

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Agricultural Research Division News & Annual Reports

Agricultural Research Division of IANR

5-1950

63rd Annual Report, Agricultural Experiment Station, University of Nebraska College of Agriculture, May 1950

Follow this and additional works at: <https://digitalcommons.unl.edu/ardnews>



Part of the [Agriculture Commons](#)

This Article is brought to you for free and open access by the Agricultural Research Division of IANR at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Agricultural Research Division News & Annual Reports by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

63rd Annual Report



Agricultural Experiment Station

The University of Nebraska College of Agriculture

W. V. Lambert, Director

M. L. Baker, Associate Director

Lincoln, Nebraska

May, 1950

Introduction

THE UNIVERSITY OF NEBRASKA's experimental work in agriculture began in 1873 when a few test plots at Lincoln were planted to sugar beets, oats, barley and wheat. Today the Agricultural Experiment Stations' laboratory extends across the State.

Investigations in crops, livestock, soils, chemurgy, farm management, marketing and farm and home equipment are being carried on at Lincoln and at six outstate locations. These include the North Platte, Scottsbluff and Valentine Substations, the Box Butte Experiment Farm, the Union Fruit Farm, and the new Fort Robinson Beef Cattle Research Station near Crawford. Human nutrition and family life problems are studied by a research staff at Lincoln.

Throughout the areas between these stations the Outstate Testing Project is studying agricultural problems in cooperation with the State's farmers.

This 63rd Annual Report describes the Experiment Station's aims and its accomplishments during the past year. Many of the projects discussed here are not completed, and conclusions cannot yet be stated. Others afford definite answers to specific questions. All of the work is designed to contribute to a better system of agriculture in Nebraska.

In past annual reports work done at Lincoln was reported by the various departments of the Experiment Station, and work at the substations was reported in separate sections. In this year's report the projects of the substations and the central station are combined under subject-matter headings. This new organization is designed to make the report more readable.

M. L. BAKER, *Associate Director*

Letter of Transmittal

THE UNIVERSITY OF NEBRASKA—AGRICULTURAL EXPERIMENT STATION

To His Excellency, Val Peterson, Governor of Nebraska:

Sir: In accordance with the Act of Congress approved March 2, 1887, and the Act of the General Assembly of the State of Nebraska, approved March 31, 1887, establishing and regulating experiment stations, I have the honor herewith to submit the Sixty-third Annual Report of the Agricultural Experiment Station of Nebraska.

W. V. LAMBERT, *Director*

February 1, 1950

Governor's Certificate

STATE OF NEBRASKA, EXECUTIVE DEPARTMENT

Dr. W. V. Lambert, *Director, Nebraska Agricultural Experiment Station:*

Sir: I hereby acknowledge receipt of the Sixty-third Annual Report of the Agricultural Experiment Station of Nebraska.

VAL PETERSON, *Governor.*

February 1, 1950

Contents

Cover photograph by Soil Conservation Service.

Soils Research	5-23
Erosion Control and Moisture Conservation, Soil Microbiology and Crop Residue Management, Mineralogical Studies, Classification and Correlation of Soils in Soil Conservation Districts, Influence of Perennial Grasses on Soil Structure, Phosphorus Status of Nebraska Soils, Fertilizers for Corn on Nonirrigated Soils, Nitrogen Fertilizers for Bromegrass, Properties of Sandy Soils in Northeastern Nebraska, Fertilizers for Winter Wheat, Lime and Commercial Fertilizers for Sweetclover, Nitrogen Maintenance in Sharpsburg Silty Clay Loam Soil, Influence of Irrigation Practice, Seeding Rate and Fertilizer Application on the Production of Safflower, Cultural Experiments with Sugar Beets, Fertilizers for Potatoes Following Bromegrass Pasture, Influence of Irrigation Practice, Plant Population and Fertilizer Application on the Yield of Corn, Commercial Fertilizers for Native Meadows, Reclamation of Seeped and Alkaline Soils.	
Field Crops Research	24-53
A Half Century of Crops Research, Improvement of Small Grains, Small Grain Varietal Tests at North Platte, Time and Rate of Planting Oats, Dry-Land Crop Rotations at North Platte, Crop Rotations Under Irrigation at Scottsbluff, Corn Improvement, Hybrid Corn Tests at North Platte, Corn Genetics, The Growth and Reproduction of Corn, Sorghum Improvement, Varietal Tests of Grain and Forage Sorghum at North Platte, Adaptation and Improvement of Grasses, Alfalfa Improvement, Sweetclover Improvement, Soybean Improvement and Production Practices, Weed Control Research, Outstate Testing Project.	
Horticultural Crops	54-66
Food Value of Nebraska-Grown Vegetables, Vegetable Variety Tests, Vegetable Breeding Experiments, Cultural Experiments with Potatoes, Absorption of Carbon Dioxide by Potato Leaves, Potato Storage, Quality-Price Relationship of Retail Potatoes, Fruit Breeding, Fruit-Stocks Investigations, Orchard Spraying, Orchard Culture, Supplemental Water for Eastern Nebraska Orchards, Horticultural Studies at North Platte.	
Plant Diseases	67-71
Bean Diseases, Sugar Beet Diseases, Cereal Diseases, Diseases of Special Crops, Virus Diseases, Plant Disease Survey, Seed Treatment Tests, Field Bean Date-of-Planting Tests, Adaptability of the Hybrid Wax Bean, 4023, in Nebraska, Susceptibility of Crop Varieties to Disease in Outstate Plots.	
Investigations in Agricultural Chemistry	72-75
Nutritive Value of Rations for Chicks, Nutritive Value of Legume Seeds, Studies on Alfalfa in Chick Rations, Animal Protein Factors, Proteolysis in Wheat Flour Doughs, Relation of Starch to Bread Baking.	
Insect Control Experiments	76-86
Insect Surveys and Outlook for 1950, Livestock Parasite Experiments, Field Crop Insects, Potato Insects, Horticultural Insects.	
Chemurgic Research and Development	87-93
Industrial Surveys, Improvement and Testing of Special Chemurgic Crops, Oilseed Processing, Utilization of Vegetable Oils and By-products, Utilization of Wheat Starch, Carotene Retention in Alfalfa.	
Cattle, Hogs and Sheep	94-112
Beef Cattle Feeding, Grazing and Management Investigations, Beef and Dual-Purpose Cattle Breeding Investigations, Systems of Breeding for Swine Improvement, Swine Feeding Investigations, Rendering Lard in the Home Pressure Cooker, Sheep Breeding Investigations, Lamb Feeding Experiments.	

Dairy Cattle Investigations	113-117
Reproduction and Breeding, Feeding and Management.	
Dairy Products Investigations	118-120
Ice Cream Studies, Experiments with Cheese, Sanitation.	
Poultry Nutrition and Breeding	121-124
Rations for Poultry, Poultry Breeding.	
Poultry Products Investigations	125-127
Rancidity in Chicken Fat, Yield of White Leghorn Cockerels, Egg Washing Studies.	
Animal Diseases	128-131
Death Losses in Young Pigs, Pathogenesis of Listeriosis, A Study of Bovine Hyperkeratosis (X Disease in Cattle), Neoplastic and Neoplastic-like Diseases of the Chicken, Diagnostic Laboratory.	
Agricultural Engineering	132-144
Irrigation and Drainage, Farmstead Equipment, Farm Machinery and Power.	
Studies in Agricultural Economics	145-148
Cost of Producing Farm Crops, Marketing, Farm Organization and Farm Costs, Land Use Adjustment, Agricultural Credit, Adjustments in Farm Organization, Trends and Changes Affecting Rural Schools and Problems of Their Reorganization, Classification of Land to Determine Value for Tax Purposes.	
Home Economics	149-153
Nutrition Research, Household Equipment Research, Housing Research, Family Life Research.	
Experiment Station Publications	154-155
Administration and Staff	156-159
Experiment Station Financial Report	160-162

Soils Research

Department of Agronomy and Scottsbluff and
North Platte Experiment Substations

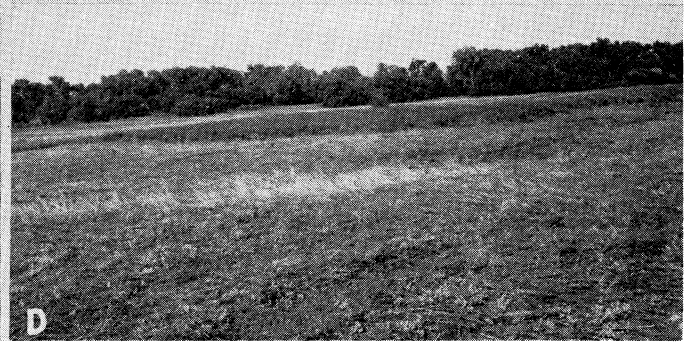
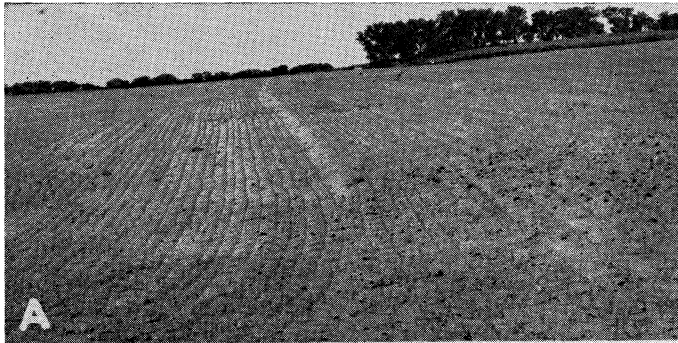
Erosion Control and Moisture Conservation

This report covers the twelfth year of research on factors affecting soil and moisture conservation. The studies have been conducted cooperatively with the U. S. Department of Agriculture, Soil Conservation Service—Research Division. The work has been closely coordinated with soil and moisture conservation work in other parts of the United States and in the Prairie Provinces of Canada. Problems similar to those in Nebraska exist in Canada and several methods have been found practical in the two areas.

Much work has been devoted to a study of the effects of crop residues left on the surface of the soil on the amount of runoff and soil erosion by water or wind. Extensive work has also been done on practical methods of farming land protected with crop residue.

Soil conservation problems on sandy land. Approximately one-ninth of the cultivated farm acreage of Nebraska is sandy land, and deserves study fully proportional to that given other cultivated land of the State. Since 1947 the Soil Conservation Service—Research Division, and the Agronomy Department of the College of Agriculture have increased attention to sandy soils. Two fundamental problems are recognized—wind erosion and a shortage of residues for soil protection. All of the sandy soils of Nebraska with a few exceptions along stream bottoms are inherently low in nitrogen content and this is reflected strongly in crop production.

During the year distinct progress was made in methods for reducing wind erosion through the use of residues, and in increasing the production of residues through the use of adapted legumes. A number of different subsurface tillers were tested under a variety of conditions such as light and heavy residues and wet and dry soil. Treaders and skew treaders also were tested. These implements were found to be both practical and desirable as a means of maintaining maximum dead vegetal cover on land at planting time. Rolling coulters on subsurface tillers are essential and can be made to operate so that no trenches are dragged out by uncut material wrapped about subsurface tiller standards. A skew treader in place of the more common treader is a desirable implement for uprooting and detaching subtitled vegetation so that it will quickly die. Extensive tests of seeding grain through residues show that this can be successful provided a proper drill is used. Practically all residues existing at planting time can be left on the surface for subsequent protection from wind erosion when a single, flat cutter drill is employed. Additional tests with other types of drills are needed. Legume plantings with residues on the soil surface have been accomplished without any burial of residues by the simple practice of broadcasting on subtitled and double-treaded seedbeds with a seeder mounted on a treader. Rolling the seedbed afterward to firm the soil about the seed is a desirable practice. Residue protection for both small grain and legumes helped to prevent fall blowing in a number of instances in 1949. Methods of planting and cultivating row crops on sandy land with residue protection have not yet been studied.



Soil Conservation on Sandy Soil

A. Many sandy soils are seeded to rye. Wind erosion is often serious on this kind of land.

B. Spring-seeded hairy vetch growing on sandy soil.

C. Volunteer partridge pea on heavily farmed and eroded soil.

D. Residue of partridge pea being used to protect land from wind erosion during growth of rye crop.

At the outset it was realized that no benefit could come from studies on residue protection of sandy land unless at the same time methods could be evolved for increasing residue production. This would mean increasing crop production. The most reasonable way would be an increased use of legumes in crop rotations, provided some legume well adapted to sandy land could be had for the purpose. Tests previous to 1949 showed the shortcomings of sweetclover, both annual and biennial, particularly on sandy land low in calcium where liming would be necessary. On the other hand, two relatively new legumes, partridge pea and hairy vetch, show strong possibilities.

In 1949, 20 lots each of partridge pea and hairy vetch and several lots of other legumes were tested on 20 farms on sandy land in different parts of the State.

Partridge pea and vetch were notably successful, particularly on the sandy soils immediately east of the Sandhills. Several farmers harvested the test areas of partridge pea for seed and will use this seed to expand seedings in 1950. Hairy vetch planted in the spring performs as a biennial, that is it produces fall pasture and winter cover and should produce seed the following year. Several farmers have been found who have been growing hairy vetch as a winter annual for several years, or who have had an unknown legume growing on their farms which proved to be partridge pea. As a result the seed supply of these two legumes has been greatly augmented. Heretofore the only source of partridge pea seed has been plantings made by the Agronomy Department.

A number of yield tests of partridge pea and vetch were made this year. Partridge pea appears decidedly superior in quantity of residue production. In three comparative tests partridge pea gave a yield of 3.2 tons and vetch 2 tons per acre. However, 1949 was an unusually favorable year for these legumes.

Partridge pea and vetch have not yet been tested sufficiently for any precise knowledge of subsequent crop yield effects. Partridge pea has been grown at Lincoln since 1945 in an oats-corn rotation where it has volunteered consistently in oat stubble every year. Corn in that rotation in 1949 yielded 61.6 bushels per acre compared with 41.7 bushels in a rotation without partridge pea. At the Hastings watershed project on badly eroded land partridge pea has been grown continuously in a rotation of corn and oats since 1945. Corn in 1949 following oats with volunteer partridge pea yielded 37 bushels per acre compared with 22.5 bushels of corn where a mixture of legumes was grown in 1948 with oats for the first time and with 7.7 bushels of corn following oats without any legume.

A Madison County farmer, who has had hairy vetch as a volunteer crop in a rotation for several years, this year had corn following vetch in rye which yielded 51 bushels per acre compared with corn on an adjacent field following rye without vetch which yielded 32 bushels per acre.

Like other legumes, partridge pea and vetch are highly nitrogenous in composition and they fix nitrogen from the air. Thus it is to be expected that their consistent growing in rotation will increase the yield of grain and the production of residue provided the nitrogenous material is returned to the land.

Infiltration studies. This project has included much investigation of factors affecting the intake of water by soils. The earlier work was concerned chiefly with the condition of the soil at the surface and the protection of the surface against raindrop action. This year an attempt was made

to determine the effect of heavy clay layers below the surface on intake of water from rainfall or sprinkler irrigation.

Tests have been made on some of the land having heavy subsoils in Lancaster and Seward Counties. It was found that these soils will transmit water through the heavy layers in sufficient quantities and at a rate rapid enough to permit absorption of most rains or low-rate sprinkler irrigation. If the surface is protected most rains can be absorbed without much runoff. If the heavy clay subsoil is dry at the time of the rain or irrigation, the soil will take in large amounts of water before the clay swells enough to greatly slow down the downward movement of water. The accompanying diagram shows the movement of water downward in the soil.

Additional work will be required to establish definitely the rate at which water may penetrate and pass through these clay layers at different initial moisture contents.

F. L. DULEY, J. C. RUSSEL, T. H. GOODDING, PAUL E. FISCHBACH

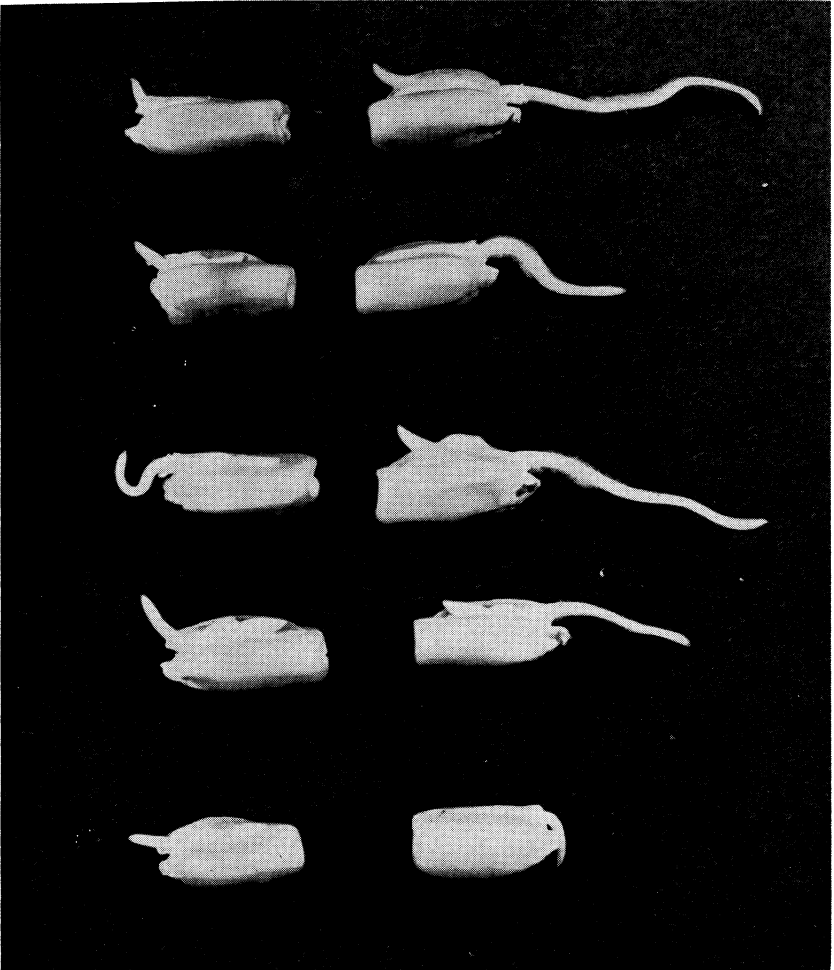
Soil Microbiology and Crop Residue Management

Reducing water intake. Laboratory experiments were carried out to determine the influence of microorganisms on reducing the percolation of water through the soil during prolonged submergence. Results showed that microorganisms produce substances that limit the movement of water through a layer of soil. When treatments that increase microbial activity were applied to the soil, there was a more rapid reduction in the movement of water through the soil than when no treatment was used.

The addition of 10 p.p.m. of HgCl_2 to the percolating water maintained a high intake of water for a long period. In the absence of HgCl_2 the percolation rate gradually diminished until at the end of 50 days it had been reduced to about 5 per cent of the original rate. Reduction of the percolation rate was more rapid when wheat straw was used as a mulch than when it was not used. It seems reasonable to assume that the mulch supplied energy to the microorganisms, thus increasing their activity and the production of substances that resulted in a rapid reduction of percolation. The addition of different amounts of sucrose to the soil followed by incubation resulted in a reduction of percolation somewhat proportionate to the amount of energy material supplied for microbial growth.

Effect of soil microorganisms and plant material on geotrophism and growth of germinating corn. A study was made of some factors involved in stubble-mulch farming that may under certain weather conditions reduce germination and growth of corn seedlings. In the laboratory, corn germination in soil mulched with wheat straw was less than in bare soil whenever both test soils were maintained in an extremely wet condition. Similar results were obtained in the greenhouse.

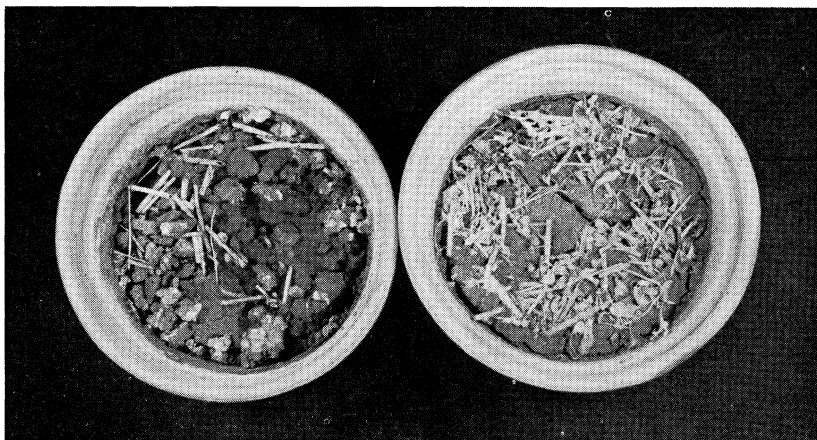
It was found that a mineral agar medium containing a source of organic nitrogen stimulated the growth of soil microorganisms, causing the roots of corn seedlings to grow upward. Corn kernels soaked in a plant material-water mixture for 24 to 48 hours and then placed on an agar medium usually produced seedlings with a small percentage of their roots growing upward. When organic nitrogen compounds were added to mineral nutrient agar they seemed to stimulate the production of substances by microorganisms, causing a high percentage of the seedling roots to turn upward. The growth of these seedlings was greatly reduced as compared with the control. (See photograph on page 9.)



Influence of microorganisms on the direction of the root growth of corn seedlings (side view). Left, germinated in the presence of microorganisms on Peptone plates. Root sprouts turn upward. Right, control germinated on Crone's medium. Roots normal.

Earthworms. A survey of earthworm population under different cropping systems was made under stubble-mulch farming and where the residue was plowed under. The influence of earthworms on some of the important physical and biological properties of the soil, and their role in the decomposition of crop residues was also studied.

In the surface 8 inches of soil, plots with residue cover contained two to five times as many earthworms as plots in which the residue was plowed under. In the stubbled plots there was less variation in soil moisture and temperature than in the plowed plots. These variations were related to earthworm population under these two tillage conditions.



Earthworms hasten the loss of residue from the soil. Sweetclover residue was spread over the soil in these laboratory pots at the rate of 3 tons per acre. Pot on left had earthworms and lost 79 per cent of residue in one month. Pot on right had no earthworms and lost only 44 per cent of residue. Note the larger aggregates of soil having earthworms.

When rotations included legumes there was a higher population of earthworms than when no legumes were used. With a heavy straw mulch application of eight tons per acre there was a higher population of earthworms than with any of the other treatments.

Species of earthworms found during these studies were *Helodrilus calignosus*, *Helodrilus parvus*, *Diplocardia riparia*, and *Octolasion lac-teum*. There was a significant seasonal change in the population of these species in the surface soil under the various treatments.

Although different species formed wormcasts at somewhat different rates, a close relationship existed between the amount of wormcasts produced and earthworm population. *Helodrilus calignosus* formed the most wormcasts.

Laboratory tests showed that the rate of percolation of water was much greater in 8-inch depths of soil when earthworms were present. No tests of this sort were made in the field.

Waterdrop tests showed a significant increase in the stability of wormcasts as compared with the original soil. Wormcasts produced under alfalfa mulch showed greater stability than those produced under straw.

Mechanical analyses of wormcasts and soil showed that wormcasts contained more silt and clay and less sand than the soil. There were more bacteria and fewer fungi in wormcasts than in the original soil. Earthworms under laboratory conditions hastened the decomposition of crop residues. (See photograph above.)

Work on this project is in cooperation with the U. S. Department of Agriculture, Soil Conservation Service—Research Division.

T. M. McCALLA, F. L. DULEY, T. H. GOODING, J. C. RUSSEL, S. P. TEOTIA

Mineralogical Studies

Mineralogical studies on two soils of considerable acreage in eastern Nebraska were initiated. Preliminary investigations on the sand and coarse silt fractions indicate that very little of the phosphorus in the Sharpsburg silty clay loam, the Marshall silt loam and their intergrades is in the form of the phosphorus minerals, i.e., apatite, monazite. Qualitative petrographic and chemical analyses indicate that the soil phosphorus is in the form of an impurity or inclusion in some of the more dominant minerals.

Since the source of phosphorus from the soil for plant growth is important, quantitative mineralogical investigations are now underway to determine the location of the phosphorus within the soil.

New method for the separation of soil minerals. A simple and rapid procedure for the separation of soil minerals was developed. The minerals were separated into specific gravity groups by centrifugation in bromoform and the suspensions were frozen. The light minerals near the surface of the frozen bromoform were detached from the heavier minerals which were in the bottom of the tube and washed free with bromoform at 35° C. After cleaning, the minerals were weighed separately. This procedure for separating minerals made possible the use of the common, easily procurable and cheaper centrifuge tubes. The method was twice as rapid as the usual methods, since double the ordinary weight of soil sample could be used in the separation.

R. P. MATELSKI

Classification and Correlation of Soils in Soil Conservation Districts

During 1949 representatives of the Agronomy Department assisted in the field and laboratory correlation of soils in the Soil Conservation Districts. Soils investigated were from Banner, Hamilton, Holt, Stanton, Clay, Fillmore and Lancaster Counties. Field work consisted of the inspection of a few soil groups that were causing considerable difficulty in mapping areas for land use recommendations. Laboratory analyses included mechanical analyses, total salt content, exchangeable plus soluble cations, and pH. These analyses were used by the Soil Conservation Service as guides in separating soils into mapping units.

R. P. MATELSKI

Influence of Perennial Grasses on Soil Structure

Measurement of soil structure is difficult but the properties determining soil structure are more easily obtained. The usual properties defining structural condition of soil include the size, shape, and arrangement of aggregates; the stability of aggregates; and the size, shape, and arrangement of pores.

In 1946 a study was initiated to determine the influence of perennial grasses on soil structure. Size distribution of dry aggregates was obtained for 12 plots under different grasses after two years' growth. The plots are located on Sharpsburg silty clay loam at the Agronomy Farm, Lincoln, Nebraska. The soil at field moisture capacity was sampled from these plots by 2-inch increments to a depth of 12 inches. The field cores were permitted to dry under laboratory conditions and then subjected to dry sieving by a motor-driven Tyler-Sieving machine. The results of the size distribution of dry aggregates are expressed by geometric mean diameter.

The larger the geometric mean diameter the larger the size of aggregates. The geometric mean diameter is mathematically related to the surface area of the aggregates. This fact gives an added physical significance to the size of aggregates, for in soil structure phenomena surface areas in one form or another are involved.

After two years' growth of the various grasses, the geometric mean diameter of aggregates for each 2-inch increment from the grass plots increased progressively with the soil depth studied. The geometric mean diameters of aggregates at the 10- to 12-inch depths were 1.5 to 3.6 times greater, depending upon the vegetal treatment, than those at 0- to 2-inch depths. In general, the cool-season grasses yielded smaller-sized dry aggregates than the warm-season grasses for all the depths studied. The aggregation of Sharpsburg soil appeared to vary in the surface 4 inches depending on the amount and nature of the vegetation. Below this depth the vegetation seemed to have no measurable effect on the geometric mean diameter of aggregates. Alfalfa sod yielded the largest-sized dry aggregates while bromegrass sod yielded the smallest-sized dry aggregates.

Closely related to the geometric mean diameter of dry aggregates, the bulk density values (pounds of oven-dry soil per cubic foot of volume) showed similar results. The bulk density values increased with depth studied and they also varied with vegetal treatment. The total organic matter percentage appeared to be of little value in explaining the size distribution of dry aggregates.

A. P. MAZURAK, S. MILLER, E. C. CONARD

Phosphorus Status of Nebraska Soils

An investigation was initiated in 1949 to determine the phosphorus status of 41 soil profiles from the following 15 soil series: Keith, Sherman, Holdrege, Hastings, Crete, Moody, Marshall and Sharpsburg soils developed on the upland from loess; Burchard soil developed on the upland from glacial materials; Anselmo, Dickinson and Thurman soils developed on the upland from sandy materials; and Cass, Lamoure and Wabash soils developed on the bottomland. The properties of these soils which have been determined include total phosphorus content, organic matter content, total nitrogen content, pH and mechanical analysis. To date, the available phosphorus content and cation status of Cass, Thurman, Sharpsburg, Marshall and Wabash soils have been measured and are discussed here.

Total phosphorus contents of the various horizons ranged from 52 to 185 p.p.m. in the sandy Cass and Thurman soils, from 360 to 742 p.p.m. in the various horizons of the Sharpsburg and Marshall soils, and from 937 to 1125 p.p.m. in the horizons of the Wabash soil. The proportions of the total phosphorus that were soluble in 0.1 N HCl in the various horizons of the different soils ranged from 8 to 29 per cent in the Cass soil, 9 to 21 per cent in the Thurman soil, 2 to 70 per cent in the Sharpsburg soil, 3 to 66 per cent in the Marshall soil, and 23 to 34 per cent in the Wabash soil. The higher percentages of the total phosphorus that was acid-soluble occurred in the lower horizons of the soils studied. Cass and Thurman soils decreased in phosphorus content with depth, Sharpsburg and Marshall soils tended to decrease in phosphorus content gradually to the B horizon and then increased again until the phosphorus content of the C horizon was greater than that of the A horizon. The phosphorus content of the Wabash profile was fairly uniform with depth. Field ex-

periments have shown a greater response of crops to phosphorus on Cass, Thurman, Marshall and Sharpsburg soils than on Wabash soils.

LEON CHESNIN, R. C. LIPPS, W. E. RINGLER, C. H. YIEN

Fertilizers for Corn on Nonirrigated Soils

Fertilizer experiments were conducted at eight locations on nonirrigated land to study the influence of the following on the yield of corn: (1) combinations of nitrogen (20 pounds N/acre), phosphorus (40 pounds P_2O_5 /acre) and potassium (40 pounds K_2O /acre) fertilizer applied at planting time with applications of nitrogen fertilizer (40 to 120 pounds N/acre) as a side-dressing; (2) applying all the nitrogen fertilizer at the last cultivation, when corn was 10 to 18 inches high, at planting time, or as a surface application prior to plowing or listing; and (3) two plant populations with three rates of nitrogen fertilizer as a side-dressing (0, 60 and 120 pounds/acre), one plant population being approximately that which the farmer considered optimum for the particular soil and the other a larger population.

An application of a mixed fertilizer at planting time increased the yield of corn at one location, decreased the yield at three locations, and had no noticeable effect upon yield at the other four locations. These results were obtained even though a marked response to mixed fertilizers containing nitrogen and phosphorus was indicated at all locations by the early growth of corn. The increase in yield of corn resulting from an application of a mixed fertilizer at planting was obtained on Marshall silt loam in northeastern Nebraska and was due largely to the phosphorus in the fertilizer. However, decreases in yield due largely to phosphorus fertilizer were obtained at two locations on sandy soils (Thurman series) in northeastern Nebraska. The effect of phosphorus fertilizer on the Thurman soils was especially noticeable where it was applied with a nitrogen fertilizer; this was attributed to marked tillering. A decrease in yield due to potassium in the mixed fertilizer was obtained at one location. These results point out clearly the undesirability of recommending the general use of a mixed fertilizer at planting for corn production on nonirrigated land in Nebraska. Further information is needed to determine the condition under which a mixed fertilizer at planting may be expected to increase corn yields.

Experiments on irrigated land in Nebraska indicate that the effectiveness of time of applying nitrogen fertilizer for corn is in the following order, the most effective first: (1) at the last cultivation or on the plow furrow at plowing in the spring; (2) when the corn is 10 to 18 inches high; (3) to the surface of the ground prior to plowing in the spring; and (4) at planting time. Little evidence has been obtained prior to 1949 on the most desirable time for applying nitrogen for corn on nonirrigated land although it has been pointed out that soil moisture conditions are frequently more favorable at the second than at the last cultivation. The results obtained this year indicate that the effectiveness of time of applying nitrogen fertilizer for corn on nonirrigated land is in the following order, the most effective first: (1) when the corn is 10 to 18 inches high or at the last cultivation; (2) to the surface of the ground prior to plowing in the spring or at planting time; and (3) applying to the surface of the ground prior to listing.

A comparison was made of the effects of 0, 60 and 120 pounds of nitrogen applied as side-dressing with two plant populations. Maximum yields

were obtained at six of the eight locations from an application of either 60 or 120 pounds of nitrogen to the plots with the larger plant population. At one of the other locations there were no differences in yields due to plant population with any of the rates of nitrogen studied. At the remaining location where moisture was limiting during July larger yields were obtained with the smaller plant population at all rates of nitrogen applied. These results emphasize the importance of adjusting stands and fertility levels on nonirrigated lands in Nebraska to obtain maximum yields of corn from the moisture supply available.

R. E. LUEBS, J. J. HANWAY, H. F. RHOADES

Nitrogen Fertilizers for Bromegrass

An experiment was conducted in 1948-1949 on Rokeby silty clay loam at Lincoln to study the effectiveness of different nitrogen carriers applied in the fall and spring on the production of hay, protein in the hay and seed by bromegrass. Bromegrass was established on the field used in this study in 1945 and a severe sodbound condition existed in 1949. Fall applications of nitrogen fertilizer were made on October 12, 1948, and the spring applications were made on April 7, 1949. A portion of each plot was harvested June 6, 1949, for yields of hay and protein in the hay; the remaining portion was harvested at a later date for seed yield. The severe sodbound condition of the field under study is indicated by small yields of 1,200 pounds hay, 81 pounds of protein and 25 pounds seed per acre from the plots receiving no nitrogen fertilizer. The need for nitrogen and the favorable climatic conditions for growth of bromegrass are illustrated by mean yields of 7,820 pounds of hay, 663 pounds of protein and 545 pounds seed for fall and spring applications of 120 pounds nitrogen as ammonium nitrate.

The order of decreasing effectiveness of four nitrogen carriers applied in the spring at the rate of 120 pounds nitrogen per acre for the production of hay, protein in the hay and seed was as follows: ammonium nitrate, ammonium sulfate, uramon and cyanamid. With all materials fall applications were superior to spring applications for seed production. In contrast, spring applications were superior to fall applications for protein production in the hay. Yields of hay were slightly greater for fall applications of ammonium nitrate, ammonium sulfate, and cyanamid than for spring applications. However, a spring application of uramon was markedly superior to a fall application for the production of hay. It was assumed that the results obtained with uramon were due to an appreciable leaching of the fall-applied carrier.

A comparison was made of the effectiveness of anhydrous ammonia applied at the rate of 60, 120 and 240 pounds per acre in the fall with that of ammonium nitrate applied at the same rates in the fall and spring on the production of hay, protein in the hay and seed by bromegrass. Anhydrous ammonia applied in the fall was slightly less effective than ammonium nitrate applied either in the fall or spring for the production of hay. There was little difference in effectiveness between fall-applied anhydrous ammonia and spring-applied ammonium nitrate on the production of protein in hay although both were superior to fall-applied ammonium nitrate. Seed yields were greatest for fall-applied ammonium nitrate, intermediate for fall-applied anhydrous ammonia, and least for spring-applied ammonium nitrate. The influence of rate of nitrogen was similar for anhydrous ammonia and ammonium nitrate. Mean yields of

hay were 5,730, 7,570, and 8,140 pounds per acre for application of 60, 120 and 240 pounds per acre, respectively. Similarly, mean yields of protein were 448, 665 and 1,057 pounds per acre. Thus, approximately 98, 78 and 65 per cent, respectively, of the 60, 120 and 240 pounds of nitrogen applied was recovered in the hay. Seed yields were 445 and 517 pounds for 60 and 120 pounds of nitrogen, respectively. Lodging was so severe with the 240-pound rate of nitrogen that seed yields were not obtainable. These results are in agreement with the general recommendation of 60 pounds nitrogen for bromegrass seed production in eastern Nebraska. On the basis of the results reported here and those obtained in previous years it seems reasonable to assume that a rate of 100 to 120 pounds of nitrogen per acre will be optimum for forage production on nitrogen deficient bromegrass fields during most years. However, where the bromegrass field is greatly deficient in nitrogen, where the soil moisture supply is favorable, and where there is an interest in obtaining forage of high protein content, rates as high as 200 to 240 pounds per acre may be desirable.

C. W. BOURG, J. J. HANWAY, H. F. RHOADES

Properties of Sandy Soils in Northeastern Nebraska

Considerable difficulty has been encountered in establishing stands of legumes on the sandy soils of the Thurman and Ortello series in northeastern Nebraska. Preliminary results reported in 1948 showed that the organic matter, total nitrogen, and total phosphorus contents of these soils were very low, and the pH values were moderately low. The study was continued and the status of the exchangeable cations was determined.

Cation exchange capacity values of the sandy soils varied from 1.99 to 14.82 m.e./100 grams with most values being less than 6 m.e./100 grams. The exchange complex of most of the soils was about 40 per cent saturated with hydrogen ion. The percentage saturation of the cation exchange complex with calcium ion ranged from 31.8 to 58.3 per cent, with potassium ion from 1.1 to 10.6 per cent, with magnesium ion from 2.9 to 10.7 per cent, and with sodium ion less than 4 per cent. These results suggest that liming should be practiced on most of the Thurman and Ortello soils in northeastern Nebraska to improve the growth of legumes. Since excessive amounts of liming materials applied to these sandy soils are likely to make other nutrient elements unavailable to plants, an application of not more than one ton of limestone per acre is recommended. Although the exchangeable potassium levels in the sandy soils are low compared with other Nebraska soils, they are not low in relation to levels of other nutrient elements. Thus, crop responses to applications of potassium fertilizer are not likely to be obtained until the levels of the other nutrient elements have been raised. Investigators at other experiment stations have shown the need of magnesium fertilizer for alfalfa where the saturation of the clay with magnesium ion is less than 10 per cent. Since many of the sandy soils in northeastern Nebraska are less than 10 per cent saturated with magnesium ion, the use of dolomitic lime or some soluble form of magnesium on these soils may aid in improving legume growth. To obtain further information on the sandy soils, field experiments were established to study the response of alfalfa to applications of dolomitic and calcitic lime and commercial fertilizers.

J. J. HANWAY, H. D. FUEHRING, LEON CHESNIN

Fertilizers for Winter Wheat

Considerable work has been carried on in Nebraska during the past ten years to determine the need for and the benefits that can be expected from the use of commercial fertilizer for winter wheat. This work was continued in 1949 with 14 experiments under the Outstate Testing Project in all sections of Nebraska where winter wheat is a major crop. In addition, the results obtained from current fertilizer studies were correlated with soil properties.

Need for nitrogen, phosphorus and potassium. The following table summarizes fertilizer results for the period 1945-1949 on the Sharpsburg and Marshall, Crete, Hastings, Holdrege, and Keith and Rosebud soils, recognized as the major soils on which wheat is produced in Nebraska.

Fertilizer application * lbs. N-P ₂ O ₅ -K ₂ O	Sharpsburg and Marshall soils (12 expts.)	Crete soils (11 expts.)	Hastings soils (9 expts.)	Holdrege soils (3 expts.)	Keith and Rosebud soils (13 expts.)
Increases in yield due to fertilizer, bushels per acre					
0-30-0	2.2	-0.5	0.6	0.2	0.0
40-0-0	6.9	7.8	10.2	6.1	3.4
40-30-0	11.4	7.8	11.4	7.9	3.3
40-30-30	9.1	7.7	11.8	—	3.9

* Nitrogen fertilizer applied in the spring, phosphorus and potassium fertilizers at planting time.

Consistent yield responses have resulted from nitrogen fertilizer applied in the spring at a rate of 40 pounds of nitrogen per acre in the eastern two-thirds of the State where the increases ranged from 5 to 14 bushels per acre and averaged about 8 bushels per acre. In the western one-third of the State the results from the use of a nitrogen fertilizer for wheat have been less consistent than in the eastern two-thirds. In 1948 and 1949, fall and spring applications of fertilizers were about equally effective for increasing yields. However, in most of the earlier experiments spring treatments were generally superior. Nitrogen carriers with part or all of the nitrogen in the nitrate form have proved more effective for spring application than those carriers containing only the ammonium form of nitrogen; both forms are superior to calcium cyanamid. The urea form of nitrogen was about equally as effective as the nitrate form. In addition to the effects on yield, consistent increases in protein content of the wheat produced have been obtained from nitrogen treatments in recent experiments. This has also been true in the western section of the State where winter wheat is produced after summer fallow. Spring applications were superior to fall applications, and ammonium nitrate was more efficient than ammonium sulfate or calcium cyanamid for increasing protein content of the grain.

To derive optimum returns from nitrogen fertilizer on the Sharpsburg and Marshall soils, phosphorus should also be applied. This was not generally true with the other soil series investigated. It is also apparent that a phosphorus supplement applied alone to soils deficient in both nitrogen and phosphorus is not likely to constitute profitable fertilizer practice; under such circumstances both elements should be supplied. Further, a definite trend toward depression in yield of wheat is evidenced from applications of phosphorus carriers alone to soil definitely deficient in nitrogen but not in phosphorus. Phosphorus fertilization is not likely to increase the protein content of the grain unless the soil is decidedly de-

ficient in phosphorus. Superphosphate (18 to 43 per cent available P_2O_5) is generally recommended for Nebraska conditions; however, there is need for information concerning the value of other phosphorus carriers. For this reason, experiments were initiated in the fall of 1949 to evaluate the more important phosphatic fertilizers on the market under different conditions where phosphorus deficiency is known to exist.

At present potassium fertilizer is not required for wheat grown on the major soils devoted to wheat production. As with phosphorus, there appears to be no advantage to applying potassium fertilizer to soils not deficient in that element. Occasionally yield reductions as well as decreases in protein content of the grain have resulted from applications of potassium fertilizers.

Relation of soil properties to fertilizer response of wheat. In conjunction with the field experiments, laboratory investigations were made on soil samples collected at the experimental sites in 1947, 1948 and 1949. The soil properties determined were and are being further correlated with supplemental nutrient requirements of the wheat crop. The laboratory investigations showed a gradual decline in organic matter and cation exchange capacity, and a progressive increase in pH, soluble phosphorus, percentage base saturation, percentage calcium saturation and percentage potassium saturation in the soils from east to west across the State. Percentage exchangeable magnesium saturation was similar for all soils, and the percentage sodium saturation was very low with all soils. Nitrification rates of the soils were quite low for all series, which explains in part the excellent results which have been obtained from nitrogen fertilization of winter wheat throughout much of the continuously cropped areas as well as some of the dry farming regions where summer fallowing is practiced.

A direct relationship was noted between nitrification rate of the soil and the yield of nonfertilized wheat. A significant inverse correlation existed between nitrification rate and yield increases from nitrogen fertilization. The nitrification rate above which nitrogen fertilizer failed to increase yields was approximately 20 p.p.m. of nitrate nitrogen per four-weeks incubation period. The percentage of soil organic matter could not be correlated with yields or increases in yields from fertilization with a nitrogen fertilizer.

A definite inverse correlation was obtained for the 1948 and 1949 experiments between soluble phosphorus in the soil and yield increases from phosphorus fertilization where nitrogen fertilizer was applied. This was not true where a nitrogen fertilizer was not applied since there was little or no response of wheat to phosphorus when the phosphorus fertilizer was applied alone. The procedure for determining soluble phosphorus was essentially that employed by the Nebraska Soil Testing Laboratory. With this procedure, the amount of soluble phosphorus in the soil above which phosphorus fertilization failed to increase yields was approximately 0.47 p.p.m. of phosphorus.

Laboratory determinations confirm field results with respect to potassium fertilizer in that large amounts of exchangeable potassium occurred in all of the soil series studied, ranging from 1.3 to 2.0 m.e./100 grams in the surface horizons. Even the smallest value of exchangeable potassium represents a large amount of available potassium in the soil.

R. A. OLSON, R. E. LUEBS, T. PANALAKS, A. F. DREIER

Lime and Commercial Fertilizers for Sweetclover

An experimental program has been in progress since 1948 to determine the value of lime and commercial fertilizers for legumes in Nebraska. As a part of this program a few preliminary investigations were conducted to study (1) the effects of lime and commercial fertilizers on the yield and nitrogen content of the tops and roots of biennial sweetclover and (2) the relationship between the amount of first year's growth of biennial sweetclover and the yield and nitrogen content of the second year's growth. These studies were made at the Agronomy Farm, Lincoln, on a moderately acid Sharpsburg silty clay loam which is typical of much of the upland soil of southeastern Nebraska and in Merrick County on an acid Cass loamy fine sand.

Lime for sweetclover on Sharpsburg silty clay loam. A group of plots being conducted at the Agronomy Farm, Lincoln, by the Soil Conservation Service—Research Division, were available to study the effects of lime applications under different conditions on both the first and second year's growth of biennial sweetclover.

Sweetclover had been seeded in April, 1948, with and without a companion crop on limed and unlimed plots in two adjacent fields. A larger production of sweetclover and a greater amount of total nitrogen in the sweetclover was obtained on one of the fields where corn was grown the preceding year than on the other field where small grain was the preceding crop and weeds came up to compete with the sweetclover. Sweetclover seeded with a companion crop produced less growth the first year and contained less nitrogen than where it was seeded alone. An application of lime markedly increased the yield and total nitrogen in sweetclover where seeded with a companion crop, but had no effect where the sweetclover was seeded alone.

Two other adjacent fields had been seeded to sweetclover in 1947. One field consisting of limed and unlimed plots had produced a poor first-year growth of sweetclover. The other field, which was limed, had produced a good growth the first year. Sweetclover that had made a good first-year growth made even better growth the second year and on June 11 contained 129 pounds of nitrogen per acre compared with 80 pounds of nitrogen per acre where the sweetclover had made a poor first-year growth.

The second year's growth of sweetclover consisted essentially of an increase in tops with no appreciable change in the weight of roots. The percentage nitrogen in the roots was reduced from 3 to 4 per cent on April 3 prior to initiation of top growth to about 1 per cent on June 11 when the plants were in full bloom. The total amount of nitrogen in the sweetclover increased considerably during the second year's growth, since the roots on April 3 contained only one-third to one-half as much nitrogen as was present in the mature crop on June 11.

Lime stimulated early spring growth and nitrogen content in the second-year sweetclover, but had no effect on the yield and nitrogen content of the mature crop. Yield and nitrogen content of the sweetclover on the limed plots was considerably higher by May 18 than on the unlimed plots. The nitrogen content of the sweetclover on the limed plots did not increase between May 18 and June 11 even though the weight of plants continued to increase during that period. However, on the unlimed plots both weight of plants and nitrogen content continued to increase and by June 11 were equal to those of the limed plots.

Lime and commercial fertilizers for clovers on an acid Cass loamy fine sand. On an acid Cass soil in Merrick County in 1949 lime applied for a seeding of a mixture of sweetclover and red clover increased the yield of first-year sweetclover from 820 pounds per acre on the untreated plots to 1,460 pounds per acre on the limed plots. The amount of nitrogen in the sweetclover tops was increased from 25 pounds per acre on the untreated plots to 39 pounds per acre on the limed plots. On the basis of the results obtained at the Agronomy Farm in 1948 the roots would be similar to the tops in yield and nitrogen content. Lime had no effect on the yield or nitrogen content of the red clover in the mixture. Applications of phosphate fertilizers had no effect on the yields of the clovers, probably because manure had been applied to the field several times in recent years.

J. J. HANWAY

Nitrogen Maintenance in Sharpsburg Silty Clay Loam Soil

An experiment has been in progress on Sharpsburg silty clay loam at the Agronomy Farm, Lincoln, since 1946 to determine the effects of bromegrass, alfalfa, sweetclover, legume-grass mixtures, and commercial nitrogen fertilizer on soil nitrogen maintenance as measured by crop yields, by crop composition, and by soil composition. The cropping system adopted in the investigation included corn, oats and wheat to partially measure the effects of grasses, legumes, and legume-grass mixtures.

As a part of the investigation, a rotation of corn, oats and wheat without a legume or nitrogen fertilizer was compared with a similar rotation in which each crop was fertilized with 40 pounds of nitrogen per acre. Applications of phosphate were made for the oats and wheat. The results for the period 1946 to 1949 have been summarized. Mean yields without nitrogen for the four-year period were 52.5 bushels of corn, 47.5 bushels of oats, and 32.1 bushels of wheat per acre. Mean increases in yield due to the application of a nitrogen fertilizer were 5.7, 8.2, and 4.1 bushels per acre for corn, oats and wheat, respectively. Protein percentages in the grain were increased from 10.7 to 11.2 per cent for corn, from 14.5 to 15.1 per cent for oats, and from 12.9 to 14.2 per cent for wheat.

In connection with the investigation of the effects of forage crops for three- and six-year periods on soil properties and the yields of corn, oats and wheat, yields have been obtained of bromegrass with and without nitrogen, mixtures of bromegrass with sweetclover or alfalfa, and alfalfa. Blanket applications of lime and phosphate were made to these plots to obtain the maximum benefit from the legumes in the cropping systems, as it is known that Sharpsburg silty clay loam soil is deficient in calcium and phosphorus. In 1946, the first year of establishment of the plots, the grasses, legumes and legume-grass mixtures were clipped and the material was left on the surface of the ground. Mean yields for the period 1947 to 1949 are reported here. Bromegrass with no nitrogen fertilizer produced 1.1 tons hay and 140 pounds protein per acre. Where 40 pounds of nitrogen per acre was applied each year to bromegrass, yields of 2.8 tons hay and 418 pounds protein per acre were obtained. A mixture of bromegrass with sweetclover produced 2.2 tons of hay and 378 pounds of protein per acre. There was considerable sweetclover in the mixture in 1947 but relatively little in 1948 and 1949 even though it had been reseeded in the bromegrass sod. A pure stand of alfalfa and a mixture of alfalfa and bromegrass produced the same yield of 5.3 tons hay per

acre. As would be expected, alfalfa was somewhat superior to the mixture for the production of protein, mean yields of protein being 1,658 and 1,465 pounds per acre, respectively. Changes in organic matter and nitrogen contents of the soil as influenced by the various practices will be measured in soil samples taken in 1946, 1949, and at later dates.

W. E. LYNES, LEON CHESNIN

Influence of Irrigation Practice, Seeding Rate and Fertilizer Application on the Production of Safflower

Because of the increased interest in the production of safflower under irrigation in western Nebraska it seemed desirable to obtain some information on the interrelationships of irrigation practice, seeding rate and fertilizer application upon the yield of safflower seed. Accordingly, a factorial experiment with safflower including two irrigation practices, three seeding rates, and five fertilizer treatments was conducted at the Scottsbluff Substation in 1949. One irrigation practice included two irrigations; the first application of water was made when the plants began to show drouth distress or approximately two weeks prior to blooming and the second application of water was made two weeks after blooming. The other irrigation practice included five irrigations, each application of water being made two to five days after the mercury reached 500 mm. in tensiometers placed at a depth of six inches. The three planting rates were 15, 25 and 35 pounds of seed per acre. The fertilizer treatments were: (1) none, (2) 40 pounds nitrogen as ammonium nitrate, (3) 160 pounds P_2O_5 as treble superphosphate, (4) 40 pounds nitrogen plus 160 pounds P_2O_5 , and (5) 80 pounds nitrogen plus 160 pounds P_2O_5 . The fertilizers were applied to the surface of the soil and plowed under.

Neither irrigation practice nor fertilizer application had an effect upon safflower seed yields although there appeared to be differences in growth of safflower plants due to irrigation practice. Planting rate did not significantly influence yields of safflower seed although the seeding rate of 25 pounds per acre was generally superior to the other two seeding rates. Yields of safflower seed were 1,751, 1,922 and 1,790 pounds per acre for planting rates of 15, 25 and 35 pounds seed per acre, respectively.

O. W. HOWE, H. F. RHOADES

Cultural Experiments with Sugar Beets

Length of growing season is a factor which influences the production of sugar beets in western Nebraska. Short growing seasons have limited sugar beet production on soils of high productivity where the crop has been grown with the best cultural methods. Under these conditions the sugar beet plants have been unable to respond to abundant fertility and good culture because of the limited time for growth. Opportunities for extending the growing season in the fall are rare. However, experience and observation indicate possibilities for taking greater advantage of favorable weather in the spring by proper irrigation and planting.

A study was initiated at the Scottsbluff Substation in 1948 to determine the possibilities of increasing the yields of sugar beets by irrigation for emergence and by the use of the ridge-cover method of planting at different planting dates. The use of the ridge-cover method of planting and of irrigation for emergence have the same objective of providing adequate moisture for germination immediately after the seed is planted. During 1948 sugar beets were planted April 3 (early), April 18 (medium), and May 2 (late). During 1949 the three planting dates were March 26

(early), April 12 (medium), and May 2 (late). Two methods of planting were used at each planting date: (a) surface or regular planting of sugar beets, and (b) surface planting with a ridge cover. Irrigation for emergence was practiced on one-half of the plots in each planting method at each planting date.

In 1948 a marked decline in yield of sugar beets occurred with a delay in planting date where the sugar beets were irrigated for emergence. However, where the sugar beets were not irrigated for emergence differences in yield due to planting date were small. In contrast to the results obtained in 1948, yields of sugar beets in 1949 for the medium and late planting dates were significantly higher than the yields of sugar beets planted March 26. The latter results were due in a large measure to frost injury to the early planted sugar beets as they emerged.

Irrigation at planting of sugar beets compared with no irrigation at planting in 1948 resulted in a large increase in yield at the early planting date, a moderate increase in yield at the medium planting date, and no increase in yield at the late planting date. In 1949, however, irrigation for emergence at the early planting date resulted in a significant decrease in yield of surface planted sugar beets and a small but nonsignificant increase in yield of sugar beets planted with the ridge-cover method. These contrasting results for irrigation at planting in 1949 were attributed to differences in stand which were a consequence of the variable effect of planting method and irrigation practice upon frost damage. The influences of irrigation for emergence on yields of sugar beets at the medium and late planting dates were similar in 1948 and 1949.

Essentially the same yields of sugar beets were obtained for the ridge-cover and surface methods of planting in 1948. That was also true in 1949 where irrigation was practiced at planting. However, where irrigation was not practiced at planting in 1949, the surface method of planting was distinctly superior to the ridge-cover method.

LIONEL HARRIS, F. V. PUMPHREY, H. F. RHOADES

Fertilizers for Potatoes Following Bromegrass Pasture

An experiment to determine the influence of nitrogen, phosphorus and potassium fertilizers on the production of Progress potatoes was conducted at the Scottsbluff Substation on a field plowed from bromegrass sod that had been pastured by dairy cattle for 11 years. The pasture originally contained alfalfa and sweetclover as well as bromegrass but after nine years of pasturing the legumes had entirely disappeared and the bromegrass was sod-bound. Because of that sod-bound condition, emphasis was placed upon applications of nitrogen fertilizer.

In early July differences in color of the foliage due to fertilizer application were evident. By the middle of August the intensity of green color of the foliage and the extent of vine growth varied directly with the amount of nitrogen applied, the foliage on the unfertilized plots being light green in color. Even though there were marked differences in color of foliage and vine growth due to fertilizer application, differences in yields of tubers due to treatment were relatively small. The unfertilized plots produced 560 bushels of tubers per acre with 460 bushels per acre grading U. S. No. 1. Small but significant increases of 30 bushels per acre in total yield of tubers and 40 bushels per acre in yield of U. S. No. 1 tubers were obtained for an application of 80 pounds nitrogen per acre applied as ammonium nitrate. An application of 160 pounds nitrogen per

acre had no significant effect upon yields while an application of 320 pounds nitrogen per acre reduced yields significantly. Phosphorus and potassium fertilizers had no significant effects upon yields of tubers. Under the conditions of this experiment the soil was sufficiently supplied with available nitrogen to produce a large yield of tubers even though there were symptoms of nitrogen deficiency in the foliage. It seems likely that the nature of the residues accumulated in the soil under pasture management and the favorable season of the year for organic matter decomposition contributed to the formation of an adequate supply of available nitrogen in the soil for tuber production.

F. V. PUMPHREY, LIONEL HARRIS

Influence of Irrigation Practice, Plant Population and Fertilizer Application on the Yield of Corn

An experiment was conducted at the Scottsbluff Substation to obtain information on the influence of soil moisture level, plant population and fertilizer application on the yield of corn. It was planned to have three moisture levels but because of seasonal conditions the low and medium moisture levels were nearly identical. In the experiment, the low moisture level received irrigations on July 5, August 1 and August 30; the medium moisture level received irrigations on July 5, August 1 and August 23; and the high moisture level received irrigations on July 5, July 23, August 6 and August 19. Tensiometers and gypsum blocks were used for indicating the soil moisture levels at which irrigation water was applied. Three plant populations were obtained by thinning to one plant per foot of row in rows spaced 36, 28 and 20 inches apart. Seven fertilizer and manure treatments with and without a phosphorus fertilizer were as follows: (1) none, (2) 40 pounds nitrogen, (3) 80 pounds nitrogen, (4) 160 pounds nitrogen, (5) 320 pounds nitrogen, (6) 25 tons manure, and (7) 25 tons manure plus 160 pounds nitrogen. Ammonium nitrate and superphosphate (43 per cent P_2O_5) were used to supply nitrogen and phosphorus. All fertilizers were broadcast on the surface of the soil and plowed under except that one-half the nitrogen fertilizer in the treatment receiving 320 pounds nitrogen was applied as a side dressing at the last cultivation.

There was a highly significant effect of irrigation practice on yields of corn. Mean yields of 130, 131 and 140 bushels of corn per acre were obtained with the low, medium and high moisture levels, respectively. The influence of moisture level on yields was more pronounced with the 20-inch rows than with the 28- and 36-inch rows. The maximum effect of moisture level was obtained in the 20-inch rows where an application of 25 tons manure plus 160 pounds nitrogen was plowed under, the yields being 129, 132 and 158 bushels per acre with the low, medium and high moisture levels, respectively.

There was a highly significant effect of plant population on the yield of corn obtained by different row spacings. Mean yields of 126, 138 and 137 bushels per acre of corn were obtained with row spacings of 36, 28 and 20 inches, respectively. However, where the high moisture level was maintained the yields were 132, 140 and 147 bushels per acre for the three spacings. The maximum effect of plant population was obtained with the high moisture level where 25 tons manure plus 160 pounds of nitrogen was applied, the mean yields being 134, 144 and 158 bushels per acre for row spacings of 36, 28 and 20 inches, respectively. Although the yields were higher in the 20-inch rows under conditions of high moisture and

high fertility, the stalks were weak and the ears were small. By harvest time more than one-half the stalks were lodged. The corn in the 28- and 36-inch rows did not lodge.

The response of corn to applications of fertilizer was definitely influenced by the irrigation practice and by the plant population. There was no response of corn planted in 36-inch rows to fertilizer application when a low moisture supply was maintained in the soil. On the other hand, the maximum effects of fertilizer application on corn yields were obtained with corn planted in 20-inch rows where the moisture content of the soil was maintained at a high level.

O. W. HOWE, H. F. RHOADES

Commercial Fertilizers for Native Meadows

An experiment designed to study the response of native meadows to applications of nitrogen, phosphorus and potassium fertilizers was conducted at locations in Logan and Lincoln Counties by the North Platte Substation in cooperation with the Agronomy Department. The eight fertilizer treatments included two rates of nitrogen (0 and 60 pounds N per acre), two rates of phosphorus (0 and 40 pounds P_2O_5 per acre) and two rates of potassium (0 and 40 pounds K_2O per acre) applied in all possible combinations. Nitrogen was applied as ammonium nitrate, phosphorus as superphosphate (43 per cent P_2O_5), and potassium as potassium chloride.

There was no significant response of native grass to applications of fertilizers to Cass loamy fine sand in the South Loup Valley of Logan County. This result may have been due to the relatively wet condition of the soil that persisted throughout the growing season.

Fertilizer applications to a meadow on Lamoure very fine sandy loam in the South Platte Valley of Lincoln County influenced the yield of grasses and legumes significantly. The grasses consisted of big bluestem, Indian grass, and switchgrass as codominants; Canada wildrye, western wheatgrass, blue grama and saltgrass occurred as scattered colonies. The legumes included first- and second-year sweetclover, prairie clover and silver-leaf psoralea. There was a marked increase in yield of grasses and a small decrease in yield of legumes due to the application of 60 pounds of nitrogen per acre. In contrast, an application of a phosphorus fertilizer increased the yield of legumes markedly and had either no effect or only a small effect upon the yield of grasses. Where the phosphorus fertilizer was applied without a nitrogen fertilizer the yield of grasses was not influenced. However, where the phosphorus fertilizer was applied with a nitrogen fertilizer there was a small but significant increase in yield of grasses due to phosphorus. Potassium fertilizer had no significant effect upon the yield of either grasses or legumes.

PAUL EHLERS, ROBERT RAMIG, GLENN VIEHMEYER

Reclamation of Seeped and Alkaline Soils

Studies were started on the reclamation of seeped and alkaline soils at the North Platte Substation. Completion of a drainage ditch set up satisfactory conditions for the study of the effect of lowering water levels, changes in salt content and physical condition of the soils. Piezometer tubes and a continuous recording gauge were installed. Water-level readings were made weekly during the summer and monthly thereafter.

R. E. RAMIG, FRED HAMILTON, A. P. MAZURAK, MILTON GREENWOOD

Field Crops Research

Department of Agronomy, Scottsbluff and North Platte Experiment
Substations, and Box Butte Experiment Farm

A Half Century of Crops Research

It is very fitting at this midpoint of the Century to make note of what has been accomplished agronomically along the lines of crop improvement and crop production practices. In 1900 no crops were being grown on Nebraska farms that had undergone improvement by modern plant-breeding procedure. The science of genetics and its application in the breeding of crop plants was then in its very infancy. Technics for the comparative evaluation of crop varieties and cultural practices were crude and little understood. The State's agriculture was young and the crops under production were introduced from more easterly states with more favorable climatic conditions or were unimproved importations from Europe and Asia. At that time common Kherson oats had just been introduced from Russia. Ordinary Turkey winter wheat had been brought to the State from Russia only a few years before and was rapidly replacing the late ripening and poorly adapted spring wheat. Common rye and Common Six-row barley were available. Timothy, red clover, alfalfa, cane, and the millets supplemented the native meadows. Few determinations had been made regarding the best field management for raising these crops.

At the end of this period, today, the story is very different. The adaptation requirements and breeding behavior of the various crops is well understood, and through hybridization and selection marked plant breeding results have been achieved. Eighty-five per cent of Nebraska's winter wheat acreage is planted to Pawnee, Cheyenne, and Nebred varieties, all originating in experiment station plant breeding nurseries. Ninety-five per cent of the State's oats and barley have had a similar origin. Ninety-six per cent of the corn acreage was grown to hybrids between inbred lines in 1949, whereas this manner of corn breeding was not even known at the beginning of the period. Only one acre in a thousand of corn was planted to hybrid seed by 1933. Sweetclover has been domesticated since 1910 and superior varieties have been developed. Sudan grass was first introduced from Africa by the U. S. Department of Agriculture in about 1909 and now it is extensively grown as a temporary pasture and forage crop. Safflower has been introduced from India, and improved varieties have recently been distributed in western Nebraska where the crop is adapted for oil production. Lodge resistant, early maturing, shatter resistant, high yielding varieties of grain sorghum suitable as "combine types" for Nebraska have been bred and made generally available. More productive varieties of soybeans, forage sorghum, brome-grass, alfalfa, and better perennial grasses for pasture meadow and permanent waterways are in use. Many of these crops are not only superior as to yield, but also as to other important agronomic characteristics.

The virtues of such an improvement program are readily recognized by a 35 per cent grain-yield superiority of Pawnee wheat over the original Turkey, 50 per cent superiority of Nemaha oats over the original Kherson, and 20 per cent gain of standard corn hybrids over the better original open-pollinated varieties of corn. Although the underlying crops research

may have cost the State nearly a million dollars in the aggregate over the 50 years, the annual increased returns to the farmers of the State are now estimated at 90 million dollars at current prices. An appraisal of new breeding stocks currently growing in the Station nurseries discloses that materially better varieties are still in the making. It is important that the breeding program keep abreast with changing conditions as, for example, new plant diseases and insects appear from time to time, as well as new races of the old insects and disease organisms. These crop breeding results are made highly effective through the Outstate Testing Project by means of which new creations may be compared regionally with established varieties under farm conditions throughout the State. In addition, as soon as the superiority of new varieties becomes established, seed supplies of known identity are made available rapidly for farm use by the Foundation Seed Project in cooperation with the certified seed activities of farmers themselves.

In addition to the development of all these new superior varieties, valuable information has been acquired as to the best cultural practices for growing the various crops. These may be illustrated by the early and thorough seedbed preparation for winter wheat, timely planting, seed treatment for control of certain plant diseases, thorough weed control by tillage and chemical herbicides, and manner of establishing stands of small-seeded legumes and grasses. The growth and nutrition of crop plants has also come to be much better understood, and recommendations for profitable crop rotations, fertilizer applications, soil conservation, and irrigation are made as a result of the soils and crop research.

Many exploited crops and practices that have been tested were found unprofitable and farmers have been advised against their use. This has prevented much disappointment and needless expense.

These agronomic investigations have benefited by collaboration with other departments and substations of this Experiment Station, other state agricultural experiment stations, the U. S. Department of Agriculture, the Nebraska Crop Improvement Association, the Nebraska Grain Improvement Association, the Nebraska Certified Hybrid Seed Corn Growers Association, and many individual farmers.

T. A. KIESELBACH

Improvement of Small Grains

Investigations concerning the improvement of wheat, oats, and barley are cooperative with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. They are closely coordinated on a state-wide basis by the project leaders at Lincoln.

The scope of activities during the current year included variety tests with these crops, breeding experiments aimed toward the development of more productive and dependable varieties, and related research. Barley and oats were studied both on dry land and under irrigation. In this work new and old local varieties and selections were compared with those developed in nearby states. Superior strains, irrespective of origin, are tested widely for several years to determine whether they merit release for commercial production. In the current season about 20,000 plots were observed in the various stages of the program. In 1949 many strains were "about as good" as established varieties, but of course this is not good enough. It is believed that a few superior selections were discovered but

only repeated tests will establish this. A number of significant developments and facts about the small grains in Nebraska are reported here.

Winter wheat. The recommended varieties did well in 1949 tests in their respective areas of adaptation except that all wheat winterkilled rather badly in parts of eastern Nebraska. At Lincoln, Pawnee was the highest yielding named variety. Minter, which survived best, yielded 3.2 bushels to the acre less than Pawnee. Among varieties compared 10 or more years, Pawnee, Cheyenne and Comanche are outstanding at Lincoln, especially Pawnee which has surpassed Kharkof and Turkey by about 35 per cent. Comanche was added this year to the list of recommended varieties for the southern two tiers of counties bordering Kansas, west of U. S. Highway 81.

At Alliance, Cheyenne, Pawnee, and Wichita were the high-yielding named varieties in 1949. In 12 years of testing, Cheyenne has surpassed the Kharkof check by 5.6 bushels to the acre and hence is deserving of its popularity with farmers in that area. Over the years, Pawnee and Wichita have been less productive here than Cheyenne.

According to a state-wide survey, farmers planted Pawnee on 32.9 per cent of the State's acreage in the fall of 1948, 26 per cent was planted to Nebred, and 24.6 per cent to Cheyenne. Thus, these three varieties constituted 83.5 per cent of the Nebraska wheat acreage in that season. All were developed by the Nebraska Agricultural Experiment Station in cooperative experiments.

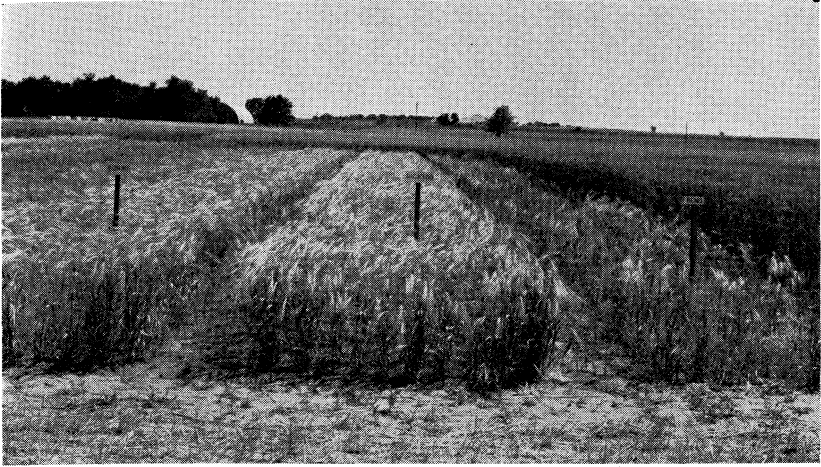
Spring wheat. Mida is the leading spring wheat variety grown commercially in northwestern Nebraska. It continued to perform satisfactorily in 1949 in tests on fallow land at Alliance where it yielded 25 bushels to the acre. During the last five years it has averaged 27.8 bushels to the acre compared with 21.5 for Marquis and 24.8 for Thatcher. Adverse weather and harmful insects caused very low yields at Lincoln and North Platte.

Barley. Frontier, a new barley variety named and distributed by the Wyoming Agricultural Experiment Station, was placed on the list of Nebraska certified varieties this year. It is recommended only for the irrigated sections in the western counties where its average yields are equal to those of Trebi. Frontier has stiffer straw than Trebi. This is a very desirable character in an irrigated area where small grain frequently is grown as a companion crop with alfalfa. The new variety appears resistant to loose smut under field conditions but is susceptible when artificially inoculated.

Plains and Feebar, recommended for general distribution in 1947, continued to be among the more productive varieties included in most tests across the State. Only one grower of Plains applied for seed certification in 1949 and no fields of Feebar were inspected. These two varieties are superior to Velvon 11 and Ezond for combine harvesting and merit a wider distribution within the State.

Two new selections, Velvon B.C. 4-51 and Velvon B.C. 4-68, are being increased as possible replacements for Velvon 11 and Ezond. These selections have the desirable characteristics of those two older varieties and in addition are stiffer strawed and the awns break off more readily in threshing.

Barley yields at Lincoln this year were fair but the grain quality was poor. Plains ranked first in yield and Feebar and Velvon 11 ranked seventh and eighth. In recent years at Lincoln the average yields of Feebar, Plains, Spartan, and Velvon 11 have been 32, 29, 9, and 9 per



Winter barley variety plots. Reno, right, one of the best varieties now available, nearly all winterkilled. The two experimental varieties at left showed good survival. Agronomy Farm, Lincoln.

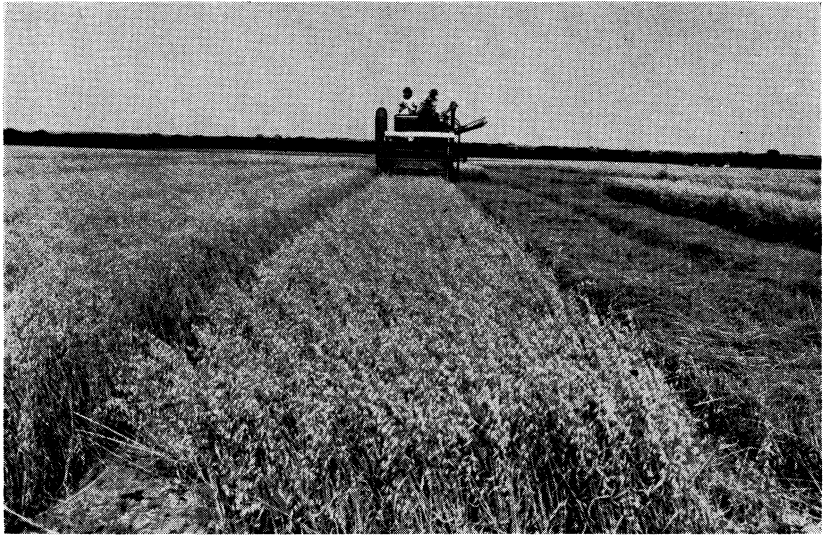
cent above that of Trebi. Trebi is the leading variety at North Platte and Alliance.

Greater emphasis is being given to the development of superior barley varieties for the irrigated sections in western Nebraska where barley is the major grain crop. Several productive, stiff strawed selections are being tested at the Scottsbluff Substation. Trebi and Velvon 11 are the principal varieties now being grown in this area.

Several of the varieties tested this year on the Box Butte Experiment Farm at Alliance averaged over 50 bushels per acre after fallow. Velvon 11 and Gem were among the highest yielding varieties. For a 12-year period Trebi ranks first in average yield, followed by Ezond, Club Mariout, and Spartan.

The winter barley nurseries at Lincoln and North Platte were not harvested because of nearly complete winterkilling. This is the third year in the past nine that winter barley was not harvested at Lincoln because of severe winter injury. Reno and Ward continue to be recommended for those areas of the State where winter barley has been successfully grown in past years. Selections which have more hardiness than Reno and Ward are being investigated.

Oats. The productivity of oats has been raised greatly in Nebraska in recent years by the breeding, testing, and distribution of new varieties. A total of nine varieties are now being recommended on a regional basis and it is important that varietal choice be based on these recommendations. In eastern Nebraska, Nemaha, Cherokee, and Clinton are especially recommended, with Mindo and Marion in addition in the northeast. Marion is included in this list for the first time this year. Since 1945 it has yielded about the same as Clinton, is resistant to smut and victoria blight, and tolerant to crown rust. It has a tendency to lodge when grown on rich, bottom soil. In central and south-central Nebraska the preferred varieties are Bruncker, Osage, Otoe, and Cedar. Bruncker is most highly



Harvesting oat variety plots on Agronomy Farm, Lincoln. This work is greatly facilitated by use of a self-propelled combine.

recommended for the north-central area, whereas Osage and Brunker are outstanding in the far west and southwest.

A new race of crown rust attacked oats in 1949 causing varieties such as Clinton and other Bond derivatives, formerly considered highly resistant, to appear susceptible to this disease. Nemaha, Cherokee, and Marion showed some tolerance to this new race and gave relatively better yields than Clinton. Cedar and Osage were highly resistant but victoria blight attacked these varieties, damaging them as far west as North Platte. New selections of hybrid origin were observed to have resistance to both diseases in breeding nurseries.

L. P. REITZ, O. J. WEBSTER, T. A. KIESSELBACH

Small Grain Varietal Tests at North Platte

Varieties of winter wheat, oats, and barley were tested in replicated 1/50-acre plots on fallowed land at the North Platte Substation. Varieties of spring wheat and winter barley were tested in nursery plantings, also on fallowed land. Varieties of oats were also grown in a nursery under irrigation. No results were obtained for spring wheat because of severe aphid damage.

Winter wheat. The winter wheat tests included 17 varieties. The surface soil was dry at seeding time, resulting in uneven and late emergence in the drier spots. Final stands were incomplete and a cause of considerable yield reduction but this was not highly variable between varieties. Some damage was done by aphids and Hessian fly. Leaf rust infection was heavy and stem rust light on susceptible varieties.

Yields ranged from 25.5 to 17.4 bushels per acre. Top yields of 25.5 and 25.1 bushels were made by the two experimental strains of hybrid origin, C. I. 12128 and 12500, grown in the field plots for the second year.

The first is highly resistant to leaf rust but showed moderate susceptibility to stem rust. The second was infected more heavily with leaf rust but was free of stem rust. Pawnee with 24.8 bushels was third in yield for both 1949 and the 1948-1949 average. Red Chief, with a yield of 23.1 bushels, ranked fifth for 1949 and ninth for 1948-1949. During the last six years its average yield has been 2.7 bushels below that of Pawnee. The two varieties that are most extensively grown in central and western Nebraska, Nebred and Cheyenne, yielded 21.5 and 19.6 bushels, respectively, while Turkey, used as the long-time standard of comparison, was third from the bottom with a 1949 yield of 18.5 bushels. Comanche matches Pawnee in earliness and stem rust resistance but has averaged lower in yield.

Oat varietal test on dry land. There was considerable unevenness in early growth but under the favorable moisture conditions of 1949 this was largely overcome before the crop matured. In spite of some injury by aphids and the rusts, the general level of yields was high. Victoria blight was identified at the Station for the first time and became an important factor in reducing the yield of the susceptible varieties Neosho, Cedar, Osage, and Ventura. Because of this handicap these varieties which ranked among the five highest in yield in 1948 dropped to 7th, 8th, 14th, and 17th places in 1949. Their further value will depend upon the future prevalence of this disease.

An experimental selection (C. I. 4673), grown for the first time in field plots, made the highest yield of the test, 72.8 bushels. It has high resistance to stem and crown rust and with other selections from the same cross has made good yields in nursery tests. Cherokee, Clinton, and Nemaha yielded 69.7, 66.6, and 65.9 bushels. Fulton, in third place this year, has ranked first in yield among five varieties compared for 10 years. It is early in maturity but is susceptible to both stem and crown rust. Kanota, Otoe, and Brunner, with yields of 60.6, 58.4, and 50.6 bushels, occupy 6th, 11th, and 15th rank in the 1949 test. All are rather susceptible to stem and crown rust and Brunner has weak straw. They have made their best showing in comparison with other varieties in years when moisture was the chief limiting factor in determining yield and on that account are still recommended among varieties suitable for dry-land planting.

Oat varietal test under irrigation. In this irrigated nursery yields ranged lower than for the previous two years. Straw growth was heavier, lodging more prevalent, rust infection higher, and yields no better than on dry land. The top yield of 72.8 bushels was made by Ajax and the next best by Andrew with 69.4 bushels. Andrew ranked first in 1948 and also holds first place for the 1947-1949 average. In comparison, the productive eastern Nebraska varieties, Nemaha, Cherokee, and Clinton, yielded 58.2, 55.7, and 54.3 bushels, respectively. Brunner yielded 52.1 bushels, and its heavy lodging would have made machine harvesting difficult.

Barley. Twelve varieties of spring barley were included in the 1949 test. As with oats, unfavorable early growing conditions resulted in spotted growth. This was later overcome and yields were high in comparison with those of other years. The range was from 63.9 to 39.2 bushels and the mean was 49.9 bushels. The high yield of 63.9 bushels was made by a new selection designated as Velvon B.C. 4-51. This has been the top yielding entry in nursery tests in both 1948 and 1949 with an average yield of 191 per cent of the Spartan check. Trebi was in second place in 1949

with a yield of 55.4 bushels. This variety holds the top long-time average yield record for the North Platte Substation, being at the head of all varieties tested since 1931. Feebar, Plains, and Velvon 11 yielded 53.7, 50.8, and 48.5 bushels, respectively.

The winter survival of varieties of winter barley was so poor in the 1949 test that no attempt was made to obtain yield records. Survival was 10 per cent or less for 33 of the 66 varieties tested. This is better than the outcome at Lincoln. Only two entries, Purdue 1101 and Nebraska 412490, gave stands greater than 50 per cent in both locations. Survival percentages of varieties at Lincoln and North Platte were: Ludwig 28 and 77; Dicktoo 34 and 72; Reno 2 and 50; Ward 2 and 26.

L. L. ZOOK, R. E. RAMIG, M. J. GREENWOOD, L. P. REITZ, O. J. WEBSTER

Time and Rate of Planting Oats

With a nearly complete turnover in the varieties of oats grown in eastern Nebraska during the last six years, it has seemed desirable to determine whether the newer sorts have the same optimum requirements as to time and rate of planting as did their predecessors. Accordingly, two prominent recently introduced varieties, Clinton and Nemaha, have been tested at Lincoln at three planting rates for each of three planting dates. As an average for the two years, 1948 and 1949, drilling 6, 8, and 10 pecks of Clinton seed per acre yielded 41.3, 43, and 44.4 bushels. Nemaha gave the corresponding yields of 39.5, 44, and 44 bushels. These comparative results are similar to those for other varieties tested in earlier years. Six pecks of seed is evidently too thin for maximum yield. The small reduction is not considered serious, however, when this reduced rate is sown as a companion crop for seeding sweetclover. Normally, a half bushel more seed should be sown per acre if broadcast than if drilled because of less uniform germination. Low yields may result from thin stands because of inadequate seed covering if the seedbed is poorly prepared on corn-stalk land. Careful attention should be given to proper covering of the seed with the grain drill.

The great disadvantage of very late planting, near the end of April, is clearly indicated. On the other hand, the maximum yields of both varieties were obtained from midseason rather than from early planting. This is contrary to results from former varieties in earlier years. The two-year average yields for Clinton planted April 4, April 15, and April 26 were 46.2, 48.9, and 33.6 bushels per acre, respectively. Corresponding yields for Nemaha were 43.4, 48.6, and 35.4 bushels. The cold wet spring of 1948 was especially unfavorable for the early crop. On the basis of long-time results with oats in general, planting as early in the spring after about March 20 as conditions permit is regarded as good practice.

W. E. LYNESS, T. A. KIESSELBACH

Dry-Land Crop Rotations at North Platte

Cropping conditions in 1949 were especially unfavorable for small grains in these rotation experiments at the North Platte Substation. Poor stands of winter wheat were caused by dry seedbeds in the previous fall, and cold wet weather in spring resulted in nitrate deficiency, serious root diseases, heavy weed competition, and severe aphid damage to retarded small grains. As a result the small grain yields in these rotations were the lowest of record for any year with above-normal precipitation and without hail damage.

Cropping practices and crop yields. Average yields in bushels per acre in 1949 on cropped land and fallow were: winter wheat 5.1 and 18.8; spring wheat 4.2 and 3.2; oats 29.9 and 40.2; barley 11.2 and 20.3; corn 40.7 and 34.6; early kalo 45.5 and 55.4; potatoes 96.2 and 119. Winter wheat after corn was a near failure with an average yield of only 2.1 bushels. After potatoes its stands were somewhat better and the average yield was 8.3 bushels. Tillage preparations for potatoes were reflected in the yield of wheat following potatoes. With fallow, corn and wheat preceding potatoes, wheat yields after the potatoes were 11.7, 5.6, and 8 bushels, respectively.

Winter wheat yields following corn grown in 40-, 80-, and 120-inch rows were 2, 3.6, and 5.6 bushels in comparison with averages for the previous 12 years of 14, 18.6, and 9.5 bushels. Corn yields in rows of these spacings were 36.6, 27.3, and 15.3 bushels in comparison with 12-year averages of 16.8, 13.9, and 10 bushels. Yields of early kalo and winter wheat grown in a two-year rotation were 59 and 2.8 bushels in comparison with averages for the previous 12 years of 21.3 and 11.7 bushels. In a four-year rotation with a year of fallow preceding each crop, yields were 59 and 12.5 bushels in comparison with averages for the previous 12 years of 36.1 and 29 bushels.

Potato yields after fallow, corn and wheat were, respectively, 119, 86.2, and 106.1 bushels in comparison with averages for the previous 12 years of 29.9, 88.8, and 107.7 bushels. Of the spring grains, aphid injury was most severe on spring wheat, intermediate on barley, and least on oats. Damage was less severe after fall than spring plowing. Average yields on fall and spring plowing were 6.7 and 2.2 bushels for spring wheat; 14.6 and 6.1 for barley, and 39.7 and 17.8 for oats.

Soil fertility and crop yield. The above-normal moisture supply permitted differences in soil fertility resulting from use of barnyard and green manures to show more than usual effects on crop yield. In companion three-year rotations of corn, spring wheat, and oats, barnyard manure is applied previous to plowing for oats in one rotation and omitted in the other. The rate of application is 10 tons per acre. During the 12 years previous to 1949 each plot in the rotation has received four applications of manure. The 1949 yields from the manured and unmanured rotations were 46.2 and 38.8 bushels for corn; 8.8 and 1.8 for spring wheat; and 67.2 and 30.9 bushels for oats. Yields with and without manure for the previous 12 years were 19.4 and 20.3 bushels for corn; 8.8 and 8.5 for spring wheat; and 33.4 and 29.6 for oats. In two-year rotations with and without manure yields were 67.9 and 50 for early kalo and 4 and 1.5 for winter wheat. Averages for the previous 12 years were 2.14 and 21.1 for early kalo and 9.7 and 13.6 for winter wheat. In four-year rotations with fallow as the preparation for each crop, yields with and without manure in 1949 were 62.5 and 55.4 for early kalo and 12.7 and 12.3 for winter wheat. Average yields for the previous 12 years with and without manure were 37.1 and 36 for early kalo and 29.9 and 28.1 for winter wheat. Winter wheat on alternate fallowed plots of similar tillage treatment with and without manure produced yields of 19.7 and 12.2 bushels in 1949. Averages for the previous 12 years with and without manure were 29 and 32.6 bushels.

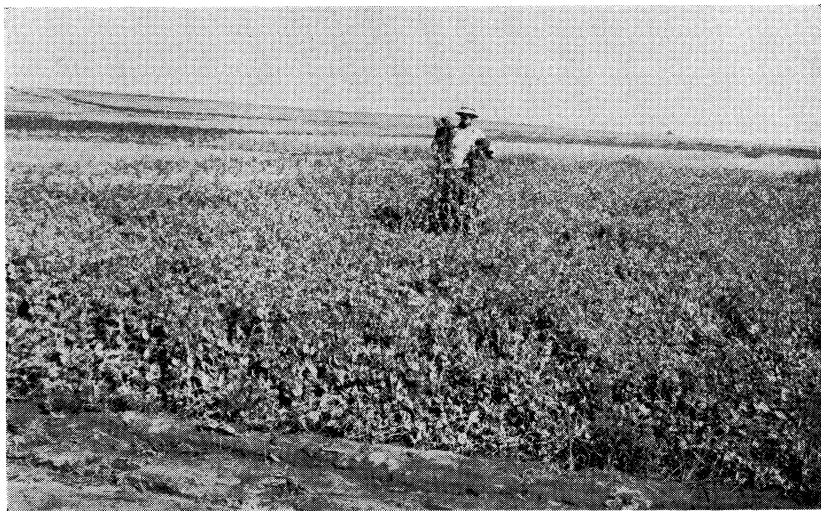
Four four-year rotations use fallow and rye, peas and sweetclover for green manures as preparations for winter wheat followed by corn and barley. As in previous years, yields of wheat were lower after green manures than after fallow because of less favorable moisture at seeding

time. This year corn and barley in these rotations showed favorable response to the accumulating effects of the green manures. The yield of corn, with fallow in the rotation, was 29.9 bushels; with rye green manure 39.4; with peas green manure 44.5; and with sweetclover green manure 41.3 bushels. The corresponding barley yields were 6.9, 8.4, 18.9, and 16.8, respectively.

Effect of crop rotation and manure on the protein content of winter wheat. A preliminary study of the accruing effects of barnyard and green manures and of certain management practices on the protein content of winter wheat may be reported as follows:

(1) In two wheat-fallow rotations barnyard manure has been applied in one at the rate of 10 tons per acre during the fallow year. During a 12-year period each plot in this rotation has received six applications of manure. The protein content of the 1949 crop of wheat from this rotation was 16.1 per cent in comparison with 14.4 for the crop from the rotation receiving no manure.

(2) In four-year rotations rye, peas, and sweetclover are used in comparison with clean fallow as preparations for winter wheat. Generally the loss of soil moisture during the growing season of the green manures has been more important in determining wheat yields than has the increase in fertility resulting from their use. As a result, better yields have been secured from fallow. In these rotations during a 12-year period a crop of green manure has been plowed under on each plot three times. With fallow in the rotations, the protein content of the wheat crop was 12.1 per cent, whereas it was 11.6 per cent following rye green manure. Although the yield decrease was less than for the other green manures, the lower protein content widened the difference in value between green manure rye and fallow. The leguminous green manures improved the protein content of the wheat crop. Percentages were 15 from peas and 13.1 from sweetclover. For peas the value of the increased protein can-



Colorado field peas used for green manure at North Platte.

celled out a large part of the loss in yield. Sweetclover used as an annual crop produced the greatest loss in wheat yield, and the small increase in protein offset but a small part of this.

(3) The outstanding difference in the protein percentage of winter wheat was from rotations in which brome-grass and alfalfa were used as sod crops for six-year periods. After the sod crops were broken out the land was fallowed previous to seeding winter wheat. With brome-grass as the sod crop, the protein in winter wheat was 11.6 per cent which is the same as following rye green manure. After alfalfa, the 17 per cent protein was the highest of any of the determinations.

(4) From an eight-year system of annual cropping of fallow, wheat, corn, wheat, fallow, wheat, corn, and wheat, protein of the first wheat after fallow was 10.5 per cent which is the lowest of the determinations made. Previous to 12 years under this cropping system the land had been used for corn and small grains for about 40 years. Use of soil improvement practices for four-year periods to extend this cropping system into 12-year rotations improved protein in the first crop of winter wheat after fallow to 13.3, 13.7, and 16.2 per cent where the respective four-year treatments were idle land, brome-grass sod, and sweetclover. No plant growth material was removed from the land during the four-year periods. Weeds were not controlled on the idle land. Brome-grass sod was well established and sweetclover frequently produced a second two-year crop from self-seeding.

Effects of manner of residue disposal and of nitrogen fertilizer on yield and quality of winter wheat. Preliminary results have been obtained from experiments comparing four methods of residue disposal, with and without nitrogen fertilizer applications, on both continuous cropping and alternate fallow for winter wheat. The methods of residue disposal were plowing, one-waying, sub-tilling, and plowing after burning. The fertilizer rate was 30 pounds nitrogen per acre. On continuous cropping the low yield of 7.2 bushels was from sub-tilling. Yields from plowing, one-waying, and burning and plowing were, respectively, 11, 10.6, and 10.5 bushels. Because of uneven stands and high variability between individual plots of the same treatments, these yield differences are not statistically significant.

The average protein content of winter wheat was increased from 13.25 per cent without fertilizer to 13.85 per cent with fertilizer on continuous cropping and from 13.51 to 14.27 per cent on alternate fallow. Yields after fallow were 21 bushels without fertilizer and 24.8 bushels with fertilizer. The value of the increased yield and higher protein after fallow more than repaid the cost of fertilizer materials but failed to do so under continuous cropping.

L. L. ZOOK, R. E. RAMIG, M. J. GREENWOOD

Crop Rotations Under Irrigation at Scottsbluff

The annual precipitation for 1949 equalled the 40-year mean of 13.8 inches at the Scottsbluff Substation. Nearly half of this came during April, May, and June and was favorable for the emergence and growth of spring-planted crops. A light hail on August 20 caused some damage to crops. Crop rotation work included studies of the value of farm manure, commercial phosphate and nitrogen fertilizers, alfalfa as a green manure, and sweetclover as a pasture and green manure crop. In addition to continuous plots, the experiment included rotations ranging in length

from two to six years. Several rotations have been designed to study the development of scab on potatoes. Part of the rotations have been in operation since 1912, a period of 38 years. Those dealing with commercial fertilizers and potato scab were started in 1942.

Continuous cropping. In 1949, manure, nitrogen, and nitrogen plus phosphorus increased the total yield of potatoes on continuous plots. These treatments also increased the yield per acre of No. 1 potatoes. Scab was more severe on the potatoes from untreated plots than on those from the treated continuous plots. The continuous untreated plot of beans produced 22.5 bushels per acre compared with 23.9 bushels from the continuous manured plot. The continuous untreated plot of barley produced 56.4 bushels per acre compared with 63.9, 76.3, and 57.1 bushels per acre from similar plots treated respectively with manure, nitrogen, and nitrogen plus phosphate. The untreated continuous plot of sugar beets yielded 5.71 tons per acre compared with 11.42 tons from the continuous plot treated with phosphate and nitrogen. Sugar beet diseases greatly reduced the stand on the continuous sugar beet plots. The continuous untreated corn plot produced 25.7 bushels per acre compared with 118.8 bushels from the continuous manured plot.

Potatoes. Potato scab has been one of the most serious problems encountered in potato production in the irrigated rotations. During the first 30 years scab was generally severe on potatoes produced in short rotations, but negligible on potatoes from long alfalfa rotations. In recent years the favorable influence of the long alfalfa rotations in reducing scab has been less pronounced. In 1947 and 1948, for example, practically no No. 1 Triumph potatoes were produced in any of the rotations. Because of these circumstances four varieties of potatoes—Triumph, Progress, Yampa, and Ontario—were planted in 1949. These four varieties were planted in each of 17 rotations to determine the influence of rotation on yield and quality. The mean total yields from the 17 rotations for the Yampa, Progress, Triumph, and Ontario varieties were 393, 387, 336, and 257 bushels per acre, respectively. The mean yields of No. 1 potatoes were 260, 228, 218, and 180 bushels per acre, respectively. The yield of No. 1 potatoes for the Triumph variety is a marked contrast to yields obtained in 1947 and 1948, when, because of scab, only a few bushels of No. 1 potatoes were harvested from any rotation. A great reduction in the scab on Triumph potatoes occurred in 1949, as compared with the two previous years.

The mean yield of potatoes (average of four varieties) from untreated alfalfa rotations was 335 bushels per acre compared with 329 bushels from similar rotations treated with farm manure or phosphate and nitrogen. The yield from a pastured sweetclover rotation was 356 bushels per acre, compared with 346 bushels in a comparable rotation treated with phosphate and nitrogen. A yield of 336 bushels per acre was harvested from a rotation where sweetclover was used as a green manure crop, compared with 360 bushels from a comparable rotation treated with farm manure. The yield from nonlegume rotations fertilized with manure was 350 bushels per acre, and 352 bushels from similar rotations treated with phosphorus and nitrogen.

Barley. The yield of barley was 42.7 bushels per acre in nonlegume rotations treated with manure and 39.9 bushels in similar rotations treated with nitrogen and phosphorus. The yield from untreated alfalfa rotations was 56.5 bushels per acre; from alfalfa rotations treated with manure, 68.5 bushels; and from rotations treated with phosphorus and nitrogen,

69.6 bushels. The yield from a rotation with sweetclover as a green manure crop was 31.8 bushels per acre, compared with 47.8 bushels from a similar rotation treated with farm manure.

Corn. The yield of corn from a short untreated rotation was 25.4 bushels per acre compared with 101.4 bushels from a similar rotation treated with farm manure, and 116 bushels from one treated with phosphorus and nitrogen. The yield from a six-year, nonlegume rotation treated with farm manure was 129.7 bushels per acre, compared with 127.4 bushels from a similar rotation treated with phosphorus and nitrogen.

Field beans. The yield of beans from an alfalfa rotation fertilized with manure was 21.6 bushels per acre, compared with 26.2 bushels from a similar rotation treated with phosphorus and nitrogen. The yield from nonlegume, manured rotations was 23.3 bushels, and 21.5 bushels from similar rotations treated with phosphorus and nitrogen. An extremely severe epidemic of bean rust during August and September greatly limited the yield of beans in all rotations.

Sugar beets. The highest yield of sugar beets (21.8 tons per acre) was harvested from alfalfa rotations treated with farm manure. The yield from alfalfa rotations treated with phosphorus and nitrogen was 21.7 tons per acre, and from nonlegume rotations similarly treated, 21.3 tons. The mean yield from nonlegume rotations treated with manure was 18.9 tons. The lowest yield (8.2 tons) was harvested from untreated nonlegume rotations. A yield of 14.8 tons was harvested from a pastured sweetclover rotation, compared with 23.8 tons from a similar rotation treated with phosphorus and nitrogen. The mean yield from two beet crops in a pastured sweetclover rotation in which the second crop received manure was 16 tons. The yield from the first-year beet crop following sweetclover pasture was 14.1 tons and the second-year manured crop, 17.9 tons. The yield of beets from a three-year rotation where the sweetclover was used as green manure for potatoes followed by beets was 19.2 tons per acre, compared with 17.9 tons from a similar rotation treated with farm manure.

LIONEL HARRIS, F. V. PUMPHREY

Corn Improvement

Nebraska corn growers, particularly those in the eastern third and central portions of the State, had ample opportunity to witness the reaction of corn plants to a heavy attack by the European corn borer in 1949. The insect population was particularly heavy in certain local areas but damage was readily noticeable throughout these regions. In the corn testing plots at Lincoln the second-generation borer population was exceedingly heavy, resulting in excessive stalk breaking and ear dropping. This provided opportunity to observe the degree of tolerance of hundreds of experimental hybrids. Extreme differences were noted. Several new hybrids appeared highly tolerant to the borer.

Among the hybrids available to corn growers it was noted that U. S. 13, which is known for its tendency to drop ears under some conditions, was particularly damaged by the borer. In these same tests and in farmers' fields where U. S. 13 and Nebraska 701 were growing side by side, the latter hybrid was greatly superior in borer tolerance. It did not drop its ears nor stalkbreak as badly as U. S. 13. Seed supplies of Nebraska 701, a 120-day hybrid, were short of demand in 1949 but should be generally available for the 1950 season.

Nebraska 503, a 110- to 114-day hybrid at Lincoln, and Nebraska 701 were released last year for commercial production. Both hybrids did well as shown in the Corn Performance Test report for 1949, and as evidenced by favorable comments of farmers growing them for the first time.

New hybrids for distribution. Three yellow experimental hybrids that are suitable for east-central Nebraska and areas of similar maturity requirements, were produced in limited commercial quantities for farmer trial in 1950. These were Nebraska 893B, Nebraska 1219B, and Nebraska 1372A. All have good long-time records in the Nebraska Corn Performance tests.

Seed of two white experimental hybrids also was produced in limited commercial lots. Nebraska 801W, although a few days earlier ripening than K2234, has been higher yielding in southeastern Nebraska tests during the last three years. The husks of Nebraska 801W open as it matures, permitting faster drying and some greater ease in picking. A second new white hybrid, Nebraska 5059C, corresponds in maturity with such hybrids as Iowa 306 and Iowa 4059, i.e., about 110 to 114 days at Lincoln. Its performance has been equal to that of Iowa 306 and Iowa 4059 and consequently its availability will provide a suitable white hybrid for a much greater area of the State than has been possible heretofore. Several other white hybrids in this maturity group give special promise in preliminary field trials and may soon be released for production.

There has been a lack of good early maturing hybrids suitable for dry-land areas in the Nebraska Panhandle. During the period of testing hybrids on the Box Butte Experiment Farm no hybrid has been found that would consistently outyield the local, open-pollinated strain of Dawes No. 2. However, during the past three years an early Iowa hybrid, Iowa 4417, has been consistently drier at harvest and higher in yield than Dawes No. 2, thus appearing to be the first hybrid worthy of recommendation for this area. Seed of this hybrid is available commercially in Iowa.

Corn performance tests. In cooperation with the Outstate Testing Project and the substations, corn tests were planted in 15 different localities in 1949. The hybrids were divided on the basis of maturity into early, midseason, and late groups. The early group was planted in each of five localities in northeastern and western Nebraska; the midseason group in eight localities; and the late group in two southeastern localities. The average yields of the various tests ranged from 72.6 bushels per acre in Washington County to 125.9 bushels in Lincoln County, the latter test being grown under irrigation.

The highest yielding hybrid in these tests was Nebraska 501. It was included in five tests of early hybrids and eight tests of midseason hybrids. Its yield surpassed that of the next best hybrid of each group by more than 2 bushels per acre. As a basis of comparison, U. S. 13 yielded an average of 88.4 bushels per acre in the eight midseason tests compared with 96.8 bushels for Nebraska 501. Other hybrids recently released by the Agricultural Experiment Station again had favorable performance records this year. Not only is the performance of corn hybrids dependent upon their local adaptation and the combining ability of the parental seed stocks, but care in production methods as suitable isolation, roguing of off-type plants, and thorough detasseling is very important.

Breeding. Emphasis was continued on a study of more efficient methods for extracting superior inbred lines for use in hybrid pedigrees. Approximately 50,000 pollinations were made in 1949. In addition to the

regular tests of single- and double-cross hybrids, topcross tests were made to determine the combining ability of nearly 1,000 new lines. Data on yield, maturity, and resistance to common crop hazards were obtained. Because of the heavy corn borer infestation, excellent comparisons as to borer tolerance were possible. Several new lines in the breeding nursery appeared outstanding in resistance to borer injury as compared with some commonly used lines.

J. H. LONNQUIST, D. P. MCGILL

Hybrid Corn Tests at North Platte

The hybrid corn test under irrigation included 40 entries, of which 28 were experimental, 9 certified, and 3 others grown as checks. With but one exception, stands ranged from 95 to 100 per cent with a mean of 97.8. Three irrigations were given. Yields ranged from 142.4 to 103.9 bushels with a mean of 125.9 bushels. The least significant difference was 11.3 bushels. The certified hybrids ranged from 112- to 120-day types, and some of them are recognized as too early maturing for maximum yield under irrigation. Their comparative yields in 1949 were as follows: Nebraska 501, 142.4 bushels; Nebraska 502, 131 bushels; Nebraska 503, 130.7 bushels; Ohio C92, 124.9 bushels; Nebraska 601, 124.8 bushels; U. S. 13, 119.6 bushels; Iowa 306, 117.9 bushels; Iowa 4059, 111.1 bushels per acre.

The dry-land test included 26 entries, most of which were earlier in maturity than those tested under irrigation. An effort was made to get a stand of two per hill compared with three plants under irrigation. The average stand obtained was 94 per cent. The entries gave a mean yield of 47 bushels and ranged from 54.4 to 40.8 bushels per acre. These high yields reflect unusually favorable weather conditions. The least significant difference of the test was 5.7 bushels.

The local open-pollinated variety Substation White gave the lowest yield of all, 40.8 bushels, and contained 22.2 per cent kernel moisture when husked. In comparison, Nebraska 501 and Nebraska 503 yielded 54.4 and 59.4 bushels. Their high kernel moisture of 28 per cent on October 13 indicates that they are too late for safe production on dry land in the North Platte territory. Iowa 306 and Iowa 4059 both yielded 46.4 bushels and had kernel moistures of 24.8 and 26.1 per cent. Iowa 4316, the earliest of the Nebraska certified hybrids, produced 42.1 bushels and contained 25 per cent kernel moisture.

L. L. ZOOK, M. J. GREENWOOD, PAUL EHLERS, J. H. LONNQUIST

Corn Genetics

The objective of the corn genetics project is to develop basic genetic information which may ultimately be helpful in corn breeding work. The current investigations include the following principal phases:

Conversions. Many of the corn genetic stocks available for the genetic studies to be undertaken are not adapted to Nebraska conditions. Therefore, a program is under way to transfer or convert the desired genes into one or more inbred lines that are locally suitable. The lines being used for this purpose are N6 and L289 with yellow endosperm and N75 and K41 with white endosperm. The genetic stocks will be backcrossed to these four adapted lines two or more times and these progenies will be selfed to obtain the desired degree of homozygosity.

The genetic stocks in the conversion program include 24 linkage testers, 35 single gene markers, 11 group gene markers, and 6 translocation testers.

Popcorn sterility. Work was started in 1945 to determine the inheritance of a female cross-sterility character found in the popcorn line SA24. When SA24 is used as the female parent, it produces little or no seed when pollinated by most other dent, pop, or sweet corn lines. However, SA24 ovules are fully receptive to SA24 pollen, and SA24 pollen is functional on other lines.

The program in 1949 consisted of the following four parts: (1) a natural crossing block of SA24 x 38-11 backcross progenies which had SA24 as the recurrent parent, and Wf9 x 38-11 as the male parent in the crossing block; (2) advancing to the F_2 , a series of F_1 crosses of SA24 by various linkage testers; (3) hand pollinations to attempt making diallel crosses of SA24, 10 other popcorn lines, and a dent line; and (4) testing pollen receptivity of F_1 , F_2 , and backcross progenies of SA24 x 38-11 on SA24 female plants.

Data obtained to date indicate that the inheritance of the sterility character is genic rather than cytoplasmic, that it is complex, and that SA24 plants used may not have been pure for the genes involved.

Homozygous lines. A group of inbred lines were grown and self-pollinated in 1949. These inbreds are being selfed each year to increase the degree of homozygosity for use in future genetic studies.

Nuclear reactor irradiated material. F_1 progenies of the two single crosses L289 x I205 and CC5 x L289 were grown to continue a study of the genetic effects of exposing pollen at a nuclear reactor. Measurements and notes were taken on many individual plants to determine the frequency and type of mutations, pollen samples were collected to determine the percentage of plants with abnormal pollen, and the plants were self-pollinated for a continuation of the study in the F_2 generation.

Another phase of the study consisted of growing progenies of F_1 plants with abnormal pollen crossed with normal plants. Sporocyte samples were taken on these plants to study chromosomal abnormalities induced by the nuclear reactor. Preliminary data indicate that approximately 45 per cent of these progenies grown in 1949 contained plants with aberrant pollen.

Translocation analysis. Considerable work has been done to find stocks with heterozygous translocations which have no sterility or at least substantially less than the approximately 50 per cent sterility ordinarily present in this type of material. Such stocks would be of value as a tool in the breeding program. Previously selected stocks had been crossed with translocation testers in 1948. The F_1 progenies were grown in 1949 and sampled cytologically to identify the chromosomes involved in these newly-acquired translocations.

E. F. FROLIK, ROSALIND MORRIS

The Growth and Reproduction of Corn

Manner of growth and reproduction. Corn growers are interested in how the corn plant makes its growth and inherits its characters. If they understand these principles they will appreciate more fully the advantages of maintaining favorable field conditions throughout the growing season. Such information has been gathered over many years and may be partially summarized as follows:

The mature kernel of corn consists of (1) an embryo plant with stem, roots, and leaves; (2) an endosperm which occupies the remainder of the interior of the kernel and serves as food for the seedling upon germination; and (3) the outer covering or pericarp with adhering remnants of seed coats, nucellar tissue, and pedicel by which it was attached to the cob. The pericarp is actually the transformed ovary wall of the pistil, and corresponds with the pod of the pea. When the seed germinates, the stem, leaves, and roots of the embryo resume growth. Within three weeks of seedling development, when the plant is about 10 inches tall, all of the leaves have started and the young tassel has formed within at about the level of the ground. At the same time the tiller buds and young ear shoots have all started. The primary root of the embryo also has grown nearly 2 feet long and the crown roots at the base of the stem have grown more than a foot. This ends the seedling stage.

Thereafter the crown roots increase in number and branch and rebranch until they occupy the soil to a depth of 5 to 7 feet and have a lateral spread of about 4 feet in all directions from the crown. Placed end to end the roots of a single well developed corn plant would have a length of about 6 miles. Further growth of the stem results from division and enlargement of the cells (units of structure) at the base of each of its segments or internodes. This elongation simultaneously lifts the tassel, leaves, and ear shoots to their final position above ground, and each of these parts makes its own further individual growth. Although an ear shoot starts at each of the nodes above ground to the uppermost ear, usually only the upper one or two reach the silking stage.

The reproductive process of the corn plant and the mode of inheritance of characters have been found to be rather similar to those of the higher animals. The tassel bears the male or staminate flowers and the ear bears the female or pistillate flowers. The staminate flower produces the pollen grains, each of which contains two sperms. The pistillate flower has an embryo sac containing an egg and two so-called polar nuclei. When a pollen grain falls upon a silk, a very slender tube grows from it into the body of the silk. There it continues growth until it enters the embryo sac within the ovary. The two sperms of the pollen grain are conducted in this tube and within 24 hours after pollination one of them has fused with the egg to form the zygote or first cell of the embryo. This is the beginning of the next generation. At the same time the other sperm fuses with the two polar nuclei, thereby starting growth of the new endosperm. Such double fertilization of both egg and polar nuclei is essential for grain formation. For each silk failing to receive viable pollen, a kernel will be missing on the ear. After fertilization, by numerous cell divisions and growth, the kernel with its embryo and endosperm enclosed in the ovary wall or pericarp is matured in about 50 days under corn belt conditions. Thus a crop cycle of the corn plant has been completed.

Mode of inheritance. The inheritance of the plant is mostly transmitted from generation to generation by means of genes or character-determiners which are arranged in linear series in "bead-like" chromosomes. These constitute the so-called germ plasm. In most corn the male and female reproductive cells (sperm and egg) or gametes each contain one set of 10 chromosomes. Upon fertilization, those of the sperm are added to those in the egg and all ensuing vegetative cells of the embryo and resultant plant have the two sets or 20 chromosomes just as received from the two parents. Their identity is maintained from cell to cell dur-

ing growth by equal splitting lengthwise of each chromosome, one-half entering into the new cell in the process of cell division. The interaction of the many individual genes located on these two sets of homologous chromosomes guides the growth and determines what the heritable characteristics and performance of the plant will be. The hybrid vigor of superior corn hybrids depends upon the degree to which the favorable (dominant) genes of the one set of chromosomes supplement the less favorable (recessive) homologous genes of the other set. This principle is known as combining ability and is regulated by the successful corn breeder in mating parents of known high combining ability.

In the formation of the gametes by a special type of cell division known as meiosis, the two sets of chromosomes intermingle or cross-over and new ones are formed from segments of each homologous pair, thereby incorporating within individual chromosomes part of the genes from each original parent. Thus each gamete again comes to contain a single set of 10 new chromosomes. And then, upon fertilization of the egg, the two homologous sets are restored per cell, and this process repeats from generation to generation.

Limiting factors of growth and production. The productivity of the crop depends upon the number and size of cells that form in the plant tissues, the amount of food reserves stored within them, and upon the number and size of kernels on the ear. The favorableness of development depends upon such factors as seed quality, soil productivity, weather conditions, and heredity. Insofar as possible the field management practices should be so planned as to enable continuous thrifty growth. As soon as any condition becomes a limiting factor, the yield will be reduced. The common limiting factors are deficiencies of soil moisture, soil nutrients, soil drainage, and soil aeration; unfavorable atmospheric temperature and relative humidity; plant diseases and harmful insects.

Of the total basic substance of which the plant is composed, about 5 per cent consists of mineral elements derived from the soil, and 95 per cent is manufactured photosynthetically in the leaves by a chemical combination of water from the soil and carbon from the air, with sunlight as the source of energy.

T. A. KIESSELBACH

Sorghum Improvement

The breeding and testing of sorghum is carried on at Lincoln, North Platte, Alliance, and Hastings. Tests are also made in cooperation with the Outstate Testing Project. All the work within the State is coordinated into one program and is cooperative with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Grain varieties. Martin and Midland continue to be the varieties recommended and generally grown in the central and south-central counties. These varieties yielded about 68 bushels per acre at Lincoln this year, which is the same as for the corn hybrid included in the test. At Hastings they yielded about 50 bushels per acre. Martin is preferred by most growers since its harder textured seed gives better stands, and the crop can be harvested a few days earlier in the fall. Midland grain is preferred for livestock feeding. Martin should be planted at a rate of 3 or 4 pounds viable seed per acre and Midland at 4 or 5 pounds.

Norghum, a new combine variety recently distributed by the South Dakota Agricultural Experiment Station, has been placed on the Nebraska list of certified varieties. It is recommended for the western and northern counties and for late June planting elsewhere in the State. It was among the lowest yielding varieties at Hastings and North Platte as would be expected because of its earliness but was superior to all others tested at Alliance.

Grain varieties ranged from 61.3 to 90.6 bushels per acre at Lincoln. Two combine kafirs developed by the Texas Agricultural Experiment Station show promise for the chinch-bug area in the southeastern part of the State. They are similar to Western Blackhull but are dwarf types.

Forage varieties. Forage yields at Lincoln in 1949 ranged from 14.6 tons per acre for Ellis to 23.1 tons for Waxy Atlas on a 70 per cent moisture basis. The yields of varieties recommended for eastern Nebraska were: Axtell 20.5 tons, Atlas 20.3 tons, Norkan 19.7 tons, Rox 18.7 tons, and Leoti 17.8 tons. Ellis is a recent development by the Ft. Hays, Kansas, Experiment Station from the cross Atlas x Leoti. It is not as productive in Nebraska as Leoti or Norkan but does produce a high quality bundle feed. In central and northeastern Nebraska Axtell, Norkan, Leoti, and Rox are the recommended varieties, whereas the earlier varieties, Rancher, Black Amber, and Fremont, are best adapted at Alliance.

Effect of 2,4-D on sorghum varieties. The effectiveness of 2,4-D in killing such broad-leaf plants as pigweed and kochia is well known. Before recommendations can be made on the use of such herbicides for weed control it is essential to know what their effect will be on the crop itself. This year three grain sorghums, Martin, Midland, and Coes, were sprayed 35 days after planting with $\frac{1}{2}$ and $1\frac{1}{2}$ pounds of amine salt of



Sorghum field on July 7, one week after spraying with 2,4-D at a rate of $\frac{1}{2}$ pound of amine salt per acre. Common pigweed predominated.

2,4-D using 40 gallons of water per acre. Little effect on the plants was noted even at the heavy rate. There was no reduction in yield except for 1½ pounds applied to Midland. Fasciation of the brace roots was pronounced in all plots treated at 1½ pounds and root development seemed to be reduced but even in November the plants in all plots were still standing well enough for combine harvesting. In addition to the above named varieties, 183 others were sprayed 50 days after planting with ½ pound of butyl ester of 2,4-D in 20 gallons of water per acre. No effect was observed on floral fertility or plant development except for the usual fasciation of brace roots.

The use of 2,4-D in sorghum fields is recommended as a supplement to cultivation when applied at a rate no heavier than ½ pound per acre.

Sudan grass. Yield tests with sudan grass are conducted at Lincoln and North Platte. A new strain, Wisconsin 797, outyielded Wheeler in both localities. This new strain is lower in prussic acid than Wheeler and has been more productive during two years. Some progress is being made toward the development of a strain of sudan similar to Texas Sweet but lower than Wheeler in prussic acid content.

O. J. WEBSTER

Varietal Tests of Grain and Forage Sorghum at North Platte

Nineteen varieties and selections of grain sorghum and 10 forage varieties were grown in replicated 1/200-acre plots at the North Platte Substation. Planting was later than usual (completed on June 13) but mild fall weather permitted most entries to mature.

The yields of grain sorghum ranged from 68.2 bushels per acre for Early Hegari to 33 for Norghum. Yields next in order after Early Hegari were Plainsman Sel. 62.3, Westland 61.9, Western Blackhull x Day 44317 61.7, and Martin 60 bushels per acre. Early Kalo ranked fourteenth with a yield of 43.9 bushels per acre. For the period 1944-1949, eight varieties produced the following average yields in bushels per acre: Early Hegari 54.9, Martin 53.3, Early Kalo 52.4, Midland 51.2, Westland 47.4, Day 46, Coes 43.9, and Cody 42.8. All yields were based on 56 pounds per bushel with 14 per cent of moisture.

The forage varieties ranged in yield from 6 to 3.6 tons of field cured forage per acre. The five highest yielding varieties were in order of rank: Leoti x Blackhull, Axtell, Leoti, Atlas, Waxy Atlas. The yields for Ellis, Rox, Black Amber, Fremont, and Norkan ranged from 4.6 to 3.6 tons per acre. Norkan was tenth in forage yield but was first in grain yield with 41.5 bushels per acre. Leoti, Ellis, and Axtell were the three other high grain yielding varieties. Leoti x Blackhull, first in forage yield, was tenth in grain yield.

MILTON GREENWOOD, PAUL EHLERS, O. J. WEBSTER

Adaptation and Improvement of Grasses

Yields of forage grasses. Nitrogen fertilization of grasses greatly increased yields of forage at the Experiment Station and two substations in Nebraska in 1949. Effects on six cool-season grasses, a grass mixture, and alfalfa were compared at Lincoln, North Platte, and Alliance. Replicated plots at the first two locations were in their second year of production in 1949 and those at Alliance were in their third year. In addition, yields were obtained with four warm-season grasses in their second season at Lincoln and North Platte.

The cool-season grasses were bromegrass (*Bromus inermis*), Fairway and Standard crested wheatgrass (*Agropyron cristatum*), western wheatgrass (*A. smithii*), and intermediate wheatgrass (*A. intermedium*) at each station. Russian wildrye (*Elymus junceus*) and a mixture of wheatgrasses (*A. smithii* and *A. trachycalum*) were included at the two western substations. Canada wildrye (*E. canadensis*) and a mixture of bromegrass and alfalfa were used in the Lincoln test. Alfalfa appeared in each of the tests. Four warm-season grasses, big bluestem (*Andropogon furcatus*), side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), and buffalograss (*Buchloe dactyloides*) were grown in separate tests at Lincoln and North Platte.

Nitrogen fertilizer in the form of ammonium nitrate was applied to one-half of each of the plots of cool-season grasses before growth started in the spring, and to the warm-season grasses in late May of 1949. The cool-season grasses received 40, 60, and 26 pounds of elemental nitrogen per acre at Alliance, North Platte, and Lincoln, respectively. The warm-season grasses received an application of 40 pounds at Lincoln and 54 pounds at North Platte. The cool-season grasses were harvested for hay in June and the warm-season grasses in midsummer. Forage yields were calculated on a moisture-free basis from samples which were oven-dried.

At Lincoln, the average forage yields of the six cool-season grasses harvested on June 10 were 0.76 and 1.38 tons per acre for the unfertilized and fertilized areas, an average increase of 82 per cent as a result of the nitrogen application. All of the grasses responded favorably whereas alfalfa did not. As an average of both treated and untreated plots, alfalfa gave the largest yield, 1.92 tons per acre. The bromegrass-alfalfa mixture approached the yield of the alfalfa plots (1.54 tons) and exceeded in yield the six grasses grown in pure stands. Bromegrass, western wheatgrass, and intermediate wheatgrass gave the largest yields among the six grasses, namely, 1.28, 1.33, and 1.28 tons per acre, respectively. The crested wheatgrasses were relatively low yielding under these conditions, averaging 0.82 ton per acre.

At North Platte, the average forage yields of the six cool-season grasses harvested June 27 were 1 and 1.74 tons per acre for the unfertilized and fertilized treatments, respectively. The response to nitrogen was shown by all grasses and the mixture but was not significant for alfalfa. Bromegrass and the crested wheatgrasses yielded 1.64 tons; western wheatgrass, 1.49 tons; and alfalfa, 1.40 tons per acre when the yields of all plots are considered. Intermediate wheatgrass gave relatively smaller yields than these grasses, averaging 1.03 tons, and Russian wildrye gave the lowest yield, 0.76 ton per acre.

At Alliance, the six cool-season grasses were harvested on June 29. The average yield with fertilization was 1.17 tons, representing an increase of 144 per cent over 0.48 ton per acre on the unfertilized plots. The grass mixture showed a similar response to that of all of the grasses planted in pure stands but alfalfa gave a decreased yield. Averaging both treatments, alfalfa yielded approximately one ton per acre. Of the grasses, intermediate wheatgrass and western wheatgrass gave the largest yields of 1.11 and 0.97 tons, and Standard outyielded Fairway crested wheatgrass by a small amount, 0.88 and 0.80 ton per acre, respectively.

The four warm-season grasses gave a similar response to nitrogen fertilization as did the cool-season grasses. Each of them yielded more as the result of fertilization, in both locations. The plots were harvested at Lincoln on August 10 and at North Platte on August 27. At Lincoln, the

fertilized areas averaged 1.48 tons as compared with 0.89 ton per acre for untreated areas. This is a gain of 66 per cent. At North Platte, corresponding average yields were 1.24 and 0.77 tons per acre—an increase of 61 per cent in favor of fertilization. The four warm-season grasses yielded in the same relative order at both locations. Big bluestem gave the largest yields, averaging 1.88 and 1.47 tons; side-oats grama yielded 1.17 and 1.06 tons; blue grama produced 1.06 and 0.98 tons; and the mowed clippings of buffalograss were 0.61 and 0.50 ton per acre at Lincoln and North Platte, respectively.

E. C. CONARD, L. C. NEWELL

Exploration for new strains of native grasses. The introduction of new plant materials into the grass improvement project was initiated during the year in cooperation with the Division of Plant Exploration and Introduction of the Bureau of Plant Industry, U. S. Department of Agriculture. Plans were laid for detailed exploration of Nebraska's native grasslands over a period of years to discover and isolate outstanding geographical strains of the most important grasses. These strains are to be grown and evaluated in nurseries at various experiment stations. The best of these will be used in breeding domesticated strains acceptable as varieties for certified seed production.

This project is an extension of the grass breeding work which is cooperative with the Division of Forage Crops and Diseases, U. S. Department of Agriculture. The native grasses offer one of the most important sources of plant materials which are adapted to the drier parts of the Great Plains region. Previous work has shown that a wide variation of plant types exist within each of these species. Some of these variations, such as plant size, productiveness of forage and seed, seed size and seedling vigor, disease resistance, and drouth tolerance, offer great promise in the domestication of these grasses. Present demands for larger acreages of grasses, particularly on submarginal cropped lands, make this investigation one of prime importance at this time.

Accessions of forage plant and seed materials totaled 270 in 1949. Collections were made primarily in the western part of the State and in the Nebraska Sandhills. Strains of wheatgrasses, bluestems, switchgrass, sand lovegrass, and side-oats grama predominate in the collections. Only the most promising materials were selected from the many local types examined. Twenty-two genera and 38 different species of grasses and legumes are represented. It is planned to continue this survey in 1950 and to make collections of grama grasses and buffalograss from native grasslands to the south and west of the area investigated in the first year of the study.

L. C. NEWELL, E. C. CONARD

Seed increase of certified varieties. Notable progress was made during 1949 in the increase of several promising varieties of grasses, including two new strains of bromegrass and one each of intermediate wheatgrass, switchgrass, and sand lovegrass.

Under supervision of the newly organized Foundation Seed Division of the Agronomy Department, small acreages of the bromegrass and intermediate wheatgrass varieties were harvested and additional plantings made for the further production of foundation seed. These acreages are on the Genoa Seed Farm or under contract on privately owned land.

Under this plan a control of seed stocks is maintained. A sufficient acreage is to be built up as rapidly as possible to meet the seed demands of the principal seed producers interested in these crops.

With seed harvested in 1949, the acreages established during the fall of Nebraska 36 and Nebraska 44 bromegrasses were increased to 30 and 95 acres, respectively. Nebraska 36 is an improved aggressive bromegrass thought best adapted to the more difficult planting sites. It has especially good seed quality in most years. Nebraska 44 is a synthetic variety with high yields of forage and seed. A foundation seed field of Lincoln bromegrass was also established as a source for pure seed of this well known variety. Approximately 2,000 pounds of Nebraska 50 intermediate wheatgrass was produced and the acreage was increased by fall planting to 300 acres.

Nebraska 28 switchgrass and Nebraska 27 sand lovegrass have been released to farmers for the production of certified seed. In 1949 there were 15 growers of the switchgrass variety and 6 growers of the sand lovegrass. Some of these stands produced seed in 1949.

L. C. NEWELL, F. D. KEIM

Effects of time of cutting prairie hay. The study of time of cutting prairie hay was continued on the Dalbey Memorial land in Gage County in 1949. Hay yields were obtained from replicated plots mowed, respectively, in early July, early August, and mid-September during the fifth year of such treatments on the same plots. The early cut plots produced an aftermath crop in four of the five years, the 1947 season being too dry. Two additional treatments, also started in 1945, are characterized by early and midseason cutting in alternate years. These differ merely in that one began with early and the other with midseason cutting in the first year. The removal of two harvests from all plots receiving the early cutting treatments gave the largest average yields and the best quality of hay as judged by feeding trials in three of the four years.

In the fifth year of the experiment, the cumulative effect of continuous early cutting and aftermath removal reduced the yields to the smallest among the treatments. The yields from early, midseason, and late cutting were 1.28, 1.69, and 1.31 tons per acre, respectively. Alternation of early and midseason cutting gave average yields of 1.54 tons per acre. As an average for five years, early, midseason, and late harvest yielded 1.42, 1.37, and 1.30 tons, and the plots receiving the alternate treatments yielded 1.40 tons per acre. The treatments involving early cutting continue to show an advantage in both yield and quality. There has been no advantage in allowing the prairie grasses to use the entire growing season to produce a maximum yield of hay, and their loss in quality has been shown in the results of feeding tests.

The lowered yield in 1949 of the plots receiving the more frequent mowing appears to have resulted from a lowering of root reserves from the cumulative effects of this treatment. Plots receiving such treatment only in alternate years had opportunity to recover. These results were expected to occur earlier in the experiment but may have been delayed by the failure of the plots to produce an aftermath crop for removal in 1947. The continuation of this study should show the maximum effects of such treatment on the composition and yielding capacity of prairie hay meadows, and will be valuable in formulating conclusive recommendations for long-term practices.

Present indications point to the desirability of harvesting half of a meadow in early July and the other half during early August to obtain both superior quality and high yields. Aftermath crops may be removed without damage at least for a period of several years, provided that this practice is alternated annually on the two halves of the meadow.

E. C. CONARD, M. L. BAKER, L. C. NEWELL

Alfalfa Improvement

The alfalfa project is cooperative with the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Major emphasis of the project is on the breeding of improved varieties. Attention is also given to the testing and evaluation of varieties tracing to outside sources and to investigating cultural and meadow management practices which have timely importance.

Hybrid vigor. Hybrid vigor in alfalfa has been demonstrated repeatedly through progeny tests of seed produced by growing two selected, high-combining clonal lines subject to natural hybridization in an isolated crossing field. While the better single crosses thus obtained have given yield increases of 10 to 15 per cent over the standard varieties, their general use as synthetic varieties seems impractical because of reduced yields in advanced generations. Comparative data involving two generations of 10 different single crosses show a significant yield reduction of 7.5 per cent for the second- as compared with the first-generation progenies. Eight of the 10 first-generation hybrids under investigation produced more than the average of the check varieties, whereas only one of the ten second-generation progenies tracing to these same hybrids out-yielded the checks.

The results from multiple-line hybrids used as synthetic varieties, each involving four or more high-combining clonal lines, offers distinct encouragement for the partial utilization of hybrid vigor in alfalfa. Although such synthetics usually show slightly less hybrid vigor in the first generation than do the better single-cross hybrids, their better performance in advanced generations gives them a distinct advantage. Experimental studies with eight synthetic varieties indicate a nonsignificant reduction in yield of less than 2 per cent for the second-generation progenies as compared with the first generation. Furthermore, seven of the first-generation and five of the second-generation progenies outyielded the check varieties. Tests concerning the performance of synthetics in the third and fourth generations are lacking, but will be obtained as rapidly as possible. Theoretically they should be equal to the second. Should they also perform satisfactorily, the release of a superior synthetic variety involving several outstanding clones with favorable, specific combining ability may be expected within the next few years.

Stafford alfalfa. A currently publicized variety named Stafford has been included in experimental tests at Lincoln during the past two years. On the basis of second-year forage yields from nine replicated plots, Stafford failed to show any advantage over the standard varieties Ranger, Grimm, Buffalo, Kansas Common, and Ladak. In general characteristics this variety resembles Common alfalfa which is most widely grown in the central Great Plains. It has a rather narrow crown, an upright habit of growth, and a fairly rapid rate of recovery after cutting. Results from repeated controlled tests show Stafford to be inferior to Ranger in re-

sistance both to cold and to bacterial wilt which is the most serious disease of alfalfa in Nebraska and the United States. Stafford is equally as susceptible to alfalfa wilt as is Grimm, and it is comparable to Kansas Common in cold endurance. The claims that Stafford possesses special drought resistance and excels in stand establishment and persistence on sandy soils have not been established experimentally.

Alfalfa meadow management. The rapid development of the alfalfa dehydrating industry in Nebraska has revived interest in cutting practices as related to the maintenance of good vigorous stands of alfalfa. For such use it is the practice to cut the crop more frequently and at earlier maturity stages than is commonly recommended as a standard hay-making procedure. The general physiologic principles bearing on this question may be stated as follows: The development of new top growth on established alfalfa plants, both early in the spring and after each cutting of hay during the growing season, is closely correlated with the amount of reserve food materials stored within the roots and crown. In fact, most of the food materials needed in early growth and structural development of stems and leaves is drawn from the reserves contained within the underground portions of the plant. Numerous experiments indicate that coincident with early vegetative growth there is a continued lowering of food reserves in the roots for approximately three to four weeks (varying with environment and geographic location), after which the plants manufacture sufficient food material for their continued development. The replenishment of food reserves within the roots starts for each cutting at about the "bud stage" of growth and continues at a very rapid rate until new growth appears at the crown, or the plant reaches the one-tenth to one-half bloom stage. Additional amounts stored after the plant has reached the one-half bloom stage are usually so small that little or no advantage results from further delay of harvest.

Although harvesting in prebloom stages results in hay that is more leafy and higher in protein, this early removal of top growth definitely limits the amount of food restored in the roots. Repeated and continuous cutting at such early or premature stages results in a gradual lowering of the reserves during the season and from year to year. Coincident with this there is a weakening of the plants and consequent lowering of hay yields. In Nebraska tests, cutting continuously at the prebloom stage produced 34 per cent less hay over a three-year period than did cutting at the tenth-bloom or new growth stage. Furthermore, this premature cutting resulted in a very marked weakening of plants and thinning of the stand.

The most critical periods of growth as related to maintenance of stand are late fall and early spring. It is important that fall growth be sufficient to permit the manufacture and storage of large quantities of food in the crown and roots if winter losses in stand are to be minimized. In order that plants weakened during the winter may recuperate and continue producing vigorous growth and high yields it is equally important to avoid excessively early harvest of the first cutting.

H. O. GRAUMANN, T. A. KIESSELBACH

Sweetclover Improvement

Breeding for low coumarin content. Coumarin is the substance in sweetclover which gives it a bitter taste and causes the loss of clotting power in the blood of animals feeding on spoiled sweetclover hay. Prog-

ress is being made toward the development of a low-coumarin strain of sweetclover. Lines which are nearly free of coumarin have been made available by the Wisconsin Agricultural Experiment Station but these are, in general, lacking in vigor and are being used in a program of back-crossing to vigorous varieties. Low-coumarin segregates are selected by the semiquantitative fluorescence method for transplanting into the breeding nursery.

Eight lines were received from Germany in the spring of 1949, all of which were reported to be low in coumarin, but without exception these proved to be relatively high in this character. All of these lines in their first season's growth were short and bushy with many fine stems arising from the base of the plant. It is possible that because of their many fine stems these may be used as breeding material.

At present, the available low-coumarin breeding material is of the white-flowered (*M. alba*) type. It has been demonstrated that in most of the Great Plains area, the yellow-flowered (*M. officinalis*) varieties show greater adaptation and are preferred by farmers. For this reason it would be highly desirable to develop a low-coumarin strain of this type. A survey of a large number of plants from different varieties within this species has been initiated. From a total of 2,500 plants analyzed thus far, a few have appeared by the rapid, semiquantitative method to be quite low in this character, but these will need to be checked for actual coumarin content with the photofluorometer.

One of the large seeded, annual species, *M. messanensis*, has been found to be free of coumarin but is unadapted for growing in this region. Crosses between this species and *M. officinalis* varieties were attempted in the 1949 greenhouse but without success. Attempts at obtaining such hybrids are being continued.

Breeding for a finestem hay type. The green-seeded, finestem synthetic strain, N1, is highly susceptible to anthracnose, *Colletotrichum trifolii*. Remnant seed of five of the six component lines of this strain was available and plants grown from this seed were inoculated with the organism. One line was highly susceptible to the disease, two were moderately susceptible, one moderately resistant, and one showed only slight infection. Of approximately 5,000 plants of this synthetic strain subjected to mass inoculations, 10 showed resistance. These were increased by cuttings and transplanted into an isolated nursery. These lines will be used in crosses with others that are low in coumarin in an attempt to combine the two characters, fine stems and low coumarin, into one strain. The inoculation work was conducted in cooperation with the Plant Pathology Department.

In an attempt to increase the general vigor of the N1 strain, natural crosses with numerous other strains and varieties of the *M. alba* type were obtained by allowing the border rows in the forage yield plots to stand following harvest. From the seed which was harvested from the N1 plants, the yellow seeds were assumed to have resulted from crossing with other white-flowered varieties in the nursery. Approximately 150 plants from these yellow seeds have been established in the 1949-1950 greenhouse for the purpose of obtaining F₂ seed for planting in 1950.

Breeding for larger seed size. Progenies of crosses between *M. polonica* and *M. alba* have been grown during recent years in the hope that the large seed size of the former species might be incorporated into a strain of the *M. alba* type. However, in this material large seed size and large

number of flowers per raceme were found to be negatively correlated, and in no case were plants found which produced both large seeds and satisfactory seed yield. Interspecific hybridization involving the larger-seeded species, *M. speciosa*, *M. italica*, *M. messanensis*, and *M. sulcata* in crosses with our common yellow and white-flowered varieties is being continued for the purpose of increasing, if possible, the seed size of the commonly grown varieties.

Genetic and cytogenetic studies with interspecific hybrids. An analysis of the progenies of crosses among *M. alba*, *M. suaveolens*, and *M. polonica*, which was begun at the Iowa Agricultural Experiment Station and concluded at the Nebraska Agricultural Experiment Station, produced the following results: (1) Pollen analysis of F_1 hybrids showed an average of approximately 75 per cent aborted pollen. The mean percentages of normal pollen and self-fertility increased in the F_2 and F_3 generations and several plants showing normal pollen and high fertility were recovered. (2) Meiosis in the F_1 hybrids seemed to be as normal as that of the parent plants and pollen abortion was concluded to be the result of causes other than meiotic irregularity.

A study of various genetic characters involved in these crosses is being continued.

Varietal yield test. Eight varieties and three strains were compared under two conditions of planting, namely (1) with a companion crop of oats and (2) no companion crop—weeds controlled by hand weeding. At the end of the first growing season (1948), sharp differences in survival were noted among the varieties grown with the companion crop, but these differences were not reflected in the yields produced by the second year's growth in 1949. Forage yield determinations taken at the full bloom stage again showed the highest production to be from the later maturing varieties such as Evergreen and Willamette. Redfield was a near failure, apparently as a result of winter injury. The finestem synthetic strain, N1, and Brandon Dwarf were next lowest in yield. The relative performance and acre yields of varieties and strains in the hand-weeded plots were very similar to those established with a companion crop of oats.

Foundation seed. Approximately 800 pounds of foundation seed of Madrid was produced for the Agronomy Department by the Soil Conservation Service Nurseries at Waterloo, Nebraska. This seed has been turned over to the new Foundation Seed Division within the Agronomy Department for distribution to certified growers. About 350 pounds of foundation Spanish were produced on the Agronomy farm for similar distribution.

G. T. WEBSTER

Soybean Improvement and Production Practices

With curtailed production of both wheat and corn now assured for 1950 through federal acreage control, soybeans are likely to command greater interest as a substitute crop. They merit serious consideration in eastern Nebraska and should prove profitable if suitable cultural practices are followed. The area harvested in this State in 1949 was 21,000 acres, which is slightly under that of 1948. The average yield of 22 bushels per acre was considerably above the long-time average. The chief essentials with soybeans are thorough weed-free seedbed preparation; choice of a regionally suitable, productive variety; seed inoculation; delay of

planting to facilitate early weed control; adequate stands; weed-free tillage of the growing crop whether solid-drilled or in cultivated rows; and delay of combining until the grain is thoroughly dry. The results of various tests made on the Experiment Station farm since 1942 with the use of standard farm implements are here reported.

Soybean improvement. Hawkeye and Lincoln have replaced the older varieties on most of the acreage because of their greater yield, improved agronomic characters, and higher oil content. Two uniform varietal tests were conducted at Lincoln and one at Wakefield in cooperation with the U. S. Regional Soybean Laboratory. Five other varietal tests at five locations and one forage yield test at Lincoln were carried out.

Several experimental strains slightly exceeded Lincoln, Adams, and Hawkeye in yield in the uniform tests at Lincoln. Adams, the new variety released in Iowa in 1948, again proved equal to Lincoln in yield although it matured about six days earlier this year as compared with an average of two days earlier in previous experiments. At Wakefield, the Adams and Hawkeye varieties were superior to Lincoln in yield and ranked with the highest yielding experimental strains. The superiority of these varieties is normal for northeastern Nebraska and is undoubtedly associated with the fact that they mature a few days before Lincoln. Blackhawk, a new variety developed in Iowa from the same parental varieties as Hawkeye, yielded almost as well as Hawkeye at Wakefield although it matured five days earlier. It may be of value in northeastern Nebraska when delayed planting is necessary.

Varietal tests in Hall and Phelps Counties indicated a tendency for early maturing varieties such as Hawkeye to yield more than later varieties when grown under irrigation. In Dodge County the highest yielding varieties were Adams and Lincoln. Later maturing varieties such as Chief and Wabash seemed to have a slight advantage in Nemaha County.

Cultural practices. As an average for six years, 1944-1949, the yields have been 15.5, 17.2, 18.1, and 19.4 bushels per acre when planted, respectively, on May 16, May 26, June 8, and June 21. To avoid danger of immaturity in the fall, planting between May 25 and June 10 is preferred. This provides time for eradicating several crops of weed seedlings in connection with seedbed preparation before planting. Harrowing a few days after planting, just before the soybean seedlings emerge, is very helpful in weed control. Use of a rotary hoe or harrow two or three times thereafter until the soybeans have made a growth of about 10 inches is a very good procedure. If grown in widely spaced rows, two or three additional cultivations may be needed.

As an average of four dates of planting during the six years, cultivated rows spaced 35 inches apart and planted at 60 pounds per acre yielded 17.3 bushels compared with 17 bushels for solid drilling at 90 pounds of seed per acre, and 18.4 bushels at 120 pounds of seed per acre. These are comparatively better results for solid drilling than obtained in earlier years. This is accounted for by a better understanding of weed control methods in recent years.

During four years, 1944-1948 omitting 1947, planting in cultivated rows spaced 35 inches, at the rates of 25, 40, 60, and 80 pounds of seed per acre, gave the respective yields of 18.5, 20, 19.8, and 20.4 bushels. In the last three of these years, rows spaced 21, 28, 35, and 42 inches apart, all planted at 60 pounds per acre, yielded respectively 20.8, 18.6, 18.3, and 17.2 bushels. Forty-two inches appears to be too wide for maximum yield of midseason varieties most suitable in this region.

Comparing three methods of planting in cultivated rows as an average for four years, use of a surface corn planter yielded 20.1 bushels, furrow openers 20 bushels, and listing 18.8 bushels per acre. Listing has proved least satisfactory.

Inoculation of the seed before planting increased the yield 3.5 bushels per acre in 1949 on the Experiment Station farm at Lincoln. An application of three tons lime per acre had no effect on yield.

DON HANWAY, W. E. LYNNESS, T. A. KIESSELBACH

Weed Control Research

Again in 1949, as in 1948, unusual climatic conditions brought about serious weed situations which could not be handled by the usual cultural methods. Serious winterkilling in many fields of winter wheat resulted in thin stands with reduced vigor. Annual broad-leaved weeds were the major problem in fields which were not plowed and put to another crop. Above-normal rainfall occurred from late in April to early July. This caused much late planting of spring grain and corn and increased annual weed problems. Widespread use of 2,4-D resulted in sharp reductions in weed competition and in many cases actually saved crops which otherwise would have been lost.

Rather comprehensive studies on weed control are conducted cooperatively with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Use of 2,4-D in Nebraska. Acceptance and use of 2,4-D (2,4-Dichlorophenoxyacetic acid) is still gaining in this State according to surveys conducted by the Agricultural Extension Service. In 1947 approximately 70,000 acres were sprayed with 2,4-D. In 1948 the acreage jumped to 550,000. This was more than doubled in 1949, with ground and airplane equipment spraying more than 1,280,000 acres. Approximately 25 per cent of the total acreage was treated by airplane.

Effect of 2,4-D on weed-free grain crops. A study to determine the effect of 2,4-D and 2,4,5-T on weed-free Pawnee wheat was continued in 1949. The wheat was sprayed at four different stages of growth, i.e., jointing, early boot, late boot, and flowering.

While all rates of $\frac{1}{2}$ pound or more of 2,4-D ester reduced the yield significantly in 1948, such reductions were not obtained in 1949 until rates approaching 2 pounds ester were used. In both 1948 and 1949 greatest floret sterility occurred at the early boot stage and greatest reduction in yield may be expected from spraying at that stage of growth. Percentage germination of the crop harvested was not affected by any date or rate of treatment. Pawnee wheat reacted similarly to 2,4,5-T.

Nemaha oats sprayed at the same stages of growth were affected differently. All rates of $\frac{1}{4}$ pound or more of ester gave significant reductions in yield when applied at the jointing stage of growth. Yields were not affected by any of the other rates or dates of application. Unfavorable yield effects were accompanied in all cases by reductions in fertile florets per culm, fertile florets per spikelet and 1,000-kernel weight. The amine salt consistently gave less injury on both wheat and oats.

Perennial weeds. At the end of three years of treatment, bindweed growing in bluegrass sod shows the greatest reduction in stand (91 per cent) where sprayed with the amine salt of 2,4-D. The sodium salt shows the least reduction (81 per cent) and the ester formulation is intermediate

with 86 per cent reduction. A rate of 1 pound acid per acre gave as good results as 2, 3, and 4 pounds where the amine salt was used. The higher rates were slightly advantageous for the sodium salt, whereas the ester gave poorer results as the rate was increased above 1 pound per acre. Where bindweed was treated in four different growing crops, $\frac{1}{2}$ pound of either ester or amine gave reductions in stand of bindweed equivalent to those obtained from 1 and 2 pounds. Closely drilled sudan appears promising as a crop which competes vigorously with bindweed. Even more promising is its apparent tolerance to high rates of 2,4-D. For use in the treatment of small areas of perennial noxious weeds, four new boron compounds appear promising. Three of these, Polybor, Polyborchlorate, and Chlorax, are soluble in water and thus have the added advantage of easier application over dry insoluble products.

Control of woody plants. Buckbrush sprayed in 1948 with 1 and 2 pounds per acre each of 2,4-D ester and 2,4,5-T ester showed the 2,4-D to be greatly superior in June, 1949. An average reduction of 64 per cent in stand was obtained with the use of 2,4-D as compared with only 1 per cent for 2,4,5-T.

Foliage spray treatments on Osage orange in 1948 indicated that 2,4,5-T is much superior to 2,4-D for this purpose. Early in 1949 all of the 2,4,5-T treatments with 2,000 or more p.p.m. showed 95 per cent or better of the top growth killed with only moderate regrowth from the base. All 2,4-D treatments were relatively ineffective. Following a re-treatment of one-half of each plot in the fall of 1948, only one out of six trees showed regrowth in 1949 compared with five out of seven where a single treatment had been made in 1948. By September, 1949, there were some new shoots at the base of most trees. All applications were made using 160 gallons per acre.

Weed control in seedling grasses. The use of 2,4-D may be advantageous for broad-leaved weed control in seedling grasses if the weedy grasses are not a problem in the area. Under such conditions the spring-planted grasses gave marked response in growth vigor the year following treatment as compared with either an untreated or a mowed check.

Crabgrass control. Selective control of crabgrass in lawns has been under investigation since 1947. A single spraying with 3 quarts of kerosene per square rod has given approximately 95 per cent control. Treatment should be made when the crabgrass seedlings are in the two- to three-leaf stage. Bluegrass was not injured by initial treatments or by repeat treatments made early in August.

N. E. SHAFER, D. L. KLINGMAN

Outstate Testing Project

Crop variety tests. Field crops research at the Experiment Station and substations is supplemented by variety tests conducted by the Outstate Testing Project on farms throughout the State. These tests provide a means of more rapidly evaluating new superior crop varieties and determining their regional adaptation. In 1949 a total of 77 crop variety tests were planted. The distribution by crops was as follows: winter wheat 14, winter barley 2, rye 3, oats 17, barley 13, spring wheat 1, hybrid corn 11, popcorn 1, grain sorghum 6, soybeans 5, safflower 1, and castors 1. Results of the fall-sown small grain, hybrid corn, and spring small grain tests are summarized in Outstate Testing Circulars 6, 7, and 8, respectively.

Seven winter wheat variety tests were harvested. Excessively cold and wet conditions caused severe winterkilling in eastern and south-central Nebraska. Unfavorable spring weather resulted in poor plant growth and favored development of leaf rust and other diseases. Conditions farther west were more favorable. Pawnee and the experimental variety C. I. 12500 (Nebraska 60 x Mediterranean-Hope) ranked high in yield in nearly all the 1949 tests. For the five-year period, 1945-1949, Pawnee has been the highest yielding variety in the Southeast District, while Cheyenne and Nebred have performed well in the South-central, Southwest, and West Districts. The experimental variety C. I. 12142 (Turkey x Cheyenne) has an excellent record in western Nebraska.

In general, conditions for growth of spring grains were unfavorable, especially in eastern Nebraska. Wet weather delayed planting over most of the State. Continued cool and wet conditions produced a soil-nitrogen deficiency and resulted in poor plant development in many areas. In general, Nemaha and Cherokee exceeded Clinton in yield by about 10 bushels in the eastern one-third of the State in 1949. These three varieties have performed nearly alike in previous tests. Clinton was heavily infected with a new race of crown rust in 1949; this probably accounts, at least in part, for the difference in yield. In the Southwest and West Districts Neosho, Cedar, and Osage have the highest yield records. As yet, victoria blight has not been a major factor in oat production in these areas. Over a four-year period, Trebi has been the highest yielding barley variety in the West and Southwest Districts. Velvon 11 and Emond have excellent yield records in nearly all districts; however, two newly released varieties, Plains and Feebar, although not equal in yield, have stiffer straw and more stem rust resistance.

As in the past, the corn performance tests included Nebraska-certified hybrids and promising yellow and white experimental combinations. The cold, wet spring delayed planting and several tests were planted about June 1. However, favorable moisture and growing conditions produced good yields where soil fertility was adequate. Yields were generally good but not so high as in 1948. Average acre grain yields of all hybrids included in each outstate test were: Holt 32, Knox 55, Dakota 72, Washington 73, Fillmore 74, Seward 76, Phelps 82, Valley 87, Richardson 92, and Hitchcock 109 bushels per acre. Nebraska 501, Nebraska 503, and Nebraska 701 have excellent performance records.

A more complete varietal testing program for grain sorghums and soybeans was initiated in 1949. The safflower and castor tests were cooperative with the Chemurgy Department.

AUGUST DREIER, PAUL EHLERS

Horticultural Crops

Department of Horticulture, North Platte and Scottsbluff Experiment
Substations, and Box Butte Experiment Farm

Food Value of Nebraska-Grown Vegetables

Sweet potatoes. During the last three years average dry-matter, starch, ascorbic acid and carotene content of sweet potatoes of three or four varieties was greatest in those grown in the southeastern portion of the State and diminished in those produced at increasingly higher altitudes farther west. Sweet potatoes at Nebraska City or Omaha generally had highest values, followed by those from Lincoln and Grand Island or North Platte. Those from Scottsbluff had the lowest values. Dextrose and sucrose content differences were less consistent but the relative position of the varieties was about the same at all of the places.

Dry-matter values of sweet potatoes of three varieties harvested the third week in October at Lincoln and stored at 50°-60° F. decreased about 2 per cent during the first three months and then increased by mid-May to about 1 per cent higher than the October levels. Both dextrose and sucrose increased about one-half during the first six weeks of storage, then decreased slightly and remained almost constant for the remainder of the storage period. Starch content decreased until January and then increased. Starch content in mid-May was generally about the same as that in late November. Carotene values increased about one-third during the first six weeks, then decreased slowly. In mid-May they were only a trifle lower than at harvest. Ascorbic acid content decreased slowly throughout the entire storage season but by mid-May still averaged 14.72 mg. per 100 grams fresh weight or 52 per cent of that at harvest. Variety differences were about the same throughout the storage period. These late spring ascorbic acid values have dietetic significance. They are about equal to the values of most canned tomatoes and are higher than those of most white potatoes when analyzed six to eight weeks after harvest.

Sweet potato seedling selections from the Oklahoma Agricultural Experiment Station were grown at Lincoln and most of them had much higher carotene values than the commercial varieties. A number of these seedlings exceeded 100 mg. carotene per gram of fresh weight of sweet potato and one had 132 mg. The highest value found in a commercial variety grown under the same conditions was 58.7 mg. for Orange Little Stem. The common varieties Yellow Jersey, Red Bermuda and Porto Rico had only 1.1, 1.8 and 21 mg., respectively. These seedling roots also varied in ascorbic acid content more than the commercial varieties. The range of ascorbic acid values for seedlings was 10.1 to 34.6 mg., compared with 17.8 to 37.1 mg. for the varieties.

Most of the recently named varieties have more carotene and ascorbic acid than the older varieties.

Squash. Great differences in ascorbic acid content were found for three varieties of squash. Values were 16.6 mg. per 100 grams fresh weight for Butternut, 17.6 mg. for Table Queen and 34 mg. for Rainbow.

Tomatoes. Progress is being made in developing tomato varieties with higher ascorbic acid content without sacrificing fruit size. Fruits approaching the size of their commercial parents but with considerably higher ascorbic acid values have been produced by crosses between sev-

eral commercial varieties and lines with small fruit but high ascorbic acid content (crosses of *Lycopersicum esculentum* with *L. peruvianum*).

Potatoes. In contrast with those from unsprayed plants, tubers of seven varieties from plants sprayed to control leaf hoppers and harvested on seven dates attained significantly higher ascorbic acid values and retained the high values for a longer time.

The Entomology Department cooperated in the spraying test.

H. O. WERNER, PAUL K. YAGYU, RUTH M. LEVERTON, MARY R. GRAM,
MARILYN KUHLMAN, RUTH LEBO JOHNSON

Vegetable Variety Tests

Peas. Twenty-five varieties were tested, including the early and mid-season varieties which performed best in several other seasons and a few recently developed varieties. Yields were lower than in most other seasons, largely because of the severity of powdery mildew. The most satisfactory of the early varieties were Freezonian, Little Marvel and Burpeanna Early Dwarf. A very promising variety is P17 developed by the Regional Vegetable Breeding Laboratory at Charleston, South Carolina. Bonner is a very good new midseason variety producing large kernels.

Lettuce. A test of head lettuce varieties was initiated in 1949. The seed was sown in the greenhouse in midwinter and plants were shifted to the field on April 5. Irrigation was necessary during April. During May and June the rainfall was adequate and temperature was below average so the season was more favorable than most seasons for lettuce. The three varieties found to be most satisfactory for head production were Cosberg 3719 (USDA), Penn Lake (Penn. Agr. Exp. Sta.), and 20609M (USDA and Calif. Agr. Exp. Sta.). Other varieties worthy of further testing were Imperials 44 and 456, New York 515, Great Lakes, and selections 20454M and 20298M from California.

Onions. In a preliminary test of onion hybrids with several standard varieties the hybrids were superior because of earliness, thereby avoiding much thrip damage.

PAUL K. YAGYU, H. O. WERNER

Potatoes. Twenty-two potato variety test plots were conducted by the Outstate Testing Project during 1949. Seven were between Omaha and North Platte and the remaining fifteen were in the western potato area. Most varieties in plots at the experiment substations were replicated for yield. Others were single-row plots for observation.

All available varieties known to have scab resistance were tested. Two white varieties—Ontario from New York, and Menominee from Michigan—proved very resistant but both were too late and produced too many poor quality tubers to be recommended for Nebraska. Yampa, a white variety from Colorado, showed considerable scab resistance and was satisfactory on dry land, but under irrigation produced too many large tubers, growth cracks and hollow hearts. Progress was the only variety with some scab resistance that can be recommended to growers that have scab in their land. Although it was not immune to scab infection, fewer tubers had lesions than with any other red variety; the lesions covered less tuber surface and were not as deep. Unless grown under the best cultural conditions this variety may produce too many small tubers and growth cracks. Because of small tubers, it was not satisfactory for central Nebraska.

The following table gives a comparison of Triumph with the most scab-resistant varieties. Averages are based on eight irrigated plots and five dry-land plots, except for Ontario and Menominee which were in only four dry-land plots.

Comparison of Triumph with scab-resistant varieties.

Culture	Variety	Total yield	Yield U.S. No. 1	Per cent			
				U.S. No. 1	1 scab*	2 scab*	3 scab*
Irrigated	Triumph	396	127	32	13	21	7
	Progress	374	161	43	11	8	1
	Yampa	340	156	46	9	1	0
	Menominee	310	158	51	3	1	1
	Ontario	253	124	49	3	1	0
Dry	Triumph	172	69	40	3	8	1
	Progress	182	87	48	2	3	1
	Yampa	203	120	59	1	2	1
	Menominee	173	73	42	1	1	1
	Ontario	158	58	37	1	0	0

* 1 scab = slight infection, 2 scab = medium infection, 3 scab = severe infection.

Because the length of season required for many varieties was not known, four plantings of all lines were made at the two western substations, beginning May 19 and continuing at two-week intervals until July 1. Varieties known to require a long season were planted the third week of May in the other plots. This was two or three weeks ahead of the customary planting date in that area. The others were planted on the usual planting dates. It was hoped that some of the lines requiring a long season would take advantage of the longer growing period and produce a larger yield.

A poor stand was obtained for the last planting at each of the two western substations. This was due to the difficulty of keeping seed late in the season and to the drying out of the topsoil at planting time. On the dry-land Box Butte Experiment Farm the largest total yield and yield of U. S. No. 1 tubers was obtained from the plantings made June 2 and June 17. On the irrigated Scottsbluff Substation the largest yield of U. S. No. 1 tubers was generally obtained from the June 3 and June 16 plantings. With the earliest planting dates, scabby and rough potatoes were produced in greater abundance.

Very few new varieties obtained from other states gave satisfactory results under Nebraska conditions. Waseca and Satapa from the Minnesota Experiment Station set a small number of tubers and they may have had sufficient size for dry-land production in central Nebraska. However, Satapa tubers sometimes had many growth cracks and those of Waseca always had deep eyes. Both lacked the bright red color of Triumph and Red Warba. Kennebec, a large long white USDA introduction, showed promise in central Nebraska. Although it yielded well in western Nebraska, it was very late and produced many rough tubers. It was extremely susceptible to fusarium wilt. Essex from New York produced a good yield but needs further testing. Lasoda, a bright red variety from Louisiana, produced large potatoes on dry land but under irrigation it gave extremely large hollow-heart tubers.

Of the unnamed lines from the Nebraska breeding program one white and three or four red lines show some promise. One red line may be well adapted to the central area, since it produces large yields of tubers which are better than those of Red Warba.



Custom-built level-bed potato digger mounted under tractor and used for harvesting outstate tests. It can be turned sharply for use in small plots. The whole assembly is easily loaded on a truck.

Because of the possible seed value of potatoes planted late at North Platte, one plot was planted there July 8. Since the yield and quality of tubers obtained was acceptable, this plot will be repeated another year.

ROGER SANDSTED

Sweet potatoes. Sweet potato variety plots including from 15 to 30 varieties or advanced selections were planted by the Outstate Testing Project at Nebraska City, Omaha, Kearney, North Platte and Dakota City. Yield and quality of crops harvested in the eastern Nebraska plots were comparable to those in the regions considered most favorable for sweet potatoes. At Dakota City, Kearney and North Platte, all near the margin of the sweet potato production area, yields and percentages of U. S. No. 1-quality roots were sufficiently high to justify serious interest in this crop not only for home use but for commercial production. Among the most promising varieties for these areas are Red Nancy, Orange Little Stem and Ranger. Older varieties that yield well but whose roots are not as good in quality are Red Bermuda, Nancy Hall and Yellow Jersey. Some of the roots from these plots were analyzed for ascorbic acid and carotene.

Tomatoes. Ten varieties and advanced lines were planted in five locations to study their adaptation. Sioux was satisfactory in yield at all locations and distinctly so at Scottsbluff. Segregates from a Red Cloud x Rutgers cross showed promise because of its dense foliage, excellent fruit type and yield.

Under lower temperature and high altitude conditions in western Nebraska, there was a general reduction in vine size, fruit depth and fruit-wall thickness. The extreme-determinate line referred to in the 62nd Annual Report did not show the proportional decrease noted in the larger-vined types.

Muskmelons. In a preliminary Outstate Testing Project trial of 12 varieties at Florence, Nebraska, varieties showing up well were Iroquois, Early Sunrise, and Pride of Wisconsin.

H. O. WERNER, PAUL YAGYU, ROGER SANDSTED

Vegetable Breeding Experiments

Potatoes. The breeding program to develop a scab-resistant, red-skinned, early-maturing variety of potatoes with superior cooking quality was continued. The work embraced the following activities.

1. Crossing advanced red-skin tuber selections of good cooking quality with a number of scab-resistant varieties or breeding selections. A total of 233 such crosses were made in February and March of 1949.

2. Initial tuber production from 16,600 seedlings in the greenhouse in the fall of 1949 for planting in the field in 1950. With half of these the growing medium was inoculated with a virile culture of common potato scab to determine the possibility of ascertaining the degree of scab susceptibility or resistance in the first tuber generation, thus permitting the elimination of many clonal lines without field tests.

3. Field increase of 12,000 seedlings (harvested in the greenhouse in January, 1949) in an isolated scab-infected field at the Scottsbluff Substation. All tubers produced by 251 seedlings (mostly red-skinned) were saved because of superior appearance. In addition, 3,298 tubers were saved as single tuber selections from each plant of 178 families having scab resistance in parent or grandparent stocks. These will be planted at Scottsbluff and Alliance on land that is heavily infected with common scab.

4. Tests of seedling selections for adaptation to various Nebraska conditions, commercial suitability, insect resistance, cooking quality and ascorbic acid content.

5. Preintroduction of seed stocks of advance lines, in cooperation with the Box Butte Experiment Farm. Disease-free stocks of approximately 20 advance lines are being built up for more comprehensive field tests and for possible dissemination. Of these, two white-skin selections and three or four red-skin selections look very promising for commercial production. The Foundation Seed Department of the Nebraska Certified Potato Growers Cooperative participates by developing a supply of foundation seed stock and building up preintroduction stocks of seed potatoes.

6. Launching two new varieties. Throughout the winter of 1948-1949 two new varieties were named and introduced—the Progress and White Cloud. After the commercial acceptability of Progress was established by marketing several carloads in Chicago, St. Louis and Lincoln (by a cooperative), the variety was released for commercial production. Approximately 30,000 bushels of seed potatoes were sold to 160 certified seed and commercial potato growers who planted them on 2,200 acres in north-western Nebraska. Of this acreage, 66,655 bushels produced on 333 acres were certified for seed in 1949.

Progress appears to have been well received in western Nebraska. Seventy farmers reported average total yields of 362 bushels per acre with Progress when Triumph, grown under comparable conditions, yielded 348 bushels. Growing conditions in western Nebraska in 1949 are recognized as exceptionally favorable for harvesting Triumph potatoes without mechanical injury. In spite of these favorable conditions for the Triumph,

Progress surpassed it in production of U. S. No. 1 A-grade tubers, the average yield of this grade having been reported as 64 per cent for Progress and 53 per cent for Triumph, so that the average yields per acre were 232 and 186 bushels. In other years the differences in these grades have been greater because of more scab and mechanical damage with Triumph.

Despite this superior performance of the Progress it has several shortcomings that may prevent it from being grown by many farmers in western Nebraska unless their production methods are greatly modified. A much noticed difference is the high percentage of small tubers, the B-size (under 1 $\frac{1}{8}$ inches) having averaged 16.4 per cent with Progress and 9.1 per cent with Triumph. However, when yields are high this percentage will generally be lower and in fields of low virus disease content these small potatoes have high value for seed purposes. The most serious grade defect is the production of tubers with growth cracks. Some farmers have encountered difficulty in obtaining a good stand of plants. This variety is not suitable for the South or for eastern Nebraska.

These difficulties with Progress can be overcome by greater spacing of the plants or by planting smaller seed pieces, by irrigating earlier and by keeping the top 2 feet of soil constantly moist until mid-September.

The use of small whole seed will eliminate most of the difficulty in obtaining stands of plants. If grown with well proved methods, which should be used by all potato growers, Progress will probably prove satisfactory with irrigation in western Nebraska, but it is looked upon as a "stop gap" variety until another of equal scab resistance and better grade quality evolves from this project.

The White Cloud variety is being grown commercially in central and eastern Nebraska. It has been well received because of attractiveness and uniformity of tubers and superior cooking quality.

H. O. WERNER, HAROLD CHAPMAN, ROBERT O'KEEFE

Tomatoes. A selection from the cross Red Cloud x Illinois 698-228 has shown promise as an early home garden type. It is compact and produces fruits about 10 days earlier than Red Cloud. Progress has been made in obtaining better and larger fruited lines by means of crossing to other determinates.

Segregates from Red Cloud or Sioux crossed with denser foliage types have shown promise for adaptation to the Great Plains area. Their denser, larger foliage has given more protection from sunburn without loss of yielding ability.

Selections from the cross Red Heart x Pan American have given long, solid, meaty fruits which are excellent for slicing, ripening the same time as Sioux.

As a precaution against outbreak of spotted wilt like that in the vicinity of Lincoln in 1948, a program for procuring resistant material has been initiated. This disease is very destructive and has an extremely wide host range; therefore, an outbreak may be expected in any season and in other locations. There was no outbreak during the summer of 1949, so the project for isolation of resistant material is being carried on in the greenhouse during the winter with the cooperation of the Plant Pathology Department.

To determine varietal purity and conformation to the original type, comparative tests were grown with seed samples of the Sioux variety

procured from 10 commercial sources. Observations in these tests indicated that: (1) Most lines conformed to the original type. (2) Several lines had varietal mixtures (chiefly Red Cloud). One sample was mislabeled and consisted mostly of Red Cloud types. (3) One company had selected a larger flatter-type fruited line for the canning trade.

PAUL K. YAGYU

Cultural Experiments with Potatoes

Rate of tuber development. To determine their rates of tuber production, Triumph, Progress and White Cloud potatoes were harvested at the Box Butte Experiment Farm on four dates from September 2 to October 12. The yield of White Cloud was greater than that of the other varieties when harvested on September 2, but was lowest of the three varieties at the later harvest dates. Progress, being slightly later than the other varieties, was lowest in yield on September 2 but was about equal to Triumph during the remainder of the season.

A definite decrease in total yield was observed with all three varieties from October 1 to October 12. The vines were dead and the soil was dry during this period.

Seed-piece size and planting distance. Four treatments involving two sizes of cut and whole seed and two spacings with Progress, White Cloud and Triumph potatoes were planted in 1949. Yield of potatoes from plots planted with whole seed was higher than that of similar plots planted with cut seed. Two-ounce whole seed of the Progress variety planted at 1.2 feet in the row produced 230 bushels per acre for the highest yield of any treatment in the experiment. Good stand of plants was secured with all treatments. In contrast with Triumph, maximum yield of Progress potatoes on dry land for seed purposes may be expected from 2-ounce whole seed planted at about 14 inches in the row.

In general as spacing distance in the row was decreased and to a lesser extent as seed-piece size was increased, a higher percentage of small potatoes but a greater total yield resulted.

Evidence of maturity in the vines was seen several days earlier with the 1.2-foot spacing than with the 2.4-foot spacing.

Pre-emergence management of potato soil. To alleviate the compacted condition often found in potato fields following planting, a series of treatments for loosening the soil under and around the seed piece before emergence of the plant has been applied for three years. The expected improvement in tuber type has not occurred. Total yields per acre of potatoes from the various treatments have not been significantly different.

HAROLD CHAPMAN, H. O. WERNER

Absorption of Carbon Dioxide by Potato Leaves

As part of a project to study differences between varieties in rate of metabolism, equipment for measuring the rate of carbon dioxide absorption (apparent photosynthesis) by single potato leaves was constructed and was operated in the field at the Box Butte Experiment Farm during the summer of 1949.

It was found that large natural variations occurred between paired leaves on the same plant under nearly identical conditions. A mean variation of 28 per cent was found from some 50 determinations.

The older leaves, 10 or 12 internodes from the terminal bud, were only 66 per cent as efficient in carbon dioxide absorption as the younger leaves 3 or 4 internodes from the terminal bud. Means of 8.8 and 13.3 mg. of carbon dioxide absorbed per 100 sq. cm. of leaf surface per hour for the old and new leaves, respectively, were recorded.

Hourly records of carbon dioxide absorption by individual leaves showed that the maximum rate of carbon dioxide absorption is reached between 7 and 9 a.m., followed by a gradual decline during the remainder of the day and a rapid fall to zero as light decreases in the late afternoon. Most rapid absorption of carbon dioxide by potato leaves was found at temperatures between 80° and 90° F. Under dry-land conditions at Alliance an increase in the general level of carbon dioxide absorption by potato leaves occurred after each effective rain.

A test now is underway in the greenhouse to determine the effect of several temperature levels on the rate of carbon dioxide absorption by potato leaves.

HAROLD CHAPMAN, H. O. WERNER

Potato Storage

The shell-cooled bin at the Box Butte Experiment Farm was again altered to permit a comparison of cooling potatoes by circulating air through and around a bin of potatoes. When air moved through the pile, the potatoes were cooled quickly, the temperature throughout the bin was more uniform and sprout growth was more uniform, but shrinkage was greater than in the solid-walled bin with air circulating around the bin.

H. O. WERNER, HAROLD CHAPMAN

Quality-Price Relationship of Retail Potatoes

Consumer-size packages of three red and one white variety of potatoes were issued by pairs under "blind" numbers to 55 Lincoln families for evaluation after preparation in three different ways. On the basis of appearance only (before cooking), half of the families expressed a preference for the white variety. It had been believed by most dealers that only red potatoes could be sold in this market. Most families were not discriminating in their preferences but a sufficient number detected relatively small differences in color and texture to indicate that many families would like to buy potatoes graded according to characteristics for various uses.

The study of price-size relationships was continued in Chicago by experiment stations of the North Central Region during the winter of 1948-1949. This year the project was outlined to determine the interrelation of uniform or different price upon the sales volumes of three sizes of potatoes. Interviews provided much information on the preferences of various types of customers for potatoes for various purposes. Findings from this project will be published as a regional project report.

H. O. WERNER

Fruit Breeding

Apples. Observations were continued on new varieties of apples growing at Lincoln. All varieties, except a few newly planted ones, bore some fruit during the 1949 season, although most varieties had a very

light crop. These trees fall into three groups: some on seedling roots, some top-worked on Virginia Crab interstocks, and some top-worked on Hibernial interstocks. There was some varietal difference, but in general scions top-worked on Virginia Crab produced best, followed closely by the trees on seedling roots. Scions top-worked on Hibernial were a poor third. Webster, for example, produced fruit this past season only when top-worked on Virginia Crab.

Strawberries. A sizable variety test of strawberries was planted in April of 1949. Two rows of 50 plants each, of each of the following varieties were planted: Gem, Streamliner, Minnesota 1166, Minnesota Arrowhead, Robinson, Temple, Premier, Dunlap, Blakemore, Beaver, Bellmar, Utah Centennial and Marshall. Nine rows of Sioux were planted and one each of Fairfax and Dorsett.

Walnuts. Observations were continued on the black walnut planting at Union. Fourteen named varieties secured from various parts of the black walnut's native home were in fruit this past season. For some unexplained reason the crop was generally light, but there were enough nuts for another cracking test. These varieties varied greatly in (1) number of nuts per pound (Booth 21.3 per cent—Stabler 39.6 per cent), (2) percentage of usable nuts (Hepler 96.7 per cent—Tasterite 65.4 per cent), (3) percentage of meats (Stambaugh 26.2 per cent—Booth 12.1 per cent), (4) maturity stage as indicated by the number of sappy or shriveled kernels, (5) color of the meats, and (6) percentage of the meats removed as quarters or halves.

Excessive shriveling was found in Thomas, Ten Eyck, Beck, Booth, Creitz and Stabler while maturity was good in Edras, Ohio and Mintle. Very dark-colored skins on the meats came from Thomas, Beck, Stambaugh, Rohwer, Ten Eyck and Stabler with the better or lighter color in Creitz, Hepler, Ohio and Mintle.

Edras and Hepler seemed to give the best all-round performance in 1949.

C. C. WIGGANS, V. J. MILLER

Fruit-Stocks Investigations

Top-worked Hibernial and Virginia Crab. During seven seasons' growth in the orchard, the 105 Hibernial trunks increased more rapidly in diameter than the 85 Virginia Crab. The Hibernial trees now average 3.74 inches in diameter, and the Virginia Crab trees average 3.37 inches. Almost all varieties produced some fruit in 1949, with Golden Delicious and Jonathan producing the most. These two varieties averaged almost $\frac{1}{2}$ bushel of fruit per tree. Golden Delicious was more fruitful on Virginia Crab interstock than on Hibernial, but the reverse was true for Jonathan. When the trees of these two varieties were divided into two equal numbered groups by size (large trees and small trees), 75 per cent of the large trees fruited, whereas only 33 per cent of the small trees fruited.

The bark on the trunks of all Virginia Crab trees that were top-worked with Golden Delicious and Red Delicious split badly during this past season. The splits range to 10 inches long and are quite evenly distributed around the trunk. Further observation is necessary to determine whether this was due to winter injury or to incompatibility.

New interstocks. All of the trees in this block were pruned severely the last of March. Only the scions with which the interstocks had been

top-worked were left, except on trees needing more budding. Budding was done in August to replace the missing buds. Many of the buds needing replacement had been killed by the egg-laying punctures of the snowy tree cricket. Interstocks Malling II and Malling XII were still so small that budding was deferred for another year. Two trees of Malling I which were top-worked with Wealthy bore two apples each. Since most of the trees in the interstock block were planted 5 feet apart and some were beginning to crowd, every other tree in each row was removed at the end of the past growing season.

Laboratory testing for winter hardiness. The possibility of determining the winter hardiness of apple varieties or seedlings by laboratory methods is being investigated. Shoots are frozen in a refrigerator and then placed in water where electrolytes diffuse out of them. The more the shoots are injured, the greater the amount of electrolytes diffusing out. The electrical conductance of the solution is then measured. If winter hardiness can be accurately measured this way, it will be possible to determine whether a new variety is winter hardy before it is planted extensively.

V. J. MILLER

Orchard Spraying

Blossom or fruit thinning. Apples were thinned with the sodium salt of naphthalene acetic acid. Two concentrations, 8 and 16 ounces per 100 gallons of water, were applied two weeks after the calyx spray. Three Jonathan trees were sprayed with each concentration, and three nearby trees were used as checks. At harvest, 80.4 per cent of the apples on the check trees were 2½ inches or more in size, whereas 89.5 per cent of the fruit on the trees sprayed with 8 ounces of the naphthalene acetic acid and 88.7 per cent of the fruit on trees receiving 16 ounces was 2½ inches or more in size. Total yield was smaller on the trees sprayed with 16 ounces, but the effect of a treatment on yield cannot be determined in tests involving such a small number of trees. The value of waiting until after bloom to thin fruit is that the thinning spray can be omitted if fruit set is poor.

Control of apple scab and blotch. Four of the newer fungicides, Fermate, 341 "C", Puratized, and Tennessee "26" Copper, were compared with the standard treatment of liquid lime-sulfur followed by wettable sulfur to control scab and blotch. Too little scab was present to give an idea of the relative merits of these materials. The Tennessee "26" Copper caused severe russetting of Jonathan apples. Fermate gave the best control of the blotch on Duchess fruits.

Effect of fungicides on the growth of young apple trees. The top-worked block of Hibernial and Virginia Crab trees, now seven years old, is divided into five plots receiving different spray treatments. The different spray materials being used are Fermate, Puratized, 341 "C"; Tennessee "26" Copper, and liquid lime-sulfur followed by wettable sulfur. These treatments have been used on the same plots during the past two seasons. Best growth has been made by the plots sprayed with Puratized and Fermate; poorest by the plots sprayed with Tennessee "26" Copper and with liquid lime-sulphur followed by wettable sulfur.

Control of cherry leaf-spot. All regular spray treatments, including four applications each of Fermate, 341-"B", Phygon XL, and the standard

spray of lime-sulfur solution followed by a 4-6-100 Bordeaux mixture, failed to prevent defoliation by this disease during the past season. When a second post-harvest spray of the Bordeaux mixture was applied, excellent control was obtained.

V. J. MILLER

Orchard Culture

This project has entered a new phase in the young contoured orchard blocks at both Union and Lincoln. The Lincoln area was seeded down in late fall but the one at Union is still under clean culture. A few breaks in the contour ridges occurred during the unusually wet month of June, but in general there has been sufficient storage capacity to hold what would otherwise have been runoff.

In the vineyard, deep soil sampling indicates that with the above-normal rainfall of the past year soil moisture conditions are very good to 30 feet or deeper in the mulched area and average over 2 per cent higher than in the cultivated area. The relative percentages of moisture based on the dry weight of the soil on November 19 were 27.3 for the mulched block and 25.1 for the cultivated rows.

C. C. WIGGANS

Supplemental Water for Eastern Nebraska Orchards

With an annual rainfall of nearly 34 inches at Union during the past calendar year there probably was no need for supplemental water in orchards. This precipitation was well distributed, with 2 inches or more falling each month between March and October. During June 11.95 inches of rain fell but most of it was conserved for later use because of the large number of relatively small rainfalls. This amount of precipitation, particularly when it is combined with moderate summer temperatures, is probably ample to meet the needs of most orchard crops.

Some deep soil sampling done in commercial plantings near Nebraska City tends to support the above supposition. In one case where samples were taken near the spot sampled several years ago, moisture percentage is definitely higher than it was at the earlier date. Increase in the moisture percentage is apparently greater in the upper levels with replenishment being definitely less at the greater depths.

In another orchard a number of samples taken at various locations with respect to tree position and variety gave indications that the upper 15 or 20 feet had a better moisture supply than the lower levels. This might be explained by the hypothesis that the water supply has been replenished during the past several years but that this replenishment has not yet reached the point where all the previously removed water has been restored throughout the root zone. Unfortunately, no earlier sampling had been done in this orchard which is now about 10 years old. It is planned to continue the sampling work in this orchard with the idea of getting a continuing record of the moisture situation.

In the young Delicious block at Union several samples were taken during the growing season. Moisture in the upper 10 feet was definitely less in mid-November than below that level but was still adequate despite the fact that these trees are planted at four times the normal number per acre.

A sample taken in the 30-year-old Wealthy block in mid-June showed a definitely low available moisture content below the 5-foot level. Moisture in this upper layer had been replenished by the earlier rainfall but the amount over and above the current needs of the tree had not been great enough to penetrate very deeply.

The use of trees on contour ridges is contemplated for this orchard. Water can then be more definitely controlled. Water application may also be combined with varied cover cropping practices.

This project was cooperative with the Agricultural Engineering Department.

C. C. WIGGANS

Horticultural Studies at North Platte

Strawberries. In the cooperative breeding and testing program being conducted with the Cheyenne Horticultural Field Station about 7,000 seedling strawberries have been fruited and 175 selections made at North Platte. These have been planted in ten-plant blocks for further evaluation. Plans have been completed to add some 400 selections made from the 24,000 seedlings grown at the Cheyenne Station to the block in 1950. Cheyenne 1215, a selection from the Cheyenne Station, was named "Sioux" and released to growers by the Bureau of Plant Industry. This release was largely the result of extensive trials by the North Platte substation. Foundation stock of Sioux was distributed to growers by the Substation in the spring of 1949 and plants will be available to the public through the nursery trade in 1950.

Grapes. A variety vineyard came into full production in 1949. About 30 varieties were fruited. Many varieties that cannot be considered hardy are being fruited successfully. Such varieties are trained in the fan type and are pruned and covered with earth before cold becomes severe. Experience here indicates that anyone in Nebraska should be able to grow all the grapes needed for home use by following this method. Even such tender varieties as Seneca have wintered and fruited well. Portland and Ontario (white); Athens, Van Buren and Siebel 1000 (blue); and Agawam and Brighton (red) have performed best under this type of culture. The Minnesota varieties Blue Jay, Moonbeam and Red Amber appear hardy at North Platte without protection and rate fair to good in quality.

Fruit understocks. Grafts of various fruit understocks were planted in the nursery. Weather was unfavorable but enough grafts grew to give a fair number of plants. Stock from previous propagations has reached a size for field planting in 1950.

Developing resistance to aster yellows. The cooperative work between the North Platte Substation and the Cheyenne Horticultural Field Station in breeding yellows-resistant asters was carried through the second season. Approximately 100 lines from the Cheyenne Station were planted at North Platte under epidemic conditions for the disease and screened for tolerance to the disease. Many lines were badly infected and were discarded. All lines showed some infected plants but about 25 individual plants showed no symptoms. Seed was saved from these apparently immune plants for 1950 planting.

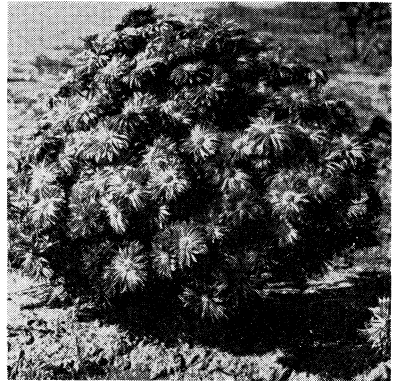
GLENN VIEHMEYER

Chrysanthemums. Stock of three new chrysanthemums, Pearle Parkinson, Ponca and Santee, was distributed to growers for increase. Limited stock should be available to the public through the nurseries in 1950. About 175 selections from seedlings grown at the Station are in various stages of testing. A few of these may be ready for release in 1950-1951. These advanced selections are being tested on a local, state and regional basis. Determination of frost tolerance was added to the objectives of the chrysanthemum project. Seedlings from the most frost-tolerant Station selections were grown in 1949. Frost tolerance was transmitted to many seedlings, with several showing more tolerance than the parent selections. A number of seedlings exposed to 20° F. showed only minor injury. The hardiest of these will be used in breeding. An estimated 25,000 hand pollinations were made under controlled conditions to provide seed for 1950 planting. Three to four thousand seedlings will be grown.

GLENN VIEHMEYER

Right, Pearle Parkinson chrysanthemum (N.P. 805), released in 1949. An early blooming, scarlet and yellow border variety.

Below, Santee (N.P. 804), released in 1949. An early blooming, semi-double, bright yellow. Valuable for cutting and for the perennial border.



Plant Diseases

Department of Plant Pathology

Studies on plant diseases were conducted in the greenhouse, in the field at Lincoln, at the various experiment substations and as a part of the Outstate Testing Project throughout the State.

Bean Diseases

Genetic studies of the halo blight reaction in bean were conducted during 1949. The segregating populations were grown in the greenhouse and field and inoculated artificially. A more reliable method of inoculation has been employed in an attempt to more accurately evaluate breeding material for halo blight resistance.

A new wax bean selection possessing a moderate degree of resistance to halo blight has been furnished the Outstate Testing Project for tests on adaptability across the State. In previous tests under irrigation the wax bean selection has appeared to be far superior.

Selections and varieties were tested for resistance to common blight, *Xanthomonas phaseoli* (E.F.S.) Dowson, under greenhouse and field conditions. In the greenhouse 17 of 196 selections were retained and tested further in the field in western Nebraska. Only two plants showed some degree of tolerance. Of beans planted on three different dates, those sown on the earliest date appeared to be more severely infected than those sown later.

M. L. SCHUSTER

Sugar Beet Diseases

The effect of the length and type of rotation of crops on the severity of root knot was studied at the Scottsbluff Substation. The shorter the rotation the greater the amount of disease, with a continuous sugar beet plot producing beets with 100 per cent of roots severely affected. The four- and six-year rotation systems had definitely less damage in 1949 than the two-year, three-year and continuous plots. Application of commercial fertilizers materially decreased the percentage of disease in short rotations (two- and three-year) but not in the longer rotations. No differential effect on disease resulted between the use of alfalfa and sweet-clover as was noted in 1947.

Seed of several crops planted in a field known to be heavily infested with root knot nematode showed a narrower host range for the organism than previously noted. Certain crucifers, legumes, grasses and solanaceous species usually considered susceptible proved to be resistant. Foxtail, puncture vine, pigweed and Kochia were not resistant.

A comparison of stand counts made after thinning with those just before harvest was used as an indication of the severity of root rot in the rotation systems at the Scottsbluff Substation in 1949. A correlation between the length of the rotation and percentage stand was indicated, the shorter the rotation the greater the reduction in stand. In the continuous, two-, three-, four- and six-year rotation systems the reduction in stand was 56, 26, 15, 16 and 14 per cent, respectively. This result checks favorably with that obtained in 1948. Application of nitrogen (125 pounds ammonium nitrate per acre) and phosphorus (50 pounds treble-super-

phosphate per acre) fertilizer apparently reduced the amount of disease in the two-year rotation but had no material effect in the longer systems. Similar results were obtained with manurial applications. It was also noted that scab of beets was more severe in plots heavily watered or located in low places.

The effect of types of crops on the percentage of root rot was studied. One plot in alfalfa for many years was plowed in 1948 and planted to five different crops. In 1949 this entire plot, including alfalfa, was sown to beets. Root rot was not a problem except where beets followed beets. However, yields were low following potatoes and beets in the manured half of the plot and low after potatoes, beans and beets in the non-manured half of the small rotation plot.

Application of Arasan (5 pounds per acre) on each side of sugar beet seed produced an 80 per cent increase in stand in a plot heavily infested with damping-off and root-rot organisms. This chemical also has a residual effect—10 per cent more plants survived compared with the untreated after thinning, and 92 per cent greater yield resulted.

Selections of mother sugar beets were made in 1947 for resistance to soil-borne diseases. Seed from these beets planted in a heavily infested plot in 1949 produced a 22 per cent increase in the initial stand. Thirty-five per cent more beets survived attacks by soil-borne parasites during the course of the growing season. A 147 per cent increase in yield was produced by beets originally selected for resistance. Further selections were made from rows planted to seed from the original selections.

M. L. SCHUSTER

Cereal Diseases

Greenhouse studies with corn planted in nonsterile soil have shown that seedling blight from soil-borne organisms is more severe with seedlings grown from seed dried artificially at 105°F. than with seedlings from seed dried at room temperature. Studies are in progress to determine why artificially dried seed is more susceptible. Blight was also greater with seedlings from immature than from mature seed.

A cooperative arrangement is being maintained with the Agronomy Department for testing the breeding material used in the production of hybrid corn for susceptibility to the organisms producing stalk rots.

Studies are being continued to determine the effect of host predisposition on the development of root rots of corn and wheat.

Thirteen isolates of the scab organism *Gibberella zeae* are being studied to determine if they represent different physiologic races. This information is essential in any breeding program designed to develop varieties of wheat, corn or barley that carry resistance to the scab organism.

Methods of inoculating corn with *Gibberella zeae* that would permit accurate studies of nutrition and other external factors on the development of root rot and seedling blight are being developed.

Seed treatment tests were conducted in cooperation with the Out-state Testing Project at different locations. Benefits in stand were obtained at practically every location. This is in contrast to previous tests when no benefits were obtained. It is therefore demonstrated that seed treatment benefits may be expected only when certain environmental conditions exist. It is apparent that seed treatment is good insurance for Nebraska farmers in obtaining good corn stands.

J. E. LIVINGSTON

Diseases of Special Crops

Eight different chemicals were used in a study of the effect of fungicidal sprays upon *Alternaria* leaf spot of safflower. Five applications of these chemicals during the course of the season indicated that Yellow Cuprocide, Copper A, Parzate, Zerlate and Arasan were effective protectants, increasing yields from 38 to 71 per cent. Dithane and Tribasic Copper Sulphate caused a decrease in yield in all cases and Fermate reduced yield in two or three replications. Dithane produced the most pronounced visible injury, causing brown, dead areas on the leaves and subsequent drying of these organs.

Safflower rust was found to be caused by *Puccinia carthami* Corda and was found to be seed-transmitted by teliospores. This disease was more prevalent in western Nebraska than *Alternaria* leaf spot, being found in every field inspected. Collections of rust were made from Lincoln and parts of western Nebraska in order to study the possibility of biologic races. These collections will be used for genetic studies of disease reaction of safflower in cooperation with the Chemurgy Department.

Root rot of safflower, first observed in Nebraska in 1948, appeared again this year. A Phycomycetous fungus appears to be the chief agent as indicated by isolation and pathogenicity studies. Varietal reactions to this pathogen are being conducted in the greenhouse in cooperation with the Chemurgy Department.

M. L. SCHUSTER

Virus Diseases

Phloem necrosis of elm continued to devastate the American elm in the vicinity of Lincoln. Several hundred large elms within the city limits were lost in 1949. No control measures have been found that are economical at present.

Western wheat mosaic appeared in epidemic proportions in southwestern Nebraska in the spring of 1949. It was accompanied by a serious epidemic of aphids which workers in other states have reported as vectors of this virus. The amount of damage was closely related to the date of planting of the wheat. Wheat planted late in the season was usually not seriously affected. Observations in Kimball and Cheyenne Counties indicated the presence of a combination of wheat mosaic and root degeneration which in many areas completely destroyed the wheat. Tests in the greenhouse designed to clarify this complex situation are underway.

Studies in cooperation with other departments are underway to devise adequate control measures for the tomato spotted wilt disease. The 1949 season was not as favorable for the spread of this disease as previous years and field tests designed to control it were therefore fruitless. This work will be continued, as will cooperative tests for varietal resistance to tomato spotted wilt.

W. B. ALLINGTON

Plant Disease Survey

Grain diseases. The cooperative disease survey in cereal crops has been continued. It was possible through this project to follow the development of a serious epidemic of leaf rust. The estimated yield loss in wheat caused by this disease alone was placed at 50 per cent in some areas. This cooperative survey also enabled authorities to give immediate

and accurate information to people vitally concerned with the weekly prospects of black stem rust damage in wheat.

Western wheat mosaic was the direct cause of crop failures on certain farms in southwestern Nebraska. This disease was perhaps more serious in 1949 than at any previous time.

J. E. LIVINGSTON

Potato diseases. Potato scab was much less serious in general in western Nebraska in 1949 than in recent years. In the central Nebraska potato area late blight caused some heavy losses in storage. Pink rot was reported from scattered areas in the State.

Tomato viruses. Tomato spotted wilt was less serious in the Lincoln area although the viruses of tobacco mosaic and cucumber mosaic caused some damage.

W. B. ALLINGTON

Beans. Rust caused considerable damage to field beans in western Nebraska in 1949. Fields in low-lying areas were more severely affected.

Safflower. A disease causing severe damage to buds and young leaves of safflower was prevalent in the Lincoln and Mirage Flats areas. Most bud blight was observed in early plantings. The cause of this disease is unknown.

M. L. SCHUSTER

Grass diseases. Specimens of fungi causing diseases of grasses were collected in considerable numbers during the 1949 growing season. These, coupled with the collections of the previous season, begin to give a clearer picture of the fungus flora of Nebraska grasses. The determination of the smut fungi affecting grasses in Nebraska is now complete insofar as available material is concerned. No major epiphytotics were observed, but several minor problems of grass diseases became evident.

W. W. RAY

Seed Treatment Tests

Results from nine oat and seven barley seed treatment tests with Ceresan M showed very little, if any, increase on subsequent grain yields. The tests were located at points across Nebraska. Corn seed treated with Arasan and grown at nine locations across the State gave a small but consistent increase in seedling emergence and vigor. Studies on inhibition of potato seed-piece decay under field conditions were conducted at Wood River. Five chemical and two cultural treatments were employed. Dithane dip, B.K. dip, Arasan dust, Z-78 dust and planting the seed pieces immediately after cutting materially aided in maintaining sound seed pieces for six weeks after planting. Fermate dip and planting the seed pieces four to eight hours after cutting proved unsatisfactory.

Field Bean Date-of-Planting Tests

Tests involving three dates of planting for six bean varieties were conducted in Scotts Bluff and Dawson Counties. At both locations the medium date, June 10, resulted in significantly better yields than either the earlier (June 1) or later (June 22) date of planting. The later date of planting proved to be too late for the beans to mature.

Adaptability of the Hybrid Wax Bean, 4023, in Nebraska

The hybrid wax bean, 4023, which has recently been developed at the Scottsbluff Substation, was tested at five locations across the State. In the Panhandle area the hybrid yielded better than the standard varieties. The tests conducted farther east indicated that this bean is probably adapted only to the High Plains area.

Susceptibility of Crop Varieties to Disease in Outstate Plots

Leaf rust of wheat (*Puccinia rubigo-vera tritici*) was present in epidemic proportions over all of the State except the extreme western portion. All wheat varieties were heavily attacked with the exception of C.I. 12128 which displayed a high degree of resistance. All rye varieties were heavily infected with leaf rust. Crown rust of oats (*Puccinia coronata*) occurred in epidemic proportions in eastern Nebraska where oat varieties having Victoria and Bond parentage showed high resistance. Helminthosporium blight of oats (*Helminthosporium victoriae*) extended approximately 100 miles farther west in the State than in previous years, reaching as far as North Platte in the case of susceptible varieties. Plots of sorghum, castor beans, safflower, soybeans and corn did not develop enough disease to warrant evaluation of varieties for disease resistance.

JOHN L. WEHING

Investigations in Agricultural Chemistry

Department of Agricultural Chemistry

Nutritive Value of Rations for Chicks

Vitamin concentrate additions to a chick ration. The beneficial effect of adding single vitamins, or groups of vitamins, to deficient diets is readily demonstrated. However, poultry raisers are prone to make additions to a good ration with the hope that such additions will pay their way. At the Experiment Station a good ration was mixed of corn meal, shorts, ground oats, alfalfa meal, corn gluten meal, soybean meal, 3 parts each of fish solubles, meat scraps and dried buttermilk, and 2 parts of a vitamin D blend. To this was added a vitamin concentrate which furnished liberal amounts of riboflavin, pantothenic acid, choline, thiamin and niacin. Feeding the ration with and without the vitamin concentrate to day-old chicks failed to demonstrate any growth advantage in the group fed the concentrate up to four weeks of age.

Iodocasein additions to a chick ration. Special protein additions to chick rations have been studied by several workers. One such addition is iodinated casein which exhibits thyroxine-like properties. The addition of appropriate amounts of iodocasein to the basal ration described above failed to increase the growth of chicks fed from one day to four weeks of age over those on the diet without the addition.

Alfalfa in chick rations. The use of dehydrated alfalfa meal in chick rations has been under scrutiny recently, particularly in light of the so-called "high-energy" rations which omit it entirely. A test has been run on four lots of 16 hand-fed day-old chicks in which all chicks consumed equal amounts of feed. A basal ration was made of 57 parts ground yellow corn, 22 parts soybean meal, 10 parts corn gluten meal, 5 parts meat scraps, 2 parts fish solubles, 1 part animal sterol, 2 parts limestone and 1 part salt. In this base ration substitutions of 2, 4 and 6 parts of a good quality dehydrated alfalfa meal were made at the expense of the corn meal.

These four rations were fed to day-old chicks until each had eaten 900 grams. On these rations some of the chicks finished their allotment earlier than others. It took an average of 49, 44, 46 and 43 days, respectively, for the birds in lots fed rations carrying 0, 2, 4 and 6 parts of dehydrated alfalfa meal to consume 900 grams of feed.

The average weights of the chicks based on the empty weight the morning after the day on which each had finished its allotment of 900 grams of feed were 439, 465, 443 and 445 grams, respectively, for the lots fed 0, 2, 4 and 6 parts of dehydrated alfalfa meal. Individual variations between chicks in each lot were low so the difference between the lots fed none and 2 per cent alfalfa meal was of borderline significance. The lots fed 4 and 6 per cent of the meal weighed essentially the same as the lot without the alfalfa addition. It was evident in this study that the lots receiving alfalfa ate the ration more readily than the lot without the additions, finishing three to six days earlier. This would be a factor in broiler production.

Growth inhibition of saponin in alfalfa feeding. Alfalfa contains a foaming agent, saponin, to which toxic properties have been ascribed. The effect of saponin on chick growth was investigated by adding 1 per cent of commercially prepared saponin to a practical chick ration. The group of chicks on the saponin ration gained an average of 406 grams from hatching to six weeks of age with an efficiency of gain of 32 per cent (gain/feed consumed \times 100). The group on the same ration without saponin gained 459 grams with an efficiency of 34 per cent.

C. W. ACKERSON, R. L. BORCHERS, J. E. TEMPER, F. E. MUSSEHL

Nutritive Value of Legume Seeds

Biochemical and nutritional research was continued on the fundamental cause for the improvement in the nutritive value of soybeans and certain other legumes by cooking.

Purification of the growth inhibitor in soybeans. Continued efforts were made to isolate the factor responsible for the inferior value of raw soybeans. The growth inhibitor can be adsorbed from soybean extracts by several adsorbing agents. Elution of the growth inhibitor from these agents was not successful. Fractionation of soybean extracts with ethyl alcohol accomplished partial purification but most of the growth inhibitor appeared to be inactivated by the alcohol.

Comparison of eleven species of legume seeds when fed raw and autoclaved. Eleven species of legume seeds were ground and a portion autoclaved at 15 pounds pressure for 30 minutes. The ground seeds, raw or autoclaved, were fed to rats as the only source of protein at a 12 per cent protein level in an otherwise adequate diet. The nutritive value of the following was improved after autoclaving as judged by rat growth: velvet bean, black-eyed pea, jack bean, lentil and horse bean. The nutritive value of the following was unchanged by autoclaving: peanut, partridge pea, lespedeza, mung bean, guar and common vetch.

Studies on Alfalfa in Chick Rations

High levels of alfalfa. Alfalfa meal was fed to chicks at levels of 5, 10, 15, 25 and 35 per cent in an otherwise adequate ration low in fiber. Growth was generally satisfactory at the 5, 10 and 15 per cent levels. At the 25 per cent level, growth of chicks was distinctly depressed and was even more depressed at the 35 per cent level.

Fractionation of alfalfa. Efforts were made to determine the factor or factors in alfalfa responsible for the poor growth of chicks when fed high levels of alfalfa. Alfalfa fiber was prepared by the Chemurgy Department from fresh alfalfa by squeezing out the soluble materials in an expeller press. Fiber was also prepared by digesting and extracting the soluble materials from alfalfa meal. Feeding of these fiber preparations did not depress chick growth as much as did the feeding of an equivalent amount of alfalfa. Other fractions of alfalfa prepared were the soluble portion squeezed from the fiber of fresh alfalfa, the soluble material from the digestion and extraction of alfalfa meal, and the ash from alfalfa meal. When fed, each of these fractions depressed chick growth but not as much as an equivalent amount of whole alfalfa meal.

R. L. BORCHERS, C. W. ACKERSON, F. E. MUSSEHL

Animal Protein Factors

A chick ration deficient in "animal protein factors" (APF) is readily prepared by omitting animal protein supplements from the ration. Such a ration is referred to as an all-vegetable ration. When the all-vegetable ration is fed to chicks hatched from eggs laid by hens fed high levels of APF, a deficiency of APF is not apparent as far as chick growth is concerned to four weeks of age. However, when 20 per cent of corn germ oil meal is included in the all-vegetable ration, the growth of chicks from APF-fed hens is subnormal. Addition of fish solubles as a source of APF to the 20 per cent corn germ oil meal all-vegetable ration results in normal growth. The use of such an all-vegetable ration containing 20 per cent corn germ oil meal was investigated as an assay ration for the animal protein factors.

R. L. BORCHERS, F. E. MUSSEHL

Proteolysis in Wheat Flour Doughs

The study of proteolysis in wheat flour doughs as presented in the 62nd Annual Report has been continued by comparing the proteolysis which takes place in flour suspensions and doughs with that which takes place in the presence of an auxiliary substrate, bacto-hemoglobin. The proteolytic enzymes of wheat flour attack the wheat flour proteins very slowly, if at all, but show a marked activity toward bacto-hemoglobin. The activity of these enzymes was not increased by the addition of sulfhydryl compounds (cysteine or glutathione) and was not decreased by oxidizing agents. This is contrary to the generally held opinion that the sulfhydryl compounds act as activators and the oxidizing agents as inhibitors of the proteolytic enzymes of wheat flour.

Investigations at the Nebraska Station indicate the presence of at least two proteolytic enzymes in flour—one that is extractable with water or dilute salt solution and the other that is not removed from the insoluble material by continued extractions with these solvents.

In order to facilitate the addition of larger quantities of the water-soluble constituents of flour to doughs or other substrates, the extracts were dried by a freeze-drying method, i.e., the extracts were frozen and the material dried while in the frozen state by the use of a vacuum pump. This procedure allows the preparation of a dry powder which contains the active water-soluble enzymes.

The papain inhibitor of wheat flour, mentioned in the 61st Annual Report, is present in the water-soluble extract. A more complete understanding of the action of the inhibitor was made possible by adding large quantities of the dried water solubles from flour to doughs containing papain. Increasing quantities of the dried extract inhibited correspondingly greater quantities of papain. The action of papain on hemoglobin was not inhibited by the dried extracts until relatively large quantities were used, which indicates that some constituent of the hemoglobin combines with and inactivates the inhibitor.

Before the true properties of the proteolytic enzymes and of the inhibitor which occurs in wheat flour can be characterized, methods of separating the enzymes from the papain inhibitor must be found. The technics applied up to the present time have been unsuccessful.

B. D. HITES, R. M. SANDSTEDT

Relation of Starch to Bread Baking

The role of starch in bread baking. In order to better understand how differences in starch properties may affect the baking properties of flour, it is necessary to know how the various ingredients of the baking formula may change the properties of the starch. A study is in progress of the effects of various salts and of some polar organic compounds on gelatinization.

Various salts have profound effects on the gelatinization of starch—some salt solutions will cause gelatinization at room temperature whereas others will prevent gelatinization even at temperatures approaching the boiling point. These effects are largely due to the negative ions of the salts, e.g., the SCN ion is a dissociating agent and the SO₄ ion is very effective in raising the temperature of gelatinization, whereas the differences produced by sodium salts as compared with aluminum salts are much less marked. A study of the forces that cause on one hand such ready dissociation and on the other such strong association should lead to a better understanding of the forces that are responsible for starch granule properties and this in turn to a better understanding of gelatinization, retrogradation and staling.

Factors involved in bread staling. Previous work done in this and other laboratories on the role of starch in bread staling indicates the phenomenon of staling results from changes in the physical arrangement of the starch molecules within the starch granule.

The moisture content of the bread is a critical factor in staling. This role of water suggests the possibility that a portion of the water in the bread crumb may be in a different physical state than that commonly accepted for water. To determine the extent of water-starch interaction (or binding), studies have been conducted to obtain quantitative data that will indicate the magnitude of the affinity of starch for water during the gelatinization process. Wheat starch takes up about eight times its own weight of water on gelatinization. However, little if any of this water may be classed as "bound" water (according to the definition of "bound" water) since it is capable of dissolving sugars or other organic compounds.

One of the possible mechanisms for explaining changes in the physical arrangement of starch molecules during staling is the attraction which exists between hydroxyl groups (OH) on adjacent starch chains. It is assumed that some of the OH's of fresh starch are unassociated (not bound to other starch OH's) and that as the starch stales more become associated, thus binding the starch molecules more firmly together. Accordingly the number of unassociated OH's would be a key to the extent of staling. The unassociated OH's should have an affinity for the OH's of alcohols. Accordingly the attraction of the starch for an alcohol should be indicative of the number of the OH's of the starch which are not occupied as links between the starch molecules. To test this thesis a method has been devised for determining the attraction of the starch for methyl alcohol. This method is to be applied to starch from fresh and stale bread.

A photomicrographic study of gelatinization was supplemented by the use of motion photomicrographs of the gelatinization of a number of starches. This has permitted the observation of changes in the granules that were not perceptible by direct microscopic observation. It also affords an effective means of presenting observations to others.

R. L. GATES, R. M. SANDSTEDT

Insect Control Experiments

Department of Entomology

Studies were conducted throughout the State on the effect of insects on crops. Much of this work was done at the experiment substations and some was done on privately owned farms.

Insect Surveys and Outlook for 1950

Grasshoppers. Grasshoppers caused less crop damage in western counties in 1949 than they have for several years. Damage to crops in the south-central and eastern counties increased slightly. Rain was well distributed over the State. This tended to cause a continuous vegetative growth, thus reducing to a minimum grasshopper migrations into crops. Wheat, alfalfa and corn suffered the most damage.

A total of 1,603 farmers in 26 counties used approximately 280 tons of bait to protect 47,190 acres of crop, pasture and range land. The use of sprays and dusts for grasshopper control increased considerably during the year. The reported estimate of the acreage sprayed with chlordane, chlorinated camphene, and benzene hexachloride was 103,370. Probably twice this acreage was sprayed but not reported.

The 1949 summer and fall surveys showed that the grasshopper infestation had decreased slightly in western Nebraska and had increased in the eastern portion.

HAROLD A. HAUKE

Chinch bugs. The 1949 fall survey was made in 26 southeastern counties. It showed the hibernating population to be rather light. No chinch bug damage was reported during the 1949 season nor were any barrier materials used.

HAROLD A. HAUKE

Hessian fly. The harvest time survey in 1949 revealed very few Hessian flies over most of the winter wheat area of Nebraska. The increased use of Pawnee wheat is credited with a large part of this reduction. Pawnee wheat cannot be grown profitably in the southwestern counties, however, and as a result they have much higher fly populations than before. Increased populations have been noticed during the last three years in Kimball, Cheyenne and Deuel Counties in the Panhandle, and in the two southwestern counties, Perkins and Chase. Cultural practices and climatic conditions make it difficult for growers to follow recommended practices of fly control in these counties.

Three trial nurseries have been set up to test possible fly-resistant wheat varieties. Any varieties found to be resistant would be used in the Panhandle counties where Pawnee is not adaptable.

JACK W. LOMAX

Sweetclover weevil. No survey was made for sweetclover weevil during 1949. General observations, however, indicated that new seedings of clover fared much better than during the preceding year. From a study of the insect's life history it is expected that sweetclover weevils will appear in cycles like grasshoppers. Consequently, serious damage to legumes may not result every year.

JACK W. LOMAX, JOE PAPPAS

Banded webworm. Eleven counties in north-central Nebraska were surveyed for banded webworm. The insect was found infesting corn in all counties where the crop was planted in blow sand, Valentine sand, or loamy sand.

MARTIN H. MUMA, ROSCOE E. HILL

Small grain aphids. The high incidence of mosaic in wheat during 1949 made it desirable to conduct a fall survey to determine the presence and abundance of aphids in volunteer and sown wheat fields. It is known that some aphids transmit the virus that causes the disease. At least three species were found. One unidentified form occurred abundantly on wheat in the southwestern counties. This form was mainly infesting the roots and other underground parts of the plants. Continued observations will be made to determine the effects of these large aphid populations on the wintering of the wheat.

ROSCOE E. HILL

Termites. Commercial men, county agents, personal contacts and letter files were consulted for known locations of termites in the State. Results of the survey were generally as expected. Termite colonies can be found in nearly every county in the State. High concentrations occur along the Missouri River south from Omaha and west to McCook through the southern tier of counties. Incidence of infestation tapers to the north until only isolated cases can be found in the Sandhills. The Platte River Valley also had a greater infestation than adjacent areas.

JACK W. LOMAX

European corn borer. The European corn borer extended its range to an additional 19 counties in 1949. A total of 66 counties are now infested by this insect. This compares with 47 known infested counties in 1948, 18 in 1947, and 6 in 1946. The borer moved west into Hitchcock County in the Republican River Valley, but was static at Hershey in Lincoln County in the Platte River Valley. It also infested additional territory in the Elkhorn and Loup River Valleys. In the newly infested counties populations were low, but the borer did increase in numbers in previously infested areas. Heaviest infestations occurred in the northeastern counties. The average number of borers per infested stalk ran from a trace in the southwestern counties to a high of 5.6 in Burt County. Damage was estimated at four times the 2 to 3 million dollars lost in 1948.

Some spraying was done in a few heavily infested fields, mostly in sweet corn and valuable seed corn producing areas. Next year there could be a great deal of damage. However, as this is a border state for the pest the situation could change rapidly because of weather conditions. The infestation picture does not seem serious enough to warrant an all-out state-wide spraying campaign for next year, but control measures will undoubtedly be necessary in some areas in the northeastern section of the State.

Three new parasites of European corn borer were released in the State during the past year in cooperation with the U. S. Bureau of Entomology and Plant Quarantine. As yet it has not been determined whether these parasites will adapt themselves to Nebraska conditions.

JACK W. LOMAX, CLIFFORD WALSTROM

Livestock Parasite Experiments

Emphasis on parasite research during the past year was shifted slightly from that of previous years. Recent controversies over the hazards of new insecticides resulted in the introduction of nonhazardous chemicals into planned experiments. Additional emphasis was placed on experiments designed to determine the economic effects of parasite infestations on livestock.

House and stable fly control. Control tests on house flies and stable flies in 1949 included only two insecticides, methoxychlor and piperonyl butoxide-pyrethrum. Two types of experiments were conducted. In one test daily counts of the number of stable flies per dairy animal were used as indexes to the effectiveness of animal sprays containing piperonyl butoxide-pyrethrum. The other test was similar to those conducted in 1947 and 1948 in which the effects of residual insecticides, type of treatment, weather and sanitary methods on fly populations were studied. Sampling in this test consisted of recording the number of flies trapped on flypaper in a 24-hour period.

Weekly power-sprayer treatments of dairy animals with piperonyl butoxide-pyrethrum gave two- to four-day control periods. Daily compressed-air sprayer treatments adequately controlled stable fly populations on the animals. Additional research will be conducted to determine the maximum spacing of treatments that will maintain adequate stable fly control.

Results of the second test on house and stable flies were similar to those obtained in 1947 and 1948. Rain, temperature and sanitation were major factors affecting fly populations. Piperonyl butoxide-pyrethrum at the dosage and formulation used compared favorably with methoxychlor.

MARTIN H. MUMA, EPHRIAM HIXSON

Sheep tick control. This cooperative project with the Animal Husbandry Department and the Scottsbluff Substation was initiated in 1947. Experiments conducted in the 1948-1949 sheep feeding period included six pens of 24 feeder lambs. One pen of lambs was treated with 1.25 per cent of wettable sulfur, one with 0.25 per cent DDT, three with a combination of 1.25 per cent sulfur and 0.25 per cent DDT, and one was left untreated as a control. The lambs in the sulfur and DDT pens and in one of the DDT-sulfur pens were "pen sprayed." Those in one DDT-sulfur pen were treated by the "spray-ribbon" method, and those in the third DDT-sulfur pen were dipped.

Ticks were nearly eradicated from the dipped lambs while a striking control was obtained on the lambs receiving the spray-ribbon treatment. None of the other treatments differed significantly from the untreated control. One of the pens of lambs went off feed during the course of the experiment and weight gains could not be correlated.

The experiments will be continued for at least another year to compare dust applications with sprays and dips.

ROSCOE E. HILL, EPHRIAM HIXSON, MARTIN H. MUMA

Cattle grub investigations. In cooperation with the Animal Husbandry Department, a study was designed in 1948 to determine the occurrence and extent of animal weight losses during the grub migration and warble periods. In 1948, data were collected on 220 animals. An additional 156 animals were examined in 1949. A statistical correlation will not be attempted until 600 or more animals have been recorded.

MARTIN H. MUMA

Chicken lice experiments. Experiments designed to determine the effect of the common body louse, *Eoemenacanthus stramineus* (Nitz.), on weight gain, egg laying and feed consumption of chickens were initiated during the past year. The experiments will be continued during the coming year. The Poultry Husbandry Department is cooperating in this study.

EPHRIAM HIXSON, MARTIN H. MUMA

Hog lice experiments. Weight gains and feed consumption experiments on hogs infested with hog lice, *Haematopinus adventicius* Neum., were also initiated in 1949. The first experiment has not yet been concluded. Additional tests will be conducted. The Scottsbluff Substation is cooperating in these experiments.

MARTIN H. MUMA, EPHRIAM HIXSON

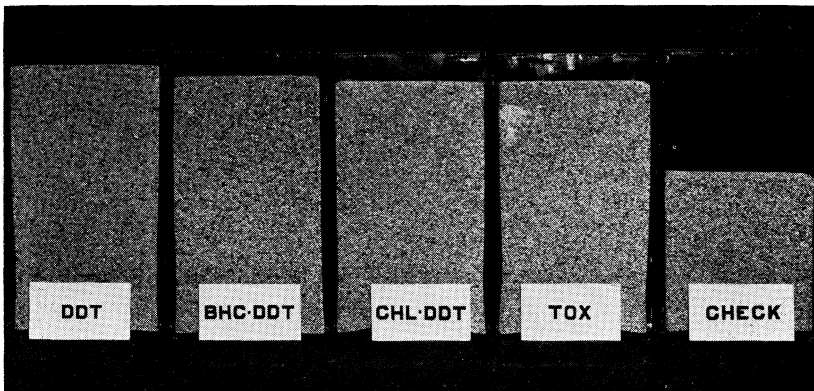
Field Crop Insects

Alfalfa seed production studies. The purpose of the 1949 tests was to determine the efficiency of sprays of various insecticides in the control of insects affecting alfalfa seed production.

The use of dust on small plots in the 1947 and 1948 tests failed to give wide differences in yields between the treated and untreated, although the insect control was striking. The failure was thought to be due to dust drift from the treated to the check plots.

The plots on the Experiment Station farm at Havelock were established in 1948 by the Alfalfa Improvement Division for these tests. There were 10 blocks, each consisting of 16 varieties or strains of alfalfa planted in three-row plots. Alternate blocks were sprayed with 1½ pounds of DDT, as a wettable powder, per acre. Two applications were necessary since the most important insect present was the potato leafhopper.

Plots on the Daniel Olsen farm at Malcolm were established in a broadcast stand of Dakota No. 12 alfalfa, and were replicated five times. Treatments were a single application of spray containing the following toxicants, given in pounds per acre: DDT, 1½; gamma benzene hexachloride, 0.36, plus DDT, 1; chlordane, 1, plus DDT, ⅔; and toxaphene, 2.



Comparative yield of alfalfa seed from various insecticide-treated plots and the untreated check plots on the Daniel Olsen farm, Malcolm, Nebraska, 1949.

The most important insects in this test were *Lygus* bugs, rapid plant bugs (*Adelphacoris* sp.), and grasshoppers.

The North Platte test was established in Ranger alfalfa planted in rows. Plots were replicated five times. Treatments were a single spray application containing the following toxicants, given in pounds per acre: DDT, 1½; chlordane, 1; chlordane, 1, plus DDT, ½; toxaphene, 2; Pyrethrin (T-313), 0.188.

The insect population in this test was low and failed to build up to sufficient numbers to cause significant differences in yield.

The 1949 tests as outlined above show:

1. That potato leafhoppers in sufficient numbers can prevent the profitable production of both alfalfa hay and seed. They can be controlled with DDT but more than one application is necessary.

2. That sprays of the insecticides used in these tests are effective for the control of insects in alfalfa.

3. That DDT is the best insecticide for *Lygus* bug control. Toxaphene is a close second and has been reported to be less dangerous to pollinating insects.

4. That profitable increases in alfalfa seed yields can be obtained by controlling insects when the population is sufficient to cause damage.

5. That mixtures of chlordane and DDT or benzene hexachloride and DDT are not superior to DDT alone in insect control under the conditions of these tests.

EPHRIAM HIXSON, JOE PAPPAS, EDWIN L. BRUNKEN

Sweetclover weevil. There was much less sweetclover stand loss in eastern Nebraska from sweetclover weevil in 1949 than in 1948. However, it was desirable to follow up in 1949 the control test results of 1948 which showed both DDT and toxaphene to be effective in the control of adult sweetclover weevils. In the 1949 tests, emphasis was placed on timing the application of the insecticides to reduce the population of adults before they laid their eggs.

Plots were established in a second-year sweetclover field and treated in early April when the new shoots were 2 to 4 inches tall and the adult beetles were emerging from hibernation. DDT was applied as a dust and as a spray at 1 pound and toxaphene as a dust at 2 pounds per acre.

Leaf samples showed a great reduction in damage in the treated plots, indicating a good kill of the adult weevils. However, an examination of the clover root systems a short time later revealed a large population of developing larvae. It therefore appears that the DDT and toxaphene applications had little effect in preventing or reducing egg laying. In an effort to destroy the developing population of larvae on the sweetclover roots, gamma benzene hexachloride was sprayed on the soil and the base of the clover plants at rates of 1 and 2 pounds per acre. Root samples taken 17 days later on June 20 in both the early and late treatments showed the following mean number of larvae per plant: DDT spray, 3; check, 2; DDT dust, 9; toxaphene dust, 9.8; gamma benzene hexachloride 1 pound, 10.5; gamma benzene hexachloride 2 pounds, 14; check, 3.5. All of the treated plots except the one on which DDT spray was used had significantly larger populations of sweetclover weevil larvae than the check plots. In making the larval counts there seemed to be more ground beetle larvae present in the check plots than in the treated plots; unfortunately, no records were kept of the ground beetles present. The ground beetle adults and larvae readily ate sweetclover weevil larvae

when caged with them. This indicates that the ground beetles were feeding on the sweetclover weevils in the checks, but that in the treated plots the insecticides were controlling the ground beetles and allowing the sweetclover weevil larvae to develop in significantly large numbers. If these data are verified in subsequent tests, it may be concluded that chlorinated hydrocarbons are killers of beneficial insects and thus in some cases actually create problems rather than solve them.

This project was cooperative with the Agronomy Department and the Bureau of Plant Industry.

EPHRIAM HIXSON, JOE PAPPAS

Grasshopper control test. This test was conducted during the 1949 season on about 800 acres of the Experiment Station farms near Lincoln to determine the effectiveness of the current grasshopper control recommendations under farm conditions for crop protection and for the possibility of eradication to avoid a 1950 problem.

Three phases of control were necessary, in the following order: (1) Control of nymphs on the egg beds, (2) control of migrating grasshoppers from adjacent areas into croplands, and (3) control of congregating adult grasshoppers in the late summer and early fall to prevent egg laying.

Crops involved were alfalfa, corn, soybeans, safflower, grain sorghum, small grain, sweetclover and various species of grasses.

Insecticides used were benzene hexachloride, chlordane and toxaphene, as dusts and sprays, and a combination of benzene hexachloride and toxaphene sprays.

Results of the above tests, carried out under the most difficult conditions, show:

1. That the present recommendations for grasshopper control are effective and economical if followed. The 800 acres of crops were protected with only a minor loss at a cost of \$1.25 per acre.

2. That where mixed species of grasshoppers are present a single application to the egg bed sites will not give complete control because hatching periods are different.

3. That adult differential grasshoppers cannot always be controlled with 2 pounds of toxaphene per acre. However, they were successfully controlled with 1 pound of toxaphene plus $\frac{1}{4}$ pound of gamma benzene hexachloride or $\frac{1}{2}$ pound each of two insecticides.

4. That the concentrations of chlordane and toxaphene could be lowered to $\frac{1}{2}$ pound of chlordane or 1 pound of toxaphene per acre when used on egg bed sites to control nymphal grasshoppers.

5. That sprays are generally more effective than dusts.

Results of the fall adult clean-up will not be known until the spring of 1950.

This project was cooperative with the Agronomy and Animal Husbandry Departments.

Responses of corn varieties to chemical control of corn rootworms. A supplementary corn rootworm control measure involving soil applications of benzene hexachloride was used in conjunction with a performance test of ten promising corn hybrids. This study formed a part of the Outstate Testing Project. At Wakefield, Wood River and Axtell the ten corn hybrids were grown in replicated plots on treated and untreated soil. Only at Wakefield did an injurious rootworm population develop. Here the benzene hexachloride was effective in significantly reducing the root-

worm population and damage. Two early-maturing corn lines lodged to a greater extent than later-maturing kinds.

Yields were not affected by the treatment. A heavy European corn borer infestation also developed at Wakefield and it is possible that borer injury may have masked any yield differences arising from the control of rootworms.

EPHRIAM HIXSON, ROSCOE E. HILL, MARTIN H. MUMA

Safflower insects. A preliminary test was conducted at Lincoln in cooperation with the Plant Pathology and Chemurgy Departments to determine whether insecticidal and fungicidal sprays would affect bud rot of safflower. Bud rot is one of the important limiting factors in safflower production in certain areas. Significant results were obtained. Bud rot was reduced and the yield of seed was increased by spraying with copper sulfate and DDT, either alone or in combination. The results indicate that insects are of some importance in the spread or development of bud rot. This work will be continued.

ROSCOE E. HILL

Cutworm control. Insecticidal tests conducted in 1948 showed that a DDT soil treatment was effective in reducing injury to corn by the sand-hill cutworm, *Euxoa detersa* (Wlk.). As the amount of DDT used was quite large (5 pounds per acre), a test was conducted in 1949 to determine the minimum effective dose. Emulsions were the only formulations used. Dosages ranged from 2 pounds to ½ pound of actual DDT per acre. A power-driven compressed air sprayer applied the sprays through 1/16-inch fan-type nozzles at a rate of 7 gallons per acre. All dosages gave good cutworm kill and produced stands of corn two to three times greater than the controls. Testing will be continued in 1950 to determine the most efficient dosage, formulation and time and method of application of the insecticide.

MARTIN H. MUMA, ROSCOE E. HILL

A sod webworm on corn. *Thamatopsis pectinifer* (Zell.), a sod webworm not normally found on corn, is injurious to the crop in northeastern Nebraska. Investigations on the identification, biology, distribution and control of the insect were conducted in 1948 and 1949.

Adult moths are identified by a wide white submarginal strip on the light brown forewing. Larvae are white to flesh colored, marked with a series of ten reddish-brown bands on the dorsal surface. Adults appear in late August and scatter their eggs over the fields. Newly hatched and partly grown larvae pass the winter in soil around sedges. Larvae mature in late August and early September. The species is confined to sandy soils. Injury to corn is usually more severe at the margins of the fields. Parasites and predators are particularly effective in controlling infestations. Avoidance of fields that contained sedges and native grasses the preceding fall offers the best control.

MARTIN H. MUMA, ROSCOE E. HILL

Garden webworm control. In the spring of 1949, injurious numbers of garden webworms, *Loxostege similalis* (Guen.), invaded corn fields in Lancaster County. As movement from the weed hosts usually occurred before the farmers noted the injury, insecticidal treatments seemed to offer the best solution to the problem.

A test field was established and several insecticides were compared. DDT and chlordane were applied as dusts and emulsions at 1 pound to

the acre, toxaphene as a dust at 1 pound, benzene hexachloride as a suspension at $\frac{1}{2}$ pound of the gamma isomer and piperonyl butoxide-pyrethrum as a dust and suspension at 10 pounds. Dusts were applied with a rotary hand duster and sprays with an estate-type sprayer at about 150 pounds pressure.

Pretreatment counts of the number of larvae per corn plant gave an average of 6.73. The mean of four daily counts of larvae per plant following application of the insecticides was used as an index to control. Only benzene hexachloride and the emulsion form of DDT gave significant reductions of larvae. DDT emulsion counts averaged 0.8 larva per plant, benzene hexachloride 0.9, and the untreated control 5.1.

EPHRIAM HIXSON, MARTIN H. MUMA

Sunflower insect control. This project, initiated in 1948, was continued during the past season. Benzene hexachloride as a suspension was the only insecticide tested. Soil treatments were applied with a sprayer at the rate of 2 pounds of the gamma isomer per acre, whereas foliage spray treatments were made at $\frac{1}{2}$ pound per acre. Foliage treatments were made at two different growth stages of the sunflower plants, one when the plants reached 18 inches in height, the other at blossoming time. A split-plot technique with two different planting dates was used.

Results of the experiment confirm the 1948 findings. Infestations of the sunflower seed weevil, *Desmoris constrictus* Say, and the sunflower head moth, *Homeosoma electellum* (Hulst.), were reduced but not controlled by the late foliage treatments. Possibility of obtaining control of the latter by earlier planting was indicated. Several stalk borers infesting the sunflowers were not affected by the treatments.

This project is cooperative with the Chemurgy and Poultry Husbandry Departments.

MARTIN H. MUMA, RICHARD N. LYNESS

Potato Insects

Three of the major potato insect pests were present in destructive numbers during 1949. In the eastern and central parts of the State, potato leafhoppers were very abundant and severe hopperburn injury was reflected in the generally poor yields in gardens and in some early-planted commercial fields. Use of DDT by most of the commercial potato growers prevented heavy losses such as occurred in 1944 when a 50 to 75 per cent reduction resulted from a heavy leafhopper infestation.

In 1949 Nebraska experienced the heaviest psyllid infestation since 1938. This was particularly true of western Nebraska. Psyllids were found throughout most of the State and the "psyllid yellows" disease was present in garden plantings at Lincoln, Fremont, Norfolk and in many other eastern Nebraska localities. Yields in early commercial plantings in western Nebraska were materially reduced because of this pest. DDT was much more generally and intensively used as a protective measure on the late-planted commercial crop than in any previous season. As a result, serious losses were prevented. However, untreated fields produced very few marketable potatoes and in a few cases the crop was not harvested.

Flea beetles were more injurious to tubers in western Nebraska than at any other time in the past five years.

The European corn borer was first observed in June in central Ne-

braska irrigated potato fields, but the infestation was light and no serious damage was evident.

Response of potato varieties to control of insects. Tests to determine the effects of insect control on the growth, quality and yield of potato varieties were continued at Lincoln. Seven varieties were planted in 50-foot rows on eight plots in an irrigated field. Four of the plots were sprayed five times during the season with DDT and four were left untreated. A heavy leafhopper population developed and some psyllids were present. Colorado potato beetles were controlled in check plots with an application of zinc arsenite. Tubers were harvested at various intervals throughout the season with a final digging on September 14. For the late harvest date, the mean average increase by all varieties in yield of No. 1-size potatoes (those over 1½ inches in diameter) owing to spraying was 49 per cent (or 127 bushels per acre).

Average weight of the vines for all varieties from the sprayed plots was greater than that of the vines from the checks. Not only was the top growth more abundant but the growing season of all varieties was lengthened following insect control. Greatest responses, as measured by yield increases of No. 1-size potatoes, were recorded for the White Cloud variety followed by three unnamed experimental lines (43.41-1, 60.37-9 and 85.41-1). Smallest responses, as measured by the number of No. 1-size tubers, occurred with the Irish Cobbler and Red Warba. The Irish Cobbler, when unsprayed, was the most productive, followed respectively by the two numbered varieties (43.41-1 and 60.37-9) and Red Warba and White Cloud. When sprayed, one numbered variety (43.41-1), White Cloud and another numbered variety (60.37-9) all outyielded the Cobbler and Red Warba. Irish Cobbler and White Cloud supported significantly greater leafhopper populations than did the other varieties.

Quality as measured in terms of specific gravity was improved to varying degrees following spraying. Moreover, the ascorbic acid content was higher in tubers from the sprayed plots. This work was performed in cooperation with the Horticulture Department.

Three tests, all similar to the above in general plan, were conducted under the Outstate Testing Project. Excellent yield increases followed the control of insects at North Platte and Scottsbluff. At Alliance the increases were insignificant owing to the light insect infestation.

At North Platte the performance relationship of the three varieties, Irish Cobbler, White Cloud and Red Warba, was much the same as at Lincoln. The mean average increase of No. 1-size tubers following spraying (all five varieties) was 400 per cent (or 233 bushels per acre).

At Scottsbluff a numbered variety (43.41-1), either sprayed or unsprayed, outyielded the sprayed and unsprayed Triumph and Progress varieties. This new line appears to be resistant to the potato psyllid. Spraying four times resulted in an average increase for all varieties of 97 bushels of No. 1-size potatoes per acre (a gain of 69 per cent).

ROSCOE E. HILL, ELDEN G. BURCHAM, EDWARD LAIRD, JR.,
EDWIN L. BRUNKEN

Tuber flea beetle and varietal resistance. Two hundred and eighty-three seedling lines were tested at the Scottsbluff Substation for resistance to larval damage by tuber flea beetles. Seven lines appeared to exhibit some degree of resistance. One of these lines had been shown to be resistant in similar tests during 1947 and 1948. This work is being conducted in cooperation with the Horticulture Department.

An investigation of the factors responsible for the apparent difference in resistance of various varieties to tuber injury was initiated. Consideration is being given in this study to tuber characteristics, time of tuber set, rate of maturity of varieties and the biology and seasonal development of flea beetles.

ROSCOE E. HILL, EDWARD LAIRD, JR.

Influence of insect control on the spread of potato leaf roll. Two plots of potatoes infected with 2 per cent of leaf roll were planted in 1948. One of these plots was dusted with a 3 per cent DDT in sulfur dust at regular intervals and the other was left untreated. The dusting program kept the treated plot virtually free of insects. A tuber from each hill of these two plots was planted in the field in 1949.

On July 29 disease readings were taken in these plots by plant pathologists and seed certification officials. In the dusted plot the virus had spread to 12 plants whereas plants grown from seed from the untreated plot showed 71 new infections. Under conditions of this test, dusting significantly reduced the incidence of leaf roll. The Plant Pathology Department cooperated in this project.

ROSCOE E. HILL, ELDEN G. BURCHAM, EDWARD LAIRD, JR.

Horticultural Insects

Control of thrips on tomatoes. An extensive outbreak of the spotted wilt disease of tomatoes greatly reduced the tomato crop of 1948, and caused a complete crop failure in certain areas. As the disease apparently is transmitted mainly or entirely by various species of thrips, the Plant Pathology, Horticulture and Entomology Departments cooperated in a study of the disease and the control of insects suspected of transmitting it. In these control tests regular applications of sprays of DDT and a proprietary piperonyl cyclenone-pyrethrum-rotenone spray material designated as T-313-A were made throughout the early blossoming period of three standard varieties of tomatoes. However, neither treatment gave a significant reduction in the number of thrips present, nor in the occurrence of the spotted wilt disease.

Control of carrot weevil. During the past ten years the carrot weevil, *Listronotus oregonensis*, has increased steadily and has caused heavy losses, both in the fields of commercial producers and in home gardens. Many growers have discontinued growing carrots because of this pest. The Horticulture and Entomology Departments cooperated in 1949 in a project to test various insecticides for control of this insect. The following insecticides were used: DDT, methoxychlor, chlordane, toxaphene, and high gamma purified benzene hexachloride. Regular applications of dusts of these materials were made to plants and adjacent soil from the time the young plants were 2 inches high until the carrots reached marketable size. Although unfavorable weather and soil conditions resulted in poor stands and unusual weed growth that interfered with the project and unquestionably reduced results, a reduction in weevil damage of 75 per cent was secured in the plots treated with high gamma purified benzene hexachloride. Those treated with a 5 per cent DDT dust also showed a significant reduction. Methoxychlor, chlordane, and toxaphene were ineffective. The tests with high gamma purified benzene hexachloride and DDT should be continued in 1950.

O. S. BARE

Control of insects attacking squash. Squash bugs, squash vine borers and melon aphids are outstanding pests of squashes and some related crops. In many years they make the growing of these crops unprofitable or even impossible. Because of the general demand for information on control of these pests, the Horticulture and Entomology Departments cooperated in 1949 in testing some of the newer insecticides for control of pests of cucurbits. A 5 per cent methoxychlor dust and a 1 per cent spray of a proprietary piperonyl cyclenone-pyrethrum-rotenone spray material designated as CPR T-313-A were applied at regular intervals to plots of three varieties of squash. Since squash vine borers did not appear in damaging numbers at any time, no conclusions regarding their control could be made. However, the methoxychlor dust gave excellent control of the nymphal stages of squash bugs and moderate to good control of adults. It also gave good control of striped and spotted cucumber beetles and melon aphids. CPR T-313-A gave good control of nymphal stages of squash bug, and also appeared to be effective against both species of cucumber beetles, although not equal to methoxychlor.

O. S. BARE

Chemurgic Research and Development

Department of Chemurgy

Industrial Surveys

Industrial surveys have been prepared on safflower, castors, and "surplus" and cull potatoes. The purpose of the surveys is to provide detailed information pertinent to industrialization of these crops. General conclusions from the surveys are listed below.

Safflower. Safflower is well adapted to the Panhandle area of Nebraska on both dry and irrigated land. A present commercial variety of seed analyzes 32 per cent oil and new lines now being released will average 34 to 36 per cent oil. Analyses of yield data and price structure for the manufactured oil and by-product feed indicate that safflower can compete with major crops now grown in the Panhandle area, although final analysis must await farmer acceptance.

Processing methods for obtaining the oil are not well established but investigations have shown that safflower may be processed by standard oilseed practices without major revisions.

Markets for safflower oil and by-products have not been established but the merits of the products should insure acceptance. A chief outlet for the oil will be in the protective coating field with potentially large markets in the edible trade. Feeding tests have shown the by-product cake to be a high quality livestock feed.

It is evident that opportunities exist for a safflower industry. Location of raw materials, feed market, and transportation rates favor development of the industry in Nebraska.

Castors. A relatively stable market exists in the United States for a castor production of a minimum of 200 million pounds, equivalent to the production from 330,000 acres (based on estimated field yields in Nebraska). Varieties of castors developed by the Chemurgy Department are adapted to the southeast one-third of Nebraska, and will yield on a weight basis approximately 33 to 40 per cent the yield of corn. Definite possibility of yield improvement exists through hybrid castor varieties (analogous to corn hybrids). The price of castors on a weight basis (assuming present experimental yields in Nebraska) would need to be two and one-half to three times the price of corn to establish equal revenue to the farmer for the two crops.

Methods for castor cultivation and harvesting are satisfactory although special equipment would be needed for harvesting. Processing methods are well developed.

Present processing installations are limited to those locations where there is direct water transportation from South America. Nearly all beans processed are imported, as plantings in the United States are insignificant.

Midwest processing plants would give impetus to castor cultivation in this area. However, because of the uncertainty of domestic production, the strong competitive position of Brazil, the potential production in California, and location of consumer markets, processors may be reluctant to make investments in the Midwest.

"Surplus" and cull potatoes. The average annual United States production of potatoes (1935-1947) was 384 million bushels. Nebraska normally produces 10 to 12 million bushels. Even with rigid acreage control, a seasonal variation in production of plus or minus 10 per cent can be anticipated. Therefore an apparent national surplus of potatoes varying from 0 to 80 million bushels will be available each year. Nebraska's share of this surplus represents 0 to 2 million bushels per year.

Livestock feeding offers the most economical outlet for surplus and cull potatoes, especially in Nebraska where there is a concentration of the livestock industry. Positive values can accrue in livestock feeding that will approximate 20 per cent that of corn on an equal weight basis.

On the basis of the chemical analyses of potatoes, the crop cannot economically compete industrially with other carbohydrate raw materials. As a nonfood industrial material, the value is usually equivalent to only 10 to 15 per cent that of corn on an equal weight basis.

R. E. WOODWARD, CARL E. CLAASSEN, ALBERT HOFFMAN, G. M. SEVERSON

Improvement and Testing of Special Chemurgic Crops

Research during the past year was confined to oilseed crops. Breeding programs are in progress on safflower, castors and sesame. Principal breeding nurseries are at Lincoln, the Scottsbluff and North Platte Substations, and the Box Butte Experiment Farm. Personnel at these locations cooperated in the breeding program. The Outstate Testing Project supervised experimental yield tests at several locations throughout the State.

Safflower. Commercial safflower acreage increased from 3,000 acres in 1948 to approximately 30,000 acres in 1949 in eastern Colorado, south-eastern Wyoming and western Nebraska. Yields on dry land (summer fallow and continuous cropping) averaged 750 pounds per acre. Yields on irrigated land ranged from complete failures to 2,700 pounds per acre. Most of the variation in yield was due to inexperience in irrigating this crop. More than 50 per cent of the farmers who irrigated safflower obtained yields of between 1,800 and 2,700 pounds per acre. More than 80 per cent of all farmers who grew safflower in 1949 were planning to grow this crop again in 1950. It is estimated that total production in the United States in 1950 will exceed 100,000 acres. Approximately 60,000 acres will be planted with seed from the newer varieties.

About 1,000,000 pounds of N-852 seed was produced in 1949. Of this amount nearly 400,000 pounds was certified. Three new varieties, N-3, N-6 and N-8, were made eligible for certification in Nebraska. N-3 is a spineless variety that averages 29 per cent oil. Its main region of adaptation is on irrigated land in the Nebraska Panhandle. N-6 is a spiny variety, has a high yield potential, and averages 32 per cent oil. It is adapted to both dry and irrigated land. N-8 is a spiny variety that is adapted east of the general safflower region and to irrigated land in the Panhandle. This variety has done well as far east as North Platte. Its seed averages 34 per cent oil.

The main object in the present breeding program at the Nebraska Station is to develop varieties high in oil content, high in yield, and resistant to rust. Genetically, rust resistance in safflower is dominant. A backcross system of breeding is being used to combine rust resistance with other desirable characteristics.



Harvesting safflower grown in cultivated rows on irrigated land, 1949. (Yield 2,700 pounds per acre.)

A few individual plant selections from crosses contained 40 per cent oil. This is the first year that oil contents of 40 per cent were obtained. It is conceivable that commercial varieties can be developed that will average 38 per cent oil.

Castors. Research on hybrid castors was continued. The normal inflorescence in castors is a monoecious raceme which bears pistillate flowers in the upper 30 to 50 per cent and staminate ones in the lower 50 to 70 per cent. A few lines have been isolated that produce racemes with 90 to 100 per cent pistillate flowers and others that segregate 1:1 for plants with normal racemes (heterozygous monoecious) and 100 per cent pistillate racemes (dioecious).

Two methods are proposed for the utilization of the pistillate character in the production of commercial F_1 hybrid seed. One method utilizes lines that breed true for 90 to 100 per cent pistillate flowers; the other utilizes 100 per cent pistillate plants in lines segregating 1 heterozygous monoecious: 1 dioecious. The latter method would require roguing of heterozygous monoecious plants in crossing blocks before flowering begins. Research is now in progress to determine general and specific combining ability of a number of high yielding lines.

A uniform regional castor nursery was grown at Lincoln in cooperation with the U. S. Department of Agriculture. Yields from this test averaged 1,000 pounds of seed per acre. Yield tests were grown at the Scottsbluff and North Platte Substations and the Box Butte Experiment Farm. Castors were also grown in Clay, Phelps and Dundy Counties in cooperation with the Outstate Testing Project.

The Chemurgy Department cooperated with the Agricultural Engineering Department in testing the new mechanical castor harvester developed at the Nebraska Station. The harvesting tests are reported under Agricultural Engineering.

Sesame. One of the problems with sesame is the shattering of the seed as soon as the capsules mature. Research has been in progress to develop nonshattering lines. An indehiscent (nonshattering) line has been obtained, but plants with this character are only partially fertile and are extremely difficult to thresh. Several more years of research will be required to determine whether the nonshattering character can be combined with high yield and adapted to direct combine harvesting.

Research on cultural practices with dehiscent varieties has shown that sesame is best adapted as a cultivated row crop. Optimum yields are obtained when plantings are made in rows 20 to 40 inches apart. Optimum stands are two to six plants per foot of row in rows 20 inches apart and six to twelve plants per foot of row in rows 40 inches apart. Optimum seeding rates vary from 1 to 2.5 pounds per acre depending upon the distance between rows.

Maximum yields have been obtained when sesame was planted between June 1 and June 15. Very early maturing lines have shown no reduction in yield when planted as late as June 20. At Lincoln yields have averaged 900 to 1,100 pounds of seed per acre and the average oil content of the seed has been 49 per cent.

Perilla. Direct combine harvesting was attempted with perilla during the past season at Lincoln. Seed loss during combining was negligible, but loss of seed before harvest was estimated at 40 to 50 per cent. High winds a few days before harvest caused most of the shattering. Swathing this crop a few days before complete maturity and using pick-up attachments on the combine appears to be a feasible method of harvesting. Selections have been made that are higher in yield, earlier in maturity, and less subject to shattering than the original introductions. The best of the Nebraska selections can be expected to yield 750 pounds of seed per acre.

Flax. A uniform regional flax nursery was grown at Lincoln and Alliance in cooperation with the U. S. Department of Agriculture. At Lincoln the yields of ten varieties ranged from 8.7 to 16.9 bushels per acre with an average of 13.6 bushels per acre for all varieties. The crop was not harvested at Alliance because of poor stands.

Mustard. Oriental mustard (*Brassica juncea*) was grown in a rate-and-date-of-planting test at Lincoln. This variety gave highest yields when planted the first part of April. There was no significant difference between yields from the 2½- and 4-pound rates of seeding. The higher rate of seeding appeared to give better weed control which resulted in easier combining and weed-free seed. The highest yield obtained was 700 pounds of seed per acre.

Sunflowers. Research on the control of insects on sunflowers was continued in cooperation with the Entomology Department. The results of this test are summarized under Insect Control Experiments.

C. E. CLAASSEN, ALBERT HOFFMAN

Oilseed Processing

A number of experiments involved the processing of safflower in an expeller pilot plant. The investigation was conducted to collect operating data, to provide small samples of safflower oil to potential consumers, and to produce safflower cake for solvent extraction studies by other agencies.

In these experiments a V. D. Anderson midget expeller and a V. D.

Anderson Red Lion expeller were used. Preliminary operating data obtained with the midget expeller were used in operating the larger Red Lion expeller. Pretreatment of the seed included only a cracking operation employing a two-banked double-roll mill with all rolls corrugated. The whole seed was pressed without dehulling.

Several runs showed that an oil of good quality and a cake containing 6 to 8 per cent oil could be obtained under the conditions given in the following table:

Throughput rate	8 tons/day
Preheat of feed	165°-180° F.
Preheat steam	20 psi
Bar spacing (from feed end to discharge end)	0.025", 0.010", 0.020"
Added surface moisture	5-7%
Power supplied	27 amps @ 220v
Cake thickness	about 3/8"
Foots in oil	4-7%

After filtration, the oil produced under these conditions had the following characteristics:

Free fatty acid	0.45-0.55%
Iodine value (Hanus)	139-143
Color (Gardner)	6
Heat bleached to (Gardner)	1L
Bodied to Z ₂ viscosity in 9.6 hours	

To obtain safflower cake suitable for solvent extraction, pressure on the machine was decreased to the point at which a cake was just formed in the machine. The residual oil in the cake under these conditions was found to be about 10 to 12 per cent, and the cake was suitable for solvent extraction studies being conducted in cooperation with the Northern Regional Research Laboratory at Peoria, Illinois.

R. E. WOODWARD, G. M. SEVERSON

Utilization of Vegetable Oils and By-products

Selective fractionation of safflower oil. Safflower oil has been treated with furfural and naphtha in single-stage extractions. Furfural shows a preferential solubility for the unsaturated components of vegetable oils. Naphtha is used to recover the oil from the furfural. The glyceride esters of unsaturated acids are generally accepted as being superior in drying oil formulations in comparison with the relatively saturated components which are preferred by the edible trade.

The preliminary work showed that in a single-stage extraction the two fractions of oil produced were little changed from the original oil regardless of the amounts of furfural and naphtha used. As an example, using a ratio of 100:200:40 (oil: furfural: naphtha) and then re-extracting the oil from the furfural layer with a large quantity of naphtha, the iodine number (Hanus) of the oil in the unsaturated oil layer was approximately 143 while that of the oil in the saturated oil layer was 137. These are to be compared with the iodine number of the original oil which is 139-140. These results are being applied to multistage fractionation.

J. H. WEBER, Dept. of Chem. Eng.

Evaluation of vegetable oils and seeds. In conjunction with the agronomic breeding program, complete analyses of safflower seed and oil of different varieties are being made. The purpose of this investigation is to determine the differences in the physical and chemical properties of seed and oil attributable to varietal breeding.

The varieties of safflower being tested include N-3, N-6, N-8, N-9, N-55, N-852 and Indian. Each variety was grown under dry-land and irrigated conditions. The following table gives pertinent results thus far obtained from investigations with the oil.

Variety	* % Color transmission (10 mm.)				% Free fatty acid		Iodine number (Hanus)	
	460 MU		525 MU		D.L.	I.L.	D.L.	I.L.
† D.L.	I.L.	D.L.	I.L.					
N-3	5.9	6.8	77.6	77.1	0.19	0.17	144	146
N-6	7.4	8.4	78.9	80.3	0.33	0.29	143	144
N-8	11.8	8.5	79.5	76.6	0.22	0.32	145	144
N-9	9.4	8.1	78.6	75.5	0.34	0.64	132	135
N-55	21.3	20.4	86.3	84.8	0.29	0.71	139	143
N-852	8.4	4.8	79.3	73.9	0.22	0.55	140	141
Indian	20.0	18.4	84.6	81.6	0.33	0.54	140	144

* Carbon tetrachloride used as blank.

† D.L. designates dry-land safflower; I.L. designates irrigated land.

R. E. WOODWARD, G. M. SEVERSON

Fractionation of safflower cake. Safflower seed of the newer varieties analyzes about 40 per cent hull and 60 per cent kernel or meats. The hull fraction contains 1 to 3 per cent oil and about 2 to 3 per cent protein. Removal of the hull prior to processing gives a kernel or meat fraction relatively high in protein and oil. The residual press cake after oil extraction of dehulled (decorticated) seed is obviously higher in protein than cake from whole seed. Depending on economic considerations, processors may elect to process either whole or decorticated seed.

The protein content of whole-seed press cake will approximate 20 to 25 per cent protein depending on the safflower variety processed. If there is an economic advantage in selling two types of meal, one relatively high and the other relatively low in protein, the whole-press cake may be quite simply separated into two fractions by grinding and screening. The following table illustrates the data obtained by such a process using a $\frac{3}{4}$ -inch screen in a hammer mill.

Sample description	Screen size	Fraction of total	Protein	Fiber
		Per cent	Per cent	Per cent
Original cake	.....	....	20.2	38.6
Thrus (kernel)	1/18 inch	50	28.8	29.9
On screen (hull)	1/18 inch	50	10.3	46.7

G. M. SEVERSON, R. E. WOODWARD

Heat bleaching of safflower oil. Studies have been made to determine the optimum conditions for heat bleaching safflower oil to obtain an oil of minimum color but possessing the original physical and chemical characteristics of the crude safflower oil.

There appeared to be no significant amount of bleaching at temperatures below 180° C., although a partial bleach at 180° C. was obtained in a one-hour heating period. Maximum bleaching was obtained at 220° to 230° C.; the color of the oil was reduced from Gardner 6 to Gardner 1L in 25 minutes.

Apart from color, controlled bleaching below 240° C. produced an oil with essentially the same physical and chemical characteristics as those of the crude oil. At higher temperatures the color and the free fatty acid content increased somewhat except when the bleaching was performed under vacuum or in an inert gas atmosphere.

R. E. WOODWARD, G. M. SEVERSON

Utilization of Wheat Starch

There is a market demand for wheat gluten. The manufacture of gluten from wheat places wheat starch in a by-product position. The purpose of this investigation is to study means of utilizing wheat starch by industrial fermentations.

The first phase of the problem has been a program of screening lactic acid bacteria for acid production from acid-hydrolyzed wheat starch. Selected strains are being used for subsequent work.

C. E. GEORGI, Dept. of Bacteriology

Carotene Retention in Alfalfa

Carotene is a valuable ingredient in alfalfa. During ordinary storage conditions, the carotene loss may be as high as 75 per cent during six months. A number of research agencies are working on this problem. The major methods of attack center around prevention of oxidation of carotene and include: (1) use of antioxidants, (2) storage in inert atmosphere, (3) storage at low temperatures to retard oxidative change, and (4) storage at high moisture levels in sealed containers to obtain anaerobic conditions.

The Chemurgy Department has applied starch films on alfalfa particles to prevent contact of the alfalfa with atmospheric oxygen. Little or no increase in carotene retention has been observed.

G. M. SEVERSON, R. E. WOODWARD

Cattle, Hogs and Sheep

Department of Animal Husbandry, North Platte, Valentine and Scottsbluff
Substations, and Fort Robinson Beef Cattle Research Station

Beef Cattle Feeding, Grazing and Management Investigations

Fattening yearling steers in dry lot. At North Platte the five lots of heavier calves from the wintering experiment were full-fed in dry lot from May 4 to September 22, 1949, a period of 141 days. Their average initial weight was approximately 775 pounds. The five lots consumed an average of 14.2, 14.46, 14.43, 14.46 and 14.46 pounds of ground shelled corn per head daily. In addition Lots 1 to 4 consumed an average of 11.5, 10.74, 13.12 and 15.09 pounds of corn silage and Lot 5 an average of 6.99 pounds of cut alfalfa hay per head daily. The five lots also consumed an average of 1.51 pounds soybean pellets, 6 pounds cut alfalfa hay, 4 pounds dehydrated alfalfa pellets, 2.94 pounds dehydrated alfalfa pellets and 2 pounds dehydrated alfalfa pellets per head daily, respectively. The average corn required for 100 pounds gain by the five lots respectively was 786, 676, 649, 669 and 665 pounds. In addition the five lots required respectively an average of 637 pounds silage and 84 pounds soybean meal; 502 pounds silage and 280 pounds alfalfa; 590 pounds corn silage and 180 pounds dehydrated alfalfa pellets; 699 pounds corn silage and 136 pounds dehydrated alfalfa pellets; and 322 pounds alfalfa plus 92 pounds dehydrated alfalfa pellets for 100 pounds gain. The average daily gains for the five lots were 1.81, 2.14, 2.22, 2.16 and 2.17 pounds per head. The steers in Lot 1 did not make as large or as economical gains as steers on similar feeds usually have made. The five lots sold in Omaha for \$33.50 per hundredweight. They yielded 61.4 per cent and good to choice in the carcass.

GUY N. BAKER, THOMAS W. DOWE

Wintering rations for range calves. At the Valentine Substation 16 lots of 10 heifer calves with an average initial weight of 372 pounds were fed a basic ration of prairie hay, beginning November 19, 1948. The prairie hay fed 13 of the lots was of the 1948 crop. Three of the lots were fed hay cut in 1947. Of the 13 lots fed hay cut in 1948, one was fed hay alone; the other 12 lots were fed pelleted supplements of cottonseed meal and dicalcium phosphate; soybean oil meal; soybean oil meal and dicalcium phosphate; soybean oil meal, dicalcium phosphate and vitamin A; dehydrated alfalfa; dehydrated alfalfa and dicalcium phosphate; dehydrated alfalfa, dicalcium phosphate and urea; dehydrated alfalfa, dicalcium phosphate, urea and corn; ground shelled corn; corn and urea; and corn, urea and dicalcium phosphate. The three lots fed 1947 hay were fed supplements of dehydrated alfalfa and dicalcium phosphate; soybean oil meal and dicalcium phosphate; and soybean oil meal, dicalcium phosphate and vitamin A.

The experiment was disrupted in January by an outbreak of X disease (hyperkeratosis). The cattle were then placed under the supervision of the Animal Pathology and Hygiene Department for observation and the study of the disease. The report of this investigation is found under Animal Diseases.

E. M. BROUSE

Wintering rations for steer calves. Seven lots of 13 steer calves with an average initial weight of approximately 452 pounds per head were fed at Lincoln for 146 days, November 23, 1948 to April 18, 1949, on 2 pounds ground shelled corn per head daily and a full feed of prairie hay. In addition the seven lots were fed respectively 2.7 pounds hot-air-dried alfalfa hay, 2.6 pounds fresh-air-dried alfalfa hay, 2.6 pounds field-dried alfalfa hay, 2.3 pounds dehydrated alfalfa pellets, 1.2 pounds linseed pellets, 1.7 pounds malt-converted distillers' dried grains with solubles, and 1.7 pounds fungal amylase-converted distillers' dried grains with solubles per head daily. The seven lots made an average daily gain per head of 0.94, 1.02, 0.98, 0.98, 1.2, 1.2 and 1.2 pounds.

The average feed consumed for 100 pounds gain by the seven lots respectively was 1,020, 970, 986, 1,029, 1,017, 876 and 880 pounds prairie hay; 212, 196, 204, 204, 174, 168, and 165 pounds ground shelled corn; and 284 pounds hot-air-dried alfalfa hay, 258 pounds fresh-air-dried alfalfa hay, 268 pounds field-dried alfalfa hay, 237 pounds dehydrated alfalfa pellets, 106 pounds linseed pellets, 146 pounds malt-converted distillers' dried grains with solubles, and 144 pounds fungal amylase-converted distillers' dried grains with solubles.

THOMAS W. DOWE, V. H. ARTHAUD

At North Platte five lots of 12 good to choice steer calves were fed for 138 days beginning December 2, 1948, on a limited feed of ground shelled corn plus various combinations of corn silage, chopped or cut alfalfa hay, dehydrated alfalfa meal pellets, beet tops, and soybean oil meal. The average daily feed consumption for the five lots was 6.18 pounds corn, 21.4 pounds silage, 1.46 pounds soybean meal; 6.25 pounds corn, 13.1 pounds silage, 3.57 pounds alfalfa; 6.25 pounds corn, 21.6 pounds silage, 3.43 pounds dehydrated alfalfa pellets; 6.25 pounds corn, 7.25 pounds alfalfa, 3.43 pounds dehydrated alfalfa pellets; and 6.16 pounds corn, 13.6 pounds silage, 5.97 pounds beet tops. The average feed requirements for 100 pounds gain for the five lots were 328 pounds corn, 1,133 pounds silage, 78 pounds soybean meal; 344 pounds corn, 720 pounds silage, 196 pounds alfalfa; 299 pounds corn, 1,042 pounds silage, 104 pounds dehydrated alfalfa pellets; 347 pounds corn, 403 pounds alfalfa, 191 pounds dehydrated alfalfa pellets; and 332 pounds corn, 812 pounds silage, 319 pounds beet tops. The average daily gains were 1.88, 1.81, 2.09, 1.79 and 1.87 pounds per head for the five lots, respectively.

Four lots of 13 calves each from the same string with an average initial weight of 430 pounds were fed for the same period as the heavier calves and on the same rations except that no corn was fed and the combination of alfalfa hay and dehydrated pellets was not included. The four lots consumed an average of 20.4 pounds silage and 6.09 pounds beet tops; 19.5 pounds silage and 5.42 pounds alfalfa; 28.7 pounds silage and 3.43 pounds dehydrated alfalfa pellets; and 29.4 pounds silage and 1.5 pounds soybean meal per head daily. The average feed required for 100 pounds gain for the four lots was 1,765 pounds silage and 526 pounds beet tops; 1,576 pounds silage and 437 pounds alfalfa; 1,928 pounds silage and 194 pounds dehydrated alfalfa pellets; and 2,002 pounds silage and 102 pounds soybean meal. The four lots made an average daily gain of 1.16, 1.24, 1.50 and 1.46 pounds per head daily.

Soon after the conclusion of the wintering period, the heavier calves were relotted for summer feeding in dry lot and the lighter calves for investigations involving the use of irrigated brome-alfalfa pasture.

GUY N. BAKER, THOMAS W. DOWE

Distillers' dried grains with solubles, linseed meal pellets and dehydrated alfalfa pellets as protein supplements for fattening steer calves. Five lots of 13 steer calves with an average initial weight of approximately 515 pounds per head were fed for 223 days, November 18, 1948 to June 29, 1949. They were full-fed ground shelled corn and prairie hay and in addition the first four lots were fed 2.62 pounds malt-converted distillers' dried grains with solubles, 2.62 pounds fungal amylase-converted distillers' dried grains with solubles, 1.71 pounds linseed meal pellets and 3.29 pounds dehydrated alfalfa pellets per head daily, respectively. Lot 5 was fed no protein supplement.

The five lots consumed respectively an average of 5.09, 5.13, 5.74, 5.04 and 5.97 pounds prairie hay; 10.44, 10.78, 12.65, 11.81 and 11.34 pounds ground shelled corn; and 2.62, 2.62, 1.71, 3.29 and no protein supplement per head daily. The average daily gain per head for the period was 1.68, 1.80, 1.88, 1.98 and 1.35 pounds for the five lots.

The average feed consumption for 100 pounds of gain for the five lots was 302, 286, 306, 258 and 441 pounds prairie hay; 621, 599, 673, 596 and 838 pounds ground shelled corn; and 155, 146, 91, 166 and no protein supplement.

At the conclusion of the trial Lot 5 was not sufficiently well finished to sell with the other lots and was continued on feed. Lot 1 sold for \$25.50, dressed 58.8 per cent and yielded 2 top-good and 11 low-good carcasses; Lot 2 sold for \$25.50, dressed 59.1 per cent and yielded 1 top-good, 10 low-good and 2 commercial carcasses; Lot 3 sold for \$26.50, dressed 59.6 per cent and yielded 4 top-good and 9 low-good carcasses; and Lot 4 sold for \$26.50, dressed 59.4 per cent and yielded 5 top-good and 8 low-good carcasses.

THOMAS W. DOWE, V. H. ARTHAUD

Wheat bran and urea as supplements for fattening cattle. Six lots of yearling steers with an average initial weight of approximately 730 pounds per head were fed prairie hay and a full feed of ground shelled corn for 140 days from September 24, 1948 to February 11, 1949. Lot 6 was fed no protein supplement but Lots 1 to 5 were fed respectively 1.5 pounds cottonseed meal, 1.5 pounds mixture No. 2, 1.5 pounds mixture No. 3, 3 pounds mixture No. 3 and 1.5 pounds mixture No. 4 per head daily. All of these were pelleted. Mixture No. 2 consisted of 10 per cent molasses, 78 per cent wheat bran, 11.5 per cent urea and 0.5 per cent bone meal; mixture No. 3 consisted of 30 per cent cottonseed meal, 10 per cent molasses and 60 per cent bran; and mixture No. 4 consisted of 27 per cent cottonseed meal, 10 per cent molasses, 8.5 per cent urea, 54 per cent wheat bran and 0.5 per cent bone meal. The crude protein contents of the cottonseed meal and of the three mixtures were 39, 41, 23 and 41.9 per cent respectively if based on N x 6.25.

The six lots of steers consumed an average of 8.64, 8.49, 8.86, 5.99, 8.74 and 6.88 pounds of prairie hay and 14.62, 14.68, 15.12, 14.69, 14.48 and 14.31 pounds ground shelled corn per head daily. The average daily gains per head for the six lots respectively were 2.20, 1.93, 2.03, 2.27, 2.03 and 1.74 pounds.

The average feed consumed for 100 pounds gain by the six lots respectively was 392, 440, 436, 264, 430 and 394 pounds prairie hay; 663, 760, 744, 647, 712 and 821 pounds ground shelled corn; and 68, 78, 74, 131, 74 pounds and no protein supplement.

THOMAS W. DOWE, V. H. ARTHAUD, KEITH GREGORY, MARVEL L. BAKER

Feeding steers on irrigated brome-alfalfa pasture. The four lots of lighter steers carried on growing rations at North Platte during the winter of 1948-1949 were used in management and feeding studies involving the use of irrigated brome-alfalfa pasture beginning May 14 and continuing until November 5, 1949, a period of 175 days. Their average initial weight was approximately 675 pounds per head. One lot was full-fed for the entire period in dry lot on ground shelled corn, dried beet pulp and alfalfa hay. During the last 8 weeks they were also given from 0.33 to 0.5 pound soybean oil meal per head daily. A second lot was full-fed ground shelled corn and dried beet pulp on brome-alfalfa pasture until September 10, a period of 119 days. They were then moved to dry lot and alfalfa hay added to their ration. A third lot was fed approximately 8 pounds of a combination of ground shelled corn and dried beet pulp on pasture until July 16, after which their ration was gradually increased. On September 10 they were moved to dry lot and alfalfa hay added to their ration. The fourth lot was fed approximately 8 pounds of a combination of ground shelled corn and dried beet pulp on pasture until September 30, a period of 139 days. They were then moved to dry lot and full-fed for the remainder of the period. The average daily gain per head for the four lots respectively was 2.15, 2.29, 1.86 and 1.85 pounds.

The average feed required by the four lots for 100 pounds gain was 581 pounds corn, 116 pounds dried pulp, 264 pounds alfalfa and 11 pounds soybean oil meal; 508 pounds corn, 109 pounds dried pulp and 80 pounds alfalfa; 463 pounds corn, 136 pounds dried pulp and 102 pounds alfalfa; 378 pounds corn, 136 pounds dried pulp and 75 pounds alfalfa. In addition the second, third and fourth lots were on brome-alfalfa pasture for 119, 119 and 139 days, respectively. The four lots sold together at Omaha at \$30 per hundred but were appraised by the buyers at \$31, \$31.50, \$29 and \$29.50. These appraisals were hardly consistent with either the carcass yields or grades. The four lots yielded respectively 61.8, 60.5, 60.7 and 59.8 per cent. The carcass grades by lots were 6 low-choice, 7 top-good; 1 low-choice, 4 top-good, 7 low-good; 9 top-good, 3 low-good; 5 top-good, 8 low-good.

GUY N. BAKER, E. C. CONARD, J. C. ADAMS

Feeding yearling steers on bromegrass pasture. Three lots of 10 yearling steers with an average initial weight of 634 pounds were fed for 216 days, from May 4 to December 6, 1949 in a study involving the use of bromegrass pasture. Lot 1 was full-fed in dry lot for the entire period; Lot 2 was full-fed and Lot 3 half-fed on ground shelled corn on bromegrass pasture for 133 days. They were then moved to dry lot and full-fed for the remainder of the period. The dry lot ration for all lots was ground shelled corn, corn silage and a protein supplement. No protein supplement was fed on pasture. For the entire period the average daily gain per head for the three lots was 2.1, 2 and 1.9 pounds. Lot 1 consumed an average of 60.3 bushels of corn, 1.24 tons of silage and 336 pounds of supplement per head and required 744 pounds corn, 546 pounds silage and 74 pounds supplement for 100 pounds gain. Lot 2 consumed 56 bushels corn, 0.67 ton silage and 154 pounds supplement per head. The steers also were on pasture for 133 days. They required 702 pounds corn, 310 pounds silage and 35 pounds protein supplement as well as 31 days pasture for one steer per 100 pounds gain. Lot 3 consumed an average of 42.9 bushels corn, 0.67 ton silage and 154 pounds supplement plus 133 days grazing

per head. They required an average of 585 pounds corn, 326 pounds silage, 37 pounds supplement and 32 steer-days grazing for 100 pounds of gain. Since Lot 3 was fed less corn on pasture than Lot 2, it undoubtedly consumed more grass. The three lots dressed 61.2, 59.9 and 59.8 per cent respectively when slaughtered. Lot 1 produced 8 low-choice and 1 top-good carcasses; Lot 2, 1 low-choice, 7 top-good and 2 commercial carcasses; and Lot 3, 8 top-good and 2 low-good carcasses.

THOMAS W. DOWE, V. H. ARTHAUD

Feeding Holstein steers. At North Platte 16 Holstein steers previously fed in the project involving the use of milk substitutes for dairy calves prior to weaning age were grazed on native grass pasture from May 5 to November 13, 1948, a period of 192 days. During this period they gained 128 pounds per head and weighed an average of 554 pounds at its close. They were placed on a growing ration of corn silage, alfalfa hay, dried beet pulp, soybean oil meal, and ground shelled corn on November 13. The corn was gradually increased until the steers were on full feed. They were fed until July 22, 1949, a period of 251 days. They consumed an average of 17.5 pounds silage, 5.1 pounds ground shelled corn, 4.8 pounds dried pulp, 0.5 pound soybean meal and 4.5 pounds alfalfa hay per head daily and made an average gain per head of 509 pounds in the 251 days. They required an average of 865 pounds corn silage, 294 pounds corn, 235 pounds dried pulp, 22 pounds soybean oil meal and 224 pounds alfalfa hay for 100 pounds gain.

The steers sold for \$21.50 per hundredweight at Omaha, yielded 56.9 per cent and produced 3 high commercial, 3 commercial, 8 low commercial and 2 high utility carcasses.

GUY N. BAKER

Feeding dual-purpose cattle. Ten head of Red Poll steers were fed at Lincoln to collect data on the feeding and carcass qualities of Red Poll steers. The steers weighed an average of 675 pounds per head when started on experiment November 1, 1948. They were fed a ration of 1¼ pounds of ground ear corn per 100 pounds of body weight in addition to 1½ pounds of linseed meal pellets and 1 pound of dehydrated alfalfa pellets per head daily. Prairie hay was fed free choice until they attained an average weight of 745 pounds. They were then raised to a full feed of ground ear corn. The steers were slaughtered individually as they attained an approximate weight of 1,030 pounds.

The steers were fed an average of 213 days and gained an average of 355 pounds per head, an average of 1.67 pounds per head daily. The average daily ration per head was: ground ear corn 16 pounds, linseed meal pellets 1.4 pounds, dehydrated alfalfa pellets 0.9 pound, and prairie hay 4 pounds. The feed required per hundred pounds of live weight gain was: ground ear corn 932 pounds, linseed meal pellets 82 pounds, dehydrated alfalfa pellets 54 pounds, and prairie hay 239 pounds.

The steers attained a satisfactory finish and yielded desirable carcasses (60.6 per cent cold) which graded high-good to low-choice. However, rather excessive deposits of kidney, crotch and internal fat were found in the steers.

THOMAS W. DOWE, V. H. ARTHAUD, C. H. ADAMS

Management of bromegrass-alfalfa pasture. The second year of study in cooperation with the Department of Agronomy on three systems of management for bromegrass-alfalfa pasture at Lincoln was conducted in 1949. The systems under study were: continuous grazing throughout the season, grazing during the spring and early summer followed by production of hay or alfalfa seed and grazing the forage remaining after a crop of bromegrass seed is harvested. The pastures were established in the fall of 1946, cut for hay in 1947 and grazed for the first time in 1948.

Six pastures, varying from 6.7 to 7.6 acres, were grazed during a 133-day season, May 3, 1949 to September 13, 1949, by four lots of 8 yearling Hereford steers with an average initial weight of 574 pounds per head.

The total forage production, consumption by grazing animals and the botanical composition of the sward were estimated by the pasture-cage method. Ten cages were used in each pasture. Clippings were made at 28-day intervals to coincide with the periodic weighing of the cattle. The clipped herbage was dried at 220° F. for 48 hours and the yields calculated on a moisture-free basis. Because of a dry season, no additional grazing of these pastures was possible after September 13, 1949.

Pastures 1 and 5 were each grazed continuously for 112 days. Pasture 1 produced 119 animal-days of grazing and 159 pounds of live weight gain per acre. Forage consumption was 1.95 tons per acre, or approximately 76 per cent of the total forage available during the period. This pasture was not grazed after August 23, 1949. Pasture 5 produced 126 animal-days of grazing and 175 pounds of live weight gain per acre during the same period. It was then grazed for an additional 21-day period by the steers and they lost 47.5 pounds per head. Forage consumption was 2.14 tons per acre for a 133-day grazing period, or approximately 77 per cent of the total forage available during the period.

Pastures 2 and 3 were grazed for an 84-day period May 3, 1949 to July 26, 1949. They were then cut for hay. Pasture 2 produced 97 days of animal grazing and 180 pounds of live weight gain per acre. Forage consumption was 1.54 tons per acre or approximately 57 per cent of the total forage available during the period. In addition, a hay yield of 0.33 ton per acre (12 per cent moisture) was harvested. In 1948, pasture 3 was grazed during the early spring and summer, then mowed for hay after the grazing season. For the 1949 season pasture 3 produced 87 days of animal grazing and 151 pounds of live weight gain per acre. Forage consumption was 1.98 tons per acre or approximately 66 per cent of the total forage available during the period. In addition, a hay yield of 0.51 ton per acre (12 per cent moisture) was harvested.

Pastures 4 and 6 were left ungrazed during the spring and early summer to produce a crop of bromegrass seed. Pasture 4 produced 43 pounds of re-cleaned bromegrass seed per acre and pasture 6 produced 171 pounds. On July 26, 1949, after the bromegrass seed crop was harvested from pasture 4, the 8 head of steers from pasture 3 were turned onto pasture 4 and grazed until September 13, 1949, or 49 days. During the 49-day grazing period the steers lost an average of 0.92 pound per head per day, or a total of 45 pounds per head for the period. The steers consumed 0.87 ton or approximately 46 per cent of the total forage available.

On July 26, 1949, after the bromegrass seed had been harvested from pasture 6, the eight head of steers from pasture 2 were turned onto pasture 6. For the period from July 26, 1949 to August 23, 1949, the 8 head of steers grazed 28 days or 224 steer-days and gained a total of 26 pounds per head or 0.93 pound per head per day. On August 23, 1949, an addi-

tional 8 head of steers were placed on pasture 6. Thus pasture 6 carried 16 head of steers from August 23, 1949 to September 13, 1949, a 21-day period or 336 steer-days. During this last 21-day period the 16 steers lost an average of 55 pounds daily, or 2.62 pounds per head per day. The forage consumption on pasture 6 was 0.89 ton per acre or approximately 49 per cent of the total forage available.

During the 1949 season it was not profitable from an animal gain standpoint to graze after August 23. In all cases during the last part of August and the first half of September, the steers lost weight. The late summer and early fall were very dry; hence no fall growth of forage occurred. Consequently, the steers were forced to consume mature forage which was accordingly not grazed in sufficient quantities to maintain the weight of these animals.

Although the forage at the beginning of the season consisted of about equal amounts of alfalfa and bromegrass, no serious trouble with bloat was experienced. The steers sought out and grazed the bromegrass in preference to the alfalfa during the early part of the grazing season.

This experiment is to be continued over a period of several years before attempting to evaluate the different management systems.

E. C. CONARD, T. W. DOWE, V. H. ARTHAUD, L. C. NEWELL

Grazing fertilized and nonfertilized bromegrass pasture. A 21.5-acre bromegrass pasture established at Lincoln in the spring of 1942 was cross-fenced to provide two pastures, one of 8.25 acres and one of 13.25 acres. The 8.25-acre pasture was treated with 158 pounds of ammonium nitrate containing 53 pounds of elemental nitrogen per acre. Each pasture was grazed for 112 days (May 4, 1948 to August 24, inclusive) with 10 head of yearling steers that weighed an average of about 636 pounds per head at the beginning of the grazing period. These steers had been wintered on 2 pounds of ground shelled corn per head daily, a full feed of prairie hay and various protein supplements. They had gained an average of 1 pound per head per day during the wintering period.

The fertilized pasture of 8.25 acres provided 0.825 acre per steer or each acre was grazed 137 steer-days, and produced 141 pounds of live weight gain per acre. The steers gained an average of 1.03 pounds per head per day during the 112-day period.

The unfertilized pasture provided 1.33 acres per steer, or each acre provided an average of 85 steer-days of grazing and produced 70 pounds of live weight gain per acre. The steers gained an average of 0.83 pound per head daily during the 112-day period.

Total forage production and the forage consumption by grazing animals were estimated by the pasture-cage method. The fertilized pasture produced 2.92 tons per acre (dry weight) of which 68 per cent was consumed. The unfertilized pasture produced 1.53 tons per acre (dry weight) of which 73 per cent was consumed. There were 9 cages on the fertilized pasture and 10 cages on the nonfertilized pasture.

The limited data indicate that the application of 158 pounds of ammonium nitrate containing 53 pounds of elemental nitrogen to a ~~three-~~ **3**-year-old stand of bromegrass increased the per acre carrying capacity, animal gain, and forage production. The fertilized bromegrass gave results comparable to bromegrass-alfalfa pastures.

E. C. CONARD, T. W. DOWE, V. H. ARTHAUD, L. C. NEWELL

Beef and Dual-Purpose Cattle Breeding Investigations

Improvement of beef cattle through breeding. This project was continued at Lincoln and North Platte; and under a cooperative agreement with the Bureau of Animal Industry, U. S. Department of Agriculture, work was begun at the Fort Robinson Beef Cattle Research Station, formerly the Fort Robinson Military Reservation near Crawford, Nebraska.

At Lincoln, work continued on the development of two lines of Hereford and one line each of Shorthorn and Aberdeen-Angus cattle. Four bulls from the 1948 calves from Line 1 and seven from Line 2 (Herefords), seven Angus, and three Shorthorn bulls were fed. Eleven heifers from Line 1 and nine from Line 2 (Herefords) as well as eight Aberdeen-Angus and six Shorthorns also were fed. The calves were weaned at an age of 196 days. The bull calves made average daily gains per head for the post-weaning period of 196 days ranging from 2.19 to 3.10 pounds for the Herefords, 2.11 to 2.98 pounds for the Angus, and 2.39 to 2.93 pounds for the Shorthorns. Average daily gain per head for the heifers fed a growing ration ranged from 0.66 to 1.53, 0.56 to 1.59, 0.97 to 1.56 and 0.99 to 1.44 pounds for the two Hereford, the Angus and the Shorthorn lines, respectively. In 1949, 25 calves were produced in Line 1 and 22 in Line 2 (Herefords), 25 in the Angus line, and 17 in the Shorthorn line. The 1949 bulls are being fed individually.

MARVEL L. BAKER, CECIL T. BLUNN, THOMAS W. DOWE, GUY N. BAKER, RUSSELL L. DAVIS, V. H. ARTHAUD, JOHN MATSUSHIMA, CHAS. H. ADAMS

Improvement of dual-purpose cattle through breeding. Twenty-three cows, 16 of which were heifers, completed records or were removed from the test at Lincoln during 1949. The cows were milked an average of 285 days, with a range of from 179 to 421 days. They produced an average of 5,312.7 pounds milk and 206.79 pounds fat, with ranges in milk production from 2,535 to 8,471.1 pounds, and in fat production from 99.23 to 344.43 pounds. The average butterfat percentage was 4.02. Eight of the 23, of which six were heifers, qualified for the Double Letter Record of Merit List and two more heifers qualified for the Single Letter Record.

As a part of this work, 13 steers from the Milking Shorthorn herd were finished for slaughter in 1949. These were fed from an average initial weight of 584 pounds per head for an initial period of 78 days in which they made an average gain of 178 pounds per head. During this period they consumed an average of 6.38 pounds ground shelled corn, 1.6 pounds soybean and linseed pellets, and 33.98 pounds corn silage per head daily. In this period they required an average of 282 pounds corn, 71 pounds oil meal pellets and 1,501 pounds silage per 100 pounds gain.

The steers were then full-fed for an average of 124 days. During this period they consumed an average of 15.06 pounds ground shelled corn, 5.64 pounds alfalfa pellets, 0.88 pound linseed pellets and 5.18 pounds corn silage per head daily. They consumed an average of 670 pounds corn, 251 pounds alfalfa pellets, 39 pounds linseed pellets and 230 pounds corn silage per 100 pounds gain.

The steers yielded 60.2 per cent cold when slaughtered at an average final weight of approximately 1,040 pounds per head and graded from medium to high-good in the carcass.

MARVEL L. BAKER, JOHN MATSUSHIMA, CHARLES H. ADAMS,
V. H. ARTHAUD, THOMAS W. DOWE, CECIL T. BLUNN

Systems of Breeding for Swine Improvement

Work under this project was continued at North Platte and Lincoln as a part of the Regional Swine Breeding Laboratory. Work also was initiated at the Valentine Substation. The inbreeding phases with Durocs, including the testing of inbred lines, were carried on at the North Platte Substation. The crossbreeding phases were carried on at Lincoln. Results are reported by stations.

North Platte. In the fall of 1948 litters were produced in Lines 8, 10 and 11 so that adequate numbers of gilts would be available for the line testing to be initiated in 1949. At 154 days of age the differences in weight between lines were not significant. Average weight ranged from 101 to 113 pounds.

In the spring of 1949, 90 litters were farrowed. These litters were farrowed about a month later than usual, for plans had been made to produce but one litter a year from the inbred lines of Durocs. Of the 90 litters, 67 were straight-line litters and 23 were three-line crosses. The latter litters were produced so that the performance of the single-line cross gilts could be checked.

At 154 days of age Lines 8, 10, 11 and 12 averaged 106, 127, 133 and 118 pounds, respectively. Line 8 was significantly lighter than the other three lines, and Line 12 was significantly lighter than Lines 10 and 11. The difference between Lines 10 and 11 was not significant. The performance of Line 11 was very gratifying, for this line represents a combination of all the original lines which were started at North Platte.

Six groups of three-line crossbred litters were produced. In general the three-line crossbred pigs were heavier than the straight-line litters at 154 days of age. The increased weights were expected. The pigs produced in these crosses carried no inbreeding and hence there was no depressing effect which is usually found in inbred animals. From the data at hand it appears that combinations of Lines 8, 10 and 12 produce the heaviest pigs at 154 days of age. These results will be checked as soon as the single-cross tests are completed.

A new Line 10 herd was started at Valentine. The pigs were farrowed in April and May. At weaning time they averaged 32.9 pounds, or 3.5 pounds heavier than the Line 10 pigs farrowed at North Platte. At 154 days of age the Valentine pigs averaged 183.8 pounds. This was more than 50 pounds heavier than the Line 11 pigs and about 57 pounds heavier than the Line 10 pigs at North Platte. This herd is being used to expand Line 10 so that some of the demands by farmers for breeding stock can be met without disrupting the breeding program.

Fewer breeding animals were sold in 1949 than in 1948. Half of the animals were sold to farmers in Nebraska, the other half to producers in other midwestern states. Boars were sold to five cooperating experiment stations.

The study on the amount and kind of selection practiced since this project was started is almost complete. Results show that the automatic selection differential for number of pigs farrowed and weaned is as large or larger than the net selection differential. This means that no conscious selection has been realized for these two characteristics. With respect to weight at weaning (both total litter and individual pig weight), some effective selection has been realized. Conscious selection for litter weight at weaning amounted to 15 pounds and for individual pig weight to slightly over 2 pounds. Replacement stock for this project has been saved from litters that were no larger than the average for the group in which

they were born. The replacement stock, however, was saved from the heavier litters, and the pigs were heavier than the average of the whole group of pigs born at the same time. The information from this study will be published as a joint contribution of the Regional Swine Breeding Laboratory. Data from eight cooperating stations are being pooled and analyzed for this publication.

Results of the first line-cross test showed that Line 8 performed best when used as the female side of the crosses. Line 12, on the other hand, performed best when used as the male side of the crosses. The combination of Line 12 boars and Line 8 sows produced the heaviest litters at 154 days of age. The rank of the lines with respect to sow performance in single crosses was 8, 10, 11 and 12 from superior to inferior. For boar performance the rank of the lines was 12, 8, 11 and 10. These results are based on one season's work and should not be taken as conclusive evidence of the superiority or inferiority of any of the lines. It will be necessary to repeat the line-cross tests at least twice before arriving at a definite decision on the combining ability of the lines.

Lincoln. Work at Lincoln was expanded this spring to include a comparison of purebred and crossbred pigs with respect to rate of growth, efficiency of feed utilization, and carcass evaluation. Two litters each of the pure breeds Duroc, Montana 1, and Hampshire, as well as two litters each of the crosses, Duroc x Montana No. 1, Montana No. 1 x Duroc, and Hampshire x Montana No. 1 were produced. Test pigs from each of these 12 litters were fed in dry lot from weaning until they were 154 days of age. When the pigs reached market weight 36 of them were slaughtered, the carcasses measured and cut-out values secured. Results of this comparison are given in the following table.

Summary of the comparison of purebred and crossbred pigs tested in 1949.

Sire Dam	Duroc Duroc	Duroc Montana 1	Montana 1 Duroc	Montana 1 Montana 1	Hampshire Montana 1	Hampshire Hampshire
A. Sow Production to Farrowing to Weaning						
Number of litters	2	2	2	2	2	2
Number of pigs						
(a) Farrowed	9.0	13.0	7.5	7.0	11.0	12.0
(b) Weaned	8.0	10.5	5.5	6.0	10.0	9.5
Average pig weight						
(a) Farrowed	3.3	2.6	3.0	2.6	2.6	2.5
(b) Weaned	32.3	27.1	31.7	28.7	27.3	27.2
B. Record of Performance Test						
Number of pigs	12	12	9	10	12	12
Average pig weight						
(a) Initial	41.1	34.4	31.7	30.6	30.8	32.8
(b) Final	170.4	171.5	166.6	123.9	139.8	155.0
Average daily gain	1.39	1.40	1.38	0.95	1.11	1.25
Feed required per 100 pounds gain	349.2	344.1	332.0	315.5	319.9	327.2
C. Carcass Evaluation						
Number of carcasses	6	7	7	4	6	6
Average live weight	211.3	220.7	214.9	203.8	216.5	216.8
Per cent yield	76.6	79.4	79.0	79.1	79.5	78.7
Thickness back fat in mm. ¹	33.9	42.7	38.2	38.7	36.4	39.5
Area of eye muscle in square inches	4.16	4.40	4.04	4.01	5.88	5.03
Per cent five primal cuts ²	43.1	42.7	43.5	44.4	45.0	42.9
Per cent total fat	16.7	20.4	18.6	18.4	17.9	18.7

¹ Average of five measurements.

² Based on weights of trimmed cuts.

Data presented in the table should not be interpreted as meaning that one breed or cross is better than the other breeds or crosses. Too few litters and animals were used to permit conclusions to be drawn. Furthermore, it is difficult to interpret the efficiency of feed utilization figures because the pigs were fed to a constant age rather than to a constant weight. The Hampshire-Montana crossbreds produced the best carcasses. They had the largest eye muscle, and highest yield of total carcass and primal cuts. They were intermediate in depth of back fat and per cent total fat in the carcass.

This breed comparison will be continued next year by testing the performance of the first cross gilts and the pigs produced by mating these gilts to a boar of a third breed. Commercial swine producers are interested in the performance of the crossbred gilts for these are the animals upon which their enterprise is based.

Crossbreeding with the four breeds Landrace, Duroc, Berkshire and Yorkshire was continued. This year the breed crosses were mated *interse*. Four boars were used to produce the fall crop of pigs. Two of these boars were the result of mating a Yorkshire boar with F₂ (Landrace x Duroc) gilts. The other two were of Yorkshire x [Berkshire x (Landrace x Duroc)] breeding. Two of the boars are shown in the photographs on the opposite page. The crossbred gilts were divided so that the pigs would have all four parent breeds represented in their genetic make-up. Ten purebred Duroc litters served as a control group.

The purebred Duroc gilts farrowed and weaned more and heavier pigs than the crossbred gilts. At weaning time the Duroc litters averaged 1.7 pigs larger and the pigs weighed 1.9 pounds more than the crossbred litters.

Record of performance tests are being conducted as in former years, with six pigs from each litter being put on feed in dry lot at the weaning age of 56 days. At 84 days of age the crossbred pigs averaged 2 pounds heavier than the purebred Durocs. At 112 days of age this difference had increased to 18 pounds, with the crossbred pigs averaging 92 pounds and the Durocs averaging 74 pounds. The pigs are being fed corn and protein supplement free choice.

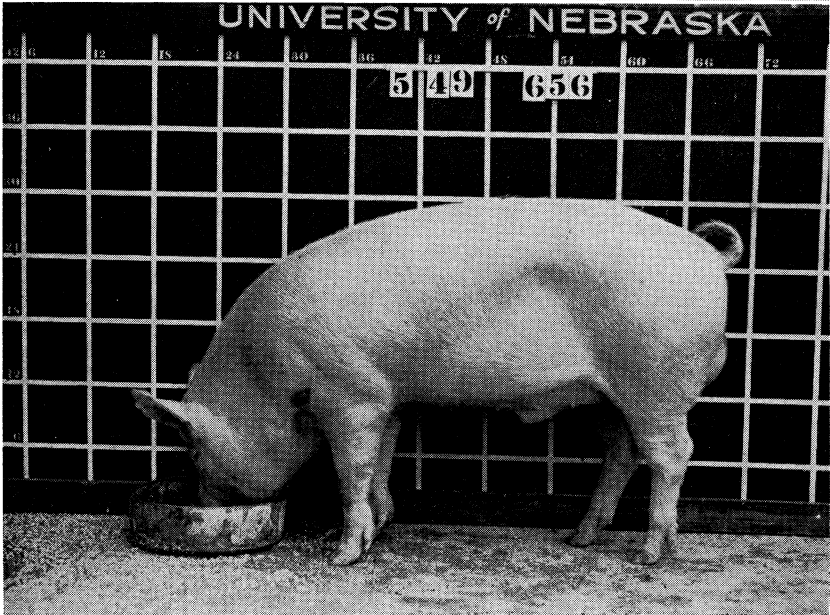
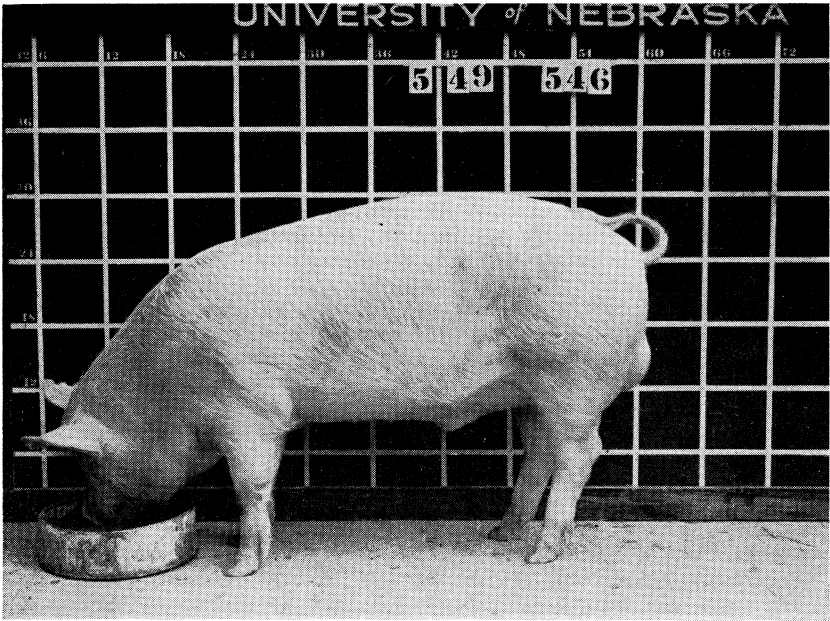
This work will be continued, with the two lines of sires being kept separate. Rather intense inbreeding will be practiced for a generation or two so that distinct lines will be formed.

A study of the relation between sow age and size to production is being made. Results to date indicate that age and size of the sow are more intimately related to litter weight than to litter size.

CECIL T. BLUNN, L. E. HANSON, GUY N. BAKER, C. H. ADAMS,
R. F. BOULWARE, E. M. BROUSE, W. E. JAMES

Swine Feeding Investigations

Use of whey products in pig rations. Two experiments were completed in 1949 in an attempt to evaluate the feeding value of two whey feeds for market hog production. One of these was a condensed product composed of 69.5 per cent whey solids, 9.7 per cent buttermilk solids, 9.2 per cent brewers' yeast slop solids, and 11.6 per cent alfalfa meal. The second whey feed was a dried product composed of 65 per cent cheese whey solids, 9 per cent cheese solids, 6 per cent dried skim milk, 14 per cent soybean meal, 4 per cent alfalfa meal, 1 per cent brewers' yeast and 1 per cent edible tallow.



Above, a Yorkshire x F₂ (Landrace x Duroc) boar. Below, a Yorkshire x [Berkshire x (Landrace x Duroc)] boar. These boars show the type of sires used to produce the 1949 crossbred pigs.

In the first experiment, five lots of 15 pigs each were used. They had an average initial weight of 43 pounds. Lots 1, 2 and 3 were self-fed shelled corn and a protein-vitamin-mineral supplement, free-choice. The P-V-M supplement contained 25 per cent meat scraps, 24 per cent each of soybean meal, distillers' solubles and alfalfa meal, and 1.5 per cent each of limestone and salt. Lots 2 and 3 were hand-fed, in addition, 0.2 pound of condensed whey product per head daily. The pigs in Lot 4 were self-fed shelled corn and a simple mineral supplement, free-choice, and were hand-fed 0.57 pound of condensed whey product per head daily. The pigs in Lot 5 were fed a mixed ration composed of ground corn, 6 per cent of the dried whey product, soybean oil meal, alfalfa meal, limestone, bone meal and salt. This mixture contained approximately 18 per cent protein, 0.7 per cent calcium and 0.5 per cent phosphorus.

The plan was to feed the pigs until each lot reached an average weight of 200 pounds per head. The condensed whey product fed to the pigs in Lot 3 was to be eliminated when these pigs reached an average weight of 125 pounds. The protein content and the amount of dried whey product fed to the pigs in Lot 5 were to be reduced when these pigs reached an average weight of 125 pounds. After eight weeks of feeding, two pigs had been removed from each of Lots 1 and 3, one pig had been removed from Lot 2, and 3 pigs had been removed from each of Lots 4 and 5 because these animals were unthrifty and were scouring. Consequently the experiment was terminated after 56 days of feeding.

Average rates of gain made by the pigs during the 56-day period were as follows: Lot 1, 0.70; Lot 2, 1.00; Lot 3, 1.00; Lot 4, 0.64 and Lot 5, 0.65 pound per head daily. The feed required per 100 pounds of gain was 444, 368, 402, 536 and 527 pounds, for Lots 1, 2, 3, 4 and 5, respectively. Since lots 2 and 3 were fed the same ration they can be considered as one lot for the purpose of comparison with the controls (Lot 1). On this basis, 20 pounds of the condensed whey product, as fed to Lots 2 and 3, saved 13.5 pounds of the protein-vitamin-mineral supplement plus 65.7 pounds of shelled corn in producing 100 pounds of gain. Replacing all of the control supplement with the condensed whey product, as was done in Lot 4, resulted in slower and less efficient gains.

The dried whey product fed to the pigs in Lot 5 did not produce as rapid nor as efficient gains as the control ration.

The second experiment included five lots of 10 pigs each, with an average initial weight of 49.5 pounds. In this trial Lots 1 to 4 were fed according to the same plan as was followed in the first experiment. For the pigs fed the dried whey product (Lot 5), the mixed ration was changed to comply exactly with the manufacturer's feeding instructions. Thus, 8 pounds of the whey product was mixed with 100 pounds of ground corn. This mixture was self-fed and, in addition, a simple mineral mixture was self-fed.

After 10 weeks on test, Lots 1, 2 and 3 had reached weights of approximately 125 pounds per head. During this period the average gain was 1.07, 1.02, 1.13, 0.52 and 0.32 pounds per head daily for Lots 1, 2, 3, 4 and 5, respectively. The feed required per 100 pounds of gain was 382, 433, 356, 540 and 761 pounds, respectively. Considering Lots 2 and 3 as one, for comparison with the controls, 27.6 pounds of condensed whey was equal in value to 13 pounds of shelled corn and 4.1 pounds of the control supplement. The pigs in Lots 2 and 3 were sleeker in appearance than those in Lot 1. At this point the condensed whey product was eliminated from the ration of Lot 3.

It was obvious that the pigs in Lots 4 and 5 were not being nourished adequately. However, they were continued for two more weeks on the original rations. Then the pigs in Lot 4 were fed an addition of $\frac{1}{4}$ pound of the control supplement per pig daily. They were then consuming 1 pound of condensed whey per head daily. For the last six weeks of the test their rate of gain was doubled.

The pigs in Lot 5 were offered the control supplement, free-choice, in addition to their original ration, for the last six weeks of the test. The change in this group of pigs was amazing. They consumed an average of 1.6 pounds of the control supplement per head daily and made an average daily gain of 1.8 pounds per head. Several pigs that had gained nothing during the first 12 weeks of the test, or at most a few pounds, made good gains.

This experiment was concluded when the pigs in the first three lots reached average weights of 208, 204 and 219 pounds, respectively. At that time the pigs in Lot 4 averaged 141 pounds and those in Lot 5 averaged 159 pounds.

These experiments demonstrate that the condensed whey product does have value as a supplement to the basal ration for pigs under 125 pounds in weight. No benefit was demonstrated from the addition of this product to the control ration for pigs over 125 pounds. It is clear that the substitution of the condensed whey product for all of the control supplement is undesirable.

The dried whey product fed to the pigs in Lot 5 is undoubtedly a good product, but it is obvious that the manufacturer's feeding instructions are not in line with the pig's nutrient requirements.

L. E. HANSON

Value of Copperas in swine gestation rations. Nutritional anemia, characterized by a low hemoglobin value, is a problem whenever suckling pigs are confined on hard floors, without access to the soil. This type of anemia was given considerable attention 15 to 20 years ago, and recommendations were made for its prevention under practical conditions.

Recently it has been reported that the feeding of Copperas (crude iron sulfate) to brood sows during gestation is a desirable practice. Benefits attributed to the feeding of this supplement were increased vigor of pigs at birth, higher hemoglobin values in the blood of pigs at birth, a reduction in the rate of decline of hemoglobin values during the suckling period, and lower mortality between birth and weaning.

This experiment was designed to test the value of the addition of Copperas to a gestation ration. Twenty-six purebred Duroc and Hampshire gilts were placed in concrete-paved lots in December 1948. They were fed a mixed basal ration of ground yellow corn, ground oats, alfalfa meal, tankage, soybean meal and salt. They were bred in January and February and sorted into three uniform lots on February 12, 1949.

Lot 1 was fed the basal ration, Lot 2 was fed the basal ration plus 0.5 pound of Copperas per 100 pounds of feed mixture, and Lot 3 was fed the basal ration plus 0.2 pound of Copperas per 100 pounds of mixture. Of the 26 gilts, 22 farrowed, 8 in Lot 1 and 7 in each of Lots 2 and 3. All gilts and their litters were kept on concrete throughout the suckling period. All gilts were changed to the same suckling ration when the pigs were about seven days old. This ration contained no iron supplement.

All live pigs were bled through an ear vein as soon after birth as pos-

sible. After each pig was bled it was ear-notched with an individual number and all of the even-numbered pigs were treated with an iron supplement (a small pinch of dry Copperas by mouth). The odd-numbered pigs were left as untreated controls.

All pigs were bled at seven-day intervals until they were eight weeks old, except that no samples were taken on the fifth or seventh weeks. Each time the pigs were bled they were weighed and the even-numbered pigs were given Copperas by mouth. Hemoglobin determinations were made by an alkaline hematin technic employing a Coleman spectrophotometer.

The pigs were provided with creeps when they were two to three weeks of age. The feed offered included rolled oats, cracked corn and protein supplement. The boars in each litter were castrated as soon as blood samples had been taken, at four weeks of age.

Results of this study show that the feeding of Copperas to bred gilts during gestation, either as 0.5 per cent or as 0.2 per cent of the ration, did not result in increased vigor of the pigs at birth; did not result in the birth of larger pigs; did not result in higher hemoglobin values in the blood of pigs at birth; did not prevent the development of anemia in pigs during suckling period; did not reduce the mortality from birth to weaning; and did not result in heavier weaning weights. The hemoglobin level of individual pigs varies widely at birth and falls most rapidly during the first week after birth. The rate of decline is accelerated if the pigs are not treated with an iron supplement.

These studies also showed that the treatment of pigs to prevent anemia should start soon after birth, not when the pigs are two to three weeks old as is often done in practice. The data indicate that the treatments at birth, at one week, and at two weeks of age were the most important. The feeding of Copperas during gestation, as was done in this experiment, is not recommended.

L. E. HANSON, R. J. MEADE

Copper sulfate in rations for market pigs. It has been reported that the addition of a trace of copper to corn belt swine rations will increase the rate and efficiency of gain of pigs thus fed. To check this report, two lots of 12 pigs each, with an initial weight of approximately 28.5 pounds were used. The basal ration, self-fed to both lots, was composed of ground corn, tankage, soybean oil meal, distillers' solubles, linseed meal, alfalfa meal, steamed bone meal and salt. For one lot, 6 grams of copper sulfate was added to each 100 pounds of mixed ration. Both lots were also fed about $\frac{1}{4}$ pound of a condensed whey product daily per pig.

The pigs were fed for 98 days. Neither lot made satisfactory gains. The controls made an average gain of 0.58 pound daily whereas the copper-fed pigs gained 0.54 pound per head daily. The feed requirement was 4.4 pounds per pound of gain for the controls and 4.7 pounds for the pigs fed the copper supplement. This study is being continued with better quality pigs, on a larger scale.

L. E. HANSON

Rearing pigs in a restricted environment. The two gilts that survived from last year's test crop were fed to market weight and then discarded. One of the fourth-generation sows was rebred and farrowed 12 pigs, 6 of which were weaned at an average weight of 28.1 pounds. Three of

these were females and are being fed to continue the stock. No tests are planned until the numbers have been increased.

L. E. HANSON

Bulk in pig rations. In many nutrition studies the use of purified diets is essential. No one has determined whether or not such diets should contain a bulk ingredient. It has been suggested that there is an optimum bulk requirement which is greater than the minimum obtained in many purified diets.

To obtain information on this point one experiment was completed last year. Various levels of cellulose (Ruffex) were substituted for starch in a purified basal ration composed of 70 per cent corn starch, 15 per cent casein, 6 per cent brewers' yeast, 6 per cent salt mixture and 3 per cent lard. In addition each pig was given a weekly supplement of cod-liver oil. The levels of cellulose (Ruffex) fed were 2.5, 5 and 10 per cent. Rates of gain and feed required per unit of gain were essentially the same on all levels of cellulose and on the basal ration.

Sixteen pigs were used in two experiments completed this year. Two uniform groups of 4 animals were used in each experiment. The basal ration was the same as that used last year. The ration was changed to include 12 per cent casein and 73 per cent starch when fed to animals over 100 pounds in weight. Cellulose (Ruffex) replaced starch to the extent of 5, 15 and 20 per cent of the basal ration.

The pigs were penned and fed individually. The amount of feed for each pig in a group was limited to the amount consumed by the pig in that group with the poorest appetite. The control pig in each group received the basal ration while the remaining three received one of the three rations including cellulose.

In both experiments the live-weight increase and economy of feed utilization for the pigs fed cellulose at the 5 per cent level were very similar to those for the control animals. The 15 and 20 per cent levels of cellulose had a depressing effect on feed utilization and daily gain.

Four digestion trials were conducted, one with each group in each experiment. Results of these trials indicate that cellulose was poorly digested at all levels. A depressing effect from the addition of cellulose to the ration was observed on the apparent digestibility of protein, nitrogen-free extract, and ether extract. This depression was progressively increased as the level of cellulose was increased from zero to 20 per cent.

In the first experiment one group of pigs was slaughtered when the pigs reached approximately 100 pounds. The second group was slaughtered when the pigs reached about 200 pounds. In the second experiment both groups of pigs were slaughtered at approximate weights of 100 pounds.

Postslaughter analyses of the carcasses were made. Except for the three 200-pound pigs which were fed cellulose in the first experiment, all of the carcasses were of excellent quality. The fat and lean tissue of the three 200-pound animals was watery, which made the carcasses extremely soft. This condition was not encountered in the experiment last year, and no explanation is possible. There were no differences in the carcasses of the pigs slaughtered at 100 pounds that could be attributed to the ration.

The experiments completed this year and last do not demonstrate benefit from the addition of cellulose (Ruffex) to the basal ration fed. It is clear that the 15 and 20 per cent levels of cellulose are excessive.

L. E. HANSON, HOWARD S. TEAGUE

Vitamin E requirements for growth and reproduction. The third experiment in this series was completed in 1949. Three groups of three gilts each were fed according to the same plan followed previously. One group was fed a natural ration previously shown to be adequate for growth and fertility. The other two groups were fed a purified ration composed of 70 per cent corn starch, 15 per cent crude casein, 6 per cent brewers' yeast (Strain G), 6 per cent salt mixture and 3 per cent lard. One of these groups was given a weekly supplement of 375 mg. alpha tocopherol per head. The starch was increased 3 per cent and the casein reduced 3 per cent when the gilts weighed approximately 100 pounds. The gilts were daughters of the sows used in the second experiment. They were weaned at ages of 29 to 40 days and all of them were fed the purified E-free diet from weaning until placed in the experimental lots. The average starting weight was approximately 22 pounds.

The pigs fed the purified diet were individually fed on A and D concentrate (stated to be vitamin E-free by the manufacturer) each 14 days. The amount given was calculated to supply at least 58 I.U. of vitamin A per kilogram of body weight daily.

Six weeks after the start of the test a pig in Lot 3 (receiving alpha tocopherol) developed a wobbly gait. She rapidly became worse and soon was unable to use her hind limbs. She appeared bright and would eat if held on her feet. When it became apparent that she would not recover, she was slaughtered for autopsy. No evidence of accidental injury or of gross pathological changes were found on post-mortem inspection. Two weeks later a gilt from the negative control group was found dead. Autopsy revealed a hemorrhagic congestion of the lungs which caused suffocation.

Pigs in both lots fed the purified ration developed wobbly gaits and by mid-October the two gilts remaining in the negative control group could not stand and would not attempt to stand unless they were abused. These gilts were then given several massive doses of A and D concentrate and their recovery was quite marked. Within a month they appeared to be completely normal. The A and D concentrate was then fed at seven-day instead of fourteen-day intervals.

The gilts were bred to farrow in May and June. The three animals fed the natural ration farrowed 30 live pigs and 1 stillborn pig, with an average birth weight of 2.5 pounds. They weaned 22 at an average 56-day weight of 28.4 pounds. Two gilts in Lot 2 (E-free basal ration) farrowed 13 live and 2 stillborn pigs. They had an average birth weight of 2.5 pounds. All of the live pigs seemed very dull the first 24 hours. One of these gilts died the day after farrowing and autopsy revealed a ruptured colon and internal hemorrhage. The second of these gilts lost her appetite several days before farrowing and ate very little all through the nursing period. She seemed to have sufficient milk for the pigs at the start and they grew well. Later they began to eat the feed put out for their dam. Five pigs were weaned in this litter at an average weight of 36.3 pounds. The day after the pigs were weaned the sow died. Autopsy revealed a severe anemia, an enlarged and friable liver and marked degeneration of the kidneys. The skeletal muscle was very light colored.

The two gilts in Lot 3 (E-free basal ration plus a weekly supplement of alpha tocopherol) farrowed 12 live and 3 stillborn pigs with an average weight of 2.8 pounds. They weaned 10 pigs at an average weight of 18 pounds. Both of these gilts had poor appetites during the suckling period. Four days after the litters were weaned, one of the gilts died. Autopsy

revealed a condition almost duplicating that of the gilt in Lot 2 that died the day after her pigs were weaned. The second gilt in this group would eat but little for many days after weaning. She was finally forced to go outdoors daily and nibble at the grass. About one month later she recovered sufficiently to be marketed.

Repeated rat assays of the basal purified ration have resulted in no litters. However, when the A and D concentrate was added to the basal ration some litters were produced by the test rats. This assay was repeated a sufficient number of times to make it clear that the A and D concentrate does contain vitamin E. Tests with certain cod-liver oils have produced no litters. Thus, this study is being continued with gilts from the litters produced in 1949 and with cod-liver oil serving as the source of vitamin A and D.

L. E. HANSON, I. L. HATHAWAY

Rendering Lard in the Home Pressure Cooker

A satisfactory method of rendering lard in a home pressure cooker is being developed at this Station. Since only one type of cooker has been available for these tests, results may not hold true for all brands of pressure cookers.

Fat rendered in the cooker at 20 pounds pressure with steam escaping through the safety valve rendered in less time, had as good keeping qualities and yielded as much lard as fat rendered by the open kettle method.

As a safety measure the cooker should not be filled more than half full of fat. This will prevent grease from getting into the safety valve and pressure gauge. Cookers with gaskets that do not resist deterioration by fats should not be used for rendering lard. Only cookers with safety valves that can be regulated for steam escape can be used.

The three advantages of rendering lard in the pressure cooker are: less labor is required; rendering can be done in the kitchen with no danger of fire; less objectionable odor is produced.

Additional tests will be made on other brands of pressure cookers before safe, dependable directions are published.

CHARLES H. ADAMS

Sheep Breeding Investigations

The validity of progeny-tested rams for improving Corriedale sheep. A new group of 120 white-face yearling ewes from the western range were used to continue the ram progeny work with Corriedale rams at Lincoln and North Platte. The 1947 breeding season started November 3 with the check ram M.M. C-5775 that has been used since the beginning of the project. Other rams used included five from the flock at Lincoln, two from the flock at North Platte, and two brought in from the Swenson and McBride flock of Harpster, Ohio.

Birth weights for the lambs by sires ranged from 9.58 to 11.04 pounds. The lambs were shorn the last of December, 1948, and produced a range in average weights by sires of from 5.50 to 6.58 pounds. A fleece analysis showed a shrinkage range of from 37.9 to 47.4 per cent by sires. The per cent dirt in the fleeces ranged from 6.1 to 9.4 by sires.

The final live weight of the lambs by sires on February 5, 1949, at about 10 months of age and not including the shorn fleece, ranged from 89.5 to 116.59 pounds by sires. The range of 27.09 pounds is the greatest

for any of the lamb crops produced to date in the project. At the same time the final weight average of 116.59 pounds is the highest to date and the 89.5 pounds average for the low-ranking ram used in the fall of 1947 is the highest of the low averages recorded for any year in the project.

One observation that reflects some hope of progress in finding a ram that may have possibilities as a desirable individual to inbreed is found in the analysis of the final weights of the lambs. The ram with the 116.59-pound lamb average at market time leads all other rams by 5.55 pounds or 20 per cent of the range in average market weights of the lambs by sires. This is the greatest margin so far in the life of the project. The ram is also superior in type and conformation.

M. A. ALEXANDER, GUY N. BAKER

Lamb Feeding Experiments

Lamb feeding experiments at the Scottsbluff Substation during 1949 comprised studies of beet top silage, corn silage, two types of linseed meal, dehydrated alfalfa pellets, and a study of methods and materials for tick control. The feeding experiments were conducted with 11 lots each containing 36 lambs; the tick control experiment, with 6 lots of 24 lambs each.

Linseed meal produced by the extractor process was compared with linseed meal produced by the expeller process. The average daily gains, and the feed required for 100 pounds gain, were essentially the same for the two types of linseed meal. Lambs on a ration of corn and alfalfa gained at the rate of 0.23 pound per day, compared with 0.30 pound for lambs fed corn and alfalfa, and either type of linseed meal in addition. On a ration of corn, alfalfa, corn silage, and either type of linseed meal, the lambs gained 0.33 pound per day.

Corn, dehydrated alfalfa pellets and beet top silage proved to be a valuable ration for lambs. On this ration the lambs gained at the rate of 0.44 pound per day.

Sugar beet top silage was fed in comparison with corn silage in a ration of grain mixture (equal weights of corn, barley, and dry beet pulp), soybean meal, bone meal and alfalfa. Lambs fed the beet top silage ration gained at the rate of 0.44 pound per day, compared with 0.36 pound for lambs fed corn silage. The two types of silages were fed on the basis of the amounts the lambs would clean up in addition to the basic ration of grain and alfalfa. In this comparison the lambs consumed beet top silage at the rate of 5.16 pounds per lamb daily, compared with 3 pounds of corn silage. The lambs fed beet top silage consumed more silage but less concentrates and alfalfa per 100 pounds of gain than those fed corn silage. The cost of 100 pounds of gain was slightly in favor of the beet top silage ration.

Three lambs died from urinary calculi on a ration of corn, cotton seed meal, bone meal and beet top silage. During past years this ration has resulted in the death of more lambs from urinary calculi than any other ration. One lamb died from urinary calculi on a ration of grain mixture, cotton seed meal, bone meal and beet top silage. Lambs fed the above two rations gained at the rate of 0.41 pound daily during 1949. On a ration of grain mixture, soybean meal, bone meal and beet top silage lambs gained at the rate of 0.44 pound daily; and even though alfalfa was not included in this ration, no lambs were lost as a result of urinary calculi. Similar results with this ration have been obtained during past years.

LIONEL HARRIS, M. A. ALEXANDER

Dairy Cattle Investigations

Dairy Husbandry Department, North Platte and Scottsbluff Substations

Reproduction and Breeding

Factors affecting reproduction. The failure of cows to breed at the first insemination is an important cause of losses to the dairy industry. It has been well established that there is a close relationship between proper endocrine balance and efficient reproductive function. Apparently the relative levels of hormones in the blood influence the proper timing of the necessary reproductive functions which lead to conception.

Many cows appear to secrete the estrogenic hormone in insufficient quantities. This is indicated by a complete absence of heat with no persistent *corpus luteum*, or by a short ill-defined heat period with a subsequent poorly developed *corpus luteum*.

From results with experimental animals, it appears that increasing the amount of estrogen in the blood at the beginning of heat in cows having underactive ovaries might affect the time of ovulation and increase the development of the *corpus luteum* subsequent to the treated heat period. Thus a more vigorous and complete estrous cycle might be brought about.

In testing the above hypothesis, 5 mg. of dienestrol (a synthetic estrogen) in aqueous solution was injected into each of 70 cows at the beginning of their heat periods. Seventy untreated cows were used as controls. Since there is extreme variability between cows in reproduction function, large numbers of cows must be treated before definite conclusions can be made. To date, the results seem to indicate that: (1) the time of ovulation was not influenced by the injection of dienestrol, (2) the conception rate on the treated service was the same as for untreated, (3) the conception rate on the service following the treated service (when required) was 14 percentage units higher than for the service following a previous service in which no injection of dienestrol was made. This difference, however, was not statistically significant.

Tests for pregnancy. Some of the methods used for diagnosing pregnancy in the human have been tested for reliability in determining pregnancy in the cow. The presence or absence of the chorionic gonadotrophin in the urine of cows is apparently of no diagnostic value. Determination of the amount of pregnanediol also appears to be of no diagnostic value in the cow. A study has been initiated to determine whether there is a change in the cellular components of the smears of the vagina and cervix of a cow during the estrous cycle and in early pregnancy. If definite cellular changes do occur, it is possible that they may be used as a criterion for determining pregnancy.

Fertility studies. In agreement with the results of previous work, the addition of 10 y per cent d,l-thyroxine (isolated from Protomone) to semen has increased conception rate from 5 to 7 percentage units (over 10,000 services). The use of thyroxine plus an antibiotic such as penicillin or sulfanilamide brought about less improvement in conception rate at the Nebraska Station than the use of thyroxine or sulfanilamide alone. This indicates that one may counteract the effect of the other. Control semen showed a conception rate of 60.2 per cent, thyroxine alone 66.7 per cent, and thyroxine and penicillin 61.2 per cent in 5,929 services. Therefore, the

following treatment was initiated: 10 micrograms per cent thyroxine is added to bovine semen at the time of collection and is followed six to ten hours later with the addition of 300 mg. per cent sulfanilamide. Results of this treatment will be compared with those obtained with untreated semen, semen treated with thyroxine alone and semen treated with sulfanilamide alone. This experiment is an attempt to determine whether increased fertility promoted by the addition of thyroxine can be maintained over a longer than usual storage period by adding sulfanilamide.

Uptake of oxygen studies. Treatment of spermatozoa *in vitro* with a male hormone (testosterone) resulted in a decreased use of oxygen. No influence on livability was noted that could be ascribed to the addition of testosterone to semen. Apparently the ability of testosterone to maintain the life of spermatozoa in the genital tract of the male over a long period of time does not continue after the sperm has been ejaculated.

Adding freshly prepared solutions of acetylcholine to semen samples treated with thyroxine appeared to increase oxygen uptake compared with that of poor-quality semen to which thyroxine alone was added. However, the instability of acetylcholine makes it almost impossible to draw definite conclusions on this point. Work is underway to determine whether acetylcholine is normally present in bovine semen and, if so, whether it is a variable factor. Results thus far indicate that a substance similar in its action to acetylcholine may be present in bovine semen but observations are too few to support any conclusion at this time.

A. B. SCHULTZE, F. N. BAKER, N. W. ROLLINS

Artificial insemination of dairy cows. The bull stud (Dairy Breeders Enterprise) was continued with success during the year and furnished semen from superior sires to farmers scattered over about 20 counties of the State. Through membership in an artificial breeding association, it was possible for farmers to obtain the services of outstanding bulls at a cost much below that of keeping even a poor bull. Records of production on the daughters of the bulls in the stud are being assembled, and from preliminary figures it appears that the bulls will be proved, with a high production average for the daughters. During 1948 an average of 30 bulls furnished semen for the breeding of 16,909 cows. Of these, 8,453 were bred to Holstein bulls, 3,310 to Guernsey bulls, 4,299 to Milking Shorthorn bulls and 847 to Jersey bulls. Ideally, a cow should conceive with one service, but studies in the University of Nebraska herd and in the dairy herds under the supervision of the Bureau of Dairy Industry, U. S. Department of Agriculture, indicate that on the average, 2.25 natural services are required for conception. This represents a conception rate of 44.44 per cent. Results in the herds of several thousand farmers in Nebraska for the last three years show that artificial insemination has given a much more satisfactory conception rate. Based upon the number of cows that did not return to heat after service in a minimum of 90 days and a maximum of 180 days, the percentages are as follows for cows bred to bulls of the different breeds:

	1946	1947	1948
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Holstein bulls	59.04	59.37	60.36
Guernsey bulls	55.02	57.94	55.00
Milking Shorthorn bulls	60.64	60.31	63.08
Jersey bulls	52.00	57.22	53.05
All bulls	58.18	59.22	59.37

Operation of a bull stud by the Dairy Husbandry Department furnishes an opportunity to study dairy bull management practices and makes possible extensive studies of bovine semen. Some of these studies have already indicated practices that are expected to improve the conception rate for cows owned by farmers.

H. P. DAVIS

Regional dairy cattle breeding project. The dairy cattle breeding project in Nebraska is being carried on with purebred Holstein cattle at Lincoln, North Platte and Scottsbluff. At Lincoln three lines of Holstein cattle are being developed. One group of cows has been mated to Wintorthur Wintorias, a son of Posch Ormsby Fobes 14th, another group to Dunloggin Duke, a son of Montvic Lochinvar, and a third group to Shaws Dauntless Direct, a son of Baker Farm Dauntless. Eighteen daughters are now in the herd from each of these bulls, and are being mated to close relatives of the original sires. Some inbred calves have already been born. At North Platte the two lines have been developed by the use of two Carnation-bred sires, Carnation Heilo Imperial and Ellenvale King Mooie Perfection. At Scottsbluff the line of breeding is much the same as in the Wintorias line at Lincoln. At both North Platte and Scottsbluff younger bulls closely related to the original sires are now being used. Some inbred offspring have been born and the inbred lines are in the process of development. It is planned to mate each bull to enough cows to produce 10 to 15 female offspring, after which the bulls are to be replaced with another bull in order to develop the inbred lines as quickly as possible in the early stages of the experiment.

When the bulls are no longer needed in the project they will be offered for service either with the Dairy Breeders Enterprise (the bull stud located at Lincoln), or in herds where a testing program is carried on and where the qualities of the bulls may be utilized and tested in unrelated herds. The original sires for the Lincoln herd are being used in connection with the Dairy Breeders Enterprise and several will shortly be proved for production.

In most cases records of the daughters are incomplete but those available indicate a production on a 10-month, twice-a-day, mature-equivalent basis of 470 to 510 pounds of butterfat for the bulls used in the foundation of the inbred lines.

MOGENS PLUM, PHILIP L. KELLY, LIONEL HARRIS, MYRON G. A. RUMERY

Feeding and Management

Effect of feeding antiathyroid drugs to dairy calves. Investigations by other workers have indicated that thiouracil may increase fattening and fleshing of farm animals. At the Nebraska Station, feeding 1.5 to 2 grams of thiouracil twice a day to dairy calves up to an age of 14 weeks did not influence growth or fleshing ability. In continuing this trial with six experimental and six control calves, the thiouracil was increased to 5 grams per 100 pounds body weight and was fed for five months. Although the experimental calves averaged somewhat greater body weight than the controls, the difference was not significant with the small number of animals involved.

Effect of feeding thyroprotein on milk production. In earlier experiments, feeding 1 to 1.5 grams of thyroprotein per 100 pounds body weight resulted in an increase in milk production for about six weeks, followed

by a slump in milk production and loss of body weight. During the past year thyroprotein was fed to 10 cows at a rate of 0.6 gram per 100 pounds body weight. Production increases are apparent in several cows but not in others. Since there seems to be an individual response to thyroprotein feeding, an attempt was made to correlate pulse rate with thyroid status and milk production in cows. Apparently pulse rate is not useful in this respect.

Effect of feeding thyroprotein on fertility of dairy bulls. Previous investigations have shown that fertility is increased in some bulls but not in others by feeding thyroprotein. Similar results were obtained this year in an experiment in which 16 grams of thyroprotein was fed each day to seven bulls during October, November and December. Although the over-all fertility for all bulls was significantly increased 6 per cent, this increase was due mainly to the favorable effect on fertility of three of the seven bulls, the fertility of the other bulls not being significantly changed from that in the prefeeding period. A statistical analysis of the data showed also a significant interaction between treatment and bulls, indicating again an individual response to the thyroprotein.

A. B. SCHULTZE, P. H. COLE

Use of irrigated brome and alfalfa pasture. Three pastures with a total area of 22 acres were used under a system of rotation grazing at the North Platte Substation. As soon as a pasture was well grazed, the cows were moved to a fresh pasture and the used pasture was irrigated. An average of 36 Holstein cows, with an average of 30 in production, were grazed from April 28 to October 20, a period of 175 days. The cows produced 203,974 pounds of milk and consumed 28,859 pounds of a grain mixture and 32.77 tons of hay. The pastures produced 10.75 tons of hay in addition to the forage grazed by the cows.

MYRON G. A. RUMERY, E. C. CONARD, J. C. ADAMS

Feeding milk substitutes to growing dairy calves. Three lots of Holstein steer calves at the North Platte Substation were fed a basal ration of 150 pounds ground yellow corn, 150 pounds whole oats, 6 pounds bone meal, and 3 pounds salt, with good quality, green alfalfa hay for 154 days, beginning November 13, 1948. The basal ration was supplemented with 20 pounds blood meal, 10 pounds linseed meal and 10 pounds soybean meal for Lot 1. Fifty pounds of tankage was added to the basal ration for Lot 2. The calves in Lot 3 were fed 10 pounds of skim milk in addition to the basal ration. Average daily gains per head for the three lots, respectively, were 2.24, 1.99, and 1.90 pounds. Lot 3 appeared somewhat more thrifty than the other lots but the difference was not as marked as in previous trials; neither was the difference in appearance and average daily gain between Lots 1 and 2 as great as in previous trials.

MYRON G. A. RUMERY

Dairy herd management. For more than 40 years careful records have been kept of the University of Nebraska dairy herd. During this period 2,428 calves of the Holstein, Jersey, Guernsey and Ayrshire breeds were born. Of this number 51.48 per cent were males and 48.52 per cent were females. This sex ratio compares closely with other studies made with cattle. Of the calves born only about nine out of ten were born alive, even though the abortion rate was low. Many calves died during the

first twenty-four months of age. Death losses approached 15 per cent, with such ailments as digestive disturbances, respiratory troubles (pneumonia) and infections taking the largest toll. Through the years, about 50 per cent of the males were sold for breeding as compared with less than 10 per cent of the females. Although every effort was made to do a good job of rearing young animals, only about 75 per cent of the females entered the herd for milking purposes. A detailed study of calf raising will soon be prepared which, it is hoped, will prove useful to herd owners.

H. P. DAVIS

Dairy Products Investigations

Department of Dairy Husbandry

Ice Cream Studies

Pasteurization and homogenization are commonly accepted as essential processes in the preparation of an ice cream mix, but a survey of commercial plants shows considerable variation in the temperature at which these processes are carried out. Since high-temperature treatment is beneficial in other milk processing procedures, it seemed worth while to determine the effect of various high-heat treatments on an ice cream mix and on ice cream, particularly with reference to protein stability, shrinkage and flavor. Sample mixes were pasteurized by heating the constituents as follows: (a) to 160° F. for 30 minutes, (b) to 175° F. for 30 minutes, (c) to 185° F. for 10 minutes, and (d) to 185° F. for 30 minutes. Although sufficient data have not been accumulated to draw conclusions, preliminary observations indicate that greater protein stability resulted from the higher-temperature treatments. In no case has an undesirable cooked or heated flavor resulted from the pasteurization treatment.

L. K. CROWE, D. D. DEANE

Experiments with Cheese

Ripening American cheddar cheese. Efforts were continued to develop methods that will increase the rapidity of cheese ripening without deleterious effects. It was found that when as little as 0.1 per cent of a *Streptococcus liquefaciens* culture is added with the usual *Streptococcus lactis* type cheese starter to the milk, the rate of ripening and the amount of water-soluble nitrogen and volatile acids in the experimental cheddar cheese are increased. Such cheese, however, becomes bitter and unpalatable after 6 to 12 weeks of ripening at 65° F. or 12 to 18 weeks at 50° F. Two other cultures which break down milk proteins under acid conditions were isolated from dairy products and used to make cheddar cheese in the hope that they would speed up the ripening process. When these cultures were added to the cheese milk in concentrations up to 0.5 per cent, no significant effect was noted on the rate of curing or on the formation of water-soluble nitrogen and volatile acids. No appreciable bitterness was found during the ripening period of six months.

Cheddar cheese ripened faster at 65° F. than at 50° F. Cheese held at the higher temperature for 18 to 24 weeks showed a pronounced development of desirable flavor whereas cheese ripened at 50° F. for the same period showed appreciably less flavor development. Holding the cheese at 65° F. during the ripening period also increased the amount of water-soluble nitrogen and volatile acids as compared with the 50° F. ripening temperature.

D. D. DEANE, P. A. DOWNS

Vitamins in cheese. In the study of the various vitamins contained in different types of cheese, the niacin content has been determined for 13 different cheeses by the microbiological method. So far 90 determinations have been made, 35 of which are assays of 13 different cheeses. Considerable variability has been obtained in the results and much additional work will be necessary before satisfactory conclusions can be drawn.

I. L. HATHAWAY

Soft cheese spreads. Many small dairy plants could increase their income and utilize their equipment and products to advantage by producing soft cheese spreads. Production of a spread developed at the Nebraska Station will utilize the type of equipment available in most small dairy plants. It was found that by combining cottage cheese with heavy cream or butter, a variety of spreads can be made with the aid of a homogenizer or a positive-action milk pump. By using equal amounts of cottage cheese and sweet cream (55 per cent fat content), a firm spreading cheese is produced. One to two per cent salt is added and the mass is heated to 160° to 165° F. with stirring. The mass is held at this temperature for 30 minutes or more. For processing it is run through the homogenizer at 2,000 to 2,500 pounds pressure. It is run through the homogenizer a second time and passed directly to Parakote-lined box containers. When the packages are filled the Parakote is folded over the top surface and sealed with the fingers. After lids are placed on them, the packages are inverted and allowed to cool. The result is a sealed package which can be removed from the container if desired. By using the new packaging materials it is possible to produce a product that will keep for long periods at ordinary home refrigerator temperatures. A variety of flavors have been offered to consumers and many have been well accepted. Plain cheese seems to be most popular, followed by pimento, olive nut, blue, cheddar and camembert mixtures. It is hoped that this study will help the smaller dairy plant find a better market for surplus products.

P. A. DOWNS, D. D. DEANE

Special wrapper for curing cheddar cheese. A laminated cellophane wrapper (Parakote) on 5-pound loaves of cheddar cheese significantly reduced the loss of moisture during curing. In 14 of 16 trials the amount of moisture lost by 5-pound loaves of cheddar cheese wrapped in Parakote varied from $\frac{1}{3}$ to $\frac{3}{4}$ ounce during a six-month curing period. Comparable loaves of cheddar cheese protected in the usual manner by a coating of paraffin lost from five to seven times this amount of moisture during the same period. No consistent influence was found on the rate of ripening of the cheese cured for as long as six months in the Parakote wrapper. The wrapper also prevented formation of rind on the cheese.

D. D. DEANE, P. A. DOWNS

Sanitation

Extraneous matter in churning cream. Foreign matter in churning cream causes a serious problem for both the producer and the manufacturer. Excess quantities of any material, and even small quantities of rodent hairs, insects or insect fragments, feather parts and discolored plant fragments, are very objectionable.

Samples of cream were studied during the various stages of their progress from the producer to the final processor. The data collected show that freshly separated cream is relatively free from foreign matter. The extraneous matter is increased in quantity with the length of time the cream remains on the farm and the number of times it is handled. Considerable quantities of foreign matter are found in cream as received at the buying stations.

In testing for extraneous matter in sour cream, filtering can be readily accomplished by the addition of some reagent, usually alkaline, which

disperses the coagulated casein. Satisfactory for this purpose is a 40 per cent solution of sodium hexametaphosphate (Calgon), added at the rate of 10 to 15 milliliters for a 4-ounce sample of cream previously diluted with two volumes of water at 180° F. Cream that is heavily contaminated with mold is difficult to filter by any known method.

L. K. CROWE

Plant sanitation. Chemical sterilizers were compared with hot water for cleaning dairy equipment. Satisfactory control of the coliform count was obtained when the sterilizing medium was circulated for a sufficient time. It is believed that the most satisfactory results are obtained when the solution is circulated at temperatures as high as or higher than that of the milk products to be handled. This expands the metals and exposes all surfaces that are exposed when heated milk products pass through the equipment. The addition of 200 parts per million of sodium hypochlorite to hot water gave good results when the solution was circulated long enough to cause maximum expansion of the metal. In the care of homogenizers the pressure of the sanitizing solution should be similar to that of the products to follow. Further experiments are being conducted to determine the minimum amount of hypochlorite needed. It is believed that where water is available at a temperature of 180° F. or higher and circulation is continued for sufficient time, satisfactory results can be expected without the addition of hypochlorites. The sterilizing efficiency of the various procedures was tested by the coliform count using Violet Red Bile Agar. Cultures isolated from the utensils indicated the presence of *Aerobacter* and coliform intermediates rather than *Escherichia coli*.

P. A. DOWNS, D. D. DEANE

Poultry Nutrition and Breeding

Department of Poultry Husbandry and North Platte Substation

Rations for Poultry

A comparison of mash and granules for chicks. Three lots of White Rock chicks were used in an experiment to determine the value of converting mash into granules. For the basal control ration, a relatively simple high corn ration was used (ration BX). To test the vitamin adequacy of ration BX, one lot of chicks was fed 1 per cent of a multiple-vitamin product with 99 per cent of the basal ration. The vitamin mix contained riboflavin, pantothenic acid, choline, thiamin and niacin. Results are summarized in the following table.

	Lot No.		
	866	867	868
*Base BX (lbs.)	100	.....	99
BX as granules (lbs.)	.....	100	.....
Multiple-vitamin mix (lbs.)	.....	.....	1
Total	100	100	100
Number chicks per lot	140	140	140
Average weight at start (g.)	47	47	47
Average weight at 28 days (g.)	297	290	292
Average weight at 56 days (g.)	680	741	715
Feed conversion factor	2.6958	2.5713	2.6684
Deaths	5	7	7

* Base ration BX was composed of the following ingredients in pounds: ground yellow corn, 54.5; soybean meal, 19; corn gluten meal, 10; meat scraps, 5; alfalfa leaf meal, 5; fish solubles blend (80 per cent fish solubles), 2.5; D_s blend (200 A.O.A.C. per g.), 1; and mineral mix No. 45, 3.

A slight improvement in growth rate resulted from the use of the granulated ration. No significant improvement in growth rate resulted from the addition of a multiple vitamin supplement to base ration BX.

F. E. MUSSEHL, C. W. ACKERSON, R. L. BORCHERS

Growth-promoting value of meat scraps. Earlier observations indicated a difference in the growth-promoting value for chicks of different samples of meat scraps processed in the same manner. The processors suggested that a difference in the source of material might account for the differences in nutritional quality.

Representative samples of meat cracklings were obtained from the same packing plant. All products were subjected to the same degree of heat treatment, and were otherwise processed in a comparable manner. Samples classified as to basic material with a summary of some constituents were as follows:

Sample Number	Type	Protein	Ribo-	Niacin	Trypto-	Methio-	B ₁₂ *
			flavin	Mg./lb.	phane	nine	
		Per cent	Mg./lb.	Mg./lb.	Per cent	Per cent	Parts per million
Meat product 94-B	Beef	60.2	4.31	42.9	0.73	0.91	0.40
Meat product 94-M	Mutton	56.5	3.31	36.5	0.67	0.85	.....
Meat product 94-P	Pork	59.1	2.65	33.1	0.65	0.88	0.07

* B₁₂, riboflavin, niacin, tryptophane and methionine determinations made by Dr. Wilder, American Meat Institute Laboratory, University of Chicago.

For the first experiment a relatively good basal ration (base PX), was fed at an 85 per cent level. It was composed of 36 pounds yellow corn, 10 pounds shorts, 10 pounds bran, 10 pounds pulverized oats, 5 pounds alfalfa meal (17 per cent protein +), 5 pounds corn gluten meal, 5 pounds soybean meal, 3 pounds mineral mix No. 45, and 1 pound D₃ blend (200 A.O.A.C. per g.).

A comparison of the growth-promoting value of the three samples of meat cracklings when fed at a 15 per cent level to supplement the above basal ration is given in the following table. Three lots of 194 White Rock chicks each were used in this experiment.

	Lot No.		
	845	846	847
Base PX (lbs.)	85	85	85
Meat product 94-B (lbs.)	15	.....	.....
Meat product 94-M (lbs.)	.....	15	.....
Meat product 94-P (lbs.)	.....	.....	15
Total	100	100	100
Average weight at start (g.)	39	39	39
Average weight at 28 days (g.)	313	249	267
Average weight at 56 days (g.)	792	740	720

For the second experiment a simplified ration (base PXS), was fed at a 70 per cent level with 30 per cent of each of the meat products. It was composed of 61 pounds yellow corn, 5 pounds alfalfa meal (17 per cent protein +), 3 pounds mineral mix No. 45, and 1 pound D₃ blend (200 A.O.A.C. per g.).

Results of this experiment, in which three lots of 170 White Rock chicks each were used, are summarized in the following table.

	Lot No.		
	848	849	850
Base PXS (lbs.)	70	70	70
Meat product 94-B (lbs.)	30	.....	.....
Meat product 94-M (lbs.)	.....	30	.....
Meat product 94-P (lbs.)	.....	.....	30
Total	100	100	100
Average weight at start (g.)	40	40	40
Average weight at 28 days (g.)	426	338	255
Average weight at 56 days (g.)	923	786	614
Deaths, 56-day period	4	20	50

There is a significant variability in the growth-promoting value for chicks of different meat packing by-products. These differences are not logically explained on the basis of riboflavin, niacin, tryptophane or methionine values. Differences in B₁₂, or more broadly, "animal protein factors," may explain the differences in biological value of these specific concentrates. Further work will be done in an attempt to establish satisfactory criteria for determining protein concentrate quality.

F. E. MUSSEHL, C. W. ACKERSON, R. L. BORCHERS

Poultry Breeding

Developing inbred lines of chickens. Development of inbred lines of single-comb White Leghorns and White Plymouth Rocks was initiated

in 1947. Inbreeding has been carried out by mating full brothers and sisters, and/or half brothers and sisters. Inbreeding will be continued in all lines. Selection within the lines, based on family performance (when possible) is practiced. The single-comb White Leghorns are selected for hatchability, viability, egg size, egg shape, egg production and adult body weight. The White Plymouth Rocks are selected for the above characteristics and for rapid feathering, growth rate, fleshing, and uniform egg-shell color.

Three inbred lines of single-comb White Leghorns were obtained from the U. S. Department of Agriculture Poultry Research Laboratory at East Lansing, Michigan, and three inbred lines of White Plymouth Rocks were obtained from Kansas State College.

Inbreeding will be initiated in four random-bred White Plymouth Rock strains in 1950. These birds are now being tested for various qualities in an effort to select the most desirable parent stock.

A general combinability test will be made in 1950. Males from five inbred lines (those with the highest coefficients of inbreeding) will be mated to females from a Rhode Island Red strain and a single-comb White Leghorn strain. Chicks from these combinations will be hatched, reared and tested under uniform conditions.

Several crosses of inbred lines of single-comb White Leghorns obtained from the Minnesota Agricultural Experiment Station were tested at the North Platte Substation. The results are shown in the following table.

Test of random-bred, top-cross, and incross single-comb White Leghorns at the North Platte Substation, 1948-1949.

Cross	Number pullets housed	Egg production Hen housed ave. to 500 days	Egg weight	Adult body weight	Mortality
Random-bred, Nebr. Station strain	128	147	24	4.2	15.62
North Platte Substation strain	138	132	....	4.5	23.19
<i>Four-Way Crosses</i>					
A	23	163	24	4.3	26.09
B	15	102	23	4.0	20.0
C	20	129	23	4.0	40.0
D	28	137	23	4.0	32.14
<i>Three-Way Crosses</i>					
E	23	148	24	4.3	13.04
F	4	146	25	4.5	40.0
<i>Adv.-Generation Single Cross</i>					
G	6	115	23	4.5	16.67
H	14	139	22	4.4	35.71
I	5	249	23	4.3	.....
J	3	118	21	3.7	.....
<i>Top Cross-Single Cross Males Mated to Random-Bred Females</i>					
	112	145	24	4.5	20.53

I. L. WILLIAMS, E. A. WOLFE

Station turkey breeding stock. Selected foundation stock of Broad-Breasted Bronze and Beltsville White breeds has been developed at the Experiment Station. Some of this stock is being retained in a random breeding program for comparison with other families which are being inbred. Twenty-five different inbred matings were made in 1949. Using good egg production, hatchability, rapid growth and good market quality as criteria, nine of these inbred lines were chosen for continued selection.

Some effects of crossbreeding on turkeys. Four lots of poults, hatched

at the same time and managed in the same manner, were compared. These lots were pure Beltsville Whites, pure Broad-Breasted Bronze and reciprocal crosses of the two breeds. Each lot was dressed and marketed when feed conversion efficiency values seemed to indicate that the point of economical conversion had been reached. Data are now being summarized.

Duration of viability of turkey sperms. Five 10-bird lots of Broad-Breasted Bronze hens were artificially inseminated with a composite sample of semen from a group of vigorous Broad-Breasted Bronze toms. The hens were inseminated at different time intervals with 0.1 c.c. of semen, and the effect on fertility and hatchability was observed.

The data obtained indicate that insemination every 21 days may provide satisfactory results, but larger number of birds should be used for further experiments before conclusions are drawn about the interval between inseminations.

One lot in the series was inseminated on February 27 and on two additional days with one day between each insemination. Vigorous poults were hatched from fertile eggs laid by some of the hens in this lot 42 days after the last insemination. It appears, therefore, that sperms will retain viability for at least 41 days in the oviduct of a normal healthy turkey hen.

Further studies were made on diluents for turkey semen. A modified buffer solution proved more effective than any of the other diluents that have been tried.

H. L. WIEGERS, F. E. MUSSEHL

Poultry Products Investigations

Department of Poultry Husbandry

Rancidity in Chicken Fat

Development of rancidity in dressed poultry presents a major problem to the poultry industry. Length of time dressed birds may be held in cold storage without loss of quality is limited. Once the highly unsaturated fats of the bird start to oxidize, rancidity with its accompanying undesirable flavors sets in rapidly.

The object of this preliminary experiment was to determine the anti-oxidative effects of alpha tocopherol with ascorbic acid in the deposited fat of a chicken, and to determine whether certain ammonium salts can be used as a substitute for the antioxidant effect of alpha tocopherol.

Thirty-two one-week-old New Hampshire chicks were divided equally into four lots. Their ration consisted of a base synthetic diet containing no vitamin E (alpha tocopherol) except the extremely small amount in casein and olive oil.

Supplements were made to the diet of the various lots as follows:

	<i>Per 100 g. diet</i>
Control	5 mg. alpha tocopherol.
Vitamin E-deficient	None.
Ammonia	2 g. ammonium carbonate $(\text{NH}_4)_2 \text{CO}_3$. 2 g. ammonium chloride $(\text{NH}_4)_2 \text{Cl}$.
Vitamin E-excess	125 mg. alpha tocopherol. 62.5 mg. ascorbic acid (vit. C).

The birds received these supplements for eight weeks, after which they were dressed and placed in cold storage. Chemical analysis for rancidity will be made at intervals during the storage period.

During the course of the experiment, the birds on the vitamin E free-diet developed symptoms of the deficiency (muscular dystrophy edema), and mortality was high. A small amount of alpha tocopherol was added to the diet to keep the last two members of the group alive.

The birds receiving 2 per cent ammonium carbonate and 2 per cent ammonium chloride did not die, nor did they develop symptoms of vitamin E deficiency.

A preliminary analysis for peroxide values in the fat of each group 14 days after the birds were killed and dressed shows greatest rancidity in the vitamin E-deficient group, a slight trace in the control group, and no evidence of rancidity in the ammonia or vitamin E-excess group.

Peroxide values were low, and serve only as an indication. Further analysis will be made after holding the birds in cold storage for a longer period of time.

I. L. WILLIAMS, H. J. PHILLIPS

Yield of White Leghorn Cockerels

An experiment was conducted to determine the age at which single-comb White Leghorn cockerels should be dressed to obtain the maximum amount of ready-to-cook meat per pound of feed consumed.

A group of 356 random-bred single-comb White Leghorn cockerels of the Station flock was segregated at four weeks of age for the test. The birds were confined to the house and a wire-enclosed sunporch.

A starting ration containing 20 per cent protein, primarily of vegetable origin, was fed. A mixture of cracked corn and oats was also before the birds at all times.

When the cockerels were nine weeks of age, 50 of them were selected at random for killing. This procedure was repeated at intervals of one week for six additional weeks, or until the birds were 15 weeks of age.

Each bird was weighed, killed, semiscalded, picked, eviscerated, and the carcass, including the neck and giblets, was weighed again. In the killing and evisceration, the blood, feathers, head, feet, oil gland, and internal organs, except gizzard, liver, heart, and kidneys, were removed.

Results are shown in the following table.

Age wks.	Average live wt.	Average dr. wt.	Per cent yield	Lbs. feed consumed per bird	Lbs. feed per pound live wt.	Lbs. feed per lb. ready to cook
9	1.78	1.169	65.19	6.30	3.53	5.389
10	2.037	1.394	68.31	7.41	3.637	5.315
11	2.31	1.58	68.19	9.129	3.95	5.777
12	2.64	1.799	67.34	10.58	4.00	5.88
13	2.87	1.937	67.63	12.09	4.20	6.24
14	3.06	2.125	68.30	13.56	4.42	6.38
15	3.31	2.225	67.26	15.18	4.58	6.82

When efficiency of gain is the factor of primary importance, there appears to be no advantage in keeping Leghorn males longer than 10 weeks. The amount of feed required to produce a pound of live weight or a pound of "ready-to-cook" weight increased with age from 9 to 15 weeks under the conditions of this test.

I. L. WILLIAMS

Egg Washing Studies

Eggs used in these studies were from single-comb White Leghorns of the Station flock. The birds were of similar breeding and all were in their first year of egg production, housed under uniform conditions, and fed the same ration. Eggs were gathered within a two-day period and cooled in a wire basket before casing. Only eggs with sound shells, and ranging from 21 to 23 ounces in weight, were used. Each egg was candled and those with interior quality defects were eliminated. Eggs were held for no more than three days after laying before treatments were applied.

Soiled eggs were prepared by wetting clean eggs and rolling them on the hen house floor until they were completely covered. The soiled eggs were then allowed to stand for 24 hours at room temperature (approximately 70° F.) before treatment.

For washing, the eggs were placed in a container, covered with washing solution, and washed by hand until clean.

The washing solution contained a detergent (37 grams of Dreft to 3 gallons of water) to facilitate cleaning. All eggs were placed in storage at 30° F. and 85 to 90 per cent relative humidity. All experimental lots contained 100 eggs each.

In the first experiment, designed to test the effect of washing solution temperature on keeping quality of eggs, one lot of dirty eggs was washed in cold water (68° F.), another lot was washed in warm water (88° F.), and a third lot was washed in hot water (130° F.). One lot of clean eggs (unwashed) was used as a control. Internal temperature of the eggs in the dirty lots at time of washing was 68° F.

In the second experiment, designed to study the effect of variation in interval between time of soiling and washing, lots of dirty eggs were washed one, two, three, four, five, six and seven days after becoming soiled. At the time of washing, the internal temperature of the eggs was 44° F., and the water temperature was 88° F.

Following treatment the eggs were placed in storage. One-half of each lot was removed after seven months and the other half after nine months. Quality was determined by breaking the eggs individually.

Analysis of variance of the data obtained revealed no differences between lots in either the first or second experiment that could be attributed to any treatment. The percentage of inedible eggs in each lot does not suggest any trend that might be construed to be a result of the treatment the eggs received.

I. L. WILLIAMS, J. W. GOBLE

Animal Diseases

Department of Animal Pathology and Hygiene

Death Losses in Young Pigs

A survey was planned for the spring months to determine whether or not toxic milk is causing mortality in young pigs. The program called for selection of herds in which there was excessive loss of young pigs during the first three days of life. Such outbreaks were rather frequent in the spring of 1947 and again in the spring of 1948. During the spring of 1949 only a few outbreaks were found and investigated. None of these was satisfactory for purposes of the test.

C. OLSON, I. C. BLORE, F. R. WOODRING

Pathogenesis of Listeriosis

A study of the reaction of blood cells in experimental listeriosis of sheep has been completed. The reaction of blood cells following exposure to the organism varies according to the method of exposure and the immunity status of the individual sheep. The details of these reactions have been reported and constitute a valuable asset in further study of the disease. During the study it was found that sheep could be immunized against intracarotid exposure to *Listeria monocytogenes*. In sheep not previously exposed, the intracarotid injection of *Listeria monocytogenes* has been 100 per cent fatal. Considerable time and effort have been required to work out various techniques and methods. Some of these are for study of the organism causing listeriosis and some for study of the pathogenesis or method of development of the disease.

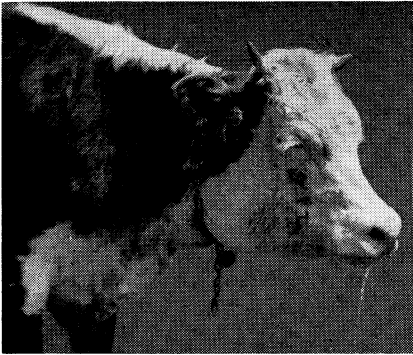
This project is supported by a special grant from the U. S. Public Health Service.

C. OLSON, R. H. COOK, H. BENGTSON, D. H. JOHNSON

A Study of Bovine Hyperkeratosis (X Disease in Cattle)

An outbreak of hyperkeratosis (X disease) occurred in a group of calves at the Valentine Substation in the winter of 1949. These calves were involved in a study of wintering rations. When it became evident that the study could not be continued because of the outbreak, the animals were made available by the Valentine Substation and used for observations on the disease.

The method of study was to make periodic examination of each of the individual animals in the original experiment. They were continued on their various experimental rations for some time, thus making possible a correlation between the rations fed and the severity of the disease in the different lots. Assistance for the observations was obtained from the Nebraska Bureau of Animal Industry and the U. S. Bureau of Animal Industry. Field veterinarians from these agencies helped with the observations and in return obtained experience in recognition of the disease. Veterinarians representing the experiment stations, the state livestock sanitary services and the U. S. Bureau of Animal Industry in the states surrounding Nebraska were invited to visit the Valentine Substation at the time observations were being made. This was done so they might become acquainted with the disease as well as to have the benefit of their suggestions.



Upper left, calf affected with bovine hyperkeratosis or X disease. Note the drooling saliva, staining of hair under eyes from an excess of tears, and swelling of jaw from an infection. The lesions of the skin over the shoulders are covered with hair.

Upper right, the same calf four months later. The affected area of skin over the shoulder can be seen. The abscess of the jaw is still draining though the swelling is almost gone. A deformity of the horns can be noted by comparing the two pictures.

Left, the wart-like papillomas around the teeth can be seen in this case of bovine hyperkeratosis. An ulcer is present on one side of the upper jaw. This calf died.

There were 160 calves in the original experiment. The first cases of the disease probably developed in early February. Diagnosis of the condition was not made until March and observations began the latter part of April. The severity of the disease is indicated by the death of 46 calves. Only 30 of the entire 160 calves could be regarded as remaining healthy. From observations made in this outbreak, the disease does not appear to be highly, if at all, contagious. The exact cause or causes remain obscure. The substances in different rations fed the calves seem to have had some influence on the severity of the disease.

Selected calves affected with the disease were treated with penicillin, sulfamerazine, potassium iodide, and sodium cocadylate. No beneficial effects were noted.

Specific study was made of the various symptoms and lesions associated with the disease. As a result, the relative significance of each of these symptoms was determined. This led to a rating system by which

the severity of the disease in an individual animal, over a given period of time, can be ascertained. This should prove of help in further work with the disease.

Experimental production of the disease is now being attempted.

C. OLSON AND STAFF

Neoplastic and Neoplastic-like Diseases of the Chicken

Work is still underway in the attempts at attenuation of a transmissible lymphoid tumor. Lymphocytoma, a spontaneous neoplastic disease of the chicken, is becoming a more serious problem among poultry flocks in Nebraska. This evidence comes from material received at the diagnostic laboratory. The problem appears most often in flocks where the chickens are of a crossbred type. Such crossbred types have been bred for increased egg production, and are of considerable economic importance in that respect.

C. OLSON, I. C. BLORE

Diagnostic Laboratory

During the past year 6,927 specimens were received by the diagnostic laboratory from farmers, veterinarians and other persons. Poultry disease problems were foremost. (See table on opposite page.)

Newcastle disease (pneumoencephalitis), continued to exact its toll through death loss of young chicks and economic loss of egg production in laying flocks. All sections of Nebraska are affected in some degree.

The Department of Animal Pathology and Hygiene, in cooperation with the Nebraska Bureau of Animal Industry and certain hatcheries, completed a field test of immunization against Newcastle disease during 1948, using live-virus vaccine. A total of 255 farm flocks, comprising 86,000 chickens supplying eggs to the cooperating hatcheries, were vaccinated. The chief object in conducting the field trial was to determine the strength of a passive immunity supposedly acquired by the chick through the egg from immune hens. Analysis was made of 51 outbreaks of Newcastle disease in young chicks during the hatching season of 1949. In the case of one hatchery, whose producing flocks had been vaccinated, many cases occurred in chicks less than seven days of age and the infection occurred within seven days of arrival on a farm. This suggests that parental immunity can be overcome by infection developed in a hatchery or while en route to a farm. Therefore, vaccination is not the complete answer to this problem.

Although Newcastle disease is a serious problem and is claiming much attention because of its more recent occurrence and spectacular symptoms, pullorum disease (salmonellosis) continues to be the more important cause of mortality in young chicks. A marked increase was noted in the incidence of pullorum disease in both chicks and poults examined during the hatching season of 1949.

Extensive losses from a neoplastic disease (lymphocytoma), have occurred in certain flocks of so-called "hybrid" chickens. The number of birds found affected indicates a 50 per cent increase over last year.

The number of swine found affected with hog cholera, on necropsy, was four times greater during 1949 than in the previous year. Most of these cases occurred 10 to 14 days after vaccination. The underlying causes of these so-called "vaccination breaks" were obvious in some instances but in others they were obscure.

F. R. WOODRING, C. OLSON, I. C. BLORE

Summary of diagnoses on animals and specimens submitted for examination for 1949.

Diagnosis	Chickens	Turkeys	Swine	Cattle	Sheep	Dog	Rabbit	Cat	Other animals	Total
Actinobacillosis	.....	.....	1	2	.....	.....	.....	.....	.....	3
Anasarca	1	.....	2	.....	.....	.....	.....	.....	.....	3
Anemia	.....	.....	6	.....	.....	.....	.....	.....	.....	7
Anthrax	.....	.....	.....	2	.....	.....	.....	.....	.....	2
Anthrax negative	.....	.....	2	13	.....	.....	.....	.....	.....	16
Arthritis	.....	1	4	.....	.....	.....	.....	.....	.....	5
Ascites	1	10	.....	.....	.....	.....	.....	.....	.....	11
Blue comb	29	.....	.....	.....	.....	.....	.....	.....	.....	29
Brucellosis	.....	.....	184	641	.....	.....	.....	.....	.....	825
Brucellosis negative	.....	.....	882	2,842	.....	.....	.....	.....	.....	3,724
Botulism	18	1	.....	.....	.....	.....	.....	.....	.....	19
Cloacitis	1	1	.....	.....	.....	.....	.....	.....	.....	2
Coccidiosis	67	28	.....	.....	.....	.....	6	.....	.....	101
Colibacillosis	9	.....	7	.....	.....	.....	.....	.....	.....	16
Coryza	6	.....	.....	.....	.....	.....	.....	.....	.....	6
Conjunctivitis	3	.....	.....	.....	.....	.....	.....	.....	.....	3
Cyst (ovarian)	1	.....	.....	.....	.....	.....	.....	.....	.....	1
Dermatitis	.....	.....	4	.....	.....	.....	.....	.....	.....	4
Dermatosis	.....	.....	4	.....	.....	.....	.....	.....	.....	5
Deformity	3	.....	2	.....	.....	1	.....	.....	.....	6
Ectoparasites	6	.....	.....	2	.....	.....	.....	.....	1	8
Enteritis	1	30	24	.....	.....	.....	.....	.....	.....	55
Enterohepatitis	4	21	.....	.....	.....	.....	.....	.....	.....	25
Enteroparasites	17	.....	.....	2	3	1	.....	.....	.....	23
Epidemic tremor	4	.....	.....	.....	.....	.....	.....	.....	.....	4
Erysipelas	.....	4	5	.....	.....	.....	.....	.....	.....	9
Fowl paralysis	9	.....	.....	.....	.....	.....	.....	.....	.....	9
Fowl typhoid	4	.....	.....	.....	.....	.....	.....	.....	.....	4
Heat prostration	1	.....	.....	.....	.....	.....	.....	.....	.....	1
Hemorrhage	3	.....	.....	.....	.....	.....	.....	.....	.....	3
Hog cholera	.....	.....	40	.....	.....	.....	.....	.....	.....	40
Hyperkeratosis	.....	.....	.....	5	.....	.....	.....	.....	.....	5
Icterus	.....	.....	1	.....	.....	.....	.....	.....	.....	1
Infection, misc.	3	.....	.....	3	.....	.....	.....	.....	.....	6
Infectious bronchitis	59	.....	.....	.....	.....	.....	.....	.....	.....	59
Injury	11	6	3	.....	.....	.....	.....	.....	.....	21
Laryngotracheitis	6	.....	.....	.....	.....	.....	.....	.....	.....	6
Leukosis	5	.....	.....	.....	.....	.....	.....	.....	.....	5
Listeriosis	.....	.....	.....	.....	8	.....	.....	.....	.....	8
Malignant edema	.....	.....	2	.....	.....	.....	.....	.....	.....	2
Malnutrition	86	56	6	2	6	.....	.....	.....	.....	156
Mastitis	.....	.....	.....	87	.....	.....	.....	.....	.....	88
Mastitis negative	.....	.....	.....	211	.....	.....	.....	.....	.....	211
Mycosis	3	9	.....	.....	.....	.....	.....	.....	.....	12
Neoplasia	96	.....	2	2	.....	.....	.....	.....	.....	101
Nephritis	.....	.....	1	1	.....	.....	.....	.....	.....	2
Newcastle disease	182	4	.....	.....	.....	.....	.....	.....	.....	186
Newcastle negative	184	27	.....	.....	.....	.....	.....	.....	.....	211
Occlusion oviduct	2	.....	.....	.....	.....	.....	.....	.....	.....	2
Omphalitis	13	8	.....	.....	.....	.....	.....	.....	.....	21
Osteopetrosis	2	.....	.....	.....	.....	.....	.....	.....	.....	2
Pasteurellosis	31	10	1	.....	.....	.....	.....	.....	.....	42
Pericarditis	2	2	.....	.....	.....	.....	.....	.....	.....	4
Peritonitis	18	.....	2	.....	1	.....	.....	.....	.....	21
Poisoning	14	1	4	4	.....	1	.....	.....	.....	25
Pneumonia	1	.....	7	1	.....	.....	.....	.....	.....	9
Pox	2	.....	1	.....	.....	.....	.....	.....	.....	3
Rabies	.....	.....	.....	.....	.....	1	.....	.....	.....	1
Rabies negative	.....	.....	.....	6	.....	14	.....	.....	.....	25
Respiratory infection	13	.....	.....	.....	.....	.....	.....	4	.....	13
Salmonellosis	275	78	8	.....	.....	.....	.....	.....	.....	361
Scabies	.....	.....	.....	5	.....	.....	.....	.....	.....	5
Scabies negative	.....	.....	1	40	.....	.....	.....	.....	.....	41
Sinusitis	.....	5	.....	.....	.....	.....	.....	.....	.....	5
Staphylococcus	1	17	.....	1	.....	1	.....	.....	.....	20
Trichomoniasis	.....	10	.....	.....	.....	.....	.....	.....	.....	10
Tuberculosis	8	.....	.....	.....	.....	.....	.....	.....	.....	8
Uremia	1	2	2	.....	.....	.....	.....	.....	.....	5
Chemical tests	.....	.....	.....	1	1	.....	.....	.....	.....	1
No diagnosis *	124	55	21	45	1	3	3	.....	2	254
TOTAL	1,330	386	1,229	3,918	19	23	12	4	6	6,927

* Includes specimens submitted for specific examination and found negative.

Agricultural Engineering

Department of Agricultural Engineering

Irrigation and Drainage

Preparation of experimental areas for irrigation. Expansion of irrigation research to learn more about soil, water and plant relationships for crop production on irrigated lands in Nebraska was begun this year. The experimental substations at North Platte and Scottsbluff were selected as suitable locations for additional development because each has an adequate and dependable water supply and trained personnel available. One source of water at North Platte is under a 200-foot elevation head which makes it a very desirable site for studying the method of sprinkler irrigation as well as other methods.

A detailed soil survey of each station has been made. The topographic survey of nearly all the irrigable area at North Platte has been completed, and the topographic maps have been drawn and printed. These maps have served as a basis for preliminary plans for plot layout, water distribution and measurement, and land grading.

This project is cooperative with Soil Conservation Service—Research Division, Department of Agronomy, and Conservation and Survey Division.

B. R. SOMERHALDER, F. B. HAMILTON, H. F. RHOADES, B. H. WILLIAMS

Design and development of water-measuring equipment. Equipment was developed for the analysis of the factors affecting the infiltration of water applied in furrow irrigation. The analysis is made by breaking the total length of run into several sections and measuring the amount of water being taken into the soil in each section. The equipment permits accurate control of the amount of water applied and measurement of the water at intervals through the field. The water applied is controlled by use of a constant water level header box equipped with calibrated discharge orifices. A broad overflow at the back of the header box provides a constant head.

Interceptors used for obtaining flow measurements at predetermined locations along the furrow were made from aluminum surface pipe and flexible couplings. The apparatus is designed so that one section of the pipe can be turned in the coupling to divert the water into a container. The rate of flow is determined by measuring the water diverted in a given length of time. To prevent fluctuations in the flow below the interception station, water from a second container is released into the furrow below the station at the rate of flow in the furrow.

An automatic recording device is being tested which may give a continuous record of water flowing past the point at which the device is placed. This device consists of a standard type water level recorder adapted to an HS or a Parshall flume. This instrument has given favorable results.

Testing water distribution equipment. Canvas hose has been tested in the laboratory to determine its suitability for conveying water to the point of application. The hoses tested have either the outside type or the flat overlap type seam. The stitching of the outside seam has broken at pressures ranging from 9 to 12 feet of water, depending upon the size

of hose. The stitching of the flat overlapping seam held the pressure of approximately 20 feet of water. Greater pressures could not be obtained with the equipment at hand because of the large amount of leakage through the fabric and the needle holes at the seam. From the tests made to date it appears that canvas hose sewed with a flat seam can be used effectively up to a pressure head of 6 feet of water. At this point the leakage approaches that from an open ditch in pervious soil.

Several different devices for delivering water from canvas hose to the individual row are under test. Of these the eyelet type, composed of a metal ring, hand-sewed into the side of the hose, and a sleeve type are the most promising. One advantage of the sleeve type is that the flow can be easily regulated with a drawstring. Discharge from the eyelet varies with the head according to the orifice formula, $Q = CA \sqrt{2gh}$, where

Q = Cubic feet per second

C = Coefficient of discharge

A = Area of orifice, square feet

g = Acceleration of gravity, feet per second per second

h = Head, feet.

For the eyelets tested C was equal to .73.

Aluminum pipe with a new type of gate, designed to serve as gated pipe for surface pipe irrigation or as pressure line for sprinkler irrigation, has been tested. The gates formed a good seal at a pressure of 1 pound per square inch and did not fail until pressures in excess of 150 pounds per square inch were applied. The remarkable characteristic is that the gates that did fail could very easily be reset and they would again withstand the same high pressure before blowing out. Since 30 to 40 pounds per square inch is the usual working pressure for a sprinkler system, this type of gated pipe meets the requirements for use in such a system.

This work is cooperative with Soil Conservation Service—Research Division.

F. B. HAMILTON, B. R. SOMERHALDER, J. F. SCHRUNK

Deep-well irrigation testing. One hundred and twenty wells and pumping installations were tested in Box Butte and York Counties during the past irrigation season. Data were recorded for the well, the pump and its drive, and the electrical motor or internal combustion engine.

The specific yields of the wells in Box Butte County ranged from 8.7 gallons to 54 gallons, and averaged 25 gallons, per foot of drawdown. In York County the specific yields ranged from 16 to 132 gallons, with an average of 69 gallons, per foot of drawdown. The specific capacity of a well is affected by the well diameter, the development procedure, the pumping rate, the length of perforated casing, and the type and installation of the casing and gravel pack. The interrelationship of these factors deserves further study. Several installations were found to be yielding an excessive amount of sand. Such abrasive material increases wear on the pump impellers and results in lower pump efficiency.

Pump efficiencies ranged from 36 to 75 per cent and averaged 58 per cent. Pump maintenance was found to be an important factor frequently overlooked by the pump irrigator. In one case, a new bowl assembly overlooked the pump efficiency 15 per cent. This increase in efficiency may save enough electric power to pay for the new bowl within one year, depending of course on the hours of pump operation.

An average over-all plant efficiency of 51 per cent was found for the pumps driven by direct-connected electric motors. The lowest and the highest over-all plant efficiency was 32 and 67 per cent, respectively. At prevailing electric rates, on the average, the man with the most efficient unit may save \$320 per season in comparison with the operator having a plant with the lowest efficiency. High over-all efficiency can result only from a good well, an efficient pump assembly fitted to the well capacity, and an efficient motor drive. Over-all plant efficiency of at least 67 per cent should be the goal for all electrically operated pump installations.

Fuel consumption data recorded for engines used to drive irrigation pumps show the following comparative fuel efficiencies:

Type of fuel used	Water horsepower-hours per gallon of fuel
Diesel fuel	8.61
Tractor fuel	5.31
Gasoline	5.05
L P gas	4.37
Natural gas	4.13 (per 100 cu. ft.)

The data indicate a possible average saving of 11 per cent of the fuel used by better matching of the carbureted engine to the pump load and more careful adjustment of the carburetor. Correction of this factor alone would result in an estimated \$400,000 saving annually for irrigators in Nebraska.

J. F. SCHRUNK, J. J. SULEK

Drainage investigation at North Platte. A study was initiated to determine the effectiveness of a recently constructed open drainage ditch located on the west edge of the North Platte Substation. The objective is to determine principles and relationships that will be of use in designing open drains and in determining the probable area they will affect.

The ditch is approximately 12 feet deep with side slopes ranging from $1\frac{1}{2} : 1$ to $2 : 1$. At three points along the 1,400 feet of ditch, holes were dug in the bottom of the drain down to the underlying gravel, which occurs at about 20 feet. Considerable water is rising through these holes and discharging along with the water gathered from a stratum just above the bottom of the drain.

The effect of the drain on water table is being observed by means of 12 batteries of piezometer tubes which have been placed at distances of 75 and 300 feet on each side of the center line of the drain. A battery consists of three tubes, 6, 12 and 24 feet in length. They are so placed as to provide an opportunity to observe the depth and the fluctuation of the water table carried in three different strata. The water level in the tubes is measured at frequent intervals with an electrical sounding device.

At the lower end of the drain, a measuring flume with an automatic recorder has been installed to give a continuous record of the flow of water from the drain. Records on rainfall and irrigation are kept to determine whether there is any immediate effect on the water table from surface applications.

Observations are available for only a part of last season. However, certain relationships are indicated by the data. (1) The gradient of the water table from the 75-foot offset stations to the water surface in the drain is steep, ranging from 3 to 6 per cent. This is true of the water table in both the 12-foot and 24-foot tubes. (2) The gradient of the water table, disregarding the local effect of the drain, is almost parallel to the

ditch. (3) The flow of the drain is affected to a lesser degree by surface application of water than by fluctuations in the water table. Correlation between flow at the drain and the height of water table in the 12- and 24-foot tubes is close.

This project is cooperative between the Agricultural Engineering and Agronomy Departments and Soil Conservation Service—Research Division.

F. B. HAMILTON, R. RAMIG, J. F. SCHRUNK

Farmstead Equipment

Grain drying. Small wooden bins fitted with lateral duct systems were used successfully to dry by natural forced air 150 bushels of green oats and two lots of brome grass seed totaling about 220 bushels during July. The green oats had been combined at a moisture content of 32 per cent to check the feasibility of early harvest to reduce field losses and to determine the practicability of finishing the curing of the grain in the bin.

Three lots of ear corn were dried to approximately 13 per cent moisture before December 1, at operating costs ranging from 1½ to 4½ cents per bushel. Ear corn tests included approximately 275 bushels picked September 9 at 33 per cent moisture, 275 bushels picked September 22 at 25 per cent moisture, and 250 bushels picked October 6 at 17.5 per cent moisture. Plans for drying tests with shelled corn above 30 per cent moisture were abandoned because of extreme damage to the corn during shelling. Approximately 375 bushels of corn at 26 per cent moisture shelled satisfactorily and was dried at a cost of about 3½ cents per bushel, although some mold developed, apparently owing at least in part to kernels cracked by the blower-type elevator used and insufficient quantity of forced air. No difficulty was experienced with corn harvested below 25 per cent moisture.

Approximately 3,400 bushels of corn, picked and shelled in the field, was dried with unheated air to approximately 12 per cent moisture in two lots. The first lot of 1,800 bushels, with initial moisture content of 18 per cent, required 290 hours of continuous blower operation plus 70 hours of intermittent operation when the relative humidity was below 65 per cent. Operating cost was slightly over 1 cent per bushel.

The second lot of 1,600 bushels averaged 17 per cent moisture and required only 170 hours of blower operation. The cost of finish curing in the bin amounted to approximately ½ cent per bushel.

During the summer and fall, unheated forced air drying installations were observed on several farms. Manufacturers, public power districts, and the Agricultural Extension Service cooperated in making these installations, and Extension Service personnel assisted in obtaining operational data. A total of 1,100 bushels of oats was dried by forced natural air in Adams and Thayer Counties; 6,100 bushels of wheat in Cheyenne, Phelps, Gage and Sarpy Counties; 2,200 bushels of sorghum in Kearney, Adams and Thayer Counties; 1,950 bushels of ear corn in Custer and Butler Counties; and 6,175 bushels of shelled corn in Custer, Phelps, Butler, Saunders, Lancaster and Saline Counties. Analysis of results from these farm tests has not been completed.

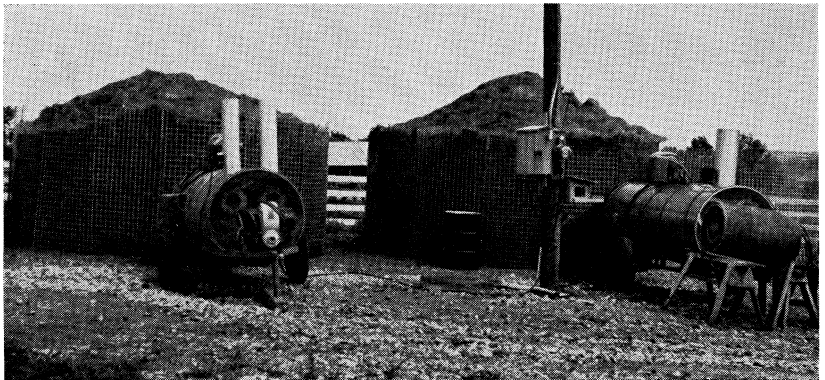
Several piles of ear corn, covered by snow during November, 1948, were shelled early in February, 1949, and placed in 2,200-bushel steel bins equipped with perforated bottoms to facilitate forced air circulation.

Much of the 1,800 bushels of shelled corn had ice and snow mixed with it. The corn kernel moisture content varied from 17 to 23 per cent. The shelled corn was refused at the local market. Air below freezing temperature was first forced through the corn to remove ice and snow by sublimation. This procedure forestalled thawing which might cause later freezing to a solid mass. Early in March, warmer natural air was circulated only when temperatures were above freezing and the relative humidities were below 65 per cent. The corn was reduced to 14.5 per cent moisture by April 6, after a total of 750 hours of blower operation requiring 2,944 kilowatt-hours of electricity. At 2 cents per kilowatt-hour the operating cost was \$58.88. As sold on April 6, the corn had normal shrinkage to approximately 1,700 bushels market measure. It graded No. 3 because of foreign material and cracked kernels, and netted \$1,912.46 after market handling charges. At the time drying was started, local market prices less usual dockage for wet corn indicated a maximum theoretical market value of 95 cents per bushel, or \$1,710 for the 1,800 bushels.

G. M. PETERSEN, F. D. YUNG, J. V. DUNLAP, JR.,
E. A. OLSON, R. L. DEROSE

Hay drying. In December 1948, two lots of forced-air dried chopped alfalfa, about 10 tons each, were included in feeding trials with Hereford calves by the Animal Husbandry Department. The hay had been dried in wire-mesh round cribs in May of the same year. One lot was dried by forced air that had been heated to 120° F. and the other lot by unheated forced air. Initial moisture of the stored hay averaged 36 per cent. Results of the 146-day feeding trials indicated very little difference in feeding value between the two lots of alfalfa in rate or economy of gain. A third lot of field-cured chopped alfalfa from the same first cutting produced essentially the same results as the air-cured hay in the feeding trials.

In July 1949, the forced-air drying of chopped alfalfa was repeated, again using forced air heated to 120° F. for one crib and unheated forced air for the other, this time with second-cutting hay. The alfalfa was cut in the morning of each day, raking was in progress about noon, and chopping was started at 1:30 to 2:30 p.m. of the same day. Initial moisture of



Drying chopped alfalfa with unheated air (left) and with heated air at approximately 120° F.

the chopped alfalfa going into the rings for forced-air curing ranged from 42 to 49 per cent. Drying time was 54 hours for the crib dried with heated air and 88.5 hours for the lot treated with unheated air. Rainy weather caught the hay that was left in the field overnight for the field-cured lot and the hay was so damaged that it was unfit for use.

Fire from an outside source later destroyed all of the forced-air cured hay and feeding trials will not be possible this winter.

Loss of leaves was heavy while the cribs were being filled during the 1948 season. This loss was due to the use of blower-elevators in the field from chopper to truck, and at the cribs from truck to crib. The loss of leaves was almost entirely overcome in 1949 by the use of drag-type elevators which were used in the field and at the cribs. This was a valuable demonstration of the importance of selecting the proper crop handling equipment.

F. D. YUNG, G. M. PETERSEN, J. V. DUNLAP, JR.

Heating drinking water for livestock. In December 1949 a study was begun to determine the savings in cost of operating electric tank heaters resulting from (1) a tank cover, (2) insulation around the tank, and (3) a wood heat-retaining box built around the heating elements to confine heat to a drinking opening.

Five small round stock-watering tanks 3 feet in diameter and 2 feet high were equipped with identical automatic floating heaters designed to keep a drinking opening free of ice. Energy-saving modifications were added as follows:

Tank 1—Heater only (uninsulated, uncovered, and without heat-retaining box).

Tank 2—Heater plus only insulation around the tank.

Tank 3—Heater plus only tight-fitting wood tank cover.

Tank 4—Heater plus only wood heat-retaining box.

Tank 5—Heater plus insulation, wood cover, and heat-retaining box.

Observations are being made regularly on electric energy consumption, water temperature, outdoor temperature, and such factors as ice formation in or adjacent to the drinking openings, the effect of snow and other severe or unusual weather conditions.

F. D. YUNG

Differential thermostat. Progress was made in the development of an electronic differential thermostat for use in temperature control in potato storages and in grain storage bins. The purpose of the differential thermostat is to start air-moving equipment for cooling potatoes or grain whenever the temperature of the outdoor air is below the temperature level of the stored product. It also shuts down the blowers when the outdoor air temperature is too high to be of value for cooling purposes.

A mechanical differential thermostat which uses bimetal heat-sensitive elements has been in service for six years at the Box Butte Experiment Farm near Alliance. Other experimental installations have been made near Gering and at Hemingford. Use of the bimetal differential thermostat is limited because its indoor heat-sensitive elements must be within a few feet of each other.

The electronic differential thermostat, based on a vacuum tube circuit, can be used under a wide variety of conditions and can have its heat-

sensitive elements widely separated and connected by insulated wires to a conveniently located control panel. In the design of the electronic unit, the objectives have included dependability, moderate cost, use of assembly, and freedom from moving parts. Several modifications have been made in the design to more nearly attain these objectives. Development is in the laboratory trial stage.

F. D. YUNG

Unit electric plants. Twenty-seven and one-half months of operation of a new model 110-volt (56-cell battery) D.C. wind electric plant was ended in November of 1949 and the plant dismantled. During this period the plant delivered a total of 3,386.7 kilowatt-hours of electrical energy of a "load" which approximated 4 kilowatt-hours per day or 120 kilowatt-hours per month.

The plant was in service continuously during this period except for 3.09 per cent of the time when the battery was not sufficiently charged for use. This lack of service was due to two major causes: First, 2.01 per cent loss of service owing to lack of wind; second, an unbalanced propeller owing to formation of ice on blade caused a loss of 1.08 per cent.

For laboratory purposes, the load of approximately 4 kilowatt-hours per day was left on continuously except when hydrometer readings indicated a low battery with specific gravity of 1.150. The load was then turned off until the hydrometer indicated a specific gravity of 1.180.

In actual use by a farm family a conservative practice would be to reduce the load as soon as the battery state of charge begins to decline. This would reduce the hours of nonservice and normally tend to lengthen the life of the battery.

With the constant load on the line the kilowatt-hour consumption per day varied from 3.8 for the condition of low battery and no charging current, to 4.9 for the condition when the battery was fully charged and the generator delivering about 10 kilowatt-hours per day.

M. P. BRUNIG, F. D. YUNG

Cooling and storing eggs on the farm. Problems of "sweating" and dirty eggs are common on many farms where eggs are stored in various stages of cleanliness at temperatures safely above freezing but so low that "sweating" occurs when they are removed from the temporary storage and taken to market.

In June, 1949, a cooperative project between the Departments of Agricultural Engineering and Poultry Husbandry was begun with the following objectives:

(a) Determination of the optimum temperature for holding eggs on the farms as it would affect subsequent keeping quality.

(b) Determination of the effect of holding eggs for varying lengths of time at selected constant conditions of temperature and relative humidity.

(c) Study of the problems of moisture condensation (sweating) and bacterial infection of clean and dirty eggs.

Attention was directed first toward the problem of moisture condensation. Three lots of 100 eggs each (50 clean and 50 dirty) were stored for 48 hours at three temperature levels, 40°, 50° and 60° F. At the conclusion of the storage period the eggs were removed and exposed for six hours to air at a temperature of 80° F. and 50 per cent relative humidity to cause moisture condensation on the surface of the eggs. At the end of the sweating period the eggs were placed at once in a commercial storage

where temperature is held at just above freezing and relative humidity is high. The first lots of eggs were placed in commercial storage on June 27, 1949. The procedure was repeated in December, 1949.

After six months in commercial storage, half of the first lots of eggs were removed for quality tests, and half were left for test at the end of nine months' storage. The quality tests indicated that sweating was detrimental and caused deterioration in quality. Dirty eggs, when subjected to sweating, were found to be more susceptible to bacterial infection than clean eggs. It is expected that quality tests at the end of nine months will be more valuable than the six-month tests. Conclusions will not be made until several series of tests have been completed.

F. D. YUNG, I. L. WILLIAMS

Frozen food-packaging materials. In recent years a number of new packaging materials for frozen foods, including meat, have been developed. Information is needed concerning their effectiveness in excluding air and retarding shrinkage, and concerning ease of sealing, convenience of handling and durability.

The Nebraska Frozen Food Locker Association requested the cooperation of the Nebraska Experiment Station in a study of the new packaging materials. A Station project was approved for cooperative work by the Association and the Departments of Agricultural Engineering and Animal Husbandry, with the following objectives:

(a) Study of the characteristics of different types of meat-packaging materials.

(b) Determination of the economic feasibility of selected representative meat-packaging materials.

Samples of approximately 1 pound each of pork chops, sausage and ground beef will be packaged in each of several types of material at three-month intervals for a period of 12 months and frozen at a local locker plant. The frozen packages will then be stored in a constant-temperature room at zero degrees F. plus or minus 2 to 3 degrees F. All of the packages will be weighed periodically during the year and at the end of 12 months will be weighed, inspected, and tested for appearance, flavor and aroma.

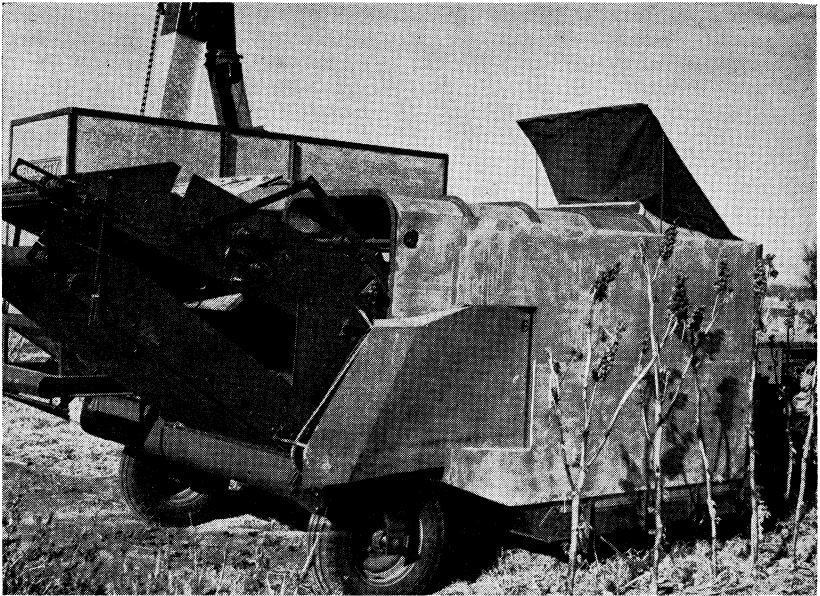
F. D. YUNG, C. H. ADAMS

Farm Machinery and Power

Castor seed harvester. Harvesting tests were made this year with a castor seed harvester patterned after the experimental machine developed recently at this Station. The machine used this year was one designed and constructed by a prominent manufacturer of agricultural machines.

The commercially produced experimental machine was tested on two varieties of castors, Connor and No. 108-3. These varieties differed considerably in average height and in location and placement of branches. No. 108-3 was low-branching with many small spikes and averaged about 5 feet in height. Connor averaged about 8 feet in height, had branches placed high on the main stem, and relatively few large spikes. Machine harvesting efficiency was based upon the yield resulting from hand harvesting.

Yield with machine harvesting was 52 to 95 per cent of that with hand harvesting. The major machine-harvesting loss resulted from capsules



The first commercially produced experimental harvester for castor seeds. This machine is patterned after the experimental machine developed at the University of Nebraska.

shattering from the plant as it entered the frontal opening of the machine. The stripper and separator loss averaged less than 1 per cent. With timely harvest, a reasonable rate of travel, and well shaped plants, machine-harvesting efficiency may be as high as 95 per cent. For short, very low-branching varieties with leaning plants, harvesting efficiency dropped as low as 52 per cent.

Certain modifications were necessary to improve the efficiency of the experimental machine. These included: (1) Providing a smooth surface on the side of the machine next to the unharvested row. (2) Mounting floating rubbing blocks on the upper side of the riddle to break up entire spikes stripped from the plant. This device was necessary only under a special harvesting condition described later. (3) Placing a bend in the return section of the riddle to keep the capsules and plant fiber from being dropped too near the lower end of the inclined cleaning apron. (4) Placing a canvas extension hood above the frontal opening to help funnel capsules shattered from the tall Connor variety into the stripping compartment of the machine.

This year an early light frost which killed only the tips of the branches, followed by high winds a few days later, caused the spiked stems to bend downward. As a result of this position and the bent spike stem, the machine strippers removed many spikes intact. The entire spikes were threshed satisfactorily by floating blocks rubbing on the upper side of the riddle.

The harvesting efficiency of this experimental machine operating un-

der good conditions compared favorably with the efficiency of machines used to harvest other crops.

This project was cooperative between the Agricultural Engineering and Chemurgy Departments.

MILO F. ARMS, ALBERT HOFFMAN

Tractor testing. Tests were completed on the following 31 tractors during the 1949 season:

Test number 406, John Deere R; 407, Gibson Model H; 408, Gibson Model I; 409, Massey-Harris 30; 410, Long Model A; 411, Minneapolis-Moline UTS; 412, Oliver Row Crop 66 HC; 413, Oliver Standard 66 HC; 414, USTRAC; 415, Caterpillar D-8; 416, Caterpillar D-6; 417, Caterpillar D-4; 418, Caterpillar D-2; 419, Farmmaster FD-33; 420, Intercontinental D-26; 421, Farmmaster FG-33; 422, Corbitt G-50; 423, John Deere MT; 424, Silver King 3-Wheel Row Crop; 425, Oliver Row Crop 77 HC; 426, Massey-Harris 44 Diesel; 427, Massey-Harris 44 K Std.; 428, Massey-Harris 55 K Std.; 429, John Deere AR; 430, Case VAC Tractor Fuel; 431, Case VAC Gasoline; 432, Universal Jeep CJ-3A; 433, Huber Model B; 434, Oliver HG; 435, Oliver DG; and 436, Oliver DD.

The test report for each tractor is available for distribution in printed form. Also data for all models tested, and offered on the market by the manufacturer, are assembled and printed in summary sheet form.

L. F. LARSEN, G. OLSON, C. W. SMITH, F. D. YUNG, L. W. HURLBUT

Spray unit for experimental plots. A two-wheel, high-clearance, push-type chassis was constructed to carry two 3-gallon spray cans, a small engine compressor unit, and a 11½-foot spray boom. Special features of this unit are (1) an accurate indicator for speed of travel, (2) constant-pressure spray tanks, and (3) parallel linkage for height adjustment of the boom.

This development was cooperative with the Agronomy Department.

M. F. ARMS, D. L. KLINGMAN

Fertilizer equipment for experimental plots. Three standard top feed fertilizer units, each equipped with two drop tubes, were mounted on a standard two-row corn planter for use in planting and fertilizing intertilled crops in the Outstate Testing Project. This equipment is constructed to permit limited variation in the rate of application of nitrogen, phosphate and potassium fertilizer on consecutive plots.

The drive originates from the main axle and goes to three standard checkrow planter clutch units. Each variable-speed clutch shaft drives a fertilizer unit.

This development was cooperative with Agronomy Outstate Testing.

L. W. HURLBUT, R. E. LUEBS

Drill for experimental plots. A tractor-mounted four-row drill for experimental plots has been constructed and used during the past year for seeding crops in the Outstate Testing Project. This machine is designed for continuous operation on consecutive plots which may be adjusted from 5 to 40 feet in length with a 3-foot alleyway.

The seeding unit consists of a special troughed rubber V-belt hopper which delivers the seed to a four-way divider. A measured quantity of seed for each plot is dropped onto the V-belt from a shallow overhead pan approximately the same length as the hopper.

Seed coming from the V-belt is dropped onto a series of baffles which

cause it to spread laterally. Below the lower baffle plate the seed stream is separated into four parts by a centrally located vertical divider plate set between two adjustable plates. The divider unit is adjustable with respect to the hopper so that it can be kept level.

The frame, furrow-opener equipment, gage wheels and markers were made from standard, but somewhat remodeled, drill and planter parts.

The drive originates from one front wheel of the tractor by means of a "universal" gear drive to a flexible cable. The flexible cable in turn drives a standard V-belt operating on variable-pitch pulleys. This arrangement provides an adjustable drive to the hopper which permits the operator to vary the linear travel of the hopper belt to fit the length of plot desired.

This development was cooperative with Agronomy Outstate Testing.
L. W. HURLBUT, F. J. BELL, A. F. DREIER

Corn picker efficiency tests. Tests were made to determine the extent to which the efficiency of mechanical corn pickers is influenced by cultural practices in raising the crop and by adjustments of the picker. Special plantings were made to provide comparisons as to (1) hybrids versus varieties, (2) maturity range of hybrids, (3) manner and rate of planting, (4) time of planting and harvest, and (5) tractor speed and picker adjustment.

Observations also were made on the moisture content of grain and stalk, and erectness and ear retention of the plant. Results show (1) husk removal, (2) ears dropped before harvest, (3) ears dropped during harvest, (4) shelled corn lost on the ground, (5) ear corn saved and delivered into the wagon, and (6) shelled corn saved and delivered into the wagon.

The results of this work have been summarized as follows:

(1) A standard full-season hybrid was planted at early, medium and late dates. The corn from each planting date was harvested at early, medium and late dates in the fall. In general the early-planted corn yielded most, ripened earliest, declined in moisture content most rapidly and needed to be picked first to avoid excessive ear dropping and shelled-grain loss during harvest. Averaging results for three planting dates and three picker speeds, corn harvested on October 19, November 30 and December 22 had respective total picker losses of 4.4, 6.5 and 9.1 per cent of the entire crop produced; and total amounts of 5.8, 13.7 and 15.0 per cent shelled by the picker.

(2) The mechanical picker operated most efficiently when kernel moisture was 20 to 24 per cent. However, since this exceeds somewhat the upper limit of moisture for safe cribbing it is advisable to pick the crop when the kernel moisture is 17 to 20 per cent if it is to be cribbed in the usual manner.

(3) Snapped ears of hybrid Ohio C92 contained 7.7 pounds of husks and 2.6 pounds of shanks per 100 pounds of ear corn. Husks remaining on hybrid ears following mechanical picking varied from 0.3 to 0.7 pound per 100 pounds of ear corn, or from 4 to 9 per cent of all the husks by weight. Other hybrids retained from 0.3 to 2.2 pounds of adhering husks per 100 pounds of ear corn. Differences appear to be related to both moisture content and heritable character of the shank.

(4) Averaging the data for three planting and three harvesting dates, low, medium and high tractor speeds showed relative grain losses of 5.6, 7.1 and 7.2 per cent of the entire crop produced. Careful driving to center the stalks between the snapping rolls is helpful in reducing all losses caused by the picker.

(5) Rate-of-planting tests were made with drilled and checked corn in rows 42 inches apart. All ripened at the same time, September 14. At the time of harvest on November 1, the corn from the six planting practices was very dry, ranging from 14.0 to 14.7 per cent kernel moisture. The stalks also were relatively dry with 40 to 47 per cent moisture. In the picker results there were few consistent differences related to spacing or to manner of planting. Nearly one-fourth of the entire crop was shelled by the picker and nearly half of that was scattered on the ground and lost.

(6) Commercial hybrids of a locally suitable type averaged 13.5 per cent higher grain yield and were distinctly more lodge resistant than were open-pollinated varieties. They also picked with fewer adhering husks and lost only half as many ears in picking.

(7) One full-season hybrid proved distinctly superior in yield to earlier-maturing ones. The advantage approximated 9 bushels per acre over standard hybrids that ripened two weeks earlier. In general, early, medium, and full-season hybrids picked with about equal efficiency. However, a somewhat late-maturing white hybrid, with unusually strong shank and higher moisture content, was subject to exceptionally low ear dropping and low shelled-grain loss. This suggests the possibility of breeding corn hybrids that are more suitable for mechanical harvesting.

(8) Although not illustrated by the tests herein reported, hybrids are known to differ in resistance or tolerance to certain insects and disease organisms which tend to cause root lodging and breaking of stalks. Rotation of crops also tends to reduce the lodging of stalks caused by certain pests and thereby lessens the grain losses incurred in mechanical picking.

Considering an average yield of 30 bushels per acre, a field loss of 7 per cent, and the price of corn at one dollar per bushel, Nebraska farmers may have spread more than 15 million dollars worth of corn on their fields in 1949. Nebraska Experiment Station Bulletin 394, entitled "Factors Affecting the Efficiency of the Mechanical Corn Picker," tells how to reduce this loss.

C. W. SMITH, T. A. KIESSELBACH, W. E. LYNSS

Sugar beet research at North Platte. In cooperation with the Agricultural Engineering Department, an 18.6-acre field was planted to sugar beets in 1949 at the North Platte Substation. This field was divided into replicated 16-row plots in which four methods of planting and establishing a stand of beets were compared.

These tests were designed to investigate the possible advantage of throwing a ridge 3 to 4 inches high over the row of beet seed at time of planting, and also to test the merits of pre-emergence irrigation under both level and ridged conditions. Segmented seed was planted April 25 at the rate of 7 pounds per acre, and the irrigation was done two days later. Five days after planting, the ridges were removed with a spike-tooth harrow set flat. Stand emergence was essentially alike for all four methods. This is attributed to a timely 0.3-inch rainfall five days after planting. The results were as follows:

Planting practice	Marketable beets per 100 ft. of row	Yield beets per acre	Yield sugar per acre
	<i>Number</i>	<i>Tons</i>	<i>Tons</i>
Flat-planted	93.3	23.4	3.38
Flat-planted, irrigated up	87.0	25.5	3.38
Ridge covered	89.2	26.7	3.39
Ridge covered, irrigated up	77.3	24.8	3.46

Although the various methods gave similar results in 1949, ridge planting and pre-emergence irrigation are recommended as desirable precautionary practices.

Three methods of thinning also were investigated after the beets had been cultivated twice with a finger weeder run diagonally and in opposite directions. Long-handled hoe trimming resulted in a stand of 76 marketable beets per 100 feet of row as compared with 92.5 beets for finger work. Mechanical blocking followed by hoe trimming gave 68.2 beets per 100 feet of row compared with 85 beets for hand blocking and thinning. There were no significant differences in yield of beets per acre.

An application of 150 pounds of ammonia sulphate (30 lbs. N) on one-half of each plot had no significant effect on yield of beets or sugar.

J. C. ADAMS, R. RAMIG, JOHN SCHRUNK, PAUL EHLERS

Studies in Agricultural Economics

Department of Agricultural Economics

Cost of Producing Farm Crops

Cost-of-production records covering the 1948 corn crop were obtained from 158 farmers in eight counties. Most of the records were for dry land, but some were for gravity-irrigated land and some were for an area where pump irrigation is used. When grouped by regions (eastern, central, southwest, and irrigated), the records showed costs per bushel ranging from 64 cents in the eastern region to 84 cents in the southwest region. The data were published in Extension Circular 840, 1948. The circular gives average data by counties covering hours of labor and power required to produce an acre of corn; average costs per acre for use of labor, power and equipment; average yields per acre; and the normal share received by the farm operator.

Ten cost-of-production records were obtained from sugar beet growers in the Tri-County area covering the 1948 crop. Findings from these records were given in Extension Circular 883, 1948. Included in the circular are average costs per acre, average yields per acre, average share received by the tenant and average cost per ton. With an average of 10.5 tons as the tenant's share, the cost per ton was \$9.63.

Production-cost records for winter wheat were obtained from 162 farms in 1949. Data from these records were summarized by counties and for three regions—eastern, central and western. The findings were given in Extension Circular 839, 1949. Costs per bushel averaged 86 cents in the western area, \$2.98 in the central area, and \$1.96 in the eastern area. Average costs per bushel by counties ranged from 73 cents in one western county to \$2.98 per bushel in a central Nebraska county.

ARTHUR G. GEORGE, A. W. EPP

Marketing

Cost of marketing grain in Nebraska. Tabulations of audits of country elevator companies for the 11 years 1936–1946 were studied. The efficiency of elevator operation was to a great extent influenced by volume of grain handled and the volume of side line business. Good business practices were also essential to efficient operation.

H. C. FILLEY, LOWELL C. JACKSON

Marketing feeder cattle and sheep. Nebraska and 13 other states in the North Central Region are cooperating with the Bureau of Agricultural Economics in securing data on the marketing of feeder cattle and sheep. The Nebraska Experiment Station, in addition to securing data from 239 representative farms handling feeder cattle and sheep and data from livestock auctions, commission firms and other dealers in feeder livestock, secured information on the use of feeding-in-transit privileges, contract feeding of cattle and sheep and the operation of the 28-hour law for livestock shipments. Marked decline in numbers of animals fed under contracts was noted. Practically no cattle were fed in 1949 and fewer sheep than in 1948 were contract-fed. Little uniformity was found in type of contract used for sheep feeding in 1949.

L. B. SNYDER, L. C. JACKSON, H. A. ALLPRESS

Marketing poultry and eggs. During the past year the first of a series of publications dealing with quality changes occurring in eggs during the market process was published. This showed that great changes in egg quality occurred between wholesale receiver (carlot shipper) and local produce dealer. A second publication will deal with changes in quality occurring while eggs are in the hands of first handlers and before the eggs leave the farm. Much of the deterioration in egg quality takes place or is started before the eggs leave the farm. Quality declines continue while the produce dealer or country buyer holds the eggs.

Nebraska is one of the 12 states of the North Central Region cooperating in this study. It will be continued throughout 1950 in an attempt to determine the major causes of deterioration in quality of eggs on the farm and in produce dealers' establishments.

L. B. SNYDER, H. A. ALLPRESS, J. W. GOBLE

Analysis of egg marketing techniques. Relationships between certain marketing practices and egg quality changes are being studied. Survey records have been taken of methods used in handling and selling eggs by 425 Nebraska farmers. To date little incentive to produce and market quality eggs has been found under existing price support programs which support case-count eggs at prices that are within a few cents of the market price of Grade A eggs. Before definite recommendations for improvement in marketing can be made, further study is necessary.

L. B. SNYDER, H. A. ALLPRESS, J. W. GOBLE

Farm Organization and Farm Costs

Profitable management and farm organization practices were determined from a study of farm records. More than 100 farmers cooperated by submitting their 1948 record books for summarization and analysis. Summaries were made for Washington County, eastern and central Nebraska, three southeast Nebraska counties, and the Republican River Valley.

With one exception, the one-third of the farms used in each summary which employed the greatest number of work units had greatest farm earnings. In four of the summaries, the one-third of the farmers whose crop yield index was greatest also had greatest farm incomes. In two of the summaries the one-third of the farms which had the greatest number of units of productive livestock also had greatest farm earnings. Four of the summaries showed that the one-third of the farms having greatest returns from each \$100 worth of feed fed to productive livestock also had highest farm earnings. The relative efficiency of labor was reflected in highest earnings in four of the summaries for the one-third of the record keepers who used the greatest number of work units per man.

The figures from four of the summaries show that highest earnings were realized by the one-third of the record keepers who had lowest costs per productive man-work unit used for labor, power, and machinery.

ARTHUR G. GEORGE, A. W. EPP

Land Use Adjustment

A study was completed of systems of farming in the Tri-County area that utilize efficiently the available resources of the farmer. Included in these resources are dry-land pastures, dry cropland and irrigated land. The proportion of irrigated land varies a great deal throughout the area, a

fact that materially affects the size of farm and complicates the problem of combining the three kinds of land into suitable systems of farming. To demonstrate the effect of irrigation upon the size of farm, systems of farming were developed for farms with varying proportions of irrigable land. Budgets prepared for these systems indicate about equal income possibilities for 160-acre farms with 112 acres irrigated (including 25 acres of beets), 240-acre farms with 60 acres irrigated (including 12 acres of beets), and 340-acre farms with no irrigation.

The larger and more dependable feed supply under irrigation encourages farmers to keep more livestock. This in turn increases farm incomes. The available feed can be efficiently utilized by beef cattle, dairy cattle, hogs or poultry. Expected returns from the various livestock enterprises do not vary greatly. Income from poultry and dairying may be slightly higher, but the work is more confining.

These livestock enterprises are best suited to small farms, whereas cattle feeding is more advantageous on the larger farms.

Some adjustments that are apparent in the area are a reduction in size of some of the larger farms, an increase in legume acreage, and an increase in corn acreage and a slight increase in livestock numbers. Some of these changes are just getting underway. Much more extensive changes are anticipated for the future.

T. S. THORFINNSON, A. W. EPP

Agricultural Credit

A study of credit in southeast Nebraska was completed dealing primarily with credit requirements of farmers in that area, sources of loanable funds, and factors that influence successful use of credit. Income and expense records of 2,557 farmers in four Nebraska counties were analyzed and summarized. The effects of fluctuating farm income upon debt management were studied.

The need for good farm management becomes apparent as actual debtor experience is told. Quality of management is a major factor in determining success or failure in the use of credit.

NORRIS J. ANDERSON

Adjustments in Farm Organization

A new study has been started to determine the effect of land use adjustments in some of the wheat-producing areas of western Nebraska.

Information will be obtained on the cost of establishing adapted grasses, on yields of crops under various cropping systems, and on receipts and expenses of operating the farm business. An analysis will be made to determine the probable returns from alternative systems of land use.

A. W. EPP

Trends and Changes Affecting Rural Schools, and Problems of Their Reorganization

Two studies of the rural school situation in Nebraska are underway. One of them deals with the changes and trends of the school population, the related causal factors and conditions and the social consequences of these trends. The other is a study of the problem of rural school reorganization in the different regions of the State. It is designed to throw light

upon the factors that influence local school situations, such as the population of incorporated places, density of farm settlement, town-and-country trade relationships, the legal basis of school districts, changes in the cost of operating schools, and the sources of receipts. Both studies point out general principles which should guide rural school reorganization.

From 1870 to 1945 the school population of Nebraska passed through three rather distinct phases. From 1870 to 1900, while the State experienced pioneer settlement and the initial development of its economic, political and social organization, the school population grew by leaps and bounds and the school system expanded rapidly. By 1900 this rapid growth was checked by adverse economic conditions of the 1890's and related population changes. The school census and enrollment fell off during the first decade of the century but rose again during the next two, until about 1930. From that year until 1945, the school population decreased both in pupils and in teaching and administrative personnel.

The situation at the close of World War II: A series of population changes has greatly reduced the rural population on farms and in small towns. Extensive decreases have occurred in their basic school population during the last two or three decades. Rural elementary school enrollment dropped from 121,664 in 1926-1927 to 54,036 in 1946-1947—a decrease of 55.6 per cent. Urban school systems also felt the impact of declining numbers until recently, but their present outlook is in the main conditioned by new industrial and commercial development and by rapid growth of population. A new tide of births from 1941 to 1949 is now increasing enrollments in the kindergarten and elementary grades. Similar increases are hardly to be expected in the rural areas of the State.

There were only 36 urban school districts in Nebraska in 1940 and an estimated 50 in 1950. Rural schools, both elementary and secondary, are represented by nearly 6,900 districts. These districts include some areas which have lost nearly half of their farm population during the past 20 years, some areas whose farm population has been fairly stable, and a few areas that have experienced an influx of population.

The problem of school district reorganization which the Legislature placed in the hands of committees now organized in the State's 93 counties is therefore one of extraordinary complexity.

JOHN P. JOHANSEN

Classification of Land to Determine Value for Tax Purposes

Using the Farm Planning Soil Conservation Surveys of Harlan County, prepared by the Soil Conservation Service, a procedure has been devised for classifying farm land on the basis of potential productivity. The three variables, soil type, soil slope and soil erosion, are the principal elements considered in devising productivity classifications for each present land use class. By computing long-run net return for each productivity class, and using prevailing interest rates and average tax levies, the value of each class may be calculated for assessment purposes.

Through a cooperative agreement with Harlan County, the Farm Planning Survey of each section in the County is now being subdivided into 40-acre tracts. The various types of land within each tract are being measured and appropriate values computed for the entire tract on the basis of the values calculated for each productivity class. The values of the appropriate 40-acre tracts will then be combined in determining the assessed value of each landowner's property.

QUENTIN W. LINDSEY

Home Economics

Department of Home Economics

Nutrition Research

Nutritional status of adult women. One hundred women between thirty and eighty years of age were studied with regard to basal metabolic rate, blood constituents, biophotometer tests, medical examinations, electrocardiograms, and supervised records of one week's self-chosen food intake. Another group—eight women—received all of the above tests plus complete metabolism studies and X-ray of gall bladder and gastrointestinal tract. Preliminary findings indicate that adult women in each successive age decade have blood values and nutritional requirements different from those of women in younger age groups.

This study is a part of a regional research project and is supported in part by the Bureau of Human Nutrition and Home Economics of the U. S. Department of Agriculture.

Nutritional status of the family. This project was designed to study the nutritional status and food habits of Nebraska families. Thirty-three families of Waverly, Nebraska, participated. A composite of the food intake for four days for each member of each of the families will be analyzed for calcium, phosphorus and nitrogen. Basal metabolism test, blood analyses, and electrocardiogram were performed on the adults. Dental and physical examinations were made for each member of the family. Evidence suggests that there is great variability in the quality and quantity of the diet between members of the family even though they all eat at the same table.

Absorption of iron by women. This study was initiated to compare the absorption of three different iron-containing compounds in the intestinal tract and to simultaneously study their effect on the hemoglobin value of the blood. Women between the ages of 18 and 50 were studied. Ferrous sulfate was given to 22 subjects, ferrous lactate to 23 subjects, and ferrous gluconate to 22 subjects, for one month. Hemoglobin values were determined weekly from one day before the iron medication was begun until one month after it was discontinued. Fifty subjects will be used in the study of each type of compound. This study is supported in part by Smith-Dorsey Company.

Low protein intake with variable distribution of animal protein and variable calorie intake. College-age women were fed diets that varied in the distribution of animal protein and calorie intake. For three 18-day periods eight subjects were fed the following: First period, 1,800 calories including 40 grams of protein with no animal protein at lunch; second period, 2,500 calories with the same distribution and quantity of protein as in the first period; third period, 1,800 calories including 40 grams of protein with animal protein at three meals per day. For the third period the protein was redistributed by transferring a glass of milk from dinner to luncheon. The metabolism of calcium, phosphorus and nitrogen was studied. This study was supported in part by the National Live Stock and Meat Board.

Generous intake of animal protein in a low-calorie diet. Fourteen subjects ranging from 18 to 85 pounds overweight were on a controlled diet for three 18-day periods. The calorie level and protein intake were main-

tained at 1,300 and 63 grams, respectively, throughout the 54 days. During the first and third periods no animal protein was given at the noon meal. The average weight loss for the subjects was 18½ pounds for the 54 days with a range of 11¼ to 22¼ pounds loss. The metabolism of calcium, phosphorus and nitrogen was measured during these periods. Basal metabolic rate was determined at the beginning and end of the study. This study was supported in part by the Millers National Federation.

Generous protein intake with variable distribution of animal protein and variable calorie intake. Eight subjects were fed controlled diets during three 18-day periods or a total of 54 days. In the first period the subjects received 1,800 calories which included 62 grams of protein, all of the animal protein occurring in breakfast and dinner. In the second period the subjects received 2,500 calories with the same quantity and distribution of protein as in the first period. During the third period the diet consisted of 1,800 calories including 62 grams of protein, the animal protein being distributed through the three meals of the day. The redistribution of the protein was made by transferring a glass of milk from dinner to luncheon. Metabolism of calcium, phosphorus and nitrogen was measured through these three periods. This study was supported in part by a grant from the American Dairy Association.

RUTH M. LEVERTON, MARY ROSE GRAM, HELEN HAMRA, MARCELLA CARTER, MARILYN CHALOUKKA, SHIRLEY STAATS GLEASON, RUTH L. JOHNSON, MARILYN KUHLMAN, AMY MITCHELL, RUTH PETERS, JOEY STRICKLER

Effect of guidance by trained personnel on family nutritional status and home management practices. Six families in the Lincoln area were chosen as subjects for this study. Two of the families have a grandmother living with them, two have small children and two have teen-age children. At the beginning of the study in November, 1949, all family members were given a physical examination to determine their nutritional status. A weighed food intake record was made for one week for each family in November. Additional information regarding home management practices is now being collected.

On the basis of the physical examinations and food intake records, recommendations for improvement of the food intake pattern were made for each family member. Procedures for improvement in home management practices are being recommended by trained personnel. Each family is visited frequently to encourage improvement in nutrition and management practices.

One year after the beginning of the study, the nutritional status and home management practices will again be checked. The effect of guidance in nutrition and home management by trained personnel will then be evaluated.

This study, which is cooperative with two other universities, is supported in part by the McCall Corporation.

DORETTA SCHLAPHOFF, RUBY NELL RUTH, EILEEN BRODOVSKY

Household Equipment Research

Liquid loss from glass jars processed in the pressure cooker. Glass jars fitted with various types of closures were processed in a pressure cooker equipped with a porthole. The jars were connected to compound gauges for measuring internal jar pressures. Water and three cooked vegetables

were used as jar contents. Tests were performed to determine the effect of the following factors upon the loss of liquid from jars: cooker pressure, jar size, jar contents, headspace above contents in jars, type of closure and seal and sealing torque. Physical conditions involved in the loss of liquid from jars were studied by determining temperature, pressure and time relations during a complete processing period for a pint jar sealed with a two-piece closure.

The results may be summarized as follows:

1. Conditions that allow excessive liquid to be expelled from the jar are (a) no headspace or insufficient headspace in terms of jar size to allow for expansion of jar contents, (b) unsealed jars, in particular those with zinc and three-piece closures, (c) sealed jars with a low differential pressure, (d) two-piece closures having insufficient stiffness in the closure band, allowing venting at a low differential pressure, (e) two-piece closures with a loose seal, in particular closures with insufficient band stiffness, and (f) a fluctuating cooker pressure which would accentuate the above conditions.

2. Conditions that reduce liquid loss to a negligible amount are (a) sufficient headspace to allow for the expansion of jar contents, in particular at least 35-ml. headspace for pint jars and 70-ml. headspace for quart jars, (b) tightly sealed jars, in particular two-piece closures having a stiff band that clamps the lid with sufficient force to maintain a differential pressure of 5 psi or more, and (c) minimum friction between the band and the jar threads so tight lid clamping will result.

ARNOLD E. BARAGAR

Coal and wood stoves. Performance data were secured on four coal ranges fired with Illinois bituminous coal. The tests were designed to determine heats available for surface and oven cookery. A technique was evolved for expressing cooking-top temperatures in terms of one temperature measured directly over the mid-portion of the firebox. Oven temperatures of 300° to over 500° F. were expressed as percentages of the average temperature of the mid-plane in the oven. Cooking-top efficiency cannot be expressed in per cent because heat from the firebox is used for the oven and for heating the room. Oven temperatures were studied with the oven damper open and closed. The type of fire needed to provide a quick preheating of the stove with a high cooking-top temperature and a low resultant oven temperature was studied. The type of fire and its method of control was an important part of the investigation because if the fire becomes too hot, oven temperatures become too high for baking food satisfactorily. The use of various types of saucapans on the cooking top will be evaluated in terms of the rate of heating like amounts of water, taking into consideration the temperature of the heating area of the cooking top at the time of heating.

The results of this investigation should provide needed information about temperatures and consequently about heat available from several parts of the coal stove as related to type of fire and method of operation.

ARNOLD E. BARAGAR

Simple equipment for home milk pasteurization. Experience gained during an investigation of electric home milk pasteurizers indicated that a home pasteurization method using simple apparatus might be desirable. Use of ordinary water-bath canning equipment is being studied. Milk in

quart Mason jars tightly sealed with two-piece closures is processed in a water bath which is heated on a cookstove. Milk temperatures are measured by a Weston laboratory thermometer inserted through the lid of one jar. The milk temperature during preheating must be related properly to the waterbath temperature so that the milk will not be overheated. This is being studied by determining preheating rates in terms of rate of heat input from the stove. Pressures attained in the jars are being checked with a compound gauge connected to the jar. After the physical conditions for pasteurization have been developed and checked, the milk will be subjected to a phosphatase test to ensure that every particle of milk is properly pasteurized. At the end of the pasteurizing period, the milk is cooled by setting the jars in cold water. It is then stored in the refrigerator. This is an in-bottle pasteurization method with jars sealed before pasteurizing, and should ensure that no recontamination of milk will occur before the jars are opened for use.

ARNOLD E. BARAGAR, P. A. DOWNS

Housing Research

Factors influencing housing needs of farm families. The report of this study is now being prepared. It will point out needs for certain features in new and remodeled farmhouses as indicated by family activities, preferences and possessions. The data came from 558 families in 83 counties, a representative sample of Nebraska families who do not live in towns or cities. Analyses have been made by type of farming area, farm tenure, and family size, type and income.

MARGARET LISTON, ESTHER HERRMANN

Family Life Research

Statistical data on Nebraska families. Preliminary findings show striking differences in divorce rate between various counties, even when they are grouped and classified according to total population, and according to population of the largest town or city in the county. Data from 11 counties indicate a considerable increase from 1940 to 1948 in the percentage of young people who are marrying at 18 and under, and 21 and under. This is especially true of girls. Analysis of data on infant mortality rates reveals certain problem-counties in this respect.

KENNETH L. CANNON

Relation between social acceptance and selected family-living variables of high school children. All students enrolled in public four-year high schools in Seward County are being used as subjects in this study. Tests have been administered and data analyzed for 10th, 11th and 12th grade students with respect to relationships between social acceptance and self reliance, social-cultural-economic status of the family, and security-insecurity rating of the student. Data have also been gathered on the differences between students enrolled in the high school at Seward (only town in the County with more than 2,500 population) and the students enrolled in the various village high schools. Other analyses will concern 9th-grade students and the differences in self reliance and security-insecurity ratings between the various high school classes.

KENNETH L. CANNON, HELEN E. SHERRILL

Variables in family life and personality development of children. Other work in this field is being surveyed in an attempt to find adequate measurements for family authority patterns, and for participation by the family in the community. It is hoped that a community can be selected that will cooperate wholeheartedly in this project, and that will be of sufficient size to permit a statistical analysis of the results. Actual field work will begin during 1950.

KENNETH L. CANNON, IRENE CARLSON

Development of a socioeconomic scale for Nebraska farm families. Data from the study of housing needs are being used to identify significant factors related to socioeconomic status and to develop a proposed scale for facilitating classification of farm families by broad socioeconomic groups.

ESTHER HERRMANN

Factors affecting rates and forms of saving of farm and town families. An extensive manuscript giving a highly analytical interpretation of this study was accepted as a doctoral dissertation at the University of Chicago and is available on microfilm from that institution. A condensed version will be published by the Nebraska Agricultural Experiment Station. The study is based on data from 163 farm and town families, a representative sample of the rural families in two counties of southeastern Nebraska.

MARGARET LISTON

Experiment Station Publications

Annual Report

Sixty-second Annual Report (148 pages). Presented to the Governor
February 1, 1949. 1,500 copies.

Bulletins

392. The Nebraska Tractor Tests, 1920-1948 (52 pages). The Board of Tractor Test Engineers. 15,000 copies.
393. Systems of Farming for the Tri-County Irrigation Area in Nebraska (52 pages). T. S. Thorfinnson and A. W. Epp. 5,000 copies.
394. Factors Affecting the Efficiency of the Mechanical Corn Picker (32 pages). C. W. Smith, W. E. Lyness and T. A. Kiesselbach. 7,000 copies.
395. Land Resources and Recommended Conservation Practices in Nebraska (140 pages). Frank Miller and Arthur Anderson. 3,000 copies.
396. Feeding Ground Corn Cobs to Fattening Yearling Steers (20 pages). Marvel L. Baker and Vincent H. Arthaud. 8,000 copies.

Research Bulletins

158. Effect of Position within a Large Storage Bin upon Midwinter Behavior of Nebraska Triumph Seed Potatoes (22 pages). H. O. Werner. 2,500 copies.
159. Effect of Grass on Intake of Water (16 pages). F. L. Duley and C. E. Domingo. 5,000 copies.
160. Pink Rot of Potatoes Caused by *Phytophthora erythroseptica* Pethyb. (27 pages). R. W. Goss. 3,000 copies.
161. The Structure and Reproduction of Corn (96 pages). T. A. Kiesselbach. 10,000 copies.
162. Effect of Storage Temperatures on Triumph Seed Potatoes Used for the Early Crop in the South and in Central Nebraska. (47 pages). H. O. Werner. 2,500 copies.
163. Liquid Loss from Glass Jars Processed in the Pressure Cooker (27 pages). Arnold E. Baragar.

Circulars

87. Safflower Production in the Western Part of the Northern Great Plains (24 pages). Carl E. Claassen. 5,000 copies.

Journal Series, Technical Articles and Papers

469. Decomposition of Wheat Straw by Some Fungi Commonly Found in Nebraska Soils. Roy C. Dawson. Soil Science 67(6):467-479. June 1949.
470. Some Factors Influencing the Injury to Winter Wheat Heads by Low Temperatures. J. E. Livingston and J. C. Swinbank. Agronomy Journal. 42(3):153-157. March 1950.
471. Cracking of Triumph Potatoes in Western Nebraska as Influenced by Vine Destruction and Root Cutting. F. V. Pumphrey and Lionel Harris. American Potato Journal. 26(10):255-361. October 1949.
473. The Inheritance of the Pistillate Character in Castors and Its Possible Utilization in the Production of Commercial Hybrid Seed. C. E. Claassen and Albert Hoffman. Agronomy Journal. 42(2):79-82. February 1950.

474. Nitrogen Excretion of Women Related to the Distribution of Animal Protein in Daily Meals. Ruth M. Leverton and Mary R. Gram. *Journal of Nutrition*. 39(1):57-66. September 1949.
475. Peeling Economy as Affected or Influenced by Size and Grade of Triumph Potatoes. H. O. Werner. *American Potato Journal*. 27(3): 97-113. March 1950.
476. Nitrogen, Calcium, Phosphorus and Basal Energy Metabolism of Obese College Women During Weight Reduction. Ruth M. Leverton and Helen N. Rhodes. *Journal of the American Dietetic Association*. 25(12):1012-1016. December 1949.
477. Pollen Substitute Tests in Nebraska. Robert J. Walstrom. *American Bee Journal*. 90(3):118. March 1950.
478. Effects of Irradiating Maize Pollen in a Nuclear Reactor on the F₁ Plants. E. F. Frolik and Rosalind Morris. *Science*. 111(2876):153-154. February 1950.
479. The Reaction of Blood Cells in Experimental Listeriosis of Sheep. Carl Olson, Jr., Raymond H. Cook and Ida C. Blore. *American Journal of Veterinary Research*. XI(38):29-40. January 1950.
480. Stubble Mulch Studies. III. Influence of Soil Microorganisms and Crop Residues on the Germination, Growth and Direction of Root Growth of Corn Seedlings. T. M. McCalla and F. L. Duley. *Proceedings of Soil Science Society of America*. Vol. 14. In Press.
481. The Food Likes of Boys and Girls in Nebraska. Ruth M. Leverton and Maude C. Coggs. *Journal of Home Economics*. In Press.
482. Xenia Effects of Irradiating Corn Pollen in a Nuclear Reactor. E. F. Frolik and Rosalind Morris. *Agronomy Journal*. 42(6):293-297. June 1950.
483. The Effect of Tissue Desiccation upon Invasion of Potato by *Erwinia caratovora* (Jones) Holland. John P. Hollis and R. W. Goss. *Journal of Phytopathology*. In Press.
484. A Genetic Study of Halo Blight Reaction in *Phaseolus vulgaris*. M. L. Schuster. *Phytopathology*. 40(6):604-612. June 1950.
485. Pore Space and Aggregation in a Chernozem Soil as Affected by Age of Perennial Grass Sod. J. Roger McHenry, L. L. Zook and H. F. Rhoades. *Agronomy Journal*. In Press.
486. Fertility Relationships and Meiosis of Interspecific Hybrids in *Melilotus*. Gilbert T. Webster. *Agronomy Journal*. In Press.
487. Natural and Controlled Crossing in Safflower, *Carthamus tinctorius* L. C. E. Claassen. *Agronomy Journal*. In Press.
488. Application of Centrifugal Force to Obtain a Saturation Extract of Soil Suitable for Flame Photometric Analysis. Leon Chesnin and W. C. Johnson. *Soil Science*. 69(6):497-498. June 1950.
489. Modification of the Smith-Weldon Wet Combustion Procedure for the Microdetermination of Soil Organic Matter. Leon Chesnin. *Agronomy Journal*. In Press.
490. "Stumpy," a Recessive Achandropasia in Shorthorn Cattle. M. L. Baker, C. T. Blunn and M. M. Oloufa. *Journal of Heredity*. In Press.
491. A Field Test of Immunization Against Newcastle Disease (Pneumoencephalitis). Carl Olson, Jr., Ida C. Blore, F. R. Woodring and C. B. McGrath. *Journal of American Veterinary Medical Association*. 117 (881):144-148. August 1950.
492. The Effect of Selection for Combining Ability Within Segregating Lines of Corn. John H. Lonnquist. *Agronomy Journal*. In Press.

Administration and Staff

The Regents of the University

GEORGE LIGGETT, Utica
ROBERT W. DEVOE, Lincoln
JAMES L. WELSH, Omaha
STANLEY D. LONG, Grand Island
FRANK M. JOHNSON, Lexington
CHARLES Y. THOMPSON, West Point, President
R. G. GUSTAVSON, Ph.D., Chancellor of the University
JOHN K. SELLECK,¹ Comptroller of the University

The Station Officers

W. V. LAMBERT, Ph.D., Director
MARVEL L. BAKER, D.Sc., Associate Director
H. G. GOULD, B.Sc., Associate Director of Agricultural Extension
R. J. GRAHAM, A.B., Agricultural Editor

The Technical Staff

C. W. ACKERSON, Ph.D., Agricultural Chemist (Chairman)
C. H. ADAMS, M.Sc., Assistant Animal Husbandman
JAMES C. ADAMS, B.Sc., Superintendent, North Platte Substation
M. A. ALEXANDER, M.Sc., Associate Animal Husbandman
W. B. ALLINGTON, Ph.D., Associate Plant Pathologist (Chairman)
H. A. ALLPRESS, M.A., Assistant in Agricultural Economics
C. R. ANDERSON, M.Sc., Assistant in Agricultural Chemistry
N. J. ANDERSON, M.Sc., Associate Agricultural Economist
MILO ARMS, B.Sc., Assistant in Agricultural Engineering
VINCENT ARTHAUD, B.Sc., Assistant in Animal Husbandry
VALENTINAS BAGONAS, D.V.M., Assistant in Animal Pathology
GUY N. BAKER, B.Sc., Animal Husbandman, North Platte Substation
MARVEL L. BAKER, D.Sc., Animal Husbandman and Associate Director of Station
ARNOLD E. BARAGAR, M.Sc., Associate Home Economist
ORLANDO S. BARE, M.Sc., Associate Entomologist
F. J. BELL,² Ph.D., Assistant Agronomist
HELEN R. BENGTON,³ B.A., Assistant in Animal Pathology
IDA BLORE, M.Sc., Assistant in Animal Pathology
CECIL T. BLUNN, Ph.D., Associate Animal Husbandman
RAYMOND L. BORCHERS, Ph.D., Associate Agricultural Chemist
E. E. BRACKETT, B.Sc. E.E., Agricultural Engineer, Emeritus
WILLIAM H. BROKAW, Director of Agricultural Extension, Emeritus
E. M. BROUSE, B.Sc., Superintendent, Valentine Substation
M. P. BRUNIG, M.A., Assistant Agricultural Engineer
W. W. BURR, B.Sc., Director of Experiment Station, Emeritus
K. L. CANNON, M.Sc., Assistant Home Economist
H. W. CHAPMAN, B.Sc., Supervisor, Box Butte Experiment Farm, Alliance
LEON CHESNIN, Ph.D., Assistant Agronomist
CARL E. CLAASSEN, Ph.D., Associate Agronomist
J. H. CLAYBAUGH, B.Sc., Associate Agricultural Economist
E. C. CONARD,³ M.Sc., Associate Agronomist

R. H. COOK, D.V.M., Assistant in Animal Pathology
 L. K. CROWE, Ph.D., Dairy Husbandman
 H. P. DAVIS, M.Sc., Dairy Husbandman
 RUSSELL L. DAVIS,⁴ M.Sc., Superintendent, Fort Robinson Substation
 DARRELL DEANE, Ph.D., Assistant Dairy Husbandman
 T. W. DOWE, M.Sc., Assistant Animal Husbandman
 P. A. DOWNS, Ph.D., Dairy Husbandman
 AUGUST F. DREIER, M.Sc., Assistant in Agronomy
 F. L. DULEY,⁴ Ph.D., Agronomist
 J. V. DUNLAP, JR., B.Sc., Farm Supervisor
 P. L. EHLERS, B.Sc., Assistant in Agronomy
 A. W. EPP, M.A., Assistant Agricultural Economist
 CARL E. ERVIN, B.Sc., Assistant in Animal Husbandry, North Platte Substation
 MARGARET FEDDE, M.A., Home Economist (Chairman)
 H. C. FILLEY, Ph.D., Agricultural Economist, Emeritus
 E. F. FROLIK, Ph.D., Agronomist
 R. L. GATES, M.Sc., Assistant in Agricultural Chemistry
 A. G. GEORGE, M.A., Assistant Agricultural Economist
 R. W. GOSS, Ph.D., Plant Pathologist
 R. J. GRAHAM, A.B., Agricultural Editor
 MARY ROSE GRAM, M.Sc., Assistant in Home Economics
 HUGO GRAUMANN,⁴ M.Sc., Agronomist
 M. J. GREENWOOD, B.Sc., Assistant Agronomist, North Platte Substation
 W. E. HAMMOND, B.Sc., Assistant Agricultural Economist, Chemurgy
 L. E. HANSON, Ph.D., Animal Husbandman
 D. G. HANWAY, M.Sc., Assistant Agronomist
 J. J. HANWAY, M.Sc., Assistant in Agronomy
 LIONEL HARRIS, M.Sc., Associate Agronomist and Superintendent, Scottsbluff Substation
 I. L. HATHAWAY, M.Sc., Associate Dairy Husbandman
 HAROLD A. HAUKE,⁴ M.Sc., Field Supervisor of Entomology
 R. E. HILL, Ph.D., Associate Entomologist
 B. D. HITES, M.Sc., Assistant Agricultural Chemist
 EPHRIAM HIXSON, Ph.D., Entomologist (Chairman)
 ALBERT HOFFMAN, M.Sc., Assistant in Agronomy
 ORLANDO W. HOWE,⁴ B.Sc., Assistant Agricultural Engineer, Scottsbluff Substation
 L. W. HURLBUT, M.Sc. A.E., Agricultural Engineer (Chairman)
 L. C. JACKSON, B.Sc., Assistant in Agricultural Economics
 W. E. JAMES,² M.Sc., Assistant in Animal Husbandry, North Platte Substation
 J. P. JOHANSEN, Ph.D., Associate Agricultural Economist
 LESLIE JOHNSON,⁴ Ph.D., Animal Husbandman
 F. D. KEIM, Ph.D., Agronomist (Chairman)
 P. L. KELLY, Ph.D., Dairy Husbandman (Chairman)
 T. A. KIESSELBACH, Ph.D., Agronomist
 DAYTON KLINGMAN,⁴ M.Sc., Assistant in Agronomy
 W. V. LAMBERT, Ph.D., Director of Agricultural Experiment Station
 L. F. LARSEN, M.Sc. A.E., Associate Agricultural Engineer
 RUTH M. LEVERTON,⁵ Ph.D., Home Economist
 MARGARET I. LISTON,² Ph.D., Associate Home Economist
 J. E. LIVINGSTON, Ph.D., Associate Plant Pathologist
 W. J. LOEFFEL, M.Sc., Animal Husbandman (Chairman)

J. H. LONNQUIST, Ph.D., Associate Agronomist
 RALPH LUEBS,² B.Sc., Assistant in Agronomy
 W. E. LYNNESS, M.Sc., Associate Agronomist
 T. M. MCCALLA,⁴ Ph.D., Associate Agronomist
 DAVID P. MCGILL, M.Sc., Assistant in Agronomy
 R. A. MAPES, Manager, Union Fruit Farm
 JOHN MATSUSHIMA, Ph.D., Assistant Animal Husbandman
 R. P. MATELSKI, Ph.D., Assistant Agronomist
 ANDREW MAZURAK, Ph.D., Assistant Agronomist
 FRANK MILLER,² Ph.D., Associate Agricultural Economist
 V. J. MILLER, Ph.D., Assistant Horticulturist
 C. C. MITCHELL, Ph.D., Agricultural Economist (Chairman)
 RUFUS H. MOORE, Ph.D., Associate Horticulturist
 R. F. MORGAN,² M.Sc., Assistant Dairy Husbandman
 MARY R. MORRIS,⁶ Ph.D., Assistant in Agronomy
 M. H. MUMA, Ph.D., Associate Entomologist
 F. E. MUSSEHL, B.Sc., Poultry Husbandman (Chairman)
 L. C. NEWELL,⁴ Ph.D., Associate Agronomist
 CARL OLSON, JR., D.V.M., Ph.D., Animal Pathologist (Chairman)
 G. W. OLSON, B.Sc. A.E., Assistant in Agricultural Engineering
 R. A. OLSON, B.Sc., Assistant in Agronomy
 G. M. PETERSEN, B.Sc. A.E., Assistant Agricultural Engineer
 MOGENS PLUM, Ph.D., Assistant Dairy Husbandman
 C. R. PORTER, M.Sc., Assistant Agronomist
 F. V. PUMPHREY, M.Sc., Assistant Agronomist, Scottsbluff Substation
 R. E. RAMIG, M.Sc., Assistant in Agronomy, North Platte Substation
 W. W. RAY, Ph.D., Mycologist
 L. P. REITZ,⁴ Ph.D., Agronomist
 H. F. RHOADES, Ph.D., Agronomist
 MYRON G. A. RUMERY, B.Sc., Assistant Dairy Husbandman, North Platte
 Substation
 J. C. RUSSEL, M.Sc., Agronomist
 W. W. SAHS, B.Sc., Assistant in Agronomy
 ROGER SANDSTED, B.Sc., Assistant in Horticulture
 R. M. SANDSTEDT, M.Sc., Agricultural Chemist
 DORETTA M. SCHLAPHOFF, Ph.D., Associate Home Economist
 J. F. SCHRUNK, B.Sc. A.E., Assistant in Agricultural Engineering
 A. B. SCHULTZE, Ph.D., Assistant Dairy Husbandman
 M. L. SCHUSTER, Ph.D., Assistant Plant Pathologist
 G. M. SEVERSON, Ph.D., Chemist and Chairman, Department of Chemurgy
 NEAL E. SHAFER, M.Sc., Assistant in Agronomy
 ARDEN SHERF,² Ph.D., Assistant Plant Pathologist
 C. W. SMITH, M.Sc. M.E., Agricultural Engineer
 L. B. SNYDER, Ph.D., Associate Agricultural Economist
 C. A. SOOTER,² Ph.D., Assistant Entomologist
 ROBERT STAPLES, Ph.D., Assistant Entomologist
 FRED TURNER,² B.Sc., Assistant Dairy Husbandman
 L. VAN ES, V.S., M.D., D.Sc., Animal Pathologist, Emeritus
 GLENN VIEHMEYER, Assistant in Horticulture, North Platte Substation
 DONALD WARNER, M.A., Assistant Animal Husbandman
 GILBERT T. WEBSTER,⁴ M.Sc., Associate Agronomist
 O. J. WEBSTER,⁴ M.Sc., Associate Agronomist
 J. L. WEIHING, M.Sc., Assistant in Plant Pathology

H. O. WERNER, Ph.D., Horticulturist
H. L. WIEGERS, M.Sc., Assistant in Poultry Husbandry
C. C. WIGGANS, Ph.D., Horticulturist (Chairman)
I. L. WILLIAMS, M.A., Assistant Poultry Husbandman
F. R. WOODRING, D.V.M., Associate Animal Pathologist
PAUL K. YAGYU, B.Sc., Assistant in Horticulture
F. D. YUNG, M.Sc. A.E., Assistant Agricultural Engineer
L. L. ZOOK,⁴ B.Sc., Agronomist, North Platte Substation

¹ By an act of the Legislature of the State of Nebraska approved and in effect February 15, 1889, the State Treasurer became ex officio custodian of the Experiment Station funds on and after July 1, 1899.

² Resigned.

³ On leave October 1, 1949 to May 31, 1950.

⁴ Detailed from the U. S. Department of Agriculture.

⁵ On leave September 1, 1949 to July 1, 1950.

⁶ On leave September 1, 1949 to June 1, 1950.

Experiment Station Financial Report

Money Received from the United States Government

Hatch Fund

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved March 2, 1887

Total		\$ 15,000.00
Expenditures		
For salaries		\$ 15,000.00
Total		\$ 15,000.00

Adams Fund

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved March 16, 1906

Total		\$ 15,000.00
Expenditures		
For salaries		\$ 15,000.00
Total		\$ 15,000.00

Dated at Lincoln, Nebraska JOHN K. SELLECK, Comptroller.

Bankhead-Jones Fund

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved June 29, 1935

Total		\$ 44,233.72
-------------	--	--------------

Expenditures

Salaries and Wages		
Regular employees		\$ 37,590.16
Total		\$ 37,590.16
Supplies		
Office supplies	\$	23.82
Institutional and household supplies		544.41
Agricultural and veterinary supplies		475.82
Shop and plumbing supplies		20.92
Miscellaneous		10.67
Total		\$ 1,075.64
Expenses		
Freight, cartage and express	\$	43.39
Traveling expense		475.01
Printing, publishing and advertising		817.35
Equipment rental and servicing		106.00
Departmental expense		3,844.08
Total		\$ 5,285.83
Repairs		
Building	\$	67.97
Equipment		214.12
Total		\$ 282.09
Grand Total		\$ 44,233.72

Purnell Fund

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved February 24, 1925

Total		\$ 60,000.00
-------------	--	--------------

Expenditures

Salaries and Wages		
Regular employees		\$ 43,923.53
Temporary employees		1,674.11
Total		\$ 45,597.64
Supplies		
Office	\$	7.50
Laboratory supplies		540.54
Institutional and household supplies		177.01
Agricultural supplies		2,065.61
Shop and plumbing supplies		103.67
Total		\$ 2,894.33
Expense		
Freight, cartage and express	\$	11.85
Traveling expense		665.32
Special and temporary services		9,531.11
Miscellaneous		175.95
Total		\$ 10,384.23

Repairs			
Buildings	\$	160.01	
Equipment		187.14	
Total	\$		347.15
Equipment			
Furniture and fixtures.....	\$	776.65	
Total	\$		776.65
Grand Total	\$		6,000.00

Regional Research

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved August 14, 1948
 Total

\$ 9,885.44

Expenditures

Salaries and Wages			
Regular employees	\$	2,913.96	
Total	\$		2,913.96
Supplies			
Office supplies	\$	19.32	
Laboratory supplies		245.43	
Institutional and household supplies.....		1,421.77	
Agricultural supplies		79.25	
Automotive gas and oil		13.92	
Total	\$		1,779.69
Expense			
Postage	\$	45.00	
Freight, cartage and express		30.13	
Traveling expense		621.38	
Publicity, printing and advertising.....		70.11	
Special and temporary services.....		771.05	
Total	\$		1,537.67
Repairs			
Equipment	\$	88.31	
Total	\$		88.31
Equipment			
Furniture and fixtures.....	\$	456.08	
Total	\$		456.08
Unexpended balance	\$		3,109.73
Grand Total	\$		9,885.44

Research and Marketing

Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1949, under act of Congress approved August 14, 1946
 Total

\$ 43,791.06

Expenditures

Salaries and Wages			
Regular employees	\$	23,860.36	
Temporary employees		468.63	
Total	\$		24,328.99
Supplies			
Office	\$	3.80	
Laboratory		205.61	
Institutional and household supplies.....		123.12	
Agricultural supplies		2,718.30	
Shop and plumbing supplies.....		60.70	
Gas and oil		81.93	
Total	\$		3,193.46
Expenses			
Traveling expense	\$	2,443.20	
Publishing, printing and advertising.....		100.15	
Special and temporary services.....		6,181.87	
Total	\$		8,725.22
Repairs			
Lands and buildings.....	\$	514.49	
Equipment		187.05	
Total	\$		701.54
Equipment			
Furniture and fixtures.....	\$	3,823.26	
Agricultural supplies and livestock.....		160.45	
Total	\$		3,983.71
Unexpended balance	\$		2,858.14
Grand Total	\$		43,791.06

Financial Statement Exclusive of Federal Funds

Statement of expenditures for the Agricultural Experiment Station of the University of Nebraska, for the year ended June 30, 1949 (exclusive of Federal Funds), including expenditures for central station of Lincoln and substations at North Platte, Scottsbluff, Valentine, Union and Alliance and for Out-State Testing.

Salaries and Wages		
Regular employees	\$204,559.88	
Temporary employees	5,158.88	
Total		\$209,718.76
Supplies		
Office supplies	\$ 5,326.00	
Laboratory supplies	8,771.17	
Fuel	1,570.29	
Household, education supplies, food.....	10,762.19	
Agricultural supplies and feed.....	75,529.28	
Shop, plumbing supplies.....	7,200.68	
Automotive supplies, gas, oil, grease.....	5,791.95	
Miscellaneous	5,647.30	
Total		\$120,598.86
Expenses		
Telephone, telegraph and postage.....	\$ 2,869.97	
Freight, express, cartage.....	3,853.93	
Traveling expense	25,515.95	
Publishing, printing and advertising.....	3,985.81	
Equipment rental and servicing.....	1,598.86	
Light, power, heat and water.....	9,237.52	
Special and temporary services.....	102,339.92	
Miscellaneous	4,352.70	
Total		\$153,754.66
Repairs		
Buildings	\$ 14,272.43	
Lands	4,827.37	
Equipment	15,875.40	
Total		\$ 34,975.20
Equipment		
Office furniture and fixtures.....	\$ 13,877.40	
Laboratory equipment	17,905.12	
Household furniture	13,155.01	
Farm machinery, automobiles.....	16,411.35	
Livestock	75,658.95	
Total		\$137,007.83
Fixed Charges		
Rental, insurance premiums.....	\$ 760.00	
Total		\$ 760.00
Grand Total		\$656,815.31