5-1948

61th Annual Report of the Agricultural Experiment Station May 1948

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University of Nebraska at Lincoln

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Cover Picture, Courtesy of Soil Conservation Service-Research

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Introduction

Nebraska farmers were faced in 1947 with production demands of global scope. The impact of the world food shortage pushed prices higher than during the war years. Operating costs on farms were increasing at a rapid rate. However, despite these mounting costs, farm people continued to find themselves in a favorable position.

Small grain crops of 1947 were generally good over much of Nebraska but corn suffered when heavy rains in May and June delayed planting, and a hot, dry summer resulted in poor plant development and poorly filled ears. A cold, wet fall delayed harvest, which was approximately 50 per cent of normal.

Although the farmer found skyrocketing demand for his products, there were long-range disadvantages in the continued pressure for full production. The hoped-for shift back to conservation farming could not be made by operators who planted the requested acreages of such crops as wheat, corn, and dry edible beans. Agriculture, like other lines of production, cannot adjust itself entirely until national and world conditions become more settled.

Livestock numbers were reduced by unusually heavy slaughter of animals to supply the urgent demand for meat. Neither beef nor pork production kept pace with food requirements.

Scarcity of labor, and high wages, caused many farmers to turn even more to labor-saving equipment as a means of keeping costs down. Difficulty in obtaining machinery resulted in an increase in joint ownership of corn pickers and combines. Custom harvest work increased.

Emphasis in the research program of the Experiment Station was placed on both immediate and long-time problems of the farmer. Investigations were continued in soil conservation and productivity, and in the production of basic crops and livestock.

A new variety of oats, Nemaha, was named and recommended for farm production. Nemaha is an early-maturing oat having resistance to Victoria blight and the common races of rust and smut. It has stiff straw and has produced high yields of good quality grain. In the spring of 1948, 2,500 bushels of Nemaha oats will be released for seed increase to farmers in the eastern two-fifths of the state, where this variety is especially adapted. This will be a notable addition to the distinctly superior crops made available to Nebraska farmers in recent years through the crop improvement work of this and cooperating state and federal experiment stations.

In cooperation with the Chemurgy Division, a new oil crop, safflower, has been established as suitable for western Nebraska. Seed of a superior variety introduced from the Anglo-Egyptian Sudan has been released for further seed increase by Nebraska farmers.
INTRODUCTION

The Station recognizes the helpfulness of various farmer organizations in connection with the rapid increase and distribution of seed supplies of newly developed superior crops. This also holds true for various livestock associations that sponsor the adoption of better breeding and management practices as they are revealed by experimental study.

Work was undertaken in 1947 to determine the effect of neutron irradiation on the rate of genetic changes in corn. Tassels were sent by air to the Argonne National Laboratory in Chicago for neutron irradiation. Upon return, their pollen was used in the fertilization of tester stocks in comparison with untreated pollen. The frequency of mutation was found to be greatly accelerated by some of the irradiation dosages.

Considerable work was done on the value of dehydrated alfalfa meal as a partial or complete replacement for the oil meals in rations for growing and fattening cattle. Trials were conducted on the value of urea in rations for growing and fattening cattle. Progress was made on the development of a beef cattle project, and a breeding project with dual-purpose cattle was initiated. A fundamental project on vitamin E requirements for swine was undertaken.

The tests conducted in 1947 for the control of sarcoptic hog mange represented a continuation and expansion of the experimental program initiated in 1946. In addition to benzene hexachloride which is proving effective for the control of this disease, two other chemicals, sulfur emulsion and chlordane, were tested. Hand-spraying equipment and the use of lower dilutions of benzene hexachloride were stressed in these studies.

Considerable emphasis was also placed on studies of farm management, farm equipment and human nutrition. "Safe and sane" reducing practices developed by the Home Economics Department nutrition laboratory were followed successfully by a group of overweight college girls. Strained meat was again added to formulas for infants, and the laboratory announced that the additional protein aided in the maintenance of high hemoglobin and red cell values and contributed to a generally high nutritional status.

This report is comprised largely of brief project summaries for the calendar year 1947, prepared by the members of the Experiment Station staff who are in charge of the specific investigations to which their names are attached. The report includes a list of publications issued during the year, copies of which are available to any citizen of the state upon request.

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-first Annual Report of the Agricultural Experiment Station of Nebraska.

W. W. Burr, Director.

January 31, 1948.
The program of soil and moisture conservation research in cooperation with the U. S. Department of Agriculture, Soil Conservation Service-Research, has been in progress for ten years. During this period, special attention has been given to the use of methods for increasing intake of water by soils, preventing erosion by water, and reducing the possibility of wind erosion. Results to date emphasize the value of protecting the soil surface by means of crop residue when there is no growing crop on the land. Rotations should be planned so the soil will be protected with a growing crop as much of the time as possible.

The possibility of utilizing these principles of protecting the surface as one means of flood control is shown by the results of runoff on test plots at Lincoln during the rainy weather of June, 1947. During that month 11.16 inches of rainfall was recorded. Amounts of runoff and erosion are shown in the following table.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Treatment</th>
<th>Runoff</th>
<th>Erosion per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Month of June</td>
<td>Rain of June 22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inches</td>
<td>Per cent</td>
</tr>
<tr>
<td>Oats</td>
<td>Plowed—No residue</td>
<td>5.41</td>
<td>48.5</td>
</tr>
<tr>
<td></td>
<td>Plowed—Residue under</td>
<td>4.80</td>
<td>43.0</td>
</tr>
<tr>
<td></td>
<td>Subtilled—Residue on surface</td>
<td>1.23</td>
<td>11.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>Plowed—No residue</td>
<td>4.13</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>Plowed—Residue under</td>
<td>1.26</td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>Subtilled—Residue on surface</td>
<td>0.77</td>
<td>6.9</td>
</tr>
<tr>
<td>Oats</td>
<td>Plowed—Sweetclover residue under</td>
<td>1.76</td>
<td>15.8</td>
</tr>
<tr>
<td></td>
<td>Subtilled—Sweetclover residue on surface</td>
<td>0.45</td>
<td>4.0</td>
</tr>
</tbody>
</table>

1 Total rainfall for June, 11.16 inches. Rainfall June 22, 1.21 inches.
2 Rotation, corn, oats, wheat.
3 Oats following sweetclover.

These results emphasize the effect of surface protection on the amount of water lost by runoff. Land plowed for oats, with no residue, lost 5.41 inches or 48.5 per cent of the rainfall during the month of June. Land in oats with cornstalk residue on the surface lost 1.23 inches, or 11 per cent of the rainfall. The lowest runoff was from an oats plot with sweetclover residue and with volunteer sweetclover growing in the oats. On this land the runoff for the month was only 0.45 inch, or 4 per cent of the rainfall.

The data for the rain of June 22 show that even though the land had been soaked by previous rains and the soil was thoroughly wet to a depth of several feet, the conservation treatments were still effective. The difference in favor of plots having stubble mulch treatments was as large proportionally for the rain of June 22 as for all the previous rains. Apparently where the surface of a soil such as that at Lincoln is kept open, that soil will continue to absorb water in considerable amounts with each
A—Badly eroded and gullied land in northern Gage county. Land was smoothed with a grader and seeded to sweetclover in the spring of 1946.

C—Sweetclover on badly eroded soil on Watershed Project in northern Webster county.

B—Sweetclover on area "A" in the spring of 1947. An excellent stand, which made rapid growth and completely protected the soil. A terrace kept out water from field above.

D—Excellent growth of bromegrass following sweetclover on eroded soil similar to that in "C." First year after seeding.
succeeding rain, without any large increase in runoff due to the subsoil being wet.

Work has been continued on the application of residue protection to the management of Class IV lands, or those that have been badly damaged by erosion and that cannot be farmed without special treatment. Some of this work is being conducted on an area of badly eroded land in Webster county in south central Nebraska.

In starting a program to improve this land, use has been made of legumes, particularly biennial sweetclover. This crop has been grown into its second year until the blossoming stage. At this time, about the last week in June, it is mowed and allowed to lie on the ground. If it is to be followed by grass seeding, the sweetclover when dry may be broken with a treader. The land can then be tilled through the clover residue with a subsurface tiller. A mixture of bromegrass and alfalfa is then seeded through the residue by means of a broadcast seeder, and covered by means of a treader. The sweetclover serves a double purpose; it supplies nitrate in abundance for the use of the grass crop, and it protects the soil against erosion until the grass is advanced to a stage where it will protect the land. The importance of this procedure is well emphasized by data of the 1947 season.

Yield per acre of crop on eroded soils in Webster county, Nebraska, 1947.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Cropping system</th>
<th>Seedbed preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plowed</td>
</tr>
<tr>
<td>Wheat</td>
<td>Fallow, wheat</td>
<td>25.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>Following oats</td>
<td>15.4</td>
</tr>
<tr>
<td>Wheat</td>
<td>Sweetclover 2 years, oats, wheat</td>
<td>40.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>Sweetclover 2 years, wheat</td>
<td>36.1</td>
</tr>
<tr>
<td>Corn</td>
<td>Sweetclover 2 years, wheat, corn</td>
<td>15.2</td>
</tr>
<tr>
<td>Corn</td>
<td>Sweetclover 1 year, corn</td>
<td>19.5</td>
</tr>
<tr>
<td>Corn</td>
<td>No legume, oats, wheat, corn</td>
<td>8.6</td>
</tr>
</tbody>
</table>

1 Difference due largely to volunteer sweetclover.

Where wheat follows sweetclover, the same procedure is followed, and wheat is seeded through a protective covering of residue. Or, if spring crops are used, the sweetclover may be harvested for seed and the residue left on the land.

On a farm in northern Gage county, severely eroded areas where raw subsoil was exposed were smoothed out with a grader. The land was then seeded to sweetclover and an excellent stand and growth obtained during the first and second years. The use of other legumes and the effect of the nitrogenous fertilizers is also being tested on this land. Terracing, contouring, grassed waterways, and other methods are being used here in an effort to obtain a high degree of erosion control and rejuvenation of these eroded soils.

Work has been started on some of the sandy soils of the state, in an attempt to reduce wind erosion by means of stubble mulch. In order to provide a supply of available nitrogen in this soil and also protect it against blowing, several legumes are being tested. Among these are winter vetch, partridge peas, trailing beans, lespedeza, and both annual and biennial sweetclover. On the Agronomy Farm, 349 pounds of partridge pea seed per acre was produced. This legume is being grown with small grain for soil improvement.

F. L. Duley, J. C. Russel.
Central Nebraska Watershed Project

A project for studying the effect of different farming practices on run-off from different sized watersheds is being conducted in the northern part of Webster county. This is a cooperative project with the Division of Research of the U. S. Soil Conservation Service. Comparisons are being made between the runoff from a 480-acre watershed in ordinary farm practices and a similar watershed where a program of soil and water conservation practices has been started. This information should be of much value in connection with the development of flood control programs. Sod crops and small grain crops have given much less runoff than corn land. Heavily grazed pasture land has lost about three times as much water as moderately grassed land. Tests are being made on different methods of renovating native pastures. Checks will be made on the effect of such treatments on the yield of grass and also on the amount of runoff.

J. A. Allis.

Soil Microbiology and Crop Residue Management

Light reflection from stubble mulch. When a soil is covered with straw mulch, some of the sunlight is reflected by the straw. This reduces the light reaching the soil, and therefore the temperature of a mulched soil is likely to be lower during daytime than a bare soil.

The soil mulched with bright straw reflected the most light and warmed the least. When bright straw was used that completely covered a dark surface soil, more than twice as much light was reflected from the mulched as from the plowed land.

Nitrate production on sweetclover land as influenced by stubble mulching. The development of nitrates in soil with sweetclover residues on the surface and cultivated by subsurface tillage was compared with nitrate

![Bar chart](image-url)
production under conventional tillage where the sweetclover residues were plowed under. The investigation was conducted on field plots at Lincoln during the period 1941–1947. The land was in first- and second-year corn after both first- and second-year sweetclover. Sampling for nitrates was done to a depth of 6 feet.

The mean available nitrogen for the six-year period in the plowed plots was about 7 per cent higher than in the subtilled plots. In the 6-foot depth the mean was 115.9 pounds of available nitrogen for the corn on the subtilled land compared with 124.5 pounds for corn on the plowed land.

The mean available nitrogen for a five-year period in first-year corn after second-year sweetclover to a depth of 6 feet was 142.9 pounds where subtilage was practiced and 158.1 pounds where the land was plowed. In either case, there was a good supply of available nitrogen for use by the crop.

Nitrate determinations in three different years in corn land about November 1, after the corn was mature, showed a higher available nitrogen content on the subtilled land than on the plowed land. The amounts of available nitrogen produced were large in every test and potentially sufficient to produce large yields of corn or other crops.

That the nitrification process following the growing of sweetclover is apparently slower under the subsurface tillage system than under the plowing system is to be regarded as a desirable circumstance in regions of limited rainfall. On the other hand, the high nitrate levels that can be obtained under subsurface tillage through the growing of sweetclover are also desirable in areas of depleted soil where a residue cover is important for erosion control.

**Microbial populations with stubble mulch.** Determinations were made on the number of soil organisms of various kinds in soil treated in different ways. Where mulches were left on the surface and the soil worked with a subsurface tiller, the surface inch showed an increase in the number of soil organisms. Fungi were especially high in this layer where the residue was from sweetclover, compared with the depth below the surface inch.

