importance of some such treatment as that developed is obvious if eggs are to reach the consumer with their original high quality.

(Departments of Chemistry, Poultry Husbandry and Home Economics. Leaders, R. M. Conrad, L. F. Payne, A. E. Schumacher, and G. E. Vail.)

Inheritance and Physiology of Reproduction in Mammals. –Work on this project was disrupted on March 15, 1941, when a fire destroyed the small animal house and a colony of about 1,200 guinea pigs was lost. Breeding records, containing data on about 25,000 litters, were saved. A number of weight records, hair samples, etc., were lost.

Many of the research problems were practically completed at the time of the fire, and data are now being assembled for summarization and publication. Much time on the project has been spent in building new cages and obtaining other equipment. New animals have been obtained.

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

Studies in Inheritance of the Grouse Locust.–Work on this project has been continued during the biennium with the addition of a collection made in Texas. New recessives have been found for a black color pattern in *P. texanus* and *A. eurycephalus* and a recessive and partial lethal in *A. eurycephalus*. Detailed results of much of the work are reported in the following publications:

The genetics of the grouse locust *Tettigidea parvipennis* Harris. *Trans. Kans. Acad. Sci., 44:234-237.*

Genetic problems of the grouse locust *Tettigidea parvipennis* Harris. *Genetics,* 27:143, 1942, abstract.

Autosomal and sex chromosomal translocation and viability in *Apotettix eurycephalus* Hancock. *Jour. Exp. Zool.* 88:239-261, 1941.

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

Effect of Climate on Inheritance of the Grouse Locust.– This is a companion project to No. 72 reported above. Studies have been made on the effect of X-raying males of the grouse locust.

No noticeable germinal effects have been discovered during the biennium. Results of previous work indicate, however, that the grouse locusts make excellent materials for studies on the gene modifications.

(Project 104; Department of Zoölogy. Leaders, R. K. Nabours and F. M. Stebbins; Adams funds.)

Bee Investigations.–Colonies on scales in 1940 made net gains of from 131 to 228 pounds for the season. During 1941 colonies made net gains of from 84 to 152 pounds.

The project leader is acting as liaison agent between the Division of Bee Culture of the Bureau of Entomology and Plant Quarantine and the War Production Board in the stimulation of beekeepers to produce more honey and beeswax to supplement the sugar supply and provide needed beeswax for the manufacture of armaments and munitions.

Experimental work of the project is furnishing information in regard to the source of queens of superior strains of bees for greater honey production. Data have been accumulated pertaining to the influence of weather factors upon nectar secretion of honey plants. Method of colony management for greater honey production have been advocated such as the two queen colonies and the equal division of strong colonies during the month of April in Kansas, where there is a long building up period for peak colony population.

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

Physiology of Reproduction.–This project was conducted in four principal phases during the biennium.

1. *The effect of adrenalectomy on the anterior pituitaries of fowls*.–The pituitaries from adrenalectomized birds contained many degenerate basophilic cells. The castrate birds showed many large, active basophils of the "castrate type." Adrenalectomy in fowls apparently causes basophilic cells to become inactive, thus withdrawing the stimulus for testis maintenance, followed by changes in other sexual characteristics. This phase was reported in detail in volume 27 (1940) of Endocrinology.

2. *The effect of male sex horomone on the developing ovaries of young fowls*.–Testosterone propionate is highly effective in depressing the gonads of both male and female fowls. The results of this study are reported in *Endocrinology,* volume 26 (1940).

3. *A comparison of two gonadtropic hormones*.–Antuitrin and Antuitrin-S were compared for their effects on immature fowl gonads. The study is reported in *Transactions of the Kansas Academy of Science,* volume 44. It has further been observed that serum from pregnant mares is capable of stimulating the gonads of young fowls.

4. *Effect of vitamin E deficiency on gonad development*.–Histological studies made on the pituitaries of vitamin E deficient fowls indicate that the fowls have pituitary glands with numerous degenerating basophil cells.

(Project 218; Department of Zoölogy. Leader, E. H. Herrick; Purnell 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.–Work on this project consisted of the development of varieties of cereals and forage crops that are resistant to plant diseases. Coöperation in these investigations has been given by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

Sorghum disease investigations.–Weakneck does not seem to be primarily the result of fungous, bacterial or insect action, but these factors may be con-

tributory and follow the primary injury.Such varieties as Colby, Wheatland, Hegari, Cheyenne and Sooner are susceptible, while kafirs and sorgos are among the resistant varieties. There are indications that certain morphologic and physiologic differences occur in plants having weakneck over those present in varieties which do not show the disease. A weakneck symptom indistinguishable from that occurring in the field has been produced artificially in plants subjected to drought and heat periods during the development of the plant.

Wheat disease investigations.–In 1940, 71 out of 110 advanced wheat hybrids grown in the bunt nursery showed a reaction of 10 percent or less. Comanche (Oro X Tenmarq) is one of the hybrids that has been developed in part through the work of the bunt nurseries.

Preliminary investigations indicate that Kawvale, Pawnee (Kawvale X Tenmarq), and several Kawvale X Marquillo hybrids are highly resistant or immune to loose smut.

Several physiologic races of *Ophiobolus graminis,* the organism causing take-all in wheat, have been found.

Oat Disease Investigations.–Of 73 varieties, selections and hybrids, 55, 72, and 71 were resistant to infection when inoculated independently with composite Kansas smut collections which attack Fulton, Kanota and Richland, respectively. Those three latter varieties averaged 22, 64, and 39 percent, respectively, when inoculated with their respective Kansas composite smuts. Thirty-seven of these oat strains had zero reaction to all three groups of smut.

Barley Disease Investigations.–In 1941, 40 out of 50 barley varieties, selections and advanced hybrids had a reaction of 10 percent or less smut, while the susceptible check variety had 33 percent smut infection.

Alfalfa Disease Investigations.–Investigations on the black stem disease of alfalfa have shown that this fungus requires cool, moist weather to produce an epiphytotic. The optimum temperature for growth of the organism is 21° C. while 9° and 33° C. are close to the minimum and maximum temperatures. No relationship exists between the age of alfalfa leaves and severity of infections following artificial inoculation. *Medicago falcata* and *M. ruthenica* were added to the host range.

The following publications contain detailed results and observations obtained in the work on this project:

The reaction of a group of sorghums to the covered and loose kernel smuts. *Amer. Jour. Bot.* 27:789-791. 1940.

The reaction of sorghum varieties and hybrids to milo disease. *Plant Dis. Rptr. Suppl.* 126:165-175. 1940.

Effect of certain environmental conditions on the prevalence of *Ophiobolus graminis* in the soil. *Jour. Agr. Res.* 63:715-726. 1941.

Smut sori from ovarial and stamina1 tissues of certain grasses. *Phytopath.* 31:1043-1046. 1941.

On the cause of the milo disease. *Phytopath.* 32:640-641. 1942.

Studies on black-stem of alfalfa, caused by *Ascochyta imperfecta. Phytopath.* 32:590-597. 1942.

(Project 76; Department of Botany. Leaders, L. E. Melchers, E. D. Hansing, and H. Fellows; State funds.)

Fruit and Vegetable Disease Investigations.–Methods of disease control in potatoes, sweetpotatoes, and black raspberries, development of mosaic resistant cucumbers and wilt resistant watermelons and the propagation of mutant sweetpotatoes to increase carotene content were included in the work on this project for the biennium.

Momentary dip treatments of potatoes in an acidulated solution containing 18 ounces of mercuric chloride to 25 gallons of water were more effective in

controlling Rhizoctonia than was the l0-minute soak treatment in the standard acidulated solution containing 6 ounces of mercuric chloride to 25 gallons of water.

Spergon was effective for increasing sweetpotato sprout production in the hotbed. In two test fields the average yield from Spergon treated sprouts at planting time was 54 bushels per acre greater than from Semesan Bel treated sprouts and 113 bushels greater per acre than from untreated sprouts.

Carotene assays indicate that Orange Little Stem Jersey (Strain 35) and Common Little Stem Jersey contained respectively 7,916 and 2,220 international units of vitamin A per 100 grams. Nancy Gold and Nancy Hall contained respectively 17,166 and 5,583 international units of vitamin A per 100 grams.

Continued investigations on the prevention of raspberry anthracnose indicate that commercial liquid lime sulfur dormant spray 1 : 10 is most effective when applied immediately before leaves appear in the spring.

Work is in progress on the development, of mosaic resistant cucumbers, wilt resistant watermelons and on vegetable seed treatment.

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

A Study of Combined Resistance of Winter Wheat to Leaf and Stem Rust Races.–Work on this project during the biennium which was conducted coöperatively with the Bureau of Plant Industry, United States Department of Agriculture, consisted of testing varieties, selections, foreign introductions, hybrids and species of wheat with leaf and stem rust in the greenhouse and rust nursery; determination of the distribution of physiologic races of the causal organisms, and other factors related to rust epiphytotics.

It was noted that many resistant selections from winter X spring crosses involving such spring varieties as Renown, Thatcher, Apex and (Ceres X Hope) X Florence lack cold resistance and yielding capacity. Most of the resistant hybrid selections involving the varieties Hope, H-44, Premier, Renown and Apex exhibited some brown necrosis although it appears that the amount may be reduced by a careful selection. Some resistant selections are now on yield tests.

Among the crosses possessing combined resistance to one or both of the rusts was the cross (Marquillo X Oro) X *Triticum timopheevi* in which it is sought to combine *T. vulgare* characters the strong resistance of *T. timophevi* to leaf rust, stem rust, bunt, loose smut, mildew and Septoria leaf spot. The F_1 plants were highly sterile, 670 heads yielding only 34 kernels and those mostly in florets backcrossed with *T. vulgare.*

The following publications contain observations and results obtained from the work on this project:

Some species of Triticum and related grasses as hosts for the leaf rust of wheat, *Puccinia triticina* Eriks, *Trans. Kan. Acad.* Sci. 43:121-132. 1940.

Modification of diurnal transpiration in wheat by infections of *Puccinia triticina. Jour. Agr. Res.* 61:427-444. 1940.

Transference of Hessian fly resistance and other characteristics of Marquillo spring wheat to winter wheat. *Kan. Agr. Expt. Sta. Tech. Bul. 49,* 1940.

The wheat stem rust epidemic of Kansas in 1940. *Plant Dis. Rptr. Suppl.* 132:95-103. 1941.

Third revision of the international register of physiologic races of the leaf rust of wheat *(Puccinia rubigo-vera tritici [triticina]). Unnumbered publication Div. Cereal Crops and Diseases, U. S. Dept. Agr., April 1, 1942.* (Mimeographed.)

(Project 171; Departments of Botany and Agronomy. Leaders, C. O. Johnston, L. E. Melchers and L. P. Reitz; Purnell funds.)

Breeding for Disease Resistance in Wheat, Oats and Sorghums.–This project is conducted coöperatively between the Departments of Agronomy and Botany of the station and the Division of Cereal Crops and Diseases, United States Department of Agriculture. Results obtained since 1938 when this project was established clearly indicate that new commercial varieties of all crops being investigated can be produced to possess practical resistance to the major diseases of this region.

Wheat investigations.–This phase of the work consists of breeding, and testing wheats for resistance to the different diseases. There were 4,470 winter and 541 spring selections of wheat observed in the rust nursery and 1,227 rows of winter wheat in the nursery for loose smut resistance testing in 1941. About 1,000 new head selections of wheat from the rust nursery were planted in the fall of 1941 in the agronomy nursery.

Ninety-one out of 191 wheat selections from 9 different F_4 populations involving both bunt and Hessian fly resistance had a reaction of 10 percent or less bunt.

Oats investigations.–Oats in the disease nursery involves resistance to crown and stem rust, and smut. In the F_3 to F_9 generation, 1,681 hybrid strains were grown and 477 saved for further study. Five strains were advanced to large-scale tests.

Sorghum investigations.–Backcrossing to Atlas sorgo and Standard Blackhull kafir was continued to obtain smut resistant forage and grain sorghums.

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

Climate and Injurious Insect Investigations.–Work during the biennium on this continuing project has consisted of gathering and publishing information for the annual insect population summaries of Kansas, preparation of a report on yearly grasshopper populations in Kansas since 1850, assisting graduate students in research and preparation of reports.

Summaries Nos. 10 and 11, covering insect populations in Kansas for 1940 and 1941 were prepared and published in the *Transactions of the Kansas Academy of Science*.

Data for the report on grasshopper populations in Kansas are being analyzed especially with reference to the effects of climatic conditions.

A study is being made, by a graduate student, of the life histories of the migratory and differential grasshoppers under controlled temperature, humidity and food conditions.

A study of the bacterial and fungous diseases of the "barren lands termite," *Reticulitermes tibialis* Banks has yielded a species of the fungus *Entomopthora* and a bacterium, *Serratia marcescens*, which were isolated from termite colonies in nature. They destroyed a significant percentage of termites in laboratory tests and they may have possibilities in actual termite control. This study is being continued.

Discovery was made of the virus of western equine encephalomyelitis in field collections of an assassin bug, *Triatoma sanguisuga* LeConte. Technical Bulletin 50 published by this station contains a detailed report of this discovery. This work was in coöperation with the Department of Veterinary Medicine.

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

The Hessian Fly and Other Wheat Insects.–The biology and control of insects attacking the wheat plant as studied under this project have included the Hessian fly, chinch bug, wheat white grub and wireworms. Hessian fly was present in almost every wheat field east of highway U. S. 81 that was examined in the fall of 1940. More than 90 percent of the wheat in eastern Kansas was planted before the fly-free date that year.

Conditions in the spring of 1941 were again favorable and oviposition began near Manhattan April 11, full-grown larvae being present by May 3 and a second spring generation followed soon afterward. This fly infestation in the absence of injurious rust diseases made possible a study of the relation of yield to infestation by both fly and wheat strawworm. It was estimated that reductions in yield from 10 to 38 percent were caused by fly infestation. A reduction occurred in both number and weight of kernels even in the absence of lodging caused by fly.

Collections of beetles of the wheat white grub, *Phyllophaga lanceolata* Say indicate that the beetles and therefore the grubs are more plentiful on the high lands rather than in the low lands. An increase in population of this grub has taken place in areas as far north as Riley county. A wide variety of plants can be utilized by the grub as sources of food.

Wireworms collected from the roots of winter wheat and reared to the adult state proved to belong to the species *Monocrepedius vespertinus.*

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

The Corn Earworm and Other Insects injurious to Corn.– An important phase of the work on this project has been the search for a safe, inexpensive and reliable control for the corn earworm in sweetcorn. Other insects studied included the southwestern corn borer, the chinch bug, the sugar cane rootstock weevil and the southern corn rootworm.

Corn ear worm.---Two grades of light mineral oil and two commercial preparations of light mineral oil with dichlorethyl ether were used on sweet corn. The results were uniformly favorable in control of the earworms but there was serious injury to the ears caused by the treatment. Possibly the high temperatures prevalent at Manhattan during the summer of 1941 were responsible.

Southwestern corn borer.—Preliminary investigations have been made in connection with the southwestern corn borer which has appeared in an alarming outbreak over the southwestern quarter of Kansas during the late summer and fall of 1941. Evidence shows that the overwintering borers can be destroyed by any treatment which throws the corn stubble to the surface such as discing or one-waying the ground during the late fall or early winter.

The occurrence in Kansas of the sugar cane rootstock weevil is reported in an article by that title in the *Journal of the Kansas Entomological Society,* 14:84-90.

The adult beetles of the southern corn rootworm did not survive the winter in the vicinity of Manhattan. More than 200 adults, collected from October to December, placed in two prepared hibernation cages, failed to survive the winter.

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

Fruit and Vegetable Insect Investigations.–This project has included studies in the following phases during the biennium: Red

spider mite control, juniper midge, redbud leafhoppers, redbud aphis, redbud whitefly and cankerworm emergence.

The red spider mite was successfully controlled in the greenhouse by the use of a dinitro-cyclohexylphenol salt at the rate of ½ and 1 pound per 100 gallons of water, using only one application. A modified alkyd resin emulsifier spreader, used at the rate of 2 gallons per 100 gallons of water, also gave good control with one application.

Control for the juniper midge is reported in the Tenth Biennial Report of this Station.

For a report on the control of insects which attack the redbud, readers are referred to the 45th biennial report of the State Horticultural Society, 46:239-242.

The need for spraying to control cankerworms on shade and fruit trees can be determined by adult fall and spring cankerworm emergence.

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

Insects Attacking the Roots of Staple Crops.–This project has for its objective the problem of determining the life histories of subterranean insects such as wireworms, white grubs, false wireworms and root worms which attack the roots of staple crops in Kansas.

The subterranean insect investigations conducted during the biennium were confined chiefly to (1) a continuation of the ecological and biological studies of white grubs and wireworms, (2) the life history and distribution in Kansas of the carrot weevil *(Listronotus oregonensis* Lec.), (3) habits of *Ligyrus gibbosus,* and (4) summarization of miscellaneous notes on click beetles and grubs.

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

Insects Injurious to Alfalfa, Grasses and Allied Plants.– Work on this project during the biennium consisted of studies on the life histories, habits and control of the sod webworms, on *Nomophilia noctuella* as a grass and alfalfa pest, the spring tail *(Smithurus Medialis),* blister beetles, pea aphids, clover seed chalcid, tree crickets, nabids, leaf hoppers, cutworms, alfalfa thrips and short-tongued bees as alfalfa flower trippers.

The results of studies on sod webworms was reported in detail in *Transactions of the Kansas Academy of Science,* 43:267-281.

"*Nomophilia noctuella* as a grass and alfalfa pest in Kansas" is the title of a detailed report on that insect and appears in the *Journal of the Kansas Entomological Society,* 15:25-34.

Work on the identification of midwestern grasshoppers by the chorionic sculpturing on the egg was continued. Fifty-five species have been identified. *Camnula pellucida,* the common clear-winged grasshopper of Colorado, appears to bear relationships to two different groups, judging by the egg sculpturing.

Some preliminary observations indicated that the honey bee is a more important cross pollenizer of alfalfa flowers than published observations from other states might lead one to believe.

Pyrocide and derris dusts and sprays were tested in the control of some of the more destructive alfalfa insects and on some garden plants. Insecticides of plant origin generally proved effective.

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

Study of the Biology and Control of Fruit and Vegetable Insects.–Only one phase of this project was operative during the biennium. All work dealt with the biology and control of the strawberry leaf roller, *Ancylis comptana fragariae* W. and R.

During the 1940 season there were tested 13 insecticides and during 1941 10 insecticides and combination of insecticides. The most successful control was obtained with the use of ½ pint of 40 percent nicotine sulfate plus 1 pint of summer oil emulsion to 50 gallons of water, applied in three sprays at five-day intervals following the appearance of the first hatched larvae during the blooming and fruiting interval. This spray and schedule will give 90 to 95 percent control of the first brood without spray residue complications. Properly timed sprays for the control of the second and third generations, using lead arsenate at the rate of 1½ pounds plus 1 pint of summer oil emulsion, or 2 pounds of cryolite plus 1 pint of summer oil emulsion to 50 gallons of water, enables fruit growers to establish new fields of plants for the following berry production season, as well as to maintain one-year-old fields for another or the second production season.

Data collected for five years regarding the relative susceptibility or resistance of eight varieties of strawberry plants to the attack of the leafroller do not show any conclusive differences between varieties.

Persons interested in detailed reports of the results of work on this project are referred to the following publications:

Control of American strawberry leafroller. *Bien. Rpt. Kan State Hort. Soc.,* 45:39-46

New and effective control for the American strawberry leafroller. *Trans. Iowa State Hort. Soc.,* 74:37-39.

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

Study of the Biology and Control of the Codling Moth.— The control of the codling moth by the use of insecticides has been carried on in the Blair experimental orchard. Lead arsenate combinations with summer oil emulsion, zinc sulfate, and soybean flours were tested during the biennium. Information for proper spray dates was obtained from a series of bait traps located in Doniphan county. Orchardists were notified concerning spray dates through a coöperative arrangement with the Farm Bureau of that county.

The results of studies on codling moth control have been reported in detail in the following publications:

Lead arsenate combinations and nicotine combinations as control measures for the codling moth during the season of 1938. *45th Bien. Rpt. Kan. State Hort. Soc.,* 45:29-37, 1940.

Lead arsenate combinations and basic copper arsenate as control measures for the codling moth during the season of 1939. *45th Bien Rpt. Kan. State Hort. Soc.,* 45:173-179, 1940.

Lead arsenate soybean flour and lead arsenate zinc sulfate combination sprays for codling moth control during the season of 1940. *46th Bien. Rpt. Kan. State Hort. Soc.* (in press).

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

The Resistance of Crop Plants to Insect Attack.–The work of this project conducted coöperatively with the Bureau of Entomology and Plant Quarantine and Bureau of Plant Industry, United

States Department of Agriculture, has been primarily concerned with the development of hard winter wheat resistant to Hessian fly, and particularly the transference of the resistance of Marquillo and other spring wheats to wheats of winter growth habit. Studies have been continued on resistance of corn to corn ear worm.

Winter Wheat.—Under a natural stem rust epidemic in 1940 the yield and test weight of the simple Marquillo hybrids were far better than those of any of the standard wheat varieties. In the presence of heavy natural epidemics of Hessian fly, the Marquillo hybrids gave yields of 8 to 10 times that of standard varieties in 1941. In the absence of stem rust and Hessian fly, most of the Marquillo hybrids have been at least equal to Tenmarq and Turkey in yield.

The detailed results of transference of fly resistance and resistance to diseases from spring wheat to winter wheats is reported in *Technical Bulletin No. 49*, published by this station.

Corn.—For the fourth consecutive year Kansas experimental corn hybrids have continued to show more insect resistance than most of the out-of-state commercial hybrids. In the 1941 yield tests, 8 of the 16 Kansas hybrids were better than the average of open pollinated varieties, while only 7 of the 55 commercial hybrids were better than this average in class of injury by corn ear worm.

Significant differences were noted in resistance of Kansas hybrids to grasshopper and chinch bug injury.

Results of one phase of this project are reported in detail in "Differential injury within varieties, inbred lines and hybrids of field corn caused by the corn earworm." *Jour. of Agri. Res.*, 61:8l-100.

(Project 164; Departments of Entomology and Agronomy. Leaders, R. H. Painter, R. W. Jugenheimer, 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.–The major portion of the work on this project was confined to western Kansas during the biennium since grasshoppers are more frequently a menace to crops in that part of the state. The work in western Kansas was terminated with the close of the biennium because of insufficient funds.

The results of studies conducted on this project have been reported in detail in the journals listed below.

Grasshopper populations (Orthoptera, Acrididae) of typical pastures in the Bluestem region of Kansas. *Kans. Ent. Soc. Jour.* 13:86-100, 1940.

Grasshopper problems associated with strip cropping in western Kansas. *Amer. Soc. Agron. Jour.* 34: 16-29, 1942.

Coleoptera associated with ironweed, *Vernonia interior* Small in Kansas. *Jour. Kan. Ent. Soc.* 15:37-44, 1942.

Lepidoptera, Hemiptera and Homoptera associated with ironweed, *Vernonia interior* Small in Kansas. With editor, *Trans. Kan. Acad. Sci*.

Diptera associated with ironweed, *Vernonia interior* Small in Kansas.

Injury to black top highway in western Kansas by mound building prairie ant. With editor, *Jour. Econ. Ent.*

(Project 211; Departments of Entomology and Agronomy. Leaders, D. A. Wilbur, R. F. Fritz and K. L. 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 Animal Diseases.–Laboratories in the Department of Veterinary Medicine have and will continue to provide a general diagnostic service in the work on animal diseases in Kansas. Much of the work on this project is devoted to laboratory analyses and diagnoses for farmers, veterinarians and other workers in the field. Five principal phases, in addition to the laboratory phase, were carried on during the biennium.

1. *Equine Encephalomyelitis.*–It was shown conclusively that the assassin bug, *Triatoma sanguisuga* Lec. taken from a pasture near Manhattan, is a carrrer of the virus of encephalomyelitis. The findings and cross-immunity tests are reported in Technical Bulletin No. 50 published by this station.

Another feature of the encephalomyelitis problem was the study of human encephalomyelitis. Nine positive cases of the western strain of the disease were found among 34 samples tested. After allowing for the cases of infantile paralysis, it appears that approximately one-half of the cases of human encephalomyelitis in Kansas can likely be attributed to the western equine virus.

2. *Hemoglobinuria in cattle.*–This disease was first noticed in 1941 and appears to be of considerable economic importance. It involves the destruction of the red blood cells, the liberation of the hemoglobin and its appearance in the urine. Mortality is high in untreated animals. A clinical study is being made of the disease.

3. *Canine meningo-encephalitis.*–Some observations that have been made on this disease during the biennium: (a) The disease still remains a likely sequel to distemper infection. (b) So-called "chorea" is apparently another likely sequel to distemper. (c) Bacteria of various types, usually streptococci, commonly are found in the cerebro-spinal fluid; (d) Removal of cerebrospinal fluid in quantities as large as 10 c. c. in some cases has afforded immediate relief. (e) Some dogs apparently are so mildly affected with canine distemper that the disease passes undetected and it is not until it becomes sick with encephalitis or chorea that it is noticed.

4. *Lymphogenous Leukemia.*–A high degree of accuracy in diagnosis of the disease has been attained by the differential blood cell count. It has been observed, however, that cattle low in blood carotene show a differential blood cell count that is similar to that of cattle affected with lymphogenous leukemia. Attempts were unsuccessful to transmit the disease to three other species of animals in which the disease naturally occurs.

5, *Parasitological Investigations.*–Work on this phase has been reported in detail in the following journals:

Studies upon *Strongylus vulgaris.* VI. Tests with copper salts. *Jour. Parasitol.*, 28 : 168.

Characteristics of the population available for bioassay of anthelmintics in *Nippostrongylus muris* infection in albino rats. *Jour. Parasitol* (In press.)

A bioassay technic for anthelmitics. *Jour. Parasitol.* (In press.)

Field tests of various anthelmintics recommended for treatment of haemonchosis. *Amer. Vet. Med. Assoc. Jour.* (In press.)

The influence of the diet upon development of haemonchosis in sheep. *Amer. Vet. Med. Assoc. Jour.* (In press.)

(Project 102; Department of Veterinary Medicine. Leaders, L.M. Roderick, R. P. Wagers, W. W. Thompson and J. H. Whitlock; State funds.)

Abortion Disease Investigations.–Investigational work on this project has been directed toward solving some of the problems of immunity associated with contagious abortion in cattle. The work has involved the use of an experimental herd and cooperative experiments with privately owned herds. The investigational work has been inactive since the project leader was called to active duty with the United States Army.

Approximately 15,000 blood samples are tested annually. Aid is given other state institutions in controlling the disease in their herds.

It appears that with the methods adopted and after nearly four years of fairly constant work under the conditions which existed in three experimental herds, in an attempt by means of vaccines to reduce the incidence of Bang's disease, the number of infected cattle remains approximately as high as it was at the beginning of the study.

(Project 135; Department of Veterinary Medicine. Leader, C. H. Kitselman; State funds.)

Anaplasmosis Investigations.–Studies in anaplasmosis during the biennium have included field and laboratory investigations of outbreaks of the disease as to type and number of animals affected, treatment, and methods of handling.

There is no conclusive evidence to date which would indicate that medical treatment has been effective in curing a case of anaplasmosis. Practitioners continue to treat cattle with arsenicals and antimony compounds. Five drugs, tested in large doses, did not check anaplasmosis in 10 cows treated.

Observations in the experimental herd indicate that once an animal has lost the "carrier" infection, it is again susceptible to the disease. This observation is contrary to general belief.

Both negative and positive results were observed while studying "incubation virus" and methods of attenuation by animal inoculation.

A new type of cattle disease characterized by hemoglobinuria and anemia, has been studied in connection with anaplasmosis. There apparently is no relationship in the two diseases, according to laboratory studies.

(Project 180; Department of Veterinary Medicine. Leaders, H. Farley and L. M. Roderick; State funds.)

Feeder Cattle Disease Investigations.–Work in this project during the biennium has consisted of field and laboratory studies of diseases of cattle, including shipping fever, cornstalk disease, ensilage poisoning, keratitis, anaerobic infections and hemoglobinuria.

Twenty-two field trips were made during the biennium to different sections of the state for the purpose of investigating the diseased conditions mentioned above. Cornstalk disease and ensilage poisoning are noninfectious and are induced by something in the feed named. There is no medical treatment known to be effective or reliable in treating cornstalk disease.

Investigations into the causes and cures of the infectious diseases will be continued during the coming biennium.

(Project 194; Department of Veterinary Mediene. Leaders, H. Farley and L. M. Roderick; State funds.)

Studies on Mastitis.–Investigations on this project are conducted coöperatively with owners of dairy herds over the state. Although it is possible to demonstrate what appears to be inclusion

bodies in the cells present in milk sediments from mastitis-infected cows, the presence of a virus could not be established.

Teats wetted naturally with milk containing mastitis streptococci are made free of streptococci within one minute after dipping in a 10 percent solution of a coconut oil (40 percent) soap.

Examination of milk from cows in 86 different herds over Kansas, disclosed that 63 percent of the herds had one or more cows which showed evidence of. streptococcic mastitis infection.

Beta hemolytic Lancefield group C streptococci are almost always present in fistulous withers, poll evil and other pus infections in horses. This fact is significant and points out certain public health dangers where feed lots and pastures are used in common by cattle and horses.

Indications to date are that the blood agar plate method is superior to the Hotis test in examination of milk samples for mastitis streptococci.

(Departments of Bacteriology and Dairy Husbandry. Leaders, V. D. Foltz, L. D. Bushnell and F. W. Atkeson; State funds.)

Poultry Disease Investigations.–Six phases of this project were carried on during the biennium, in addition to maintenance of a general laboratory service for poultrymen and the preparation and distribution of vaccines.

Effect of Phenothiazine on hemoglobin in fowls.–This drug causes a rather severe drop in hemoglobin, even with therapeutic doses. The decrease was not essentially different when the dosage was increased 10 times. No explanation for this has been advanced, except perhaps that only a certain amount is absorbed, regardless of the amount administered.

Protozoan parasites of poultry.–Clinical and field studies on the value of Mapharsen in the treatment of entero-hepatitis in turkeys showed the drug had practical application. Turkeys that were able to walk and were not too weak from the effects of the disease, were given an intravenous injection of 0.006 gram. Recoveries were 90 percent.

Pullorum agglutination test.–The addition of 1 c.c. N/l NaOH to each liter of the tube antigen helps to dissolve the fat-like substance in turkey serum and prevents it from clouding. R_1 and R_2 BAI pullorum cultures isolated from turkeys have been used to prepare antigen to test turkey blood samples, giving a more sensitive reaction.

Study of lymphomatosis.–It has been noted that almost 100 percent of birds examined and found to be suffering from any form of the leucosis complex are heavily infested with body lice. Removal of these birds from the flock seems to help halt the spread of the infection.

Study of fowl paralysis.–Transmissibility experiments were conducted with lymphomatosis in poultry. It will be necessary to have available a strain of chickens highly susceptible before accurate results can be obtained.

Study of trichomoniasis.–Further study of this problem was delayed somewhat due to the loss by fire of experimental birds. Study has been limited to poults and chickens sent to the laboratory. A pigeon has been found to be a carrier of the disease for more than 20 months.

(Project 85; Department of Bacteriology. Leaders, L. D. Bushnell and P. H. Vardiman; State funds.)

Parasitological Investigations.–Work on this project during the biennium has consisted principally of studies on the physiology of the chicken tapeworm *Raillietina cesticillus* (Molin) and of the removal of this tapeworm by short periods of host starvation.

Study of the behavior of a single tapeworm in a chicken showed that under normal conditions of host feeding, a tapeworm will develop and pass off from its strobilae from five to 15 segments per day, each segment containing from 200 to 300 mature tapeworm eggs. Carabid beetles eat the segments and serve as carriers to infect other chickens.

Directions for administration of most commercial de-worming preparations prescribe a 24-hour fasting period before the drug is given. As such treatment results only in removing the strobilae, it appears that starvation is the factor in the loss of strobilae, rather than the drug. These results will compel those who investigate new anthelmintics to revise their methods of experimentation. Drug treatment cannot be recommended because the regeneration of new strobilae is too rapid and the length of life of the parasite too long in both the larval and adult stages to make such a procedure practical.

The following publication, all based on work completed under this project, have appeared during the biennium.

The cat as a host of the nematode *Physaloptera felidis* Ackert. *Rev. de Med. Trop. y Parasitol., Bact. Clin. y Lab.* 7(1, 2):7-8. 1941.

Oriental rat flea established in Kansas. Science, N. S. 93(2424) :566-567. 1941.

Beetle supply in experimental fowl taeniasis. *Jour Parasitol.* 26(6, suppl.): 43-44. 1940.

Plague flea, *Xenopsylla cheopis* in Kansas. *Trans. Kan. Acad. Sci.* 44:238-240. 1941.

Nutritional requirements of the fowl cestode *Raillietina cesticillus* (Molin) as demonstrated by short periods of starvation of the host. *Jour. Parasitol.* 28:319-340. 1942.

The removal of the fowl tapeworm *Raillietina cesticillus* (Molin) by short periods of starvation. *Poultry Sci.* 21:220-229. 1942.

Removal of chicken tapeworms by host starvation and some effects of such treatment on tapeworm metabolism. *Jour. Parasitol.* 27 (6, Suppl.):35. 1941.

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

Resistance of Animals to Parasitism.–During the biennium work on the factors in the resistance of chickens to the nematode *Ascaridia galli* has included the following studies:

1. *The role of duodenal goblet cell mucus in the age resistance of fowls to A. galli.*–Work still in progress has thus far shown that the inhibitory factor for growth in the ascarids is present only in that part of the mucus which is soluble in 0.832 percent saline. There is also evidence to show that the factor will pass a Berkefeld filter, and that the active agent is thermostable. This explanation of age resistance of animals to their intestinal worms originated in this project. For a detailed report on this phase, readers are referred to an article, "Intestinal goblet cells and age resistance to parasitism," *Jour. Parasitol.* (Suppl. 26 (6) :14-15

2. *The effects of duodenal mucus of dogs and swine upon the viability of A. galli in vitro.*–This phase was undertaken to determine whether the effects observed on worms cultured in the presence of mucus from the duodenum of fowls was specific for chicken mucus, or whether it was a general reaction. The results obtained seem to indicate that host specificity for intestinal worms is conditioned by a factor in the duodenal mucus, and also that the reaction of chicken mucus on *A. galli* is specific. For a detailed report see: "Effects of duodenal mucus of dogs and swine upon the viability of Ascaridia lineata in vitro." *Jour. Parasitol.* 27 (6, Suppl.):36. 1941.

Negative results were obtained in several attempts to hatch *A. galli* eggs *in vitro.* This technique was desired so that experimentation could be carried out on the small, newly hatched larvae, rather than on the larger worms recovered from the host.

Other publications, based upon the work of this project, are:

Natural resistance to helminthic infections. *Jour. Parasitol.* 28 (l):l-24. 1942.

Feeding habits of nemas (Parasitica). In "An Introduction to Nematology," Sect. II, Pt. 2, 250-255. 1941.

On the resistance of chickens to the intestinal nematode *Ascaridia lineata* (Schneider) following immunization. *Amer. Jour. Hyg.,* Sect. D. 31 (3):1-11. 1940.

Studies on a mechanism of age resistance of chickens to the nematode *Ascaridia galli. Unpublished thesis.* Kans. State Col. of Agr. and Appl. Sci. 54 pages. 1941.

The role of duodenal mucus in age resistance, *Jour. Parasitol.* 27 (6, Suppl.) :36-37. 1941.

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

STUDIES IN HOME ECONOMICS

The Department of Home Economics conducts several lines of research, all of which have for their object the improvement of farm life and living. Brief summaries of the projects are presented below.

The Vitamin Content of Food in Relation to Human Nutrition.–Much of the work on this project during the biennium consisted of making biological and chemical assays of some staple foods to determine their vitamin contents.

Samples of liquid skim milk and powdered milk, collected from dairies in Kansas, were assayed for vitamin A and G content. One quart of skim milk supplies about 44 percent of the daily adult riboflavin requirement. No riboflavin was destroyed in the drying process.

The thiamin content of the wheat berry is concentrated largely in the germ. Ground whole wheat contained 6 micrograms per gram as compared with patent flour that contained about 2.4 micrograms per gram. Cooked cream of wheat did not contain a measurable amount.

Five varieties of hard winter wheat have been assayed for thiamin content. The results were: Turkey, 4.62; Comanche, Blackhull, 4.29; Pawnee, Chiefkan, 3.99 micrograms per gram, respectively.

(Project 158; Department of Home Economics. Leaders, B. L. Kunerth, P. Nutter, and B. D. Westerman; Purnell funds.)

An Investigation of the Effect Upon the Animal Body of Varying Amounts of Vitamin in the Diet.–Work on this project during the biennium consisted mainly of a study of the effect of varying the amount of vitamin C in the diet with special reference to the relation of the connective tissue in the bones of rats and their mineral content. Guinea pigs were used in these studies.

It was found that the tensile strength of the muscles and connective tissue is inversely proportional to the amount of vitamin in the diet when the animals are of the same age. The tensile strength of the muscles and tendons is greater in older animals than in younger ones. A difference in structure of the tendons and muscles of animals receiving an adequate amount of vitamin C and those receiving little or no vitamin C is noted in a microscopic examination of the tissue. No significant differences have been found

in the amount of vitamin C in the blood of animals receiving varying amounts of vitamin C in the diet.

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

The Nutritional Status of College Women.–Work on this project at this institution is part of a general study being made in coöperation with the states of Iowa, Ohio, Minnesota, Nebraska and Oklahoma.

Phases included in the general study are: Anthropometric measurements on a group of women through their four years in college; determination of basal metabolism rates on the same and other subjects in these age groups at different times; studies of the blood picture; studies of intake and utilization of food; studies of dietary habits; studies of vitamin C status.

Using Hrdlicka's method, anthropometric measurements taken during the four-year period indicate that some growth occurs in these young women. Growth decreases with the age at which they enter college.

Data on the following studies are being summarized preparatory to interpretation: basal metabolism studies, blood picture studies, studies on the intake and utilization of food, anthropometric measurements.

For detailed reports on the different phases of this project, readers are referred to the following publications:

Anthropometric data on college women in the middle states. *Amer. Jour. Phys. Anthropol.* 27:319-322.

Dietary habits of college students. *Jour. Home Econ.*, 34:379-384.

Nitrogen, calcium and phosphorus intakes of college women. *Jour. Amer. Diet. Assn.*, 17:947-954.

(Project 201; Department of Home Economics. Leaders, M. S. Pittman, B. L. Kunerth, E. J. Meiller, Dena Cederquist, Leah Ascham, and Molly Geddes; Purnell funds.)

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

1. *A comparison of the service qualities of certain synthetic fabrics and mixed synthetic fabrics.*–Statistical analyses of data showed significant differences in the physical properties of mixed, synthetic and natural fiber fabrics. Fabrics of natural fibers were not always superior to those of the synthetic fibers. The detailed results of this study are reported in *Rayon Textile Monthly*, **2**2:425-426, 471-474, 735-737; 23:29-30; *American Dyestuff Reporter*, 30:491-495; *Jour. Home Econ.* 34:245-251; Synthetic Fibers and Textiles, *Bulletin 300*, Kan. Agr. Expt. Sta.

2. *The effect of finishes on the service qualities of the synthetic fabrics and fabrics of natural fibers.*–This work is in progress. One study, dealing with resin finishes in rayon gabardines, has been completed. Results indicate that the resin finished fabrics had greater breaking strength and color fastness, less elongation and shrinkage than the nonresin finished fabrics. The resin-finished fabrics, however, were not so resistant to abrasion as the nonresin-finished fabrics.

(Project 161; Department of Home Economics. Leader, H. M. Fletcher; Purnell funds.)

Studies of Factors Affecting the Expenditures for Family Living Among Kansas Farm Families.–Data from 159 Kansas farm family account books in 1939 and 139 account books in 1940

have been tabulated and added to the data from 504 family records kept during the 5-year period from 1934 through 1939. A report on the analysis of these data is nearing completion.

The average cost of living for these families each was $1,420. Of this amount, 35 percent went for food and 53 percent of the food expenditure was furnished by the farm. Clothing averaged $124 per year and operating expenses, $115.

Data from 127 account books kept in 1941 are being tabulated.

Two mimeographed reports have been prepared from the data and are available from the Division of College Extension.

(Project 196; Departments of Home Economics and Agricultural Economics. Leaders, M. A. Gunselman and W. E. Grimes; Purnell 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 sorghum, winter wheat, winter and spring barley, oats, corn, flax and broomcorn are conducted to determine the better varieties for use in the Plains region. Plant breeding work is conducted extensively with sorghums. Two sorghum crosses, Leoti X Club (H. C. 397) and Leoti X Atlas (H. C. 41-13) produce grain which is pure for the waxy endosperm. Both crosses are adapted for production in Kansas. The Leoti X Club cross is a high yielding grain sorghum type, mid-early in maturity, with plants about 48 inches tall. The grain is without the nucellar layer and produces a starch free from objectionable color. The Leoti X Atlas cross was selected as a forage sorghum with a high sugar content. The grain is white and palatable and the plant matures similarly to Atlas. It is believed that the starch from sorghums with the waxy type of endosperm may replace in part the starch made from Cassava roots.

Norkan, a forage sorghum from the cross Atlas X Early Sumac, was released to growers during the biennium. Norkan has many of the characteristics of Atlas, except that it is much earlier in maturity, hence better adapted to the northern limits of the forage sorghum production area.

Two selections of Flynn barley have been isolated which appear to have greater stiffness of straw than the older Flynn variety. (A. F. SWANSON, *in charge.)*

Dry-Land Agriculture.–Precipitation during 1940 was about normal. The carry-over effect of moisture deficiency in 1939 was manifested in crop yields during 1940, however. The yields of grain on the experimental plots was low, regardless of cropping system or tillage method, including fallow.

The precipitation during 1941 was 28.13 inches, the highest since 1932, and was favorably distributed during the growing season, making 1941 one of the most favorable crop years. Yields averaged 45 bushels for barley, 63 bushels for oats, 17 bushels for spring wheat, 20 to 30 bushels for winter wheat, and up to 40 bushels for grain sorghums. (A. L. HALLSTED, *in charge.)*

Forage Crops Investigations.–Buffalo and blue grama grass continue to be the two more important grasses, no introduced or cultivated grasses having been found equal or superior to these native grasses. These two species comprise about 90 percent of the vegetation in native pastures in the western half of Kansas.

Irrigation of selected types of buffalo grass for production of large quantities of seed is definitely more practical than relying upon natural rainfall.

Germination of new buffalo grass seed was increased from 5 to 10 percent up to approximately 70 percent by soaking in a 0.5 percent solution of KNO_3 for 24 hours, immediately followed by storage at 41° F. for 6 weeks, then drying. Seed treated in this manner will retain its viability for at least one year. (L. E. WENGER, *in charge.)*

Noxious Weed Control Investigations.–Croprotations in which wheat or rye was grown one, two or three years after a year of intensive fallow proved to be highly practical in the eradication of field bindweed. In general, it was necessary to return to a second year of intensive fallow to complete the eradication. Bindweed was killed in two years by continuous fallow, in three years by alternate fallow and wheat, in four years by a rotation of one year of fallow and two years of wheat, and in five years by a rotation of one year of fallow and three years of wheat. The cost of eradication tended to be lower for the rotations making less frequent use of fallow although the period necessary was lengthened.

Forage sorghum and Sudan grass proved to be effective smother crops for bindweed control when drilled after periods of intensive cultivation.

Cultivating 12 days after each first emergence or about 18 days during the first year and each 20 to 25 days during the second year gave eradication of bindweed with fewer cultivations than at any other frequencies.

Bindweed seed remains viable in the soil for many years after the original stand has been killed. An average of more than five seedlings per square rod were noted in the spring of 1941 on a 14-acre field from which bindweed had been eliminated in 1921 and no old plants allowed to develop or seed for 20 years.

Sodium chlorate continued to produce more consistent results than did other chemicals tested for bindweed control. The optimum rate and time of application was 3 to 4 pounds per square rod during September or October. Russian knapweed was easily killed with sodium chlorate at three pounds per square rod. Dogbane required 6 to 8 pounds per square rod. Hoary cress was not completely eliminated with applications of chlorate as heavy as 14 pounds per square rod.

A survey of prickly pear cactus showed that this weed was almost completely eliminated from pastures in the region of Hays and other sections of the state by the activities of insect parasites during the latter part of the 1941 season. (F. L. TIMMONS, *in charge.)*

Beef Cattle Feeding Investigations.–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. A detailed report of the results of the trials is contained in Report 42-B-1, obtainable from the Department of Animal Husbandry, Kansas Agricultural Experiment Station, Manhattan, or the Fort Hays Branch Experiment Station, Hays. (L. C. AICHER and C. W. MCCAMPBELL, *in charge.)*

State Forest Nursery.–Sales of forest tree seedlings were high in 1941, but decreased slightly in 1942. The demand for different species remains fairly constant, with red cedar sales far in the lead, followed by Chinese elm. Arrangements have been made with the Extension Forester at Kansas State College whereby Country Agents and the Division of College Extension assist with the distribution of seedling trees.

An experimental windbreak approximately one-half mile in length was set out during the spring of 1942. This planting was made in coöperation with the Department of Horticulture and studies will be conducted to determine the relationship between soil moisture and spacing of trees upon survival. Several species of trees and different spacings are included. (J. C. CRUPPER, JR., *in charge.*)

Pure Seed Distribution.–Sales of certified seed of the adapted and approved farm crops continued good during the biennium. Sorghum seed stocks sold during 1942 totaled 470,839 pounds, the largest amount of sorghum seed ever sold in one season from this station. Atlas sorgo was the leading variety with 166,620 pounds. (L. C. AICHER, *in change.)*

Soil Erosion and Water Conservation.–Marked success has been obtained with the reëstablishment of native grasses on slopes of from 4 to 10 percent. Reports on the water and soil losses have been made at monthly intervals and a complete annual report has been 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 carries major projects in livestock feeding, crop improvement, dry-land agriculture investigations, soil and water conservation and entomological investigations.

Dry-land Agriculture.–The Division of Dry-Land Agriculture, United States Department, of Agriculture, continued its investigations in dry-land farming in coöperation with the Experiment Station and Soil Conservation Service.

Both 1940 and 1941 were above average in precipitation, during the former year 18.42 inches were received and during the latter 26.40 inches. Barley was seeded on the plots in the spring of 1940 instead of wheat due to drought in the fall of 1939. Good yields of barley resulted but sorghum yields were disappointing. Both wheat and sorghum yields were excellent in 1941 with a high of 42.8 bushels of wheat and 74.5 bushels of milo.

Although the Basin Lister Project was started in 1938, no yields of any value were produced until 1940 and 1941. Although no definite conclusions should be drawn from two years data, certain indications can be obtained.

In case of the wheat, listing on the contour has definitely given an increase in yield over that up and down the slope, whereas, when basin listing is compared with ordinary listing either on the contour or up and down the slope there is very little difference in yield. In fact, the yields from ordinary list-

ing on the contour were greater than from basin listing on the contour both years.

When one considers milo, however, ordinary listing up and down the slope has consistently given lower yields, the yields being considerably below those secured from basin listing up and down the slope. The yields from basin listing up and down the slope were about the same as from ordinary listing on the contour in two of the three cropping systems whereas the yields from basin listing on the contour were about the same as from ordinary listing on the contour except on fallow where the yield from ordinary listing was consistently lower.

This difference is probably due to the fact that when basin listing is used for summer fallow for wheat the basins are in for such a short time that unless considerable rainfall is received during this short period, little difference in moisture storage will result whereas in case of the milo the lister is used not only for tillage but also for seeding and basins remain for a much longer period, thus allowing a greater time for moisture differences to result. It must be emphasized again that these conclusions should not be taken as final, but should be used only as indications. (HOWARD J. HAAS, *in charge.)*

Sheep Feeding Investigations.–The results of this work are given elsewhere in this report. (See page 38.) (L. M. SLOAN and R. F. Cox, *in charge.)*

Dairy Investigations–The Holstein herd was dispersed in the fall of 1940 and replaced with a purebred herd of Brown Swiss. Plans are under way after the herd is increased to carry on pasture and feeding trials with the dairy herd. (L. M. SLOAN, *in charge.)*

Crop Improvement.–The major objective of this work is to test the adaptation of numerous varieties of sorghums, wheat, barley, oats and flax. Intensive work is carried on the testing of varieties of sorghums for resistance to milo disease, a soil borne organism which attacks many of the sorghum varieties. Many resistant strains have been developed and in 1941 a combine type, "Westland," resistant to the milo disease was released for distribution to farmers.

Alfalfa is being tested and selected in cooperation with the Bureau of Plant Industry for resistance to bacterial wilt. (ALVIN E. Lowe, *in charge.)*

Soil and Moisture Conservation.–This work is done in coöperation with the Soil Conservation Service and the Bureau of Plant Industry, United States Department of Agriculture. The work consists of analyzing soil for evidences of change in total nitrogen and organic carbon due to different methods of cultivation and cropping systems, effect of different tillage machines on water and soil losses and the effect of these machines on soil structure. (HOWARD J. HAAS and L. M. SLOAN, *in charge.)*

COLBY BRANCH EXPERIMENT STATION

The Colby Branch Experiment Station consists of 634 acres of state-owned land. A purchase of 320 acres of land lying immediately south of the station was made in 1941. One-half of this new area is in native grass pasture and the other half is plow land.

The work of the station is divided into four major projects: Dry-land agriculture investigations, general crop investigations, dairy investigations, and horticulture investigations.

Dry-Land Agriculture.–The experiments in cultural practices and soil management studies, together with the securing of climatic data in coöperation with the Division of Dry Land Agriculture, United States Department of Agriculture, were continued as in the previous biennium with few exceptions. The year 1940 was a continuation of the drought years which prevailed for the past decade. The precipitation was 15.78 inches, more than 3 inches below normal. Due chiefly to a dry seedbed in the fall, the winter wheat failed on all but two plots and from these only small yields were harvested. Pale western cutworms also contributed to the failure. Low yields were obtained

on spring wheat, barley, oats, corn and the sorghums. Barley yielded 7.1 bushels per acre on fallow and averaged 7.5 bushels on cropped land. Corn yielded 10 bushels on fallow and 2 bushels on cropped land. Milo averaged 19.6 bushels on fallow, 3.6 bushels following a green manure crop and 8.8 bushels on cropped land. As small as the yields were, they were the best since 1931.

In contrast, 1941 was the wettest year of record. The total annual precipitation was 31.13 inches, 13.56 inches more than the 54-year average. July, with 10.80 inches, was the wettest month on record. A rain of 5.15 inches on July 25 exceeded by 1.48 inches, the heaviest rain previously recorded for a 24-hour period. Due to the unfavorable distribution of rainfall, crop yields were not commensurate with the amount of moisture received. A drought period in May and extremely heavy rains in June and July affected the wheat crop adversely, and a dry period in September reduced the yields of corn and sorghum.

In spite of the abundance of moisture received, the average yields on fallow land were appreciably above those on crop land in most instances. Among the better yields obtained were those on land cropped to the same crop continuously for 27 years. The highest yield of oats, 44.1 bushels, was on a plot which had been in oats continuosly since 1914.

Winter wheat averaged 22.4 bushels on fallow and 13.6 bushels on crop land. Barley yielded 34.6 bushels on fallow and 27.2 bushels on crop land. Corn yielded 27.6 bushels on fallow and 29.7 bushels on crop land. A plot protected against run-off by a levee yielded 31.2 bushels, 1.7 bushels more than a similar plot near by without a levee.Milo averaged 51.9 bushels on fallow, 33 bushels after a green manure crop and 37 bushels on crop land.

The year 1941 was one of the better years for storing moisture by fallow. At winter wheat seeding time the soil was wet more than 60 inches deep on fallow. There was also ample surface moisture for germinating the seed. (J. B. KUSKA, *in charge.)*

General Crops.–The method of handling the general crop fields at the station was changed from straight line farming to contour farming in 1940.

Variety tests with winter wheat, spring wheat, barley, oats, corn and the sorghums were conducted during the biennium. Because of the dryness of the seedbed, neither winter wheat variety tests nor the wheat nursery was planted for the 1940 harvest.

Flynn barley remains the highest yielding variety of that crop. Several strains of barley grown in the nursery are earlier in maturity than Flynn and show some promise.

Corn produced some grain in both years of the biennium although yields were low in 1940. For the first time in the history of the test, hybrids produced more grain than open-pollinated varieties in 1941.

The earlier-maturing grain and forage sorghums continue to be the better producers for northwestern Kansas. Norkan, an Atlas X Early Sumac hybrid, has produced well. A selection of Weskan (Tribune No. 5) shows promise as a binder type grain sorghum. (E. H. COLES, *in charge.)*

Dairy Herd Improvement.–The project–a study of dairy herd improvement through continued use of purebred sires–was continued. Eleven grade cows in this project averaged 9,627 pounds of milk and 388.79 pounds of butterfat in 1940, and 10 grade cows produced an average of 8,916 pounds of milk and 362.20 pounds of butterfat in 1940.

Horticulture investigations.–The sudden freeze of November 11, 1940, killed most of the older cherry trees and the larger apricot trees in the orchard. No difference in ability to withstand these temperatures could be noted in the several varieties of cherries in the orchard. Smaller trees planted in 1938 and later were not damaged. The young orchard now contains 27 varieties of apples, 8 of pears, 16 of apricots, 20 of plums, and 12 of cherries. Most of these trees have made satisfactory growth. (E. H. COLES, *in charge.)*

TRIBUNE BRANCH EXPERIMENT STATION

The Tribune Branch Experiment Station is located near Tribune, Greeley county. The work at this station is planned to determine the better crops, crop varieties and soil management methods for the High Plains area of western Kansas. The commonly grown crops such as winter wheat, barley, oats, corn, sorghums, and crops which may have a place such as spring wheat and legumes are included in the study. Crop production in this area is variable from year to year because of the great differences in rainfall. During the last eight years, Kanred wheat on fallow has produced a yield of more than 20 bushels per acre twice; five to ten bushels twice; less than five bushels four times, two years of which the yield was zero.

Crop yields were low on the station in 1940 but good in 1941. Total rainfall, average temperature, wind movement and evaporation were all near normal in 1940. The average rainfall of the year was increased by a torrential rain in August. Winter temperatures were extremely low and summer temperatures high. The highest temperature ever recorded at Tribune, 109°, occurred July 25, 1940. These extremes reduced the crop yields far below those which might be expected by a study of annual average meteorological readings. The 1941 crop season was a cool, wet year. Wind movement was the lowest since 1930. Evaporation from a free water surface was 43.339 inches, the lowest ever recorded at the station. Crop yields were good on the station; however, a hot wind on May 13 damaged the wheat over the county so that a prospect of 25 bushels per acre was reduced to 10 bushels actual yield.

Standard wheat varieties yielded about as they have in the past in both years of the biennium. Two new selections were included in the tests in 1940 and 1941. Pawnee (Kawvale X Tenmarq, Kan. 2723) made a yield of 9.9 bushels per acre in 1940, 2 bushels less than the highest yielding variety, Early Blackhull. In 1941 Pawnee made the highest yield in the test, 34.0 bushels per acre. Comanche (Oro X Tenmarq, Kan. 2729) ranked third in the test in 1940 and fifth in 1941.

Two new barley varieties, Beecher and Spartan, were included in the tests in 1941. When compared with Flynn, Trebi, Vaughn and Malt, Beecher made the highest yield and Spartan the lowest when planted with either a furrow or common drill.

Corn hybrids were included in the tests with open pollinated varieties in 1940 and 1941. Yields were low in 1940 but some of the hybrids slightly outyielded the best open pollinated variety, Freed. In 1941 Freed made a yield of 41.5 bushels per acre which was higher than any other entry. The highest yielding hybrid, Pioneer 307, produced 30.5 bushels per acre.

By using winter wheat and Sudan grass as a supplement to native grass, good pasture has been made available for approximately six months of the year. The winter wheat provides pasture earlier in the spring and later in the fall than native grass. Sudan provides the pasture during the hot days in summer. In these pasture tests, 4.4 acres of Sudan grass furnished pasture for two cows and two horses for 72 days in 1940 and 80 days in 1941. Four and four-tenths acres of wheat furnished pasture for the same stock 80 days in 1940 and 100 days in 1941. (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. Four such bulletins were issued during the biennium.

General Bulletins.–The reports of specific investigations for popular distribution are published as bulletins. The material is presented in such a manner as to be readily understood by the average reader. Thirteen bulletins were printed during the biennium.

Circulars.–Brief popular reports of experimental results and popular discussions on various agricultural problems are published as circulars. Eight 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

No.		*Edition*	*Pages*	*Total Pages*
	Tenth Biennial Report of the Director	1,500	159	238,000

TECHNICAL BULLETINS

49	Transference of Hessian Fly Resistance and Other Characteristics of Marquillo Spring Wheat to Winter Wheat,	1,500	55	82.500
50	Equine Encephnlomyelitis Virus Isolated from Naturally Infected *Triatoma sanguisuga* LeConte	2,500	15	37,500
51	Calcium in the Nutrition of the Fattening Calf	1,500	91	136,500

GENERAL BULLETINS

201	Deferred Grazing *of* Bluestem Pastures	7,500	27	202,500
202	Kansas Corn Tests, 1940	5,000	47	235,000
203	Summer Fallow in Kansas	20,000	30	600,000
204	Planning the Farm Business in the Bluestem Belt of Kansas	5,000	23	115,000
205	Milk Cooling on Kansas Farms	5,000	39	195,000
206	Results of Bindweed Control Experiments at the Fort Hays Branch Station, 1935-1940	7,500	50	875,000
207	A Second Poultry Survey in Kansas	7,500	56	420,000
208	Market Quality of Kansas Potatoes as Determined by Federal Inspection	3,500	36	126.000
209	Kansas Corn Tests	5,000	47	235,000
300	Synthetic Fibers and Textiles	7,500	40	300,000
301	The Atchison Experiment Orchard	3,000	31	93,000

CIRCULARS

290	Turkey Management	15,000	20	300,000
201	Farm Woodlot Management in Kansas	7,500	28	210,000
202	Publication List	2,500	4	10,000
203	Strawbery Growing in Kansas	10,000	20	200,000
204	Growing Bush Fruits in Kansas	7,500	31	122,500
205	Publication List	2,500	4	10,000
206	Tame Pastures in Kansas	10,000	28	280,000
207	Swine Feeding Investigations,1936 to1940	7,500	20	150,000
208	Re-Establishing Native Grasses by the Hay Method	7,500	16	120,000
209	Preserving Foods in Frozen Food Lockers	20,000	29	580.000
210	Korean Lespedeza in Kansas	5,000	12	60,000
211	Publication List	2,500	4	10,000
212	Control of Sheep Diseases	5,000	19	95,000

ABSTRACTS

2	Abstracts of Publications of Agricultural Experiment Station	9,500	4	38,000

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*
108	1941	Planning the Farm Business in the Bluestem Belt of Kansas. R. J. Doll. Kan. Agr. Expt. Sta. Bul. 294:1-23.
109	1941	Market Quality of Kansas Potatoes as Determined by Federal Inspection. F. L. Parsons. Kan. Agr. Expt. Sta. Bul. 298:1-36.
110	1942	Forty Years of Farm Management Research. J. A. Hodges. Jour. Farm Econ. 24:392-401.

Department of Agricultural Engineering

74	1941	Milk Cooling on Kansas Farms. June Roberts and George H. Larson. Kan. Agr. Expt. Sta. Bul. 295:1-39.

Department of Agronomy

294	1940	Differential Injury Within Varieties, Inbred Lines, and Hybrids of Field Corn Caused by the Corn Earworm, Heliothis Armigera (HBN.). R. H. Painter and A. M. Brunson. Jour. Agr. Res. 61(2):81-100.
296	1939	Soil Aggregation as Affected by Certain Crops and Organic Materials and Some Chemical Properties Associated with Aggregation. J. C. Hide and W. H. Metzger. Proc. Soil Sci. Soc. of Amer. 4:19-22.
297	1940	The Transference of Hessian Fly Resistance and Other Characteristics of Marquillo Spring Wheat to Winter Wheat. R. H. Painter, E. T. Jones, C. O. Johnston, J. H. Parker. Kan. Agr. Expt. Sta. Tech. Bul. 49:1-55.
299	1940	Genetic Studies of Heat and Drought Tolerance in Maize. E. G. Heyne and A. M. Brunson. Jour. Amer. Soc. Agron. 32: 803-814.
300	1940	Effect of Inbreeding Little Bluestem. K. L. Anderson and A. E. Aldous. Jour. Amer. Soc. Agron. 32:159-160.
303	1940	The Probable Practical Significance of Adsorption of Phosphorus by Some Soils of the Prairie Group. W. H. Metzger. Jour. Amer. Soc. Agron. 32:513-525.
304	1940	Soil Moisture and Winter Wheat in Kansas. H. E. Myers. Trans. Kan. Acad. Sci. 43:69-73.
305	1940	Solution Concentration as a Possible Factor Influencing Soil Aggregation. H. E. Myers and H. E. Jones. Amer. Soc. of Agron. 32:664-665.
306	1941	Seasonal Distribution of Rainfall in Relation to Yield of Winter Wheat. J. E. Pallesen and H. H. Laude. U. S. Dept. Agr. Tech. Bul. 761:1-11.
307	1941	Deferred Grazing of Bluestem Pastures. K. L. Anderson. Kan. Agr. Expt. Sta. Bul. 291:1-27.
...	1940	Fertilizers for Kansas. R. I. Throckmorton. Kan. State Bd. Agr. Bien. Rpt. 37:80-82.
309	1940	The Effect of Selection and Inbreeding on the Growth of Big Bluestem (Andropogon furcatus, Muhl.). Alvin Law and K. L. Anderson. Jour. Amer. Soc. Agron. 32: 931-943.
310	1941	Significance of Rainfall and Temperature Trends in Crop Production. R. I. Throckmorton. Kan. State Bd. Agr. Bien. Rpt. 37:148-158.
311	1940	Storing Alfalfa Seedlings. C. O. Grandfield. Jour. Amer. Soc. Agron. 32:972.
312	1941	Changes in Soil Aggregation in Relation to Bacterial Numbers, Hydrogen Ion Concentration, and Length of Time Soil Was Wet. H. E. Myers and T. M. McCalla. Soil Science. 51:189-200.
313	1941	Summer Fallow in Kansas. R. I. Throckmorton and H. E. Myers. Kan. Agr. Expt. Sta. Bul. 293:1-30.
314	1941	Tame Pastures in Kansas. K. L. Anderson. Kan. Agr. Expt. Sta. Cir. 206:1-28.
316	1941	Kansas Corn Tests, 1940. R. W. Jugenheimer, A. L. Clapp, H. D. Hollembeak. Kan. Agr. Expt. Sta. Bul. 292:1-47.

Serial No.	*Year of issue*	*Title, author and publication*
318	1941	A Method of Maintaining Soil Moisture in Containers Below Field Capacity. C. O. Grandfield. Jour. Amer. Soc. Agron. 33:371-373.
319	1941	Vitamin B (Thiamin Chloride) and the Yield of Corn and Sorghum Under Field Conditions. H. E. Myers, R. W. Jugenheimer, E. G. Heyne. Jour. Amer. Soc. Agron. 33:473-474.
320	1941	Effect of Ensiling on the Viability of Weed Seed. J. W. Zahnley and J. B. Fitch. Jour. Amer. Soc. Agron. 33: 816-822.
321	1941	Plant Succession on Land in Continuous Alfalfa Culture as Influenced by Fertilizer Treatments. W. H. Metzger and K. L. Anderson. Trans. Kan. Acad. Sci. 44:184-189.
323	1941	An Association of Root Injury by White Grubs (Phyllophaga spp.) and Lodging of Crossbred Strains of Corn. Leonard C. Hoegemeyer. Jour. Amer. Soc. Agron. 33:1100-1107.
324	1941	Korean Lespedeza in Kansas. K. L. Anderson. Kan. Agr. Expt. Sta. Cir. 210:1-12.
325	1941	Fixation of Phosphorus in Relation to the Iron and Aluminum of the Soil. W. H. Metzger. Jour. Amer. Soc. Agron. 33:1093-1099.
327	1942	Studies on the Black-stem Disease of Alfalfa Caused by Ascochyta imperfecta. M. L. Peterson and L. E. Melchers. Phytopath. 32:590-597.
328	1942	Natural Selection in Varietal Mixtures of Winter Wheat. H. H. Laude and A. F. Swanson. Jour. Amer. Soc. Agron. 34: 270-274.
329	1941	Some Experiences with Asphalt in the Establishment of Grasses and Legumes for Erosion Control. H. E. Myers and R. I. Throckmorton. Proc. Soil Sci. Soc. Amer. 6:459-461.
330	1941	Chemical Characteristics of Some Soils with Diverse Types of Carbonate Zones and of Associated Normal Soils. W. H. Metzger. Proc. Soil Sci. Soc. Amer. 6:351-353.
331	1942	Kansas Corn Tests, 1941. A. L. Clapp, R. W. Jugenheimer, H. L. Hollembeak, J. L. Lonnquist. Kan. Agr. Expt. Sta. Bul. 299:1-47.
...	1941	History of the American Society of Agronomy. R. I. Throckmorton. Jour. Amer. Soc. Agron. 33:1135-1140.
		Department of Animal Husbandry
137	1940	Inheritance of Horns and Scurs in Sheep. H. L. Ibsen and R. F. Cox. Jour. Heredity. 31:327-336.
138	1940	Pork Storage in Freezer Lockers. G. H. Wellington, D. L. Mackintosh, G. E. Vail. Trans. Kan. Acad. Sci. 43:313-319.
139	1940	The Requirements of Calcium in the Ration of Growing Pigs. C. E. Aubel, J. S. Hughes, W. J. Peterson. Jour. Agr. Res. 62: 531-542.
141	1940	Calcium in the Nutrition of the Fattening Calf. A. D. Weber and W. J. Peterson. Kan. Agr. Expt. Sta. Tech. Bul. 51:1-91.
141-a	1940	The Minimum Calcium and Phosphorus Requirements of Growing Pigs. C. E. Aubel, J. S. Hughes, W. J. Peterson. Proc. Amer. Soc. Anim. Prod. pp. 311-315.
142	1941	Swine Feeding Investigations, 1936 to 1940. C. E. Aubel. Kan. Agr. Expt. Sta. Cir. 207:1-20.
144	1941	Influence of Freezing on Tenderness in Aged Beef. R. W. Bray, G. E. Vail, D. L. Mackintosh. Trans. Kan. Acad. Sci. 44:327-331.
...	1941	A Review of Stock Cattle Feeding and Management Tests at the Fort Hays Branch Experiment Station. 28th Ann. Cattlemen's Round-Up, 1940-'41, pp. 1-12.
146	1942	Preserving Food in Frozen Food Lockers. George A. Filinger and D. L. Mackintosh. Kan. Agr. Expt. Sta. Cir. 209:1-30.
148	1942	Influence of Freezing Upon Tenderness in Aged Beef and Fresh Pork. R. W. Bray, G. E. Vail and D. L. Mackintosh. Jour. Anim. Sci. 1:81.
149	1940	A Note on Phenothiazine Therapy in Sheep. J. H. Whitlock and R. F. Cox. Jour. Amer. Vet. Med. Assoc. 97:436-437.
...	1942	Wheat Bran versus Cottonseed Meal versus Alfalfa Hay as Protein Supplements in Winter Rations for Stock Cattle. 29th Ann. Cattlemen's Round-Up, 1941-'42, pp. 1-8.

Department of Bacteriology

Serial No.	*Year of issue*	*Title, author and publication*
184	1941	Physiologic Studies of Rhizobium meliloti with Special Reference to the Effectiveness of Strains Isolated in Kansas. John T. Kroulik and P. L. Gainey. Jour. Agr. Res. 62:359-369.
185	1939	Cation Adsorption by Bacteria. T. M. McCalla. Jour. Bact. 40:23-32.
186	1940	Physico-chemical Behavior of Soil Bacteria in Relation to the Soil Colloid. T. M. McCalla. Jour. Bact. 40:33-43.
191	1940	Measuring the Sanitary Quality of Market Cream. W. J. Caulfield, F. E. Nelson, W. H. Martin. Jour. Milk Tech. 3:245-254.
193	1940	Growth of Certain Organisms of Importance to the Dairy Industry on this New Standard Milk Agar. V. D. Foltz and L. D. Bushnell. Jour. Dairy Sci. 23:973-975.
194	1940	Notes on Types of Bacteria Associated with Plant Roots. F. E. Clark. Trans. Kan. Acad. Sci. 43:75-84.
195	1940	A Study of Home-made Ice Cream. V. D. Foltz and W. H. Martin. Jour. Food Res. 6:31-38.
196	1941	Relative Nodulation of Varieties of Medicago Sativa Varying in Susceptibility to Alfalfa Wilt. John T. Kroulik and P. L. Gainey. Jour. Soil Sci. 50:136-140.
197	1940	The Reaction of Certain Stains with Bacteria. T. M. McCalla. Stain Tech. 16:27-32.
198	1940	Effect of Salt on the Keeping Quality of Cream. W. J. Caulfield, F. E. Nelson, W. H. Martin. Jour. Dairy Sci. 23:1215-1227.
199	1940	The Utilization of Certain Hydrocarbons by Microörganisms. L. D. Bushnell, H. F. Haas. Jour. Bact. 41:653-673.
200	1940	The Adsorption of H^+ by Bacteria as Measured by the Glass Electrode. T. M. McCalla. Jour. Bact. 41:775-784.
201	1940	Changes in Soil Aggregation in Relation to Bacterial Numbers. H. E. Myers, T. M. McCalla. Soil Sci. 51:189-200.
202	1941	Dye Adsorption by Bacteria at Varying H-ion Concentrations. T. M. McCalla and F. E. Clark. Stain Tech. 16:95-100.
203	1941	Microbial Utilization of Hydrocarbons. H. F. Haas, M. F. Yantzi, and L. D. Bushnell. Trans. Kan. Acad. Sci. 44:39-45.
204	1941	The Uptake of Ions by Bacteria. T. M. McCalla and V. D. Foltz. Trans. Kan. Acad. Sci. 44:46-47.
205	1941	Microbiological and Nutritional Factors in the Take-All Disease of Wheat. C. R. Stumbo, P. L. Gainey, F. E. Clark. Jour. Agr. Res. 64:653-665.
207	1942	Further Studies on the Use of Salt for Improving the Quality of Cream for Butter-making. F. E. Nelson, W. J. Caulfield, W. H. Martin. Jour. Dairy Sci. 25:59-70.
208	1941	The Effect of Holding Cream in the Buying Station Upon Mold Content and Certain Other Quality Factors. R. W. Morrison, F. E. Nelson, W. H. Martin. Jour. Dairy Sci. 25:195-202.
213	1942	The Separation and Characterization of Carotenoid Pigments Produced from Mineral Oil by Bacteria. H. F. Haas, L. D. Bushnell, W. J. Peterson. Science 95:631-632.

Department of Botany

382	1941	Myxomycetes of Kansas—1. Travis E. Brooks. Trans. Kan. Acad. Sci. 44:130-157.
385	1940	Winter Twigs: The Identification of Kansas Woody Plants by Their Twigs. Frank C. Gates. Kan. Acad. Sci. Handbook No. 1, 1-31.
395	1940	Modification of Diurnal Transpiration in Wheat by Infections of Puccinia triticina. C. O. Johnston and E. C. Miller. Jour. Agr. Res. 61:427-444.
396	1940	The Influence of the Awns Upon the Rate of Transpiration from the Heads of Wheat. Hugh G. Gauch and Edwin C. Miller. Jour. Agr. Res. 61:445-458.
398	1940	Transference of Hessian Fly Resistance and Other Characteristics of Marquillo Spring Wheat to Winter Wheat. Reginald H. Painter, Elmer T. Jones, C. O. Johnston, and John H. Parker. Kan. Agr. Expt. Sta. Tech. Bul. 49:1-55.
399	1940	Kansas Botanical Notes, 1939. Frank C. Gates. Trans. Kan. Acad. Sci. 43:97-98.
400	1940	Recent Migrational Trends in the Distribution of Weeds in Kansas. Frank C. Gates. Trans. Kan. Acad. Sci. 43:99-117.

Serial No.	*Year of issue*	*Title, author and publication*
401	1940	Some Species of Triticum and Related Grasses as Hosts for the Leaf Rust of Wheat, Puccinia triticina Eriks. C. O. Johnston. Trans. Kan. Acad. Sci. 43:121-132.
403	1940	The Reaction of Sorghum Varieties and Hybrids to Milo Disease. L. E. Melchers and Alvin E. Lowe. Plant Dis. Rptr. Supp. 126:165-175.
404	1940	The Reaction of a Group of Sorghums to the Covered and Loose Kernel Smuts. L. E. Melchers. Amer. Jour. Bot. 27:780-791.
405	1941	Differences in Plant Type and Reaction to Rust Among Several Collections of Panicum virgatum, L. Donald R. Cornelius and C. O. Johnston. Jour. Amer. Soc. Agron. 33:115-124.
407	1941	Effect of Certain Environmental Conditions on the Prevalence of Ophiobolus graminis in the Soil. Hurley Fellows. Jour. Agr. Res. 63:715-726.
408	1941	A Method for Making Permanent Mounts of Portions of Decolorized, Whole Leaves. James C. Bates. Stain Tech. 16:38.
410	1940	Advantages of Biweekly Cultivation for the Control of Field Bindweed. John C. Frazier. Kan. State Bd. Agr. Rpt. 59:59-60.
411	1941	Preliminary Investigation on the Translocation of Food Between Vegetative Organs and Fruit in the Wheat Plant. J. C. Bates. Trans. Kan. Acad. Sci. 44:128-129.
412	1941	Smut Sori from Ovarial and Staminal Tissues of Certain Grasses. E. D. Hansing and C. L. Lefebvre. Phytopath. 31:1043-1046.
413	1941	Weeds in Kansas. Frank C. Gates. Kan. State Bd. of Agr. Rpt. 60:1-360.
415	1941	Kansas Botanical Notes, 1940. Frank C. Gates. Trans. Kan. Acad. Sci. 44:170-171.
417	1941	Climate in Relation to Plant Diseases. L. E. Melchers. Trans. Kan. Acad. Sci. 44:172-183.
418	1941	The Wheat Stem Rust Epidemic of Kansas in 1940. L. E. Melchers. Plant Dis. Rpt. Supp. 132:95-103.
420	1942	Studies on Black-stem of Alfalfa Caused by Ascochyta Imperfecta. M. L. Peterson and L. E. Melchers. Phytopath. 32:590-597.
421	1941	Influence of Time of Cultivation on the Control of Field Bindweed, Convolvulus arvensis L. John C. Frazier. Trans. Kan. Acad. Sci. 44:164-169.
423	1942	On the Structure and Staining of Starch Grains of the Potato Tuber. James C. Bates. Stain Tech. 17:49-56.
428	1942	Prevention of Potato Seed Piece Decay. O. H. Elmer. Amer. Potato Jour. 19:19-23.
430	1942	On the Cause of the Milo Disease. L. E. Melchers. Phytopath. 32:640-641.
431	1942	The Use of Spergon for Sweetpotato Seed and Sprout Treatments. O. H. Elmer. Plant Dis. Rpt. 26:44-46.
433	1942	Notes on Plant Diseases in Kansas in 1941. C. O. Johnston. Plant Dis. Rpt. 26:189-196.
		Department of Chemistry
248	1940	Effect of Parathyroid Preparation on the Blood Calcium of the Fowl. T. B. Avery, H. M. Scott, R. M. Conrad. Poul. Sci. 19:321-323.
249	1940	Effect of Parathyroid Preparation on the Calcium Metabolism of the Fowl. T. B. Avery, H. M. Scott, R. M. Conrad. Poult. Sci. 19:324-325.
254	1940	A Hormone Study of Dubbed and Normal Cockerels. H. W. Marlow and L. F. Payne. Poult. Sci. 19:401-403.
255	1941	The Requirements of Calcium in the Ration of Growing Pigs. C. E. Aubel, J. S. Hughes, W. J. Peterson. Jour. Agr. Res. 62:531-542.
256	1941	Recent Developments in Methods for Determining Carotene. W. J. Peterson. Jour. Ind. Engin. Chem. 13:212.
257	1940	Calcium in the Nutrition of the Fattening Calf. A. D. Weber, C. W. McCampbell, J. S. Hughes, W. J. Peterson. Kan. Agr. Expt. Sta. Tech. Bul. 51:1-91.
257-a	1940	The Minimum Calcium and Phosphorus Requirements of Growing Pigs. C. E. Aubel, J. S. Hughes, W. J. Peterson. Proc. Amer. Soc. Anim. Prod. 311-316.
260	1941	Carotene and Riboflavin in Alfalfa. A. R. Hunke and A. T. Perkins. Poult. Sci. 21:195-199.
261	1941	The Structure of Phospholipids. E. B. Working and A. C. Andrews. Chem. Reviews. 29:245-256.
263	1942	Phosphorus Fixation by Soil Separates and Fractions. A. T. Perkins, C. E. Wagoner, H. H. King. Soil Sci. 53:1.

Serial No.	*Year of issue*	*Title, author and publication*
265	1942	Factors Which Influence the Physical Properties of Dough. IV. The Effects of Surface Active Agents on the Characteristics of the Curves Made by the Recording Dough Mixer. C. O. Swanson and A. C. Andrews. Cereal Chem. 19:102-120.
269	1942	Differences Between High and Low Quality Fresh Eggs. R. M. Conrad and H. M. Scott. Poult. Sci. 21:77-80.
270	1942	The Accumulation of Protein in the Oviduct of the Fowl. R. M. Conrad and H. M. Scott. Poult. Sci. 21:81-85.
272	1942	A Glass Valve Pressure Regulator. H. N. Barham. Jour. Indus. Engin. Chem. 14:485.
273	1942	The Separation and Characterization of Carotenoid Pigments Produced from Mineral Oil by Bacteria. H. J. Haas, L. D. Bushnell, W. J. Peterson. Sci. 95:631-632.
		Department of Dairy Husbandry
132	1939	The Effect of Feeding Vitamin A and Carotene to Cows on the Flavor and Color of Their Milk. W. H. Martin, H. W. Cave, C. H. Whitnah, G. H. Beck, and F. W. Atkeson. Proc. Inter. Assn. Milk Dealers 32d Ann. Conv., Lab. Sect.
133	1940	Measuring the Sanitary Quality of Market Cream. W. J. Caulfield, F. E. Nelson, and W. H. Martin. Jour. Milk Tech. 3:245-254.
134	1941	A Study of Home-made Ice Cream. V. D. Foltz and W. H. Martin. Jour. Food Res. 6:31-38.
135	1940	Effect of Salt on the Keeping Quality of Cream. W. J. Caulfield, F. E. Nelson, W. H. Martin. Jour. Dairy Sci. 23:1215-1227.
136	1941	Effect of Ensiling on the Viability of Weed Seed. J. W. Zahnley and J. B. Fitch. Jour. Amer. Soc. Agron. 33: 816-822.
137	1942	Further Studies on the Use of Salt for Improving the Quality of Cream for Buttermaking. F. E. Nelson, W. J. Caulfield, and W. H. Martin. Jour. Dairy Sci. 25:59-70.
138	1941	A Comparison of Four Ice Cream Stabilizers. W. H. Martin and W. J. Caulfield. Proc. Inter. Assoc. Ice Cream Mfrs. 41st Ann. Conv. Lab. Section.
139	1942	Effect of Holding Cream in the Buying Station Upon the Mold Content and Certain Other Quality Factors. R. W. Morrison, F. E. Nelson, W. H. Martin. Jour. Dairy Sci. 25:195-202.
140	1942	The Advantage of Grinding Atlas Sorghum Grain for Dairy Cows. F. W. Atkeson and G. H. Beck. Jour. Dairy Sci. 25:211-220.
141	1942	Comparative Palatability of Some Cereal Pastures. A. O. Shaw and F. W. Atkeson. Jour. Dairy Sci. 25:503-506.
		Department of Entomology
383	1940	Some Insects Causing Injury to Shade Trees in 1939. G. A. Dean. Kan. State Hort. Soc. 45:169-172.
478	1940	Differential Injury Within Varieties, Inbred Lines, and Hybrids of Field Corn Caused by the Corn Earworm, Heliothis armigera (HBN.). R. H. Painter and A. M. Brunson. Jour. Agr. Res. 61:81-100.
481	1940	The Transference of Hessian Fly Resistance and other Characteristics of Marquillo Spring Wheat to Winter Wheat. R. H. Painter, E. T. Jones, C. O. Johnston, and J. H. Parker. Kan. Agr. Expt. Sta. Tech. Bul. 49:1-55.
492	1940	Observations on Sod Webworms (Crambus spp. Lepidoptera) in Kansas. H. D. Miller. Trans. Kan. Acad. Sci. 43:267-281.
495	1940	Equine Encephalomyelitis Virus Isolated from Naturally Infected *Triatoma sanguisuga* LeConte. C. H. Kitselman and A. W. Grundmann. Kan. Agr. Expt. Sta. Tech. Bul. 50:1-15.
...	1940	Beekeepers and the Soil Conservation Program. R. L. Parker. Amer. Bee Jour. 80:540.
500	1941	The Economic Value and Biologic Significance of Insect Resistance in Crop Plants. Reginald H. Painter. Jour. Econ. Ent. 34:358-367.
501	1941	The Occurrence in Kansas of the Sugar-cane Rootstock Weevil, *Anacentrinus deplantus* Csy., (Coleoptera, Curculionidae). Harry R. Bryson. Kan. Ent. Soc. Jour. 14:84-90.
502	1941	The Tenth Annual Insect Population Summary of Kansas, 1940. R. C. Smith and E. G. Kelly. Trans. Kan. Acad. Sci. 44:241-256.
504	1941	Nomophila noctuella D. and S. as a Grass and Alfalfa Pest in Kansas. R. C. Smith. Jour. Kan. Ent. Soc. 15:25-34.

Serial No.	*Year of issue*	*Title, author and publication*
505	1942	Grasshopper Problems Associated with Strip Cropping in Western Kansas. D. A. Wilbur, R. F. Fritz, and R. H. Painter. Jour. Amer. Soc. Agron. 34:16-29.
506	1942	Coleoptera Associated with Ironweed, *Vernonia interior* Small in Kansas. R. B. Schwitzgebel and D. A. Wilbur. Jour. Kan. Ent. Soc. 15: 37-44.
507	1942	An Epizootic Among the Thistle Hoppers, *Acoloplus turnbulli bruneri* Caud., in Kansas. D. A. Wilbur and Roy Fritz. Jour. Econ. Ent. 35:109.
		Department of Home Economics
75	1938	Lack of Vitamin C in the Diet and Its Effect on the Jaw Bones of Guinea Pigs. M. T. Harman, M. M. Kramer, and H. D. Kargis. Jour. Nutr. 15:277-284.
78	1938	Riboflavin Content of Milk Collected in Different Months and Correlated with Other Constituents of the Milk. C. H. Whitnah, B. L. Kunerth, M. M. Kramer. Jour. Dairy Sci. 21:593-600.
85	1939	Quantitative Microscopical Analysis of Mixed Fabrics. H. M. Fletcher. Amer. Dyestuff Rpt. 18.
88	1940	Biological Assay of the Riboflavin Content of Beef, Calf, Mutton, and Pork Liver. B. L. Kunerth, H. S. Cox, O. B. Saffry, M. M. Kramer. Jour. Nutr. 20:169-174.
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92	1940	Anthropometric Data on College Women. B. L. Kunerth, E. G. Donelson, M. A. Ohlson, Mary Patton, Gladys Kinsman. Amer. Jour. Anthropology. 27:319-332.
94	1941	Comparison of the Serviceability of Certain Wool, Rayon, and Wool and Rayon Mixed Fabrics. Mary Caroline Boyer, Sister Mary Catherine Floersch, H. M. Fletcher. Amer. Dyestuff Rpt. 30:491-495.
...	1941	Influence of Freezing on Tenderness in Aged Beef. R. W. Bray, G. E. Vail, D. L. Mackintosh. Trans. Kan. Acad. Sci. 44:327-331.
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97	1941	Comparison of Some Physical Properties Affecting the Serviceability of Certain Silk, Rayon, and Silk and Rayon Mixed Fabrics. H. M. Fletcher, Bula Carlson, Helen King-Platt. Rayon Textile Mo. 22:425-426; 471-474.
98	1941	Physical Properties of Cotton, Linen and Rayon Mixed Fabrics Compared with All Linen and All Rayon Fabrics. H. M. Fletcher, Martha Gene Shelden, Catharine Eva Zink. Rayon Textile Mo. 22:735-737, and 23:29-30.
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101	1942	Synthetics Fibers and Textiles. H. M. Fletcher. Kan. Agr. Expt. Sta. Bul. 300:1-40.
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		Department of Horticulture
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159	1940	Influence of Root-pruning After Digging on the Growth of Certain Hardwoods. L. F. Smith. Jour. Forestry. 38:600-601.
164	1940	A Study of Growth Rings of a Bur Oak in Miami County. L. F. Smith. Trans. Kan. Acad. Sci. 43:173-175.

Serial No.	*Year of issue*	*Title, author and publication*
165	1940	Management of the Farm Woodlot in Kansas. L. F. Smith. Kan. Agr. Expt. Sta. Cir. 201:1-28.
167	1941	Strawberry Growing in Kansas. R. J. Barnett. Kan. Agr. Expt. Sta. Cir. 203:1-20.
169	1941	Growing Bush Fruits in Kansas. G. A. Filinger. Kan. Agr. Expt. Sta. Cir. 204:1-30.
171	1941	Common Spray Materials Alter the Internal Structures of Apple Leaves. W. F. Pickett and C. J. Birkeland. Proc. Amer. Soc. Hort. Sci. 38:158-162.
172	1941	Soils and Soil Treatments Affect the Morphology of French Crab Roots. G. A. Filinger. Proc. Amer. Soc. Hort. Sci. 38:305-310.
177	1941	A Quick Method of Determining When a Plant is Killed by Extremes of Temperature. G. A. Filinger and A. B. Cardwell. Proc. Amer. Soc. Hort. Sci. 39:85-86.
178	1942	Preserving Food in Frozen Food Lockers. G. A. Filinger and D. L. Mackintosh. Kan. Agr. Expt. Sta. Cir. 209:1-30.
182	1942	Further Studies on the Effect of Common Spray Materials on the Internal Structure of Apple Leaves. W. F. Pickett and C. J. Birkeland. Proc. Amer. Soc. Hort. Sci. 40:69-70.
184	1942	The Atchison Experiment Orchard. R. J. Barnett. Kan. Agr. Expt. Sta. Bul. 301:1-31.
		Department of Milling Industry
68	1940	Factors Which Influence the Physical Properties of Doughs. I. Effects of Autolysis on the Characteristics of Dough Mixer Curves. C. O. Swanson. Cereal Chem. 17:679-689.
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70	1941	The Effect of Low Temperature in Preventing Damage to Wheat Stored with High Moisture Content. C. O. Swanson. Cereal. Chem. 18:299-315.
...	1940	Ash Elements of the Soil and Wheat Quality.
...	1941	C. O. Swanson. Milling Prod., Northwestern Miller. Dec. 9-12; Jan. 7, 8, 24.
...	1940	The Rational Position of Ash. C. O. Swanson. Milling Prod., Northwestern Miller. Aug. 16-18; Sept. 5-6.
71	1941	Bleaching Agents Versus Potassium Bromate in Baking with Dry Milk Solids. M. C. Harris and E. G. Bayfield. Cereal Chem. 18:497-514.
72	1941	Factors Which Influence the Physical Properties of Dough. III. Effect of Protein Content and Absorption on the Pattern of Curves Made on the Recording Dough Mixer. C. O. Swanson. Cereal Chem. 18:615-627.
73	1941	The Effect of Protein Content on the Baking Behavior of Some Winter Wheat Varieties. E. G. Bayfield, E. B. Working, M. C. Harris. Cereal Chem. 18:640-654.
...	1941	The Quantity of Protein in Wheat. C. O. Swanson. Milling Prod., Northwestern Miller. Feb. 9, 10, 23; April 8-9.
74	1941	Effects of Moisture on the Physical and Other Properties of Wheat. C. O. Swanson. Cereal Chem. 18:705-729.
75	1941	The Structure of Phospholipids. E. B. Working and A. C. Andrews. Chem. Rev. 29:245-256.
...	1941	The Function of Soil Water and Its Significance. C. O. Swanson. Milling Prod., Northwestern Miller. June 14, 15, 32.
76	1942	Factors Which Influence the Physical Properties of Dough. IV. The Effects of Surface Active Agents on the Characteristics of the Curves Made by the Recording Dough Mixer. C. O. Swanson and A. C. Andrews. Cereal Chem. 19:102-120.
77	1942	The Testing of Wheat Quality by Recording Dough Mixer Curves Obtained from Sifted Wheat Meals. J. A. Johnson, Jr., and C. O. Swanson. Cereal Chem. 19:216-229.
		Department of Poultry Husbandry
127	1940	Effect of Parathyroid Preparation on the Blood Calcium of the Fowl. T. B. Avery, H. M. Scott, and R. M. Conrad. Poult. Sci. 19:321-323.
128	1940	Effect of Parathyroid Preparation on the Calcium Metabolism of the Fowl. T. B. Avery, H. M. Scott, R. M. Conrad. Poult. Sci. 19:324-325.

Serial No.	*Year of issue*	*Title, author and publication*
131	1940	Inheritance of Pinkeye in the Fowl. D. C. Warren. Jour. Heredity. 31:291-292.
132	1940	A Hormone Study of Dubbed and Normal Cockerels. H. W. Marlow and L. F. Payne. Poult. Sci. 19:401-403.
133	1941	The Relation of Total Egg Weight and the Weight of the Component Parts of the Egg to Hatching Power. H. M. Scott and D. C. Warren. Poult. Sci. 20:75-78.
134	1940	Turkey Management. H. M. Scott. Kan. Agr. Expt. Sta. Cir. 200:1-20.
135	1941	The Seventh World's Poultry Congress. L. F. Payne. Kan. State Bd. Agr. 32d Bien. Rpt. 37:168-185.
136	1941	A New Type of Polydactyly in the Fowl. D. C. Warren. Jour. Heredity. 32:2-5.
137	1941	The Influence of Restricted Food Intake on the Reproductive Performance of Breeding Turkeys. H. M. Scott and L. F. Payne. Poult. Sci. 20:395-401.
137-a	1941	Histological Observations on the Formation of the Chalaza in the Hen's Egg. H. M. Scott and Wai-Lan Huang. Poult. Sci. 20:402-405.
141	1941	A Second Poultry Survey in Kansas. L. F. Payne. Kan. Agr. Expt. Sta. Bul. 297:1-56.
142	1942	Differences Between High and Low Quality Fresh Eggs. R. M. Conrad and H. M. Scott. Poult. Sci. 21:77-80.
143	1942	The Accumulation of Protein in the Oviduct of the Fowl. R. M. Conrad and H. M. Scott. Poult. Sci. 21:81-85.
		Department of Veterinary Medicine
...	1941	Feeding Habits of Nemas (Parasitica)—Monographs. J. E. Ackert and J. H. Whitlock. One of a series of Monographs entitled "An Introduction to Nematology," Sec. II, Pt. II, pp. 350-355.
...	1940	Cesarean Section in the Bovine. E. R. Frank and S. J. Roberts. The North Amer. Vet. 21:546.
84	1940	Equine Encephalomyelitis Virus Isolated from Naturally Infected *Triatoma sanguisuga*. C. H. Kitselman and A. W. Grundmann. Kan. Agr. Expt. Sta. Tech. Bul. 50:1-15.
85	1940	A Note on Phenothiazine Therapy in Sheep. J. H. Whitlock and R. F. Cox. Jour. Amer. Vet. Med. Assn. 97:436-437.
86	1941	A Practical Dilution Egg Count Procedure. J. H. Whitlock. Jour. Amer. Vet. Med. Assn. 98:466-469.
...	1940	Glucose Tolerance in Horses. R. P. Link. Jour. Amer. Vet. Med. Assoc. 97:762.
...	1941	Sulfanilamide in Coccidiosis. G. R. Moore and W. W. Thompson. Jen-Sal Jour., pp. 8-9.
...	1941	Some Fundamental Factors Involving the Control of Bang's Disease. C. H. Kitselman. Lederle Vet. Bul. 10:3.
90	1942	The Relation of Leukemia and Bovine Lymphocytoma. W. W. Thompson and L. M. Roderick. Amer. Jour. Vet. Res. 3:159-165.
92	1942	Control of Sheep Diseases. R. R. Dykstra, L. M. Roderick, J. W. Lumb, Herman Farley, and J. H. Whitlock. Kan. Agr. Expt. Sta. Cir. 212:1-19.
		Department of Zoölogy
...	1940	Artificial Evagination of Larval Tapeworms. S. A. Edgar. Trans. Kan. Acad. Sci. 43:397-399.
210	1940	On the Resistance of Chickens to the Intestinal Nematode Ascaridia lineata (Schneider) Following Immunization. L. L. Eisenbrandt and J. E. Ackert. Amer. Jour. Hyg. 32(1): 1-11.
212	1941	Polydactyl Feet of Two Strains of Chicks. Mary T. Harman and Frances Nelson. Amer. Nat. 75:540-549.
213	1940	The Effect of Adrenalectomy on the Anterior Pituitaries of Fowls. E. H. Herrick and J. C. Finerty. Endocrinology. 27(2):279-282.
...	1940	The Masquerade of La Marckism. R. K. Nabours. Amer. Nat. 74:562-566.
215	1940	New Intermediate Hosts of Fowl Cestodes. A. A. Case and J. E. Ackert. Trans. Kan. Acad. Sci. 43:393-396.
216	1941	Feeding Habits of Nemas (Parasitica)—Monograph. J. E. Ackert and J. H. Whitlock. One of a series of Monographs entitled "An Introduction to Nematology." Sec. II, pt. II, pp. 350-355.
217	1941	Genetic Aspects of Pigment Production in the Guinea Pig. Mary T. Harman and Annette Alsop-Case. Genetics. 26:474-486.

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...	1940	A Method of Evaginating Tapeworm Cysticerci. S. A. Edgar. Jour. Parasit. Supl. 26(6):41.
...	1940	Duodenal Mucus of Fowls as a Nematode Growth Inhibitor. J. E. Ackert and Lyman P. Frick. Jour. Parasit. (Supl.) 26 (6):14.
...	1940	Intestinal Goblet Cells and Age Resistance to Parasitism. J. E. Ackert and S. A. Edgar. Jour. Parasit. (Supl.) 26(6):14-15.
218	1941	Use of Bile Salts for the Evagination of Tapeworm Cysts. S. A. Edgar. Trans. Amer. Micro. Soc. 60(1):121-128.
220	1941	The External Anatomy of the Pupal Abdomen in Discosmoecus atripes Hagen (Trichoptera, Limnephilidae). A. L. Goodrich, Jour. Kan. Ent. Soc. 14(4):134-143.
221	1941	The Food of Twenty-two Mourning Doves Taken During the 1940 Hunting Season. Dolf Jennings. Trans. Kan. Acad. Sci. 44:427-428.
222	1941	Fall Food Habits of the Bobwhite Quail in Eastern Kansas. Dolf Jennings. Trans. Kan. Acad. Sci. 44:420-426.
223	1941	Plague Flea, Xenopsylla Cheopis, in Kansas. A. W. Grundmann, H. P. Boles, J. E. Ackert. Trans. Kan. Acad. Sci. 44:238-240.
224	1941	Autosomal and Sex Chromosomal Translocations and Viability in Apotettix Eurycephalus Hancock. R. K. Nabours, Florence M. Stebbins, and W. R. B. Robertson. Jour. Expt. Zoöl. 88(2):239-261.
230	1942	The Removal of the Fowl Tapeworm Raillietina cesticillus by Short Periods of Starvation. W. M. Reid. Poult. Sci. 21:220-229.
232	1942	Natural Resistance to Helminthic Infections. J. E. Ackert. Jour. Parasit. 28:1-24.
		Director's Office
68	1940	Viability of Buffalo Grass Seeds Found in the Walls of a Sod House. Alvin E. Lowe. Jour. Amer. Soc. Agron. 32:891-893.
69	1940	The Reaction of Sorghum Varieties and Hybrids to Milo Disease. L. E. Melchers and Alvin E. Lowe. Plant Rpt. Supp. 126: 165-175.
70	1940	Tenth Biennial Report of the Director of the Kansas Agricultural Experiment Station. L. E. Call. Kan. Agr. Expt. Sta. 10th Bien. Rpt., 1938-'40, pp. 1-159.
...	1940	Publication List. Kan. Agr. Expt. Sta. Cir. 203:1-4.
71	1940	The Plains Farmer and the Changing World. L. E. Call. Kan. State Bd. Agr. 32d Bien. Rpt. 37:13-24.
72	1940	The Protection of College and Station Workers from too Many Outside Demands. L. E. Call. Proc. 54th Ann. Conv. Assn. Land-Grant Colleges and Univs., pp. 121-123.
...	1941	Publication List. Kan. Agr. Expt. Sta. Cir. 205:1-4.
...	1941	Abstracts of New Publications. Kan. Agr. Expt. Sta. Abstract. 2:1-4.
...	1942	Publication List. Kan. Agr. Expt. Sta. Cir. 211:1-4.
		Fort Hays Branch Experiment Station
22	1941	Relation of Leaf Area to Grain Yield in Sorghum. A. F. Swanson. Jour. Amer. Soc. Agron. 33:908-914.
28	1940	Progress Report of Tomato Variety Tests at the Fort Hays Experiment Station. F. P. Eshbaugh. Proc. Kan. State Hort. Soc. 45:159-163.
...	1941	A Review of Stock Cattle Feeding and Management Tests at the Fort Hays Branch Experiment Station. 28th Ann. Cattlemen's Round-Up, 1940-'41, pp. 1-12.
30	1941	Soaking Buffalo Grass (*Buchloe Dactyloides*) Seed to Improve its Germination. Leon E. Wenger. Jour. Amer. Soc. Agron. 33:135-141.
31	1941	Results of Bindweed Control Experiments at the Fort Hays Branch Station, Hays, Kansas, 1935-1940. F. L. Timmons. Kan. Agr. Expt. Sta. Bul. 290:1-50.
32	1941	Reëstablishing Native Grasses by the Hay Method. Leon E. Wenger. Kan. Agr. Expt. Sta. Cir. 208:1-16.
33	1942	The Dissemination of Prickly Pear Seed by Jack Rabbits. F. L. Timmons. Jour. Amer. Soc. Agron. 34:513-520.
34	1942	Natural Selection in Varietal Mixtures of Winter Wheat. H. H. Laude and A. F. Swanson. Jour. Amer. Soc. Agron. 34: 270-274.
...	1942	Wheat Bran Versus Cottonseed Meal Versus Alfalfa Hay as Protein Supplements in Winter Rations for Stock Cattle. 29th Ann. Cattlemen's Round-Up, 1941-'42, pp. 1-8.

FINANCIAL STATEMENT, 1940-'41

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

	Federal appropriations	*State appropriations and receipts*	*Totals*
Main station	$140,050.96	$63,986.89	$204,037.85
Branch stations, appropriations	.....	88,116.23	88,116.23
Branch stations, sales	.....	59,302.56	59,302.56
Totals	$140,050.96	$211,405.68	$351,456.64
Personal services	$123,191.03	$101,097.03	$224,288.06
Supplies and materials	8,222.14	23,188.95	31,411.09
Communication service	32.08	2,256.48	2,288.56
Travel expenses	2,307.21	5,002.98	7,310.19
Transportation of things	46.35	2,285.40	2,331.75
Publications	88.74	919.96	1,008.70
Heat, light, water, power and fuel	.....	5,960.84	5,960.84
Contingent expenses	157.43	773.10	930.53
Equipment	4,542.38	24,017.67	28,560.05
Land, purchase and rent	.....	2,523.44	2,523.44
Structures and nonstructural improvements	1,463.60	9,884.58	11,348.18
Balance, June 30, 1941	.....	33,495.25	33,495.25
Totals	$140,050.96	$211,405.68	$351,456.64

FINANCIAL STATEMENT, 1941-'42

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

	Federal appropriations	*State appropriations and receipts*	*Totals*
Main station	$140,050.96	$63,018.54	$203,069.50
Branch stations, appropriations	.....	108,203.52	108,203.52
Branch stations, sales	.....	90,058.12	90,058.12
Totals	$140,050.96	$261,280.18	$401,331.14
Personal services	$124,502.85	$120,293.21	$244,795.56
Supplies and materials	8,953.95	28,787.20	37,741.15
Communication service	42.60	2,331.71	2,374.31
Travel expenses	2,072.43	3,952.09	6,024.52
Transportation of things	200.54	1,866.27	2,066.81
Publications	221.19	1,125.72	1,346.91
Heat, light, water, power and fuel	13.77	8,035.67	8,049.44
Contingent expenses	.....	1,237.50	1,237.50
Equipment	3,938.26	46,056.11	49,994.37
Land, purchase and rent	9.00	5,629.97	5,638.97
Structures and nonstructural improvements	96.87	15,924.21	16,021.08
Balance, June 30, 1942	.....	26,040.52	26,040.52
Totals	$140,050.96	$261,280.18	$401,331.14