The mean densities of microbial populations within the plow-depth layer of soils in which residues were subtilled and plowed are shown in the following table.

<table>
<thead>
<tr>
<th>Sample depth (inches)</th>
<th>Subtilled</th>
<th>Plowed</th>
<th>Mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fungi in thousands per gram of soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–1</td>
<td>231.68</td>
<td>164.17</td>
<td>66.91</td>
</tr>
<tr>
<td>1–6</td>
<td>226.83</td>
<td>225.67</td>
<td>1.16</td>
</tr>
<tr>
<td>Bacteria plus actinomycetes in millions per gram of soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–1</td>
<td>36.57</td>
<td>20.89</td>
<td>15.68</td>
</tr>
<tr>
<td>1–6</td>
<td>29.70</td>
<td>29.11</td>
<td>0.59</td>
</tr>
</tbody>
</table>

1 Significant at the 1 per cent level.

It has also been shown that the soil structure in the surface layer is more stable where the mulch has been left on the surface instead of being plowed under. This may be due largely to the effect of fungi mycelium and excretionary products in stabilizing the soil aggregates.
Influence of some microbial groups on stabilizing soil structure against falling water drops. Laboratory tests were made to determine the effectiveness of different microbial groups in increasing the stability of lumps of Peorian loess against the action of falling water drops.

The order of decreasing effectiveness of different microbial groups for soil lump stabilization against the beating action of water drops was (a) fungi, (b) Actinomycetes, (c) certain bacteria, (d) yeasts, and (e) the majority of bacteria used.

The presence of competing organisms of low stabilizing ability reduced the effectiveness of microbial groups with high stabilizing effects.

Source of energy material for the growth of microorganisms is important in soil structure stabilization. Crop residues did not give as quick or as effective structure stabilization as did soluble sugars which furnish readily available sources of energy for the growth of microorganisms.

Work on this project is in cooperation with the U. S. Department of Agriculture, Soil Conservation Service-Research and has been conducted by T. M. McCalla in collaboration with F. L. Duley, T. H. Goodding, R. C. Dawson, and J. C. Russel.

T. M. McCalla.

Fertilizers for Bromegrass

Two experiments were conducted on fertilization of bromegrass on the Agronomy Farm at Lincoln. In one of these a study was made of the rate of nitrogen application alone and in combination with phosphorus and potash. The other experiment was designed to study the effect on the seed yield of the time of applying nitrogen fertilizer. Uniform plots were fertilized, respectively, on April 10, 20 and 30, and on May 10 at the rate of 60 pounds of nitrogen per acre.

Results of these tests confirmed observations made in earlier but less complete studies. Sixty pounds of nitrogen proved optimum for seed production, increasing the yield from 197 to 320 pounds of seed per acre. The rates of 120 and 180 pounds gave yields of 298 and 331 pounds, which are not significantly different from that of the 60-pound rate. Bromegrass on the plots receiving 45 pounds P₂O₅ and 50 pounds K₂O in addition to 120 pounds of nitrogen yielded 318 pounds of seed per acre, which is almost identical with the yield from 60 pounds of nitrogen alone. A combination of 120 pounds of nitrogen and 45 pounds P₂O₅ was no better than 60 pounds of nitrogen alone.

Early spring fertilization with nitrogen proved distinctly advantageous, the highest yield of seed being obtained from the April 10 application. A gradual decrease in yield resulted from delay, May 20 proving to be excessively late.

On June 6, the grass from a portion of the plots was harvested for forage. Although 60 pounds of nitrogen per acre was the optimum rate for seed production, 120 pounds was optimum for forage. Whereas 60 pounds increased the forage yield about 1,000 pounds per acre, 120 pounds gave 2,700 pounds more forage. Higher amounts of nitrogen and combinations with phosphorus or with phosphorus and potash did not increase the yield of forage significantly compared with 120 pounds of nitrogen alone. An analysis of the forage on June 6 showed that the largest recovery of the nitrogen added in the form of ammonium nitrate was from the 120-pound rate. This amounted to approximately 63 per cent for the 120-pound application compared with 45 per cent recovery for the 60-pound rate.

J. R. McHenry.
**Fertilizers for Small Grains**

Fertilizer experiments with winter wheat were conducted on six fields in eastern and south central Nebraska. In those experiments an application of superphosphate alone or in combination with a nitrogen fertilizer had no significant effect upon the yield of wheat. An application of a nitrogen fertilizer early in the spring increased the yield of wheat significantly in four of the six experiments, the increases ranging from 4.3 to 16.8 bushels per acre for an application of 40 pounds of nitrogen in the form of ammonium nitrate. No benefit resulted from the application of potassium in the fertilizer.

Four fertilizer experiments with oats were conducted in eastern Nebraska. In one experiment on Crofton silt loam in northeastern Nebraska, an application of phosphate fertilizer alone increased the yield of oats significantly. An application of nitrogen fertilizer alone increased the yield significantly in two of the four experiments. In general, a fertilizer containing both nitrogen and phosphorus was more effective than either a nitrogen fertilizer or a phosphorus fertilizer applied alone.

**J. J. Hanway, J. W. Fitts.**

**Fertilizers for Potatoes**

Seven fertilizer experiments with potatoes were conducted in the North Platte and Lodgepole valleys on irrigated lands in cooperation with the Horticulture Department and the Potato Development Division. Five of the experiments were conducted on Tripp very fine sandy loam and two on Mitchell silt loam. Potatoes followed sweetclover or alfalfa in all but one field and in that field a large application of manure was made prior to the potato crop. The fertilizers were applied a short time after planting with a special fertilizer attachment which placed the fertilizer on one side of the row about 2 inches to the side and at the level of the bottom of the seed piece. The yields of potatoes without fertilizer ranged from 148 to 425 bushels per acre. Where the yields were greater than 350 bushels per acre without fertilizer, no increases in yield were obtained from the use of fertilizer. Increases in yield from the use of fertilizer were obtained in the field where the yields on the unfertilized plots were less than 350 bushels per acre. The increases were due to applications of a nitrogen fertilizer (ammonium nitrate) alone or to a combination of nitrogen and phosphorus (superphosphate 43 per cent P₂O₅) fertilizer. An application of a potassium fertilizer in addition to nitrogen and phosphorus fertilizers had no effect on the yield. The quality of the No. 1 potatoes as measured by specific gravity determinations varied widely from field to field, but there was very little effect of the fertilizer application on the specific gravity of the potatoes.

**H. F. Rhoades, F. V. Pumphrey, H. O. Werner.**

**Fertilizers for Sugar Beets**

Fertilizer experiments with sugar beets were conducted cooperatively by the Great Western Sugar Company and the Agricultural Experiment Stations of Colorado, Wyoming, Montana, and Nebraska. Fourteen experiments were conducted in Nebraska. The results obtained from the use of commercial fertilizers in these 14 experiments appeared to be influenced by soil type and by the cropping, cultural, and fertilization practices followed. It is interesting to note that manure had not been applied by farmers in 1947 to those seven fields in which marked response of the
sugar beets to commercial fertilizer applications was obtained. On the other hand, of the seven fields where small or no increases in yield were obtained, five had been manured in 1947.

An application of a nitrogen fertilizer alone increased the yield of sugar beets more than 1 ton per acre in five of the experiments. The percentage sugar in the sugar beets was decreased in most of the experiments where the nitrogen fertilizer had little or no effect upon yields. As a result of the decrease in percentage of sugar due to the nitrogen fertilizer, the production of sugar per acre was increased markedly in only four experiments and was decreased noticeably in five experiments. These results suggest that nitrogen fertilizers should not be used indiscriminately since an actual decrease in sugar production may result from the use of a nitrogen fertilizer where it is not needed.

The time of applying a nitrogen fertilizer was studied by comparing applications at planting time, applications following blocking and thinning, and split applications at planting and following blocking and thinning. Results obtained were so variable that no conclusions can be made concerning the proper time for applying nitrogen fertilizers.

Applications of a phosphate fertilizer alone increased the yields more than 1 ton per acre in seven experiments. Sugar percentages were not influenced noticeably either in the fields where marked responses were obtained from the use of phosphate fertilizer alone or in fields where no response was obtained from its use.

Combinations of nitrogen and phosphorus fertilizers and nitrogen, phosphorus, and potassium fertilizers increased the yields of sugar beets in nine experiments over that obtained where either a phosphate or a nitrogen fertilizer was applied alone. However, sugar production was increased noticeably in only four experiments. A definite response of sugar beets to a potassium fertilizer was obtained in one experiment.

H. F. Rhoades, F. V. Pumphrey, J. J. Hanway.

Nitrogen and Phosphorus in the Soil and Sugar Production of Beets

Field experiments were conducted at three different locations in an area of western Nebraska where sugar beets of low sugar percentage are produced. It was the purpose of the experiments to obtain some information on the role of available nitrogen and phosphorus in the soil upon sugar production. The available nitrogen supply in the soil was increased during the growing season by applications of 80 and 240 pounds of nitrogen as ammonium nitrate and was decreased late in the season by applying an easily decomposable carbohydrate. The available phosphate supply was increased by applications of 100 and 400 pounds of P₂O₅ (applied as superphosphate 43 per cent P₂O₅ and phosphoric acid) alone and in combination with the two rates of nitrogen fertilizer. Samples of sugar beets were taken three times prior to harvest and at harvest time to determine the influence of the different treatments on sugar production throughout the season. Yields from the untreated plots of the three fields at harvest time ranged from 13.4 to 19.5 tons per acre and the sugar contents ranged from 12.4 to 13.3 per cent.

Sugar content of sugar beets was influenced markedly by the level of available nitrogen in the soil. The effect of an application of 80 pounds nitrogen ranged from a small increase in percentage sugar of sugar beets in one field to decreases of 0.5 and 1.1 per cent in the other two fields. An application of 240 pounds nitrogen decreased the sugar content of sugar beets from 1.1 to 1.6 per cent in all three fields. An application of a
readily decomposable carbohydrate late in the season had no effect upon sugar content in one field but increased the sugar content by 0.7 and 0.9 per cent in the other two fields.

In contrast to applications of available nitrogen, applications of available phosphorus to the soil had a tendency to increase the sugar content of sugar beets. Applications of 100 and 400 pounds of available \( P_2O_5 \) had no effect on the sugar content of sugar beets in one field but increased the sugar content from 0.5 to 0.9 per cent in the other two fields. Where combinations of the different rates of available nitrogen and phosphorus were applied, the effect of the available nitrogen to decrease sugar percentage prevailed.

On the basis of the results obtained during 1947, it seems likely that the production of sugar beets of low sugar percentage in certain areas of western Nebraska may be due in part to either a high level of available nitrogen or to a low level of available phosphorus in the soil. However, it does appear that some factor or factors other than available nitrogen and phosphorus in the soil limit sugar production in those areas.

**F. V. Pumphrey, H. F. Rhoades, Paul Ehlers.**

**Nature of the Clay in the Holdrege, Keith, and Dawes Soils**

Chemical and physical studies were conducted on soil profiles of Holdrege silt loam, Keith silt loam, and Dawes silt loam. In addition, differential thermal analyses were made on the coarse clay (2.0 to 0.2 microns) and the fine clay (less than 0.2 micron) of selected horizons of these three soils from central and western Nebraska. The results obtained indicate that accumulation of clay in the B horizons of these soils has occurred even though the exchange complex has been dominated by calcium during the time of soil development. In all three soils the ratio of fine clay to coarse clay is greatest in those horizons of greater clay accumulation. The fine clay appears to be dominated by the montmorillonite type of clay mineral, whereas the coarse clay is dominated by an illite type of clay mineral. The nature of the clay fraction has apparently not been materially changed by the processes of soil development although much of the fine clay appears to have been formed during the time of soil development since in all the weathered horizons it greatly exceeds the amount in the unweathered horizons.

**H. F. Rhoades.**
Improvement of Small Grains

The crop season of 1947 was favorable in most respects for development of the various small grains, and for studying the disease reaction of varieties and selections. Uncommonly cool, wet weather prevailed in the spring. This promoted tillering and growth of the plants but also favored the development of several diseases. Low temperatures at time of flowering resulted in sterility of florets in some areas of the state but was not an important depressing factor in the yield of small grains at any of the stations. At Lincoln there were sharp differences among the varieties in reaction to several diseases. This afforded an opportunity to make considerable progress toward achieving greater disease resistance in varieties for possible release in future years. In the varietal tests the winter grains and spring grains were planted, respectively, after oats and corn in the rotation except at Alliance where all were planted on fallow. The small grain work is cooperative with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture.

Winter wheat. At Lincoln in 1947 the highest yielding group of named varieties included Pawnee, Comanche, and Red Chief. Yields of Cheyenne were depressed by stem and leaf rust and Nebred mainly by leaf rust. Nebraska 60, Turkey, and Kharkof made low yields of about three-fourths as much grain as Pawnee. For the nine-year period ending with 1947, Pawnee averaged 35 bushels per acre, Comanche 28.8, Cheyenne 28.4, Nebred 27.6, Tenmarq 26.6, Blackhull 25.1, and Turkey 25 bushels.

Kharkof and Cheyenne were the highest yielding named varieties at Alliance in 1947. In the last seven crop years Cheyenne averaged 30.9 bushels per acre, Kharkof 28.7, Nebred 28.6, Nebraska 60 28.3, Comanche 27.9, Pawnee 27.5, Blackhull 26.5, and Tenmarq 25.5 bushels. In recent years several new but unnamed selections have been promising in yield and certain other respects in station tests at Lincoln, North Platte, and Alliance.

Breeding for resistance to smut, stem rust, and lodging in winter hardy varieties is making good progress.

Spring wheat. Spring wheat yields at Lincoln were above average this year. Henry, Mindum, and Kearney were highest with yields above 26 bushels to the acre and with test weights from 57 to 61.5 pounds per bushel. These same varieties also have the highest four-year average yields at Lincoln.

At the Box Butte Experiment Farm, Mindum, Vernum, and Stewart, among durum varieties, and Henry, Mida, Cadet, and several other unnamed varieties of common wheat exceeded a yield of 32 bushels per acre in 1947. Except for Cadet, these varieties tested over 59 pounds per bushel. In contrast, the yield of Marquis was 21.1 bushels per acre with a test weight of 56.6 pounds. Stem rust was severe on Kearney, Ceres, Reward, and Marquis. The last four crop years show that Mida, Rival, Pilot, Cadet, and Thatcher, in the order named, have the highest average yields. Only six varieties have been compared as long as 14 years; these, in order of declining average yield, are Thatcher, Mindum, Kearney, Ceres, Reward, Marquis.
Oats. There were two significant developments in oats in 1947, namely, a new variety called Nemaha (C. I. 4301) was named and recommended for farm production, and Victoria blight or root rot disease caused widespread lodging and reduced yield in susceptible varieties.

Nemaha is an early maturing oat having resistance to Victoria blight and the common races of rust and smut. It has stiff straw and has produced high yields of plump seed. Approximately 2,500 bushels are available for distribution by the Agronomy Department to growers in eastern Nebraska extending westward as far as Boyd, Buffalo, and Franklin counties.

Varieties susceptible to Victoria blight include Cedar, Tama, Boone, Osage, Neosho, Ventura, and several others. Resistant varieties are Clinton, Nemaha, Marion, Otoe, Fulton, Brunker, and many others. The disease attacked susceptible oats, especially in eastern Nebraska, but was of no importance in the western part of the state this year.

In 1947 in the variety test at Lincoln, Clinton, Nemaha, Mindo, and Bonda produced over 100 bushels per acre with a test weight per bushel above 36 pounds. They had no rust, no blight, and did not lodge. In contrast, blight-resistant but rust-susceptible varieties yielded half to two-thirds as much grain with a poorer test. Blight began to show on Cedar, Osage, and other blight-susceptible but rust-resistant varieties in mid-May and by harvest time severe lodging had occurred. Even so, the blighted varieties exceeded the rusted varieties in the yield tests harvested with a combine. During the last three years Clinton has had the highest average yield at this station.

Ventura and Osage were highest in yield at Alliance in 1947. For the last two crop years Ventura, Fulton, Neosho, and Osage head the list. Other named varieties with good averages of two or more years are Trojan, Kanota, and Cedar.
Barley. Weather conditions during the growing season favored the later maturing barley varieties in eastern Nebraska. In the field plots at Lincoln, Mars and Wisconsin 38 gave high yields, whereas they and others of similar type usually perform rather poorly at Lincoln. Feebar and Plains, two new varieties now being distributed in South Dakota, yielded 66 and 65.9 bushels per acre, respectively, compared with 39.9 bushels for the standard Spartan. These varieties have stiff straw and are resistant to stem rust. Feebar has a good record in eastern Nebraska but over the remainder of the state Plains seems to be better adapted. Although these two South Dakota varieties look promising for Nebraska, in most tests they have been exceeded in yield by Velvon 11 and Ezond, two varieties now being recommended. Velvon 11, Trebi, and Club Mariout gave relatively poor yields this year at Lincoln because of lodging at harvest time. Spartan has the highest average yield of the varieties tested for the period since 1930, but in the more recent years it has been inferior to most other varieties tested.

High yields were obtained from several malting types tested near Wayne. At present none of the commercial varieties that are especially desired for malting are recommended for production in Nebraska. At Alliance all varieties except Spartan averaged over 50 bushels per acre. Trebi yielded 75.6, Gem 73.9, Plains 71.3, and Frontier 63.8 bushels per acre. Frontier is being distributed in Wyoming for production under irrigation. Limited tests in Nebraska indicate that it may be suited for the western irrigated sections of this state.

There was a wide range in the survival of the winter barley varieties tested at Lincoln and North Platte. Those now recommended, Reno and Ward, had an average winter survival of about 85 per cent while a few Nebraska selections suffered but little winter injury. Ward has a higher average yield than Reno in the tests conducted in the state for the past three years.

L. P. Reitz, O. J. Webster, T. A. Kiesselbach.

Sorghum Improvement

Weather conditions in 1947 were rather favorable for sorghum production over most of the state. Precipitation was above normal during the spring months and provided an abundance of subsoil moisture. This permitted normal growth during the hot, dry period which prevailed from the middle of July to the middle of September. Temperatures of 100 degrees or above were recorded on 4 days during July, 19 during August, and 3 during September at the Agronomy Farm near Lincoln.

The sorghum work was extended this year to include a testing and breeding project near Hastings in order to supplement the work at Lincoln, North Platte, and Alliance. This permits sorghum improvement work in the part of the state best adapted to grain sorghums.

The sorghum improvement work is in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Grain varieties. Grain yields of most of the varieties grown at Lincoln ranged from 40 to 60 bushels per acre. Corn averaged 23 bushels. The yields of the commercially grown grain varieties were: Early Hegari 59.2, Bonita 56.3, Early Kalo 50.9, Midland 49.6, Day 49.2, Martin 45.1, and Coes 41.8 bushels per acre. Martin and Midland are the most extensively grown grain sorghums in the state. Usually Midland will give a higher yield than Martin but good stands are more difficult to obtain with it.
At Hastings the highest yields were made by two Double-Dwarf Sooner selections with 73.6 and 71.2 bushels per acre. These two new selections appear to be well adapted to those parts of the southern half of the state where chinch bugs do not prevail. There is some question as to whether they will stand as well as Midland or Martin for combine harvesting. In this test Midland and Martin yielded 56.4 and 49.9 bushels per acre, respectively.

Forage varieties. Grain yields of ten forage varieties tested at Lincoln ranged from 27.3 bushels per acre for Waxy Atlas (H. C. 42-20) to 44.1 bushels for Norkan. Norkan averaged 48.8 bushels per acre for the tests conducted at Lincoln, Hastings, and North Platte. This was the highest average yield for the three localities. Norkan not only gives good grain yields but also good forage yields. Axtell, a new forage variety grown by Nebraska farmers this year for the first time, continues to rank among the highest yielding varieties. Compared with Atlas, it is a few days earlier in heading and usually yields slightly less forage, whereas its grain yield is higher. On a 70 per cent moisture basis the forage yields at Lincoln ranged from 9.9 tons for Black Amber to 14.9 tons for Kansas Orange.

Sudan grass. Yield tests were continued with various strains of Sudan grass. At Lincoln, Texas Sweet surpassed Wheeler by 14 per cent in yield of forage. Both yielded approximately 875 pounds of seed per acre. A breeding project is now in progress to develop a variety of Sudan grass similar to Texas Sweet but which will be as low in prussic acid as Wisconsin selection 106.

Breeding. Several Nebraska selections of grain sorghum have good yielding potentiality and are also suited for combine harvesting. A few of these have been tested for the past three years and have yielded as well as Early Kalo. Breeding work is in progress to develop white-seeded combine varieties which will be better suited for starch processing than are the red and yellow varieties now being grown.

O. J. Webster.

Corn Improvement

The 1947 corn growing season was unusual in many important respects. An excessively wet May and June made timely planting difficult, if not impossible, in many cases. This was followed by an exceedingly hot, dry summer which resulted in poor plant development and poorly filled ears. Finally a cold, wet fall delayed harvest considerably. The commercial production of hybrid seed for 1948 planting met with variable success in different areas of the state. In general, the poor pollinations brought about by excessive heat and drouth resulted in a high percentage of the round grades of seed which are not as acceptable to the farmer as are the flat grades.

The Experiment Station program involved the testing of corn hybrids at eight locations in 43 different experiments. These were as follows: 15 tests of double-cross hybrids, 11 single-cross tests, four top-cross tests of new lines, and 13 experiments involving special problems.

At the Alliance station the local open-pollinated strain of Dawes No. 2 again gave the best yield of quality grain. An early hybrid, Nebraska 301, yielded as much grain per acre, 20 bushels, but is somewhat too late ripening for that area. An attempt is under way to adapt this hybrid by using earlier maturing strains of the parental lines involved. The lines have been improved through the backcross method. They will be tested in top crosses next year.
The stands of experimental plots at the North Platte Substation were somewhat erratic, due primarily to the effects of a killing frost late in May when the plants were 4 to 6 inches tall. Yields, however, ranged from 92 to 120 bushels per acre under irrigation, and from 37 to 55 bushels on dryland in the corn performance tests.

At Lincoln, the bottomland tests were damaged considerably by standing water early in June. This resulted in a general yellowing and stunted condition and very irregular plant growth. It became necessary to discard some tests completely. Those not damaged excessively were harvested. Yields ranged from 15 bushels to 93 bushels per acre in tests located in different parts of the Experiment Station farm.

As an average for two dryland and three irrigated Experiment Station tests, Nebraska 501 was the highest yielding hybrid with 91.1 bushels per acre. Yields of other outstanding certified hybrids were: Nebraska 502, 83.3 bushels; Nebraska 601, 82.5 bushels; U. S. 13, 79.8 bushels; and Ohio C92, 77.6 bushels. Of interest also was the performance of a new experimental hybrid, Nebraska, 701, which is similar to U. S. 13 with the exception of one line which has been improved through a backcrossing program. In paired plot comparisons in these tests Nebraska 701 yielded 88.5 bushels per acre compared with 79.8 bushels for U. S. 13. This is an increase of 8.7 bushels per acre. In addition, Nebraska 701 had fewer dropped ears and showed some improvement in standing ability.

**Corn rootworm studies.** A rather extensive planting of single-cross hybrids and top crosses was made north of Lexington in a field which had been heavily infested with rootworms in 1946. While lodging of the plants was not very pronounced, damage by this pest was in evidence by way of very poor plant development and low yields. A few differences in resistance to rootworm damage were noted among the lines tested. Two types of heritable resistance in corn plants were indicated by these tests: (1) a tendency to grow new roots in replacement of those that have been injured, and (2) the occurrence of a substance within the plant tissue that is repulsive to the rootworms. The possibility of incorporating such resistance in selected lines will be investigated further. Since rootworm damage has been assuming rather serious proportions in some sections of the state where corn is grown for several consecutive years on the same land, a change of crop rotation is recommended which reduces the duration in corn.

**Production of new hybrids.** Small quantities of seed of two new Experiment Station white hybrids and four new yellow hybrids were produced this year by the Nebraska Certified Hybrid Seed Corn Producers Association for strip planting in 1948. Seed of these new hybrids will be distributed to interested growers at a nominal charge. Several of them may be considered for certification next year.

**Commercial grades of seed corn.** In a comparative test of commercial grades of hybrid seed corn, the following two-year average yields of grain (15 per cent moisture) per acre were obtained: Large round, 38.9 bushels; large flat, 39.8 bushels; medium round, 39.6 bushels; medium flat, 38.9 bushels; small round, 38.6 bushels; and small flat, 38.6 bushels per acre. An extremely small grade of round tip seed that was discarded in the grading yielded 37.4 bushels. There seems to be little significant difference in yield between standard commercial grades due to shape and size. In the case of extremely small seed, under conditions of cold wet soil or extremely early planting, the stand and accordingly the yield has been somewhat inferior.
Quantitatively inherited characters in maize. The frequency distributions of certain quantitatively inherited characters in \( F_2 \) populations of maize were determined for the two single crosses, \( Wf9 \times 30A \) and \( Wf9 \times 38-11 \). The characters studied were days from planting to pollen shedding, plant height, stalk circumference, ear length, ear diameter, number of kernel rows, and ear weight. An attempt was made to interpret these \( F_2 \) distributions with regard to the nature of the action of the genes involved.

The general trends in range and shape of the observed \( F_2 \) distributions of all these characters seem to be in general agreement with the expected \( F_2 \) distribution of a hypothetical quantitative character in which it is assumed that 20 genes are operating, acting additively, and showing complete dominance.

J. H. Lonnquist, T. A. Kieselbach.

Inducing Hereditary Changes in Corn by Neutron Irradiation of Pollen

Work was undertaken in 1947 to determine the effect of neutron irradiation on the rate of genetic changes in corn. One phase of this study consisted of determining the mutation rate expressed in \( F_1 \) endosperm by pollinating untreated plants of one genetic stock with pollen of another stock, the tassels of which had been irradiated with neutrons for various periods of time.

The two genetic stocks were planted at Lincoln and at St. Paul, Minn., for this study. These stocks carry three endosperm-marker genes which were recessive in the stock used as ear parent and dominant in that used as tassel parent. The genes were anthocyanin \(-1 \) \((a)\) which gives colorless aleurone—colored in the dominant condition; red aleurone \(-1 \) \((pr)\) which gives red aleurone in the presence of \(A\)—purple in the dominant condition; and sugary endosperm \(-1 \) \((su)\)—starchy endosperm in the dominant condition.

It is known that kernels resulting from a cross of an \( a \ pr \ su \) stock by an \( A \ Pr \ Su \) stock have a purple-colored aleurone and a starchy endosperm, providing there have been no changes at the \(A\), \(Pr\), and \(Su\) loci of the male gametes. A loss of the \(Su\) gene results in sugary endosperm, a loss of the \(Pr\) gene in the presence of \(A\) in red aleurone, and the loss of \(A\) in a colorless aleurone. A loss of \(Pr\) when \(A\) is also lost cannot be detected.

When silks of the growing plants were receptive, entire tassels were removed from the dominant \( A \ Pr \ Su \) plants and sent by air to the Argonne National Laboratory at Chicago, Ill. These tassels were placed in the thermal-neutron column of the heavy water pile, as close to the pile proper as possible, for irradiation. The radiation consisted almost entirely of slow neutrons. The flux was \(7 \times 10^{19}\) neutrons per square centimeter per second at the position of the tassels. Various dosages were secured by irradiating tassels for periods of 1, 2, 4, 8, and 16 minutes, respectively. Upon completion of the neutron irradiations at the pile, the tassels were returned to Lincoln for pollinating the recessive \( a \ pr \ su \) plants used as female testers.

At maturity the outcrossed kernels on the \( a \ pr \ su \) plants were classified with respect to color of aleurone, texture of endosperm, and over-all development of kernel.

The results of this study are summarized as follows:

Neutron irradiation of corn pollen resulted in a reduction of seed-set at the 8-minute and 16-minute exposures.
There was an increase in number of mutations involving the A, Pr, and Su loci as determined by examining the endosperms of F₁ kernels. The effect was greatest for the A locus, where it amounted to 25 per cent at the 16-minute exposure in contrast to the control where the rate was 0.1 per cent.

The percentage of defective kernels increased consistently with increase in duration of neutron irradiation and amounted to over 75 per cent with the 16-minute dosage compared with less than 1 per cent for the untreated material.

E. F. Frolik, Rosalind Morris.

Physiologic Studies With Corn

The carbon accumulation of plants is a quantitative measure of the products of photosynthesis, minus the portion lost by respiration in the release of energy. More than 90 per cent of the dry substance of corn plants originates in the leaves through photosynthesis, and carbon, which is an integral part of all organic matter, comprises approximately 44 per cent thereof. A number of experiments have been completed which indicate that the rate of carbon accumulation by the growing corn plant varies inversely with the concentration of water-soluble carbohydrates in the stalk and leaves. It appears that this relationship needs to be considered as a yield factor when breeding for specific composition of the grain.

Carbon accumulation and crop yield in relation to grain composition. The influence of chemical composition upon the yield of grain has been studied by special technic with the three primary endosperm types—starchy (dent), waxy, and sweet. Genetically, the sweet and waxy are recessive to starchy. The most striking chemical difference between these endosperm types is in the percentage of water-soluble carbohydrates within their grain—the types ranging from low to high in the order last listed above. Comparative tests of productive hybrids of each of these three endosperm types having similar maturity periods gave the following relative yields of grain per acre: dent (starchy) 100 per cent, waxy 94 per cent, and sweet 43 per cent. Outcrossing waxy and sweet by starchy (dent), thereby converting their endosperms to starchy through xenia effects, increased their respective grain yields by 3.3 per cent and 15 per cent. A negative correlation between percentage of water-soluble carbohydrates in the grain and the yield of grain per acre is apparent. Accompanying increases in total fodder yield were 0.7 per cent and 10 per cent for waxy and sweet corn, respectively, whereas corresponding reductions in the stover-grain ratio were 6 per cent and 9 per cent. It is concluded that a heritable enzyme-complex which accelerates precipitation of the carbohydrates within the grain in the form of insoluble starch; stimulates translocation from the stalk and leaves and this in turn stimulates carbon accumulation. The outcome is increased grain and fodder yield per plant and per acre.

A five-year comparison of waxy and dent hybrids that are essentially isogenic except for the waxy gene, indicates that waxy hybrids, by virtue of a higher percentage of water-soluble carbohydrates in their grain, are destined to yield approximately 5 per cent less grain per acre than their starchy counterparts.

Effect of non-fruiting on carbon accumulation. In reverse of the preceding experiment, the concentration of photosynthates within the stalk
and leaves was increased by removal of the storage organ—the ear—before fertilization, thereby eliminating the opportunity for translocation to the grain. Under field conditions, this treatment decreased the fodder or total mature plant yield of dent corn by 27 per cent, yet increased the yield of stover, consisting of stalk and leaves, by 59 per cent. This suggests that prevention of grain development results in far greater storage of photosynthates within the stalk and leaves, but at the same time materially reduces the total net photosynthetic output, even though the leaf area remains constant.

In a parallel experiment with the plants grown in large soil-filled cans, it was possible to determine the extent to which the roots may substitute for the ear as a storage organ. The roots were carefully washed from the soil, dried and weighed along with the rest of the plant. Whereas the root-weight increased somewhat for the non-fruiting plants, this increase was clearly inadequate to offset the loss of grain. It is apparent that carbon accumulation was materially reduced through grain prevention.

**Effect of partial defoliation on carbon accumulation.** A midseason reduction of 50 per cent in the leaf area of plants by removal of half of each leaf blade along one margin of the midrib, curtailed the further increment of dry matter by only 22 per cent of normal. Dry-matter elaboration thus became 56 per cent more efficient per unit of remaining leaf area. This is ascribed hypothetically to an acceleration of carbon accumulation induced by the more intense translocation from the limited remaining leaf area. It serves as a further illustration that the rate of carbon accumulation per unit leaf area becomes modified by internal conditions within the plant.

**T. A. Kiesselbach.**

**Improvement and Testing of Special Chemurgic Crops**

During the past year experimental testing and breeding of special chemurgic crops was confined to the Agricultural Experiment Station at Lincoln, the Scottsbluff Substation, the Box Butte Experiment Farm at Alliance, and the Stinburg farm north of Alliance. Experimental plantings at the Scottsbluff Substation were ruined by a hail storm which occurred the latter part of June. Emphasis during the past several years has been placed on improvement of crops through breeding rather than production tests at many locations. Commercial markets were established during the past year for safflower, castor bean, and sunflower seed.

**Sesame.** The experimental work with sesame was confined entirely to the Lincoln area. Unfavorable weather during late May and June seriously affected stands and made it necessary to replant some plots twice. This condition, however, was not without its advantages as it was possible to select a few lines which did produce good stands in all replications at the first date of planting.

The primary objective of the breeding program is to develop early ripening lines with indehiscent capsules. This is being accomplished through crosses of indehiscent types from Venezuela which are excessively late with dehiscent types from Nebraska which are early. Seed of the F1 generation has already been obtained and the F2 population will be grown in the field in 1948. It is hoped that by this means new strains will be obtained which have all the favorable characteristics of present varieties but which have in addition capsules that remain closed when the seed has matured. Such a variety would be of considerable impor-
tance in furthering the commercial production of this crop as it could then be combined directly.

During the year, 142 different selections of sesame were grown for observation. These included lines from Arizona, Kansas, India, and Africa. A few tall but fairly early types were found which might prove more satisfactory than present varieties for mechanical harvesting since some of them are characterized by having only a single stalk rather than a number of branches. One selection made in 1946 from Venezuela seed and grown in 1947 contained plants which did not lose more than 10 per cent of their seed by shattering.

**Safflower.** The recent development of a commercial market for safflower seed will be of considerable value in the establishment of this crop in western Nebraska and in other states where it is adapted. A limited supply of seed of Nebraska 852 safflower, an introduction from the Anglo-Egyptian Sudan, has been released to Nebraska farmers for further increase in 1948. This variety is superior to Indian, the only variety now available for commercial production, in yield, oil content, and rapidity of growth early in the season. This new variety averages approximately 34 per cent oil.

![Increase field of Nebraska 852 safflower planted at the rate of 6 pounds per acre in cultivated rows 40 inches apart at the Box Butte Experiment Farm near Alliance.](image)

A highly significant negative correlation of -.81 was obtained between oil and hull content in seed from individual plants selected from the Indian varieties Ahmednager 1 and Simla. As oil content is increased, the proportion of hull content is decreased. By breeding it should be possible within several years to reduce the hull to 35 per cent of the total weight of seed, and to increase oil content to 36 or 37 per cent. In order to increase oil and reduce hull still further, crosses are now being made between plants of distinct types which contain 37 to 39 per cent oil.

**Castor beans.** Since the feasibility of commercial castor bean production in Nebraska is related to the development of a mechanical means
of harvesting, the experimental work with this crop is in close cooperation with the Department of Agricultural Engineering. Through breeding it is hoped that varieties can be developed which are not only adapted to Nebraska but which are at the same time suitable for mechanical harvesting. Two early maturing experimental varieties will be increased in 1948 for possible release next year. An average yield of approximately 1,000 pounds of seed per acre was obtained at Lincoln in 1947.

**Sunflower.** Considerable interest has developed nationally in the sunflower as a source of oil. Tests during the past several years have shown that satisfactory yields can be obtained in western Nebraska. Last year Advance, a variety of hybrid origin, averaged 1,240 pounds of seed per acre on summer fallow at Alliance. The oil content of this seed was 28.7 per cent. Because of sunflower moth infestations, it has not been possible to obtain satisfactory yields of sunflower in eastern Nebraska unless the heads are dusted with DDT.

**Other chemurgic crops.** Tests were continued with perilla, chicory, and flax. Replicated tests of four mint species were established under irrigation and on dryland. Observational plantings were made with guar, okra, and kneaf.

C. E. Claassen, E. V. Staker.

**Soybean Improvement**

The production of soybeans in Nebraska has been officially estimated at 40,000 acres in 1947. This is an increase over recent years and may be accounted for by the distribution and use of better varieties, the need for an additional rootworm resistant row crop to replace part of the corn in northeastern Nebraska, better understanding of cultural practices, and attractive prices. Because of the rather serious corn rootworm situation, more extensive planting of soybeans where suited in eastern Nebraska would be justified. The Lincoln variety distributed for farm use several years ago is held in high favor. The experiment station produced 300 bushels of the new variety, Hawkeye, in 1947 and is releasing these to farmers for further seed increase in 1948. It has given superior performance in Nebraska and other corn belt states. Hawkeye is lodge resistant, 2 inches taller than Richland, ripens at the same time as Richland but a week earlier than Lincoln, and is as high in oil content as Lincoln. It is especially recommended for the northeastern counties where Richland is now grown and Lincoln is somewhat too late ripening. As a four-year average in eight states, Hawkeye and Lincoln have yielded 3.8 bushels and 4.9 bushels more per acre than Richland. Both of these varieties have been developed and tested cooperatively by a number of states collaborating with the Regional Soybean Laboratory. The varieties included in the 1947 Nebraska tests at Lincoln and Wakefield averaged 16 bushels per acre which compares with a 32-year average yield of 15 bushels for this crop at Lincoln.

J. L. Weihsing, T. A. Kiesselbach.

**Alfalfa Improvement**

**Production and distribution of Ranger alfalfa seed.** The new variety of alfalfa, Ranger, has continued in high demand because of its favorable production and longevity of stand. Nebraska farmers, cooperating in the new foundation-seed program which was inaugurated in 1947, obtained a satisfactory crop of Ranger seed on a rather limited acreage in 1947. This will enable the much needed expansion of certified seed production, thereby bringing the variety into commercial use.
The foundation seed of Ranger that was produced in this and other states will be distributed to farmers in accordance with allocations made by a special committee appointed by the National Alfalfa Conference. This committee reports that for the first time since this variety was released there will be enough foundation seed to fill the requests from all the states participating in the program for production of foundation, registered, and certified seed. Total allocations of 17,000 pounds have been made to 14 Great Plains and western states. New acreages to be established together with old meadows should provide sufficient seed to permit distribution of Ranger alfalfa through commercial channels within the next year or two.

**Forage yields of advanced-generation synthetics.** Synthetic varieties are reconstructed by the intercrossing of a relatively small number of selected lines. In the absence of previous experience, there has been widespread interest in their comparative performance in the first, second, third and later generations. Preliminary tests have given satisfactory results from such advanced-generation seed. Of eight synthetics tested in 1947, seven yielded as well or better in the second as in the first generation.

**Polycross and single-cross alfalfa yields.** Alfalfa clones, which had shown good general combining ability on the basis of polycross progeny performance, were used in making a series of single-cross combinations. Of 18 such hybrids tested in 1947, 14 produced significantly higher forage yields than the average of Buffalo and Ranger. The average yield of the 18 hybrids was 6.51 tons of hay containing 12 per cent moisture. This was an increase of 8.3 per cent over the check varieties. The striking significance of polycross tests for evaluating the combining ability of alfalfa clones is reflected in the superior performance of those specific single-cross hybrids whose pedigrees were based thereon.

**Alfalfa improvement, a nationwide endeavor.** During the past two decades alfalfa acreages have been steadily increasing in the corn belt and in more eastern states. This has placed Nebraska and other seed-producing states in a very favored position since the eastern climate is not suitable for dependable and profitable seed production.

Most varieties of alfalfa that are commonly grown in the Great Plains and western states have proved to be highly susceptible to several alfalfa diseases which commonly reach epidemic proportions in eastern states. This presents a serious problem in that both the alfalfa acreages of the east and the growing alfalfa seed industry of the western farmer are threatened unless new varieties that are resistant to these diseases are developed soon.

Development of new strains that combine resistance to bacterial wilt, black stem, leaf spots, rust, fusarium crown rot, mildew, and other diseases, and which are also desirable agronomically and chemically, requires a nationwide cooperative breeding program. It is considered that the superior germ plasm needed for disease resistance can be obtained best in the east where natural epidemics occur. Resistant selections from there may then be sent to cooperating stations in the seed producing areas where further selection will be made for high seed and forage yields as measured through the polycross progeny. With such a program it is hoped that superior lines with good combining ability may be put into disease-resistant hybrids and synthetic varieties which are adapted from coast to coast within given latitudinal ranges.

H. O. Graumann, T. A. Kieselbach.
Adaptation and Improvement of Grasses

Yields of forage grasses. Several of the most promising perennial forage grasses and legumes are being tested at three stations in Nebraska to determine their adaptation and yield under different soil and climatic conditions with and without nitrogen fertilization. After a period of years their effects on the physical and chemical properties of the soil will be determined.

At the Box Butte Experiment Farm near Alliance, six plots of each of five cool-season grasses, one grass mixture, and alfalfa were established on dryland from seedings made April 5, 1946. Ammonium nitrate fertilizer was applied April 8, 1947, to one-half of each plot at the rate of 125 pounds (40 pounds of nitrogen) per acre. The plots were harvested July 2 and 3, 1947. The yields of cured hay per acre are shown in the following table.

Comparative hay yields of several cool-season grasses and alfalfa, with and without nitrogen fertilizer, on dryland at Alliance. Harvested July 3, 1947.

<table>
<thead>
<tr>
<th>Kind of forage</th>
<th>Tons of hay per acre a (12 per cent moisture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not fertilized</td>
</tr>
<tr>
<td>Grasses:</td>
<td></td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>1.08</td>
</tr>
<tr>
<td>Lincoln bromegrass</td>
<td>0.68</td>
</tr>
<tr>
<td>Crested wheatgrass, Standard</td>
<td>0.72</td>
</tr>
<tr>
<td>Crested wheatgrass, Fairway</td>
<td>0.51</td>
</tr>
<tr>
<td>Russian wildrye</td>
<td>0.23</td>
</tr>
<tr>
<td>Mixture (crested and western wheatgrass) b</td>
<td>0.63</td>
</tr>
<tr>
<td>Average</td>
<td>0.64</td>
</tr>
<tr>
<td>Legume:</td>
<td></td>
</tr>
<tr>
<td>Ranger alfalfa</td>
<td>1.09</td>
</tr>
</tbody>
</table>

a Averages for six replicate plots sown April 5, 1946.
b Very little western wheatgrass was established in the mixture.

The total precipitation for the 12-month period, July 1, 1946, to June 30, 1947, was 18.89 inches; 2.34 inches more than the 50-year average of 16.55 inches. July and August and the winter months were rather dry, but above-normal rainfall during the fall and late spring provided ample moisture for good growth of the grasses and for favorable results from the use of nitrogen fertilizer.

Intermediate wheatgrass was the highest yielding of the grasses under both levels of soil fertility. The yields from the unfertilized plots of Lincoln bromegrass, Standard crested wheatgrass, and the mixture were practically the same, the differences being too small to be significant. With fertilization, bromegrass yielded 21 per cent more hay than the crested wheatgrass and only 13 per cent less than the intermediate wheatgrass. Whereas the grass mixture was planted with equal parts of Standard crested wheatgrass and western wheatgrass seed, very little western wheatgrass became established. These plots in 1947 were nearly pure crested wheatgrass with approximately 20 per cent less stand than on the plots which were planted to Standard crested wheatgrass alone. Application of ammonium nitrate had no significant effect on the alfalfa. It should be emphasized that the results reported here are for only one season—a year in which moisture conditions were favorable for good growth of the cool-season forage crops—and may not reflect the average
yields to be expected over a period of years. Similar plantings made in the fall of 1946 at North Platte and Lincoln had not become sufficiently established for harvest in 1947.

E. C. CONARD, J. R. McHENRY, L. C. NEWELL.

**New strains of grasses.** Seed supplies of six new grass strains are being increased for further testing and possible distribution. These strains are the most promising among the many which have been tested for Nebraska conditions. They include two new selections of bromegrass and one each of intermediate wheatgrass, side-oats grama, sand lovegrass, and switchgrass. These offer considerable choice for various soils and uses.

Nebraska 36 is an improved strain of Lincoln bromegrass produced by selection and outcrossing. This variety is outstanding for its excellent quality of seed and is more uniform in plant type than is Lincoln. It also has a stiffer stem and is more lodge-resistant. Nebraska 44 bromegrass is a synthetic variety developed by hybridization of five unrelated lines that had been selected over a period of years by means of progeny testing. In preliminary tests this variety has appeared superior in forage quality and has surpassed all other strains of bromegrass in yield of forage and seed.

A selection of intermediate wheatgrass, Nebraska 50, retains the excellent seed characteristics, seedling vigor, and ease of establishment of this cool-season grass. It produces a very tough sod and therefore should be valuable in seeding waterways.

The other three grasses under consideration should be of decided value for seeding on sandy soils. The new side-oats grama, Nebraska 52, is a warm-season grass which grows well over a wide range of soil types and has proved palatable to all classes of livestock. This is a synthetic variety produced by the recombination of several selected types. It matures a few days later and is the most leafy of the strains adapted to Nebraska. The new switchgrass, Nebraska 28, is a selection originating in Holt county, Nebraska. It has special value for seeding on sandy soils and in waterways where a warm-season grass is desired for spring planting either alone or in mixtures. Nebraska 27 sand lovegrass originated from a few selected plants found growing in the Nebraska Sandhills. This variety is superior to the Oklahoma strain under Nebraska conditions. It merits extensive trial as summer pasture on various soil types.

Research work with grasses is cooperative with the Division of Forage Crops and Diseases of the U. S. Department of Agriculture.

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 1947. The very favorable moisture conditions during the spring resulted in good yields from the early and mid-season dates of cutting. Plots harvested July 7 to 9 produced an average of 1.17 tons of cured hay per acre, containing 12 per cent moisture. Plots harvested August 5 to 7 and September 10 to 13 produced 1.48 and 1.18 tons per acre, respectively. Dry, hot weather during the summer caused severe drying of the grasses after mid-August, resulting in considerable deterioration in the quality of the September-cut hay as well as some loss in its yield. Some aftermath growth was produced on the July-cut plots but the crop was not sufficient to warrant harvesting as hay.
There has been some reduction in the vigor of the wild alfalfa, *Psoralea floribunda*, on the plots which were cut early in 1945 and 1946. Early cutting for two years reduced the average height 17 per cent and the weight per stem 43 per cent as compared with midseason and late cutting. No other changes in the vegetation which may be attributed to time of cutting have been detected.

Wild alfalfa is coarse-stemmed, woody, and unpalatable in the hay. Therefore, the reduction in its vigor by early cutting seems desirable from the standpoint of hay quality. However, since wild alfalfa is a legume, it probably is of some value in returning nitrogen to the soil. Its importance in this respect remains to be determined.


The Rotation and Manuring of Crops

The crop rotation experiments on the Agronomy Farm at Lincoln have now been underway long enough to justify conclusions regarding the benefits from legumes and manure. The four-, six-, and nine-year rotations under consideration were started in 1933 and had all completed at least one cycle prior to 1942. Data in the accompanying table show the average yields of standard grain crops in straight grain rotations during 1942–1947, and also the change in their yield due to specific legumes or manure. Red clover and sweetclover stands were obtained by sowing 15 pounds of seed per acre with oats sown as a companion crop at half the normal rate used in the other rotations, whereas alfalfa was sown alone in the fall. Applications of barnyard manure were at the rate of 12 tons per acre. These experiments were started on fertile soil as is indicated by the high yields obtained in the check plots. For this reason the crop response to legumes and manure is less than that often experienced on less fertile land in eastern Nebraska and under irrigation elsewhere.

The legume crops were all removed from the land in the form of hay except first-year sweetclover. This complete removal may account for the distinctly higher yield obtained from the supplementary manuring. The most profitable rotation included second-year sweetclover and manure.

<table>
<thead>
<tr>
<th>Kind of legume and fertilization included in the rotation</th>
<th>Length of rotation</th>
<th>Grain crop in rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yrs.</td>
<td>Corn</td>
</tr>
<tr>
<td>None (check)</td>
<td>4, 6</td>
<td>45.5</td>
</tr>
<tr>
<td>Sweetclover (2 years) and manure</td>
<td>6</td>
<td>14.9</td>
</tr>
<tr>
<td>Manure</td>
<td>6</td>
<td>8.5</td>
</tr>
<tr>
<td>Sweetclover (2 years)</td>
<td>6</td>
<td>8.0</td>
</tr>
<tr>
<td>Red clover (2 years)</td>
<td>6</td>
<td>7.8</td>
</tr>
<tr>
<td>Alfalfa (2 years)</td>
<td>9</td>
<td>6.1</td>
</tr>
<tr>
<td>Sweetclover (1 year)</td>
<td>6</td>
<td>2.7</td>
</tr>
</tbody>
</table>

---

1 All crops were represented every year for all rotations.
2 In the sweetclover and red clover rotations, all oats were planted at half the normal rate per acre, which accounts for the low yields.
3 The legumes, except first-year sweetclover, were removed as hay.
4 Manure applications at the rate of 12 tons per acre were plowed under for wheat.
which increased the annual yields by 14.9 bushels corn, 11.5 bushels wheat, 7.6 bushels oats, and 7.2 bushels barley. Two years of red clover gave approximately the same increase in grain yields as did two years of sweetclover. Both of these resulted in slightly better grain yields than in the alfalfa rotation except for the oats which was far lower, doubtless largely due to the thinner seeding rate when used as a companion crop. Oats have been at such a distinct disadvantage when sown at only half the normal rate, that a three-fourths rate is now recommended as it also has proved a satisfactory rate for use as a companion crop. Under the conditions of these tests, sweetclover plowed under in early spring of the second year was but slightly helpful in the rotation.

Compared with the straight grain rotations during 1942–1947, the rotation with two years of sweetclover and manure gave the following successive annual increases in yield of corn: 19, 20, 26, 38, 50, and 62 per cent, respectively. Excessive heat and drouth combined in midsummer of 1947 to give the corn a serious setback in these rotations, where it averaged only 20 bushels per acre. Contrary to most drouth years, corn on the more fertile soil suffered the least. This is explained on the basis of a distinct deficiency of soil nitrate development during the unusually cold wet spring and early summer.

The value of rotation for control of corn rootworms was clearly demonstrated in 1947. Even two consecutive years was excessive for corn and resulted in decidedly more lodging, dwarfing of plants, and lower yields.

W. E. Lyness, T. A. Kiesellbach.

Chemical Weed Control in Corn Fields

Excessive rainfall and cool temperatures during May and June followed by hot, dry weather later in the season, resulted in heavy infestations of annual weeds, especially cocklebur and sunflowers, in most of the corn fields of the state in 1947. The crop in many fields was severely injured or completely destroyed by the combination of weeds and drouth.

Information obtained from preliminary experiments in 1946 with 2,4-D was insufficient to recommend its use for weed control in corn in 1947, but some advice could be given to farmers who wished to try this new chemical in their corn fields. Because of the seriousness of the weed situation, many farmers obtained spray equipment and sprayed their corn. It has been officially estimated that approximately 50,000 acres, located mainly in northeastern Nebraska counties, were sprayed by the use of both farmer-owned and commercial ground equipment and by airplane.

Results of this spraying were noted on several farms to determine the extent of weed control and possible damage to the corn. Following are a few of the conclusions:

1. The most common weed species were cocklebur, sunflower, pigweed, velvetleaf, bindweed, smartweed, foxtail, and sandbur.
2. Spraying was accomplished with tractor-mounted, tractor-trailed, and truck- and jeep-mounted sprayers as well as by small auxiliary type units. Airplane spraying was also employed.
3. Of the three available chemical formulations of 2,4-D, the esters, amine, and sodium salts, the butyl ester was used in the greater number of fields. The rate of application per acre was approximately $\frac{1}{4}$ to $\frac{1}{2}$ pound of 2,4-D in 5 to 100 gallons of water. A few higher dosages also were tried.
4. No difference in the susceptibility of various corn hybrids was apparent although such difference may exist.
5. Injury to the corn plants by the chemical varied from none to approximately 10 per cent; but even where considerable lodging, reduced root volume, and distorted brace roots were noted, the ear development was fairly normal. Plant yields in such areas exceeded those from the untreated areas in all cases. Most distortion was found where the heavier dosages had been used.

6. In one field the yield was increased 11 per cent by one application and 49 per cent by two treatments. Two other fields showed 44 per cent increase from one treatment.

7. Stand counts of weeds showed that cocklebur and sunflower plants were largely eliminated in the treated portions and good kills of pigweed, velvetleaf, and wild artichoke were obtained. Pennsylvania smartweed was reduced with a second spraying in one field, but in most cases was rather tolerant. Foxtail and sandbur were relatively unaffected.

8. Yield in general was severely reduced by drouth and high temperature; but the greater reduction was on the untreated, weed-infested areas.

Experiments were conducted on the Experiment Station farm at Lincoln to determine the effect of different dosages of 2,4-D on various species of weeds in corn fields, and also the effect of the spray on the corn itself. The conditions of the experiment and the results were as follows:

Three types of 2,4-D (butyl ester, amine salt, and sodium salt) were applied to corn at dosages of \( \frac{1}{2}, 1, \) and \( 1 \frac{1}{2} \) pounds acid in 40 gallons of water per acre. Applications were made over the top of the corn at the laying-by stage in a field that had two previous cultivations. These chem-
Tractor-mounted sprayer with boom adapted for row spraying. For over-all spraying the "tee" arrangements and plugs are removed, and nozzles are inserted in all openings.

Chemical treatments were compared with two and three cultivations. The weeds present were bindweed, pigweed, buffalo bur, wild ground cherry, foxtail, and stinkgrass. Applications of the chemical were made with tractor-mounted equipment.

Observations made two days after treatment showed considerable brittleness of the treated corn. Later observations, after heavy wind, showed many broken plants in plots treated with 1 and 1½ pounds of butyl ester per acre. No broken plants were evident in the other treated plots. Distortion of the braceroots, cracked stalks, and bending at the lower nodes were noted from all treatments, with the most intense effect from the butyl ester and least from sodium salt in proportion to dosage. Yield was greater in all cases from the treated plots than from those cultivated two times. The plots treated with ½ pound of 2,4-D per acre yielded as much as those cultivated three times, but yields from the 1- and 1½-pound treatments were reduced. Yields from the ½-, 1, and 1½-pound applications, averaged for the three chemicals, were 23.9, 12.7, and 16 bushels per acre, respectively, compared with 9 and 22.6 bushels for untreated plots receiving two and three cultivations. The weed control was slightly more effective from the heavier dosage, but the differences were not great enough to warrant the increased damage to the crop. The ½-pound application is considered sufficiently effective.

Other experiments concerned the effect of 2,4-D on bindweed and hoary cress, and on the crop as well as annual weeds in fields of winter wheat, oats, and soybeans. Specifications have been developed and made available for the home construction of tractor-mounted spray equipment.

Noel S. Hanson.
Outstate Testing

Crop variety tests and soil studies were continued in all parts of the state as in past years under the Outstate Testing Program. These tests supplement the research of the Experiment Station and substations. Department circulars summarizing the results of the tests have been or are being prepared.

Crop variety tests. Fourteen winter wheat variety tests were harvested in 1947. The yields of some varieties were reduced by freezing injury in late May. Different varieties were affected in the various localities. The experimental strain, C. I. 11972, a Cheyenne x Tenmarq cross, ranks at or near the top in average yield for the 1945–1947 period in most parts of the state. Of the commercially available varieties, Pawnee has maintained the highest yield in southeastern Nebraska and Nebred, Cheyenne, and Turkey are high in the western parts of the state.

Eleven outstate corn tests were harvested. These included both yellow and white experimental and state certified hybrids. Compilation of the results has not been completed.

Oat variety tests at ten locations were harvested. In most of those in the eastern part of the state, Victoria blight was responsible for drastic reductions in the yields of Cedar, Osage, and other blight-susceptible varieties. Clinton and other varieties of Bond parentage are coming into greater prominence in these eastern districts. A new variety, Cherokee, which was selected from a D69 x Bond cross, was at or very near the top in yield in all the districts of the state in 1947. Nemaha, another new variety from a Victoria-Richland x Morota-Bond cross which carries the Bond type of resistance to crown rust and Victoria blight, had high yields in the eastern districts. In the western districts, Neosho, Osage, and Trojan have maintained the best yield records.

Five barley tests were harvested. Velvon 11 and Ezond have maintained the highest yields in most of the state with Mars, Feebar, and Plains comparing favorably in the central districts and Beecher, Trebi, and Plains farther west in the state. Tests were also conducted with varieties of sorghum, winter barley, and soybeans.

Soil studies. Commercial fertilizer and moisture studies were conducted by the Outstate Testing Program in cooperation with other Experiment Station projects. The results of part of these are given earlier in this report under the titles: Fertilizers for Small Grains, Fertilizers for Sugar Beets, Fertilizers for Potatoes, Fertilizers for Bromegrass, and Nitrogen and Phosphorus in the Soil and Sugar Production of Beets. Two experiments were conducted in cooperation with the North Platte Substation. One was a mechanical-thinning experiment with sugar beets. The other was a moisture-fertility-spacing study with irrigated corn. The results obtained from these two experiments are included herein as part of the North Platte Substation report.

J. J. Hanway.
Food Value of Nebraska-Grown Vegetables

Potatoes. The place potatoes are produced and the type of culture given them influence their ascorbic acid content, but it is difficult to determine whether differences are due to these environmental effects or to the degree of maturity of the vines or tubers. For example: The average ascorbic acid content of 16 varieties grown at Lincoln and harvested near the period of maximum vegetative growth was almost the same as that of the same varieties harvested in a dryland plot in Banner County at an altitude of about 5,300 feet from relatively green vines in early October. With these tests of 16 varieties the averages of dryland plots were generally higher than those of nearby irrigated plots.

With three varieties (Nebraska 2, Irish Cobbler and Red Warba) grown at Lincoln and harvested on nine dates the ascorbic acid content of the tubers was almost always greater (44 out of 54 comparisons) when grown with a straw mulch than when merely cultivated. With the same three varieties and the different cultural treatments the ascorbic acid content increased until vegetative growth was almost completed about July 9, when it remained near the maximum amount for about four weeks. It decreased very rapidly during the five weeks that the vines were ripening, and by September 8 it was only about one-half as great as two months earlier. Higher ascorbic acid content of straw-mulched potatoes may have been due to the delay of those plants in attaining maximum vegetative growth. However, the distinctly higher amounts in mulched potatoes, which persisted in all the varieties for a number of weeks after the vines had died, indicated that the mulching may have been responsible for the difference. At least it can be said that when harvested on any date, straw-mulched potatoes had more ascorbic acid than cultivated potatoes. Spraying the vines to control all types of insects resulted in a slight increase in ascorbic acid.

Determination of ascorbic acid is one of the tests considered in choosing breeding lines to be used as parents or as stocks to increase. This involves analyzing tubers of more than 100 different lines each year and provides an opportunity to study the possible correlation with ascorbic acid content of such factors as specific gravity, maturity and tuber size, as well as to determine the extent to which ascorbic acid is a heritable character. It will be necessary to acquire data throughout several years before trends or principles can be established. In 1946 the values of 59 lines ranged from 42.68 to 12.07 mg. ascorbic acid per 100 grams fresh weight in late October. In 1947 the value of 122 lines ranged from 42.26 to 13.59 mg.

Throughout the extensive replicated tests of 1947 and those of several previous years certain differences in ascorbic acid content of varieties have persisted. Kasota tubers have had the highest annual average. Following in fairly consistent order have been Nebraska 2, Triumph, Nebraska 3, Red Warba, Katahdin and Irish Cobbler, and finally Pawnee. Each year many varieties (especially late varieties) have had lower values than Pawnee, however.
Sweet potatoes. Composition of sweet potatoes grown in three places in Nebraska is found to be similar in all major components to that of the same varieties grown in southern states which are generally considered more suitable for the crop.

Varieties differed greatly in their content of carotene, starch, riboflavin, and sugar. With ascorbic acid the difference persisted proportionally throughout storage. Roots of the Maryland Golden have been very high in carotene and sugar but relatively low in ascorbic acid and starch. Those of Yellow Jersey have been very low in carotene and ascorbic acid, with intermediate amounts of riboflavin. Porto Rico has had an average content of these components. Other standard varieties with high contents of carotene have been Orange Little Stem and Nancy Gold.

The highest carotene content was found in a seedling from the U.S.D.A. selection O.P. 37 with 282.2 mg. per gram of dry weight, and in Orlis, a new variety from Kansas, with a value of 267.2 mg.

Time of planting and harvesting have been responsible for differences in ascorbic acid, carotene, starch and sugar.

When Porto Rico roots were harvested on the same day in mid-October, it was found that with delayed planting (from May 21 to June 20) there was a decrease in starch and riboflavin but little difference in carotene and ascorbic acid.

Roots harvested on successive dates from September 17 to October 17 showed increases in carotene and riboflavin, whereas ascorbic acid increased during the first ten days and then decreased steadily. Apparently the culture most suitable for good yield in Nebraska, i.e., planting in mid-May and harvesting in mid-October, is conducive to developing the maximum amounts of most food constituents.

During storage a steady loss of starch and an increase of sugar takes place much more slowly than with potatoes until the end of the winter when it decreases rapidly. The carotene did not seem to experience much change in storage.

Tomatoes. Ascorbic acid values of tomatoes were higher in 1947 than in most years. The Sioux tomato, which is generally the highest, had 35 mg. of ascorbic acid per 100 grams fresh weight of fruit in contrast with about 25 mg. in most seasons. Some F₁ and F₂ selections of Rutgers with small fruited Lycopersicum Peruvianum produced fruits weighing 20 to 40 grams with an ascorbic acid content of 38 to 40 mg. per 100 grams fresh weight. The fruits on F₁ plants grown from several crosses of these selections with Red Cloud had 30.5 to 45.8 mg. of ascorbic acid per 100 grams fresh weight when harvested in the greenhouse at Lincoln on June 14, 1947.

**Vegetable Experiments**

Sweet potatoes. The early part of the 1947 growing season was unfavorable for sweet potatoes, but the long warm autumn was favorable for late growth. At Lincoln, yields per acre of a number of varieties were in excess of 15,000 pounds of marketable sweet potatoes. In addition to the older varieties such as Porto Rico and Red Bermuda, several new varieties and seedlings procured from sweet potato breeders produced high yields of good quality. In a plot on sandy land directly northeast of Grand Island good yields of good quality roots were produced with most of the varieties.
**Lima beans.** Cold, wet weather during late May and most of June caused much seed decay with some varieties and the protracted hot weather from late July to early September seriously impaired pod setting with all of the 13 varieties in a test. Beans were produced during two major periods. Those of the first picking in mid-August were set before the hot weather and those harvested in late October were set after the heat subsided in late September. The five varieties that produced a fairly good early crop were Clarks' Bush, Henderson and three selections from the Illinois station (4f, 4k 46 and 11a 46). Henderson was superior to all of these with 1,600 pounds of green pods per acre on August 22. The other four yielded 1,067 to 1,268 pounds per acre. Most of the remaining eight varieties yielded less than 500 pounds. In late October Fordhook 242 and Illinois 3d each produced 6,240 pounds per acre of excellent quality. The other high producers at that time in order of yield were Illinois 4k 46, Illinois 4a 46, Clarks' Bush, Henderson and Peerless. The latter is a new variety of good quality that performed well in earlier years but fell down in this test because of the loss of stand.

H. O. Werner.

**Potato Storage**

**Storage structures for seed potatoes.** The shell-cooled bin at the Box Butte Experiment Farm as reconstructed was operated during the 1946–47 storage season with a fan circulating air continuously through air spaces that completely surrounded the bin and through tight ventilated interior partitions, with fresh air being brought into the system whenever the outside air was colder than that in the bin. By circulating the air continually and setting the thermostat to avoid bringing in air that was warmer than the potatoes in the bottom of the bin two things were accomplished. The general temperature throughout the bin was lowered and the range between bottom and top layer temperatures was greatly reduced. In the fall of the year with the continual circulation of the air around the bin, the potatoes in the upper part of the bin were cooled by the air that was cooled in passing over the cool ground beneath the bin. During the winter when the ground heat warms bins of potatoes to an undesirable extent this continual circulation carried off much of the ground heat, cooling the ground to a greater depth. The result of this change in operation was greater uniformity in the condition of the potatoes at planting time—those from the lower part of the bin having sprouts instead of being dormant and those in the top of the bin having sprouts less advanced than in former years.

The effect of the color of the roof surface of a potato storage near Alliance upon the temperature beneath the roofing material and the underlying insulation is being studied. On bright summer days the maximum temperature was lowered considerably by painting the roofing paper. In comparison with the ordinary dark gray asphalt roofing paper the maximum temperature under the portion painted white was 25° to 40° F. lower below the roofing paper and the 1-inch supporting boards, and 10° to 15° lower under 10 inches of straw insulation. The surface painted with aluminum paint was not quite as effective as a white surface in reflecting heat, although it did reflect more light. The temperatures under blue, green and red were lower than those under the unpainted roof, but still closer to them than under the white or aluminum painted surfaces.
Records for another year were procured of temperature in the ground surrounding a covered pit that was left open during the winter for cooling and filled with potatoes in late March. This is continuing to show up as a good way to keep seed potatoes dormant during the spring of the year. The sprouts on the potatoes in the bottom layer weighed 1.6 per cent and those in the top 4.3 per cent of the potatoes removed on June 9, after 10 weeks of storage.

The results of the past year showed there is still some risk in the commercial use of sprout inhibiting chemicals. Methyl ester of alphaphthalene acetic acid applied at harvest time as a dust, to inhibit the sprout growth of tubers in large (1,000-bushel) bins of Triumph potatoes, caused serious "blistering" of the skin of most of the tubers. This did not lead to rotting of tubers but because these blisters were considered as grade defects the treatment was responsible for a substantial financial loss.

H. O. Werner.

**Potato Breeding**

The customary program of producing seed in the greenhouse, testing in the field, increasing promising lines and testing for quality attributes as reported in previous years has been continued. During the past year still more seedlings with dark red skin, high specific gravity and good quality tubers have been isolated. The most promising of these are being increased as rapidly as possible for general testing. In conjunction with the Nebraska Certified Potato Growers seed production department several thousand bushels of two selections have been produced for pre-introductory commercial scale testing by growers. The early white selection, Nebraska 2, has shown up unusually well in yield tests grown in widely separated parts of the state. The red selection, Nebraska 3, is arousing considerable interest in western Nebraska. Several scab resistant varieties from other states were tested. These varieties were found to be too late, and all are white. Nebraska growers want red potatoes. These and a number of other scab resistant lines that have been developed by other breeders and several discovered in the Nebraska program are being crossed with the most promising early red Nebraska selection.

H. O. Werner.

**Tomato Breeding**

The most promising new material is a group of F₁ segregates of an extreme determinate type with relatively more foliage to protect fruit than most determinates and with a good set of commercial quality fruit. This type may supply a great need for a variety that will ripen fruit in the cool high-altitude areas in western Nebraska. It may also be suitable for the production of very early tomatoes in other parts of the state or where very intensive culture is practiced on a restricted area. The Sioux, which was introduced several years ago, is now well established. It was grown extensively in a number of other states and in several foreign countries in 1947.

H. O. Werner.

**Potato Cultural Methods**

**Advance cutting of seed potatoes.** When Triumph seed potatoes were cut four weeks before planting time and were handled properly till planted on June 25 at the Box Butte Experiment Farm, there was no seed.
Loss in removal of excess sprout growth was less than when seed potatoes were cut immediately before planting and there was no measurable difference in rate of plant emergence, stand of plants or yield of potatoes. When cut as early as March 25 (three months before planting), 0.5 per cent of the seed pieces showed some rot by planting time but otherwise results were nearly as good as with seed cut at any later date.

**Time and rate of tuber production on dryland.** Harvesting potatoes at biweekly intervals is used as a means of determining when the crop is produced and what size and grade changes occur as the harvesting season advances. In 1947 this project was expanded to determine the characteristics of two lines that are in the advanced stage of selection in the breeding project. It was found that total yields increased most rapidly in late August and early September, with very little increase during the last half of September and a decrease the first two weeks of October. With all varieties the percentage of scabby tubers increased very rapidly during the period of most rapid tuber growth in early September, after which there was little or no increase.

**Soil management to improve potato harvesting conditions.** Hard soil at harvest time increases the difficulty of getting the crop out of the ground without serious damage. Several methods of loosening the soil under the potato row without leaving it so open that it might dry out were tried. When the rows were undercut at a depth of about 6 inches shortly after planting either with long sweep shovels or a potato root cutter, or when given a close deep blind cultivation, the soil was noticeably looser throughout the summer and clods seemed less numerous and smaller than in the check plots. Yields were not affected except that undercutting with a root cutter may have reduced the yield slightly.

**Control of weeds with pre-emergence herbicide.** A pre-emergence spray of one-half pound per acre of butyl ester of 2,4-D prevented practically all weed growth without damaging the potato crop. The amine salt of 2,4-D was less effective.

**Root cutting preceding harvest of early potatoes.** With Red Warba potatoes having vines starting to mature, cutting the roots one and two days before harvesting on August 4 brought about a reduction in the feathering of the skin in washing and the development of browning and scald spot during the first few days after harvest. After three weeks in a dry cellar, 40 per cent more of the tubers were unblemished than when roots were not cut. Root cutting during this period of very hot weather increased the water loss from the tubers so that they were noticeably less turgid, but after several days in a warm room this condition was less apparent.


**Potato Marketing**

During the fall of 1947 a potato marketing project was outlined for the North Central Region of the United States. Nebraska is participating in this project. The initial phase is a study of the relation of sorting potatoes into definite sizes when marketing through retail stores in Chicago to price received and volume that can be moved. Five or six carloads of Triumph potatoes from western Nebraska will be used in this study. The Illinois Agricultural Experiment Station and several divisions of the U. S. Department of Agriculture are cooperating.

H. O. Werner.
Supplemental Water for Orchards

Natural precipitation in 1947 (34.84 inches) was far above normal for eastern Nebraska but the distribution was not good since rainfall of 6.69 inches in April and 12.18 inches in June occurred at the University Fruit Farm. Because of the heavy precipitation at the time of greatest growth, it was deemed unnecessary to use supplemental water until late in the season when conditions became unfavorable not only because of low rainfall (2.17 inches in August and 1.18 inches in September) but also because of unseasonably high temperatures. No specific data were secured indicating the effect of water on fruit size but general observations confirmed previous ones, that the effects of an extra supply of water are quite noticeable on both size of fruit and appearance of the tree.

With such heavy precipitation in the spring and early summer it might logically be expected that there would be little or no exhaustion of reserve moisture in the deeper layers of soil in the experimental block of young Delicious apple trees. This proved to be the case. No fall samples were taken but the sampling schedule will be resumed next spring.

C. C. Wiggans, E. E. Brackett.

Fruit Breeding

No specific work on crossing was attempted during the year but numerous observations on the behavior of new varieties just coming into fruiting were made.

In the black walnut variety test a good yield was obtained on several varieties, and a sufficiently large number of fruits was obtained in all cases to make a cracking test possible. Maturity in general was somewhat better than in some previous seasons but a number of varieties had very sappy meats in early December. In the case of one variety, Beck, over 44 per cent of the nuts were of little or no value. In the case of Stabler, over 31 per cent were of little or no value. Several other sorts had 20 per cent or more of bad fruits. In contrast, Edras had less than 3 per cent and Hepler less than 2 per cent unusable fruits.

Cracking percentage ranged from 15.79 in the Beck variety to 28.75 in Tasterite. Half the varieties cracked out over 25 per cent.

Removal of the kernel in large sections is especially desirable for commercial purposes, particularly when used in confectionary work. Halves are preferable. In the case of Tasterite over 50 per cent of the meats came out as halves while with Beck and Rohwer only about 3 per cent of such meats were secured. With Stabler, which produces generally a somewhat freakish kernel, over one-third of the nuts had only one cotyledon developed and many of these came out of the shell unbroken in any way. Quarters are also very acceptable. Varieties such as Ohio and Ten Eyck showed 80 per cent or more of the meat yield in either halves or quarters.

A few of the recently planted apple varieties in the Lincoln orchard fruited for the first time in 1947. Yields, however, were very light and no data were taken.

C. C. Wiggans.

Orchard Spraying

Delayed-action sprays. The 1945–46 tests of alpha-naphthalene acetic acid and 2,4-D, applied to delay the opening of flower buds on tree fruits, showed that concentrations sufficient to induce appreciably later blooming
also damaged the trees. The 1946–47 test was planned to reduce such injury. Instead of attempting to wet the buds thoroughly as in 1945, all sprays were applied lightly enough to wet the foliage without causing run-off. The quantity of spray varied from less than 1 gallon for cherry trees to 8½ gallons for apple trees. Concentrations of 25 and 150 p.p.m. of 2,4-D were applied on July 18 to entire trees of four varieties of cherries, two varieties of plums, and one variety each of apricots, peaches, and apples in the Lincoln orchard. About two weeks later, 2,4-D was used at 150 and 300 p.p.m. on three more varieties of apples at the University Fruit Farm near Union.

Although treated plum trees came into full bloom about one week later than untreated trees, the effects of concentrations of 2,4-D were not consistent. The blooming periods of Ningut apricots and of Cortland, Duchess, Jonathan, and Wealthy apples were not visibly delayed. Flower buds on peach trees had been killed by low temperatures during the winter. Early Richmond, Ostheim, English Morello, and Montmorency cherries were not appreciably affected; but the north sides of sprayed trees were retarded more frequently than the north sides of unsprayed trees, due possibly to the spray drift caused by a strong south breeze at the time the spray was applied. Quite probably the effectiveness of the delayed-action spray might have been masked by serious leaf-spot defoliation which was apparent within ten days after the 2,4-D was applied. Cherry leaf-spot was particularly serious in 1946.

**Blossom-thinning sprays.** Three spray materials were used to reduce the set of fruit on Duchess and Wealthy apple trees in the Union Orchard. The amounts of each used to make 100 gallons of spray were as follows: Elgetol, ⅛ and 1⅛ quarts; DN No. 1, 1 pound; and App-L-Set, 6 and 8 ounces. Each of these five treatments was applied May 7 to two trees of each apple variety. Duchess trees were sprayed when in full bloom and Wealthy trees just prior to full bloom. None of the applications caused apparent injury to the foliage. Random counts of the number of fruits on 100 bearing spurs per tree were taken on July 16. No record was made of spurs that had bloomed but had set no fruit. All thinning sprays reduced the number of fruits per bearing spur, but none was significantly more effective than any other. When compared to control trees, the average thinning effect of the five treatments amounted to 9.7 per cent on Duchess and 16.7 per cent on Wealthy.

Fruits from the Wealthy trees were sized and weighed. The effects of the sprays on size of fruit and reduction of yield appear in the following table.

<table>
<thead>
<tr>
<th>Per cent of fruits by weight</th>
<th>Over 2½ inches in diameter</th>
<th>2½ to 2¼ inches in diameter</th>
<th>2¼ to 2 inches in diameter</th>
<th>Less than 2 inches in diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>46.2</td>
<td>35.4</td>
<td>16.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Average of all thinning sprays</td>
<td>52.4</td>
<td>35.8</td>
<td>10.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Reduction in yield</td>
<td>9.8</td>
<td>19.3</td>
<td>50.8</td>
<td>20.0</td>
</tr>
</tbody>
</table>

The blossom-thinning sprays increased the percentage of fruits larger than 2½ inches in diameter by approximately the same amount (6 per cent) that they decreased the percentage of fruits between 2¼ and 2 inches. The table shows that the yields of all sizes of apples were reduced. The average yield of the ten treated trees was 607 pounds of
fruit and of the four control trees 759 pounds. The reduction in yield was, therefore, 20 per cent. Blossom-thinning sprays are used to break the alternate bearing habit of such varieties as Duchess and Wealthy, which tend to produce too many fruits per spur. When properly applied, these spray materials reduce the crop harvested per season, but increase the average annual production over a period of years.

Control of apple scab. Two of the newer fungicides were compared with the standard treatment of liquid lime-sulfur followed by wettable sulfur (Kolofog) to control scab on Wealthy apple trees. Fermate was used at 1 1/2 pounds, 341 “B” (a formulation of heptadecyl-glyoxalidine) at 3 pounds, and lime-sulfur solution at 2 1/2 gallons per 100 gallons of mixture in the cluster-bud, petal-fall, and first cover sprays. For the second and third cover sprays, Fermate was used at 3/4 pound, 341 “B” at 3 pounds, and 6 pounds of Kolofog was substituted for the lime-sulfur solution. Acid lead arsenate or DDT was included in all three treatments. Acid lead arsenate was used at the rate of three pounds in the cluster-bud, petal-fall, and fourth and fifth cover sprays. Two pounds of 50 per cent wettable DDT was used in the first three cover sprays. Fungicides were omitted from the spray applied to control trees. These spray schedules were replicated in both the Union and Lincoln orchards.

In the Union orchard no scab lesions were found on leaves of any of the treated trees. As scab infection was extremely light on the control trees, the local conditions did not provide a satisfactory test of the efficiency of any of the fungicides used. At Lincoln examinations were made of 200 leaves from each treatment. Sixty-four per cent of the leaves from control trees had lesions which were often too numerous to count accurately. Three per cent of the Fermate-treated leaves averaged slightly more than one lesion per leaf, 1 per cent of the 341 “B” treated leaves averaged one lesion each, and no lesions were found on the sulfur-treated leaves.

Control of cedar-apple rust. Observations were made on the occurrence of cedar-apple rust on the Wealthy trees to which the above spray schedules were applied. At Union an estimated less than 1 per cent of the leaves of control and sulfur-treated trees were infected, these usually having a single lesion. No lesions appeared on trees to which Fermate or 341 “B” had been applied. Infection was greater at Lincoln. The controls averaged slightly more than one lesion on 27 per cent of the leaves. Treatments with fungicides gave the following results: less than 2 per cent of the Fermate-treated leaves had an average of less than two lesions each, about 5 per cent of the 341 “B” treated leaves had one lesion each, and less than 3 per cent of the sulfur-treated leaves had an average of less than three lesions each. The incidence of the disease on control trees was probably less than 10 per cent of what it was in 1946.

Control of apple blotch. Fermate, 341 “B,” and the standard schedule of lime-sulfur solution followed by Bordeaux mixture were compared in a replicated experiment on Duchess trees at Union. The schedules for Fermate and 341 “B” were the same as those previously described for Wealthy trees. The season was so favorable for the development of blotch that even the trees given the standard treatment had a high percentage of seriously infected fruits. Fermate gave as good control as the standard treatment, but fruit on trees sprayed with 341 “B” was as badly blotched as that on the control trees.
Control of cherry leaf-spot. Fermate and 341 “B” were compared with the standard schedule of lime-sulfur solution followed by Bordeaux mixture to control leaf-spot on four varieties of cherries in the Lincoln orchard. The petal-fall spray was followed by two cover sprays at 10- and 21-day intervals. The fourth spray was applied as soon as the fruit had been picked. The spray mixtures were the same as those detailed above for Wealthy apple trees except that a 1:6:100 Bordeaux mixture was used as the post-harvest spray in the standard schedule for the cherries. Two trees of Early Richmond, Ostheim, and English Morello were given each of the three fungicides and one tree of each variety was reserved as a control. Four Montmorency trees were included in each of the four treatments. Control of cherry leaf-spot by all fungicides was very good to excellent on Early Richmond, Ostheim, and Montmorency, but unsatisfactory and quite variable on English Morello. The infection which did occur was doubtless partly due to wet weather that necessitated a 21-day interval between the two cover sprays. Control trees, all of which received some protection from the spray that drifted from trees sprayed with fungicides, had lost an average of 55 per cent of their leaves by August 20. This defoliation induced new growth to develop from many of the terminal buds.

Fruit-sizing spray. Dowax 222 is an emulsion used to increase the size of cherry fruits. This emulsion was added to the two cover sprays used on one-half of the Montmorency trees. Two 100-fruit samples, taken at random from the crop of each tree, showed that the fruits receiving Dowax 222 were 7.8 per cent heavier than fruits from trees not sprayed with this emulsion. Dowax 222 did not modify the effectiveness of the fungicides used to control leaf-spot.

R. H. Moore.

Fruit-Stocks Investigations

A few additional buds were placed on the young top-worked orchard of Hibernal and Virginia Crab at Union. A small amount of wood was removed in formative pruning. Several of the Golden Delicious, Jonathan, and Winesap trees bloomed on scions only three years old. A scattering of fruit set on the Golden Delicious and Jonathan trees. Neither blooming nor fruit setting was restricted to either the Hibernal or Virginia Crab interstocks.

Of the 20 varieties of apple trees included in the test to find new interstocks, 18 had nearly perfect stands. The two varieties with unsatisfactory stands were Malling II which had 68 per cent survival and Malling XII which had 58 per cent survival. Most of the mortality in these two lines was due to failure of the small trees to become established after they were set out in the spring of 1946. All surviving trees grew exceptionally vigorously early in the 1947 season. Those that had gained sufficient size were budded to one of the 16 following scion varieties: Beacon, Black Ben, Cortland, Double Red Duchess, Edgewood, Golden Delicious, Grimes Golden, Haralson, Double Red Jonathan, Secor, Sharon, Starking, Turley, Double Red Wealthy, Winesap, and Yellow Transparent. A maximum of five buds was set per tree. Budding was done in late July and throughout August. Some of the buds inserted in July grew into short shoots, but those placed in August remained dormant.

R. H. Moore, C. C. Wiggans.
Bean Diseases

Breeding for resistance to halo blight. A knowledge of the mode of inheritance of halo blight reaction and other plant characters was sought. Inheritance and linkage studies were made by the analysis of F2 and F3 populations. The 1947 field experiments, in which F2 progeny from a Mexican Red x U. S. Refugee cross were tested, indicated that one pair of factors governed the reaction to halo blight, susceptibility being dominant. This is in conformance with the results obtained in 1946-1947 greenhouse experiments. In this same cross two complementary genes were shown to govern the stringless character in pods. Further analysis indicated that the factors for halo blight reaction and stringiness of pods were located in different chromosomes. Flower color appeared to be governed by one gene pair, pink being dominant over white; it was not associated or linked with halo blight reaction. Seed coat color could be relegated in the category of quantitative characters, being determined by multiple factors.

Over 400 F3 lines from Mexican Red x U. S. Refugee and from Asgrow Stringless x Arikara Yellow crosses, as well as a hundred lines from crosses involving five other varieties, were tested for halo blight reaction in the greenhouse in 1946-1947 and in the field at the Scottsbluff Substation in 1947. Twenty selections were made on the basis of disease resistance and plant types. Three resistant selections in the F3 were being purified and will be tested further for resistance to other diseases. Two of these selections showed some mosaic susceptibility; roguing will probably aid in obtaining a line resistant to this virus disease.

An attempt to control halo blight with a bean-blight dust which contains copper and sulphur proved a failure; no difference was noted between the treated and untreated plots in the number of leaf and pod infections.

Common blight experiments. Seven new varieties from West Virginia showed susceptibility to common blight. One variety, 6 plEB, appeared to be tolerant to the disease. Four varieties were infected with common mosaic, whereas three varieties did not show any virus disease present. The reaction to common mosaic was based on natural field infection. Although all seven varieties are later than Great Northern U. I. 59 they possessed other very desirable plant characters.

Field bean tests. Selection 3837-1 during the past two years has been compared favorably with Great Northern U. I. 59 in yield, maturity and shattering.

M. L. Schuster.

Cereal Diseases

Corn root rots. A test for the evaluation of the cold tolerance of corn seedlings has been developed whereby the seeds are planted 1 inch deep in field soil at 70° F. After 48 hours the temperature is lowered to 40° F. for 14 days, then returned to 70° F. until the seedlings have developed the first leaf. In a test of 123 lines of corn, emergence with seven lines was over 80 per cent. Approximately 100 showed less than 50 per cent emergence and of these 50 gave less than 20 per cent emergence.
One hundred inbred lines, 44 single crosses, and 20 hybrids were tested for susceptibility to stalk rot caused by Diplodia zeae. Inoculation by inserting toothpicks upon which the fungus was growing into the lower portion of the stalk, was more effective than injecting the organism into the stalk with a hypodermic needle.

**Loose smut.** Tests are being continued in an attempt to find a variety of barley with resistance to loose smut and desirable agronomic qualities. One hundred and twenty inoculated head rows were planted in the field in 1947. Heads in rows having no diseased plants were inoculated for further testing and selection.

**Injury to wheat heads by freezing.** A late spring frost caused injury to the heads of very early wheat in 1947, similar to that occurring in 1946 but less extensive. In experimentally controlled frost tests it was found that heads still in the boot were injured less than heads that had emerged from the boot. Only a slight amount of sterility was produced at $-2^\circ C$ even when exposed for 14 hours. At $-4^\circ C$, even a four-hour exposure caused approximately 50 per cent of the flowers to be sterile.

**Seed treatment.** Six varieties of oats were treated with New Improved Ceresan and planted in Washington, Wayne, Platte, Valley, and Kearney counties to determine if seed treatment would improve stands and yield and reduce damage from Victoria blight. In no case was there a significant increase or decrease in stand with either the susceptible or resistant varieties.

J. E. LIVINGSTON.

**Potato Diseases**

**Tuber rots.** During the year surveys were made to determine the prevalence and identity of tuber rots occurring at harvest time and in transit in central Nebraska and at harvest and in storage in western Nebraska. Isolations of the causal organisms have been made and pathogenicity tests are being conducted with particular reference to temperature relations and varietal susceptibility.

**Central Nebraska.** The principal tuber rots in the central Nebraska area this year were bacterial soft rots which were associated with high temperatures preceding and during the harvest period. Pre-harvest flooding in some fields along with high temperatures resulted in the complete breakdown of some tubers prior to harvest. Harvest and grading damage of immature potatoes resulted in browning and scalding of tubers which damaged their appearance on the market and which in association with high temperatures resulted in bacterial soft rots. In a small number of fields which had been over-irrigated or flooded late in the season some pink rot developed as a transit trouble. No late blight was found in this area. The number of fields infected with ring rot was greatly reduced as compared with the previous season. Charcoal rot was identified as a new disease in a very few fields in the Kearney and Omaha areas and in each case was associated with extremely high temperatures late in the season.

**Western Nebraska.** Late blight was not found in the field but a few tubers were discovered from a few scattered irrigated fields. Few tuber rots were present at harvest but some pink rot tubers were found in storage in November in potatoes grown under irrigation. Fusarium dry rot types were present in small, scattered amounts. Later, bin surveys will be made to determine the development of these rots in storage.

A. F. SHERF, JOHN P. HOLLIS, R. W. GOSS.
Ring rot. Investigations were undertaken on the influence of environmental factors, such as air and soil temperature, upon symptomatology and rate of ring rot development in potato. Symptoms were found to be greatly retarded at soil temperatures below 18° and above 26° C. Also diseased plants grown at low soil temperature were found to appear healthy and sturdy 48 or more days after planting although still harboring numerous bacteria. Tubers from plants grown at soil temperatures of 14° to 30° C. appeared healthy internally and externally but still harbored numerous ring rot bacteria. The number of plants becoming infected at the various temperatures varied indirectly with the soil temperature. An air temperature of 26° C. for the first 30-day period of growth followed by a temperature of 19° C. resulted in more rapid development of symptoms (50 days) than when the reverse sequence of temperatures was used (62 days). In general, the percentage of infection was higher and the rate of symptom development was much more rapid at specified soil temperatures than at equivalent air temperatures.

Root inoculation was determined to be the most efficient method of inoculation and resulted in earlier symptoms and a more complete distribution of bacteria through the host than with any other method tested. Earlier expression of disease symptoms, more rapid subsequent development in the host, and more tuber symptoms resulted in plants inoculated with material freshly expressed from a diseased tuber than with any other type of inocula. Great differences were found to exist between varieties of potatoes in the time required for the development of symptoms after inoculation. Of 11 varieties tested, La Salle developed symptoms earliest (46 days) and Teton latest (68 days). Roots were uniformly invaded by the bacteria in all varieties but Teton.

A. F. Sherf.

Fusarium wilt and scab. Field tests of selected seedlings for resistance to these diseases were continued at the Scottsbluff Substation. Of the 29 lines tested, eight selections exhibited very promising scab resistance and nine appeared to have less than one-half as many tubers infected with fusarium wilt as Bliss Triumph. These seedlings will be useful as parent material in the breeding project. In addition, 32 selections and seven varieties of potatoes were tested for scab resistance in a commercial field near Alliance. Seven seedlings in this test appeared to be superior to Bliss Triumph in scab resistance.

A. F. Sherf.

Dryland rotation experiments. Disease readings are being made of 100-pound samples from each of the rotation plots at the Box Butte Experiment Farm. This is a continuation of the project dealing with the influence of the time interval between potato crops and the effect of preceding crops upon the incidence of scab and fusarium wilt.

A. F. Sherf.

Sugar Beet Diseases

Effect of rotations on diseases. Records were taken during the 1947 growing season on the amount and severity of root rot and root knot infection of sugar beets in the various rotation plots at the Scottsbluff Substation. Stand counts made just after thinning and just prior to harvest showed an average decrease in stand per length of rotation for the continuous, two-, three-, four-, and six-year systems of 60, 15, 11, 6,
and 9 per cent, respectively. This indicates an apparent trend, the length of rotation being inversely correlated with the amount of root rot. Further analysis showed that in plots in which manure was applied to beets, there was consistently less disease than where manure was not added. Commercial fertilizer did not produce the same favorable results upon application to one-half of the continuous sugar beet plot.

A study of the amount and severity of root knot of sugar beets in the irrigated rotations at the Scottsbluff Substation indicated a consistent trend. An increasing amount of root knot was found with a decrease in length of rotation, ranging from 7 to 100 per cent disease. Invariably there was a positive relationship between the percentage of infection and the severity of the nematode disease. Differences in comparable rotations using two types of legumes—alfalfa or sweet clover—were not noted in the 1947 tests.

Determination of the causative agents of black root and root rots was attempted by isolating from diseased roots. *Rhizoctonia sp.* was obtained quite often from diseased roots of older plants. Species of *Fusarium* and a Phycomycete were isolated from the younger seedlings. Isolates obtained less frequently were other species of fungi, bacteria and nematodes. Pathogenicity tests of the isolants will be made.

Applications of either manure or commercial fertilizer did not consistently alter the amount of root knot.

**Seed treatment.** The effect of seed treatment was determined on one of the important diseases, pre-emergence damping-off. Of 15 chemicals employed, no one seed treatment was outstanding although increases over the untreated check resulted. Treatments which contained a combination of two or three fungicides did not prove superior to other treatments. Very little difference in the rate of emergence was noticed between the pelleted and non-pelleted seed.

**Soil fumigation and amendments.** An attempt to decrease the severity of soil-borne diseases was made by application of chemicals to the soil. Soil fumigants W40 (40 per cent ethylene dibromide), S776 (DD + ethylene dibromide), and G760 (a copper compound), were applied to sections of four rotation plots. The fumigants S776 and W40 decreased the percentage and severity of root knot; complete control of the disease was not obtained in any case. Yield increases reaching as high as 100 per cent over the untreated resulted from S776 and W40. Soil fumigants were applied in October, 1947, in contrast to applications which will be made next spring, using both dry and liquid materials.

**Treatment of stored beets.** Eight different chemicals were applied to beet roots to determine their protective value under storage conditions. Roots treated with Acme Bordeaux, Barbak C or Phygon had very little fungal growth on the root surface.

M. L. SCHUSTER.

**New Diseases in Nebraska**

Phloem necrosis of elms was found to be severe in some locations in Lincoln. This is the most northwestern point at which the disease has been found in the United States. It had previously been reported from Richardson county. This virus disease, for which there is no immediate control and which usually kills large trees in a short time, presents a very serious threat to the large number of elms used as shade trees in Nebraska.

R. W. GOSS, J. E. LIVINGSTON, M. L. SCHUSTER, A. F. SHERF.
Trypsin Inhibitor of Raw Soybeans

Chemical and nutritional research was continued on the factor in raw soybeans defined as a trypsin inhibitor. It is recognized as the factor in raw soybeans which must be destroyed in order to obtain a soybean oil meal of suitable feeding value.

Trypsin inhibitor in legume seeds. Previously, the trypsin inhibitor was reported to be present in legumes other than the soybean but not in all legumes. The nutritive value for chicks of several raw legumes was compared with the same legume after heating. It was found that the lima bean and common garden bean, which contain the trypsin inhibitor, gave markedly better growth after autoclaving at 15 pounds pressure for 60 minutes than when fed raw. The mung bean and the black-eyed pea, which also contain the trypsin inhibitor, were not affected in nutritive value by heating. The garden pea, the horse bean and common vetch, which do not contain the trypsin inhibitor, were likewise not improved by heating.

Digestibility of soybean oil meal in vivo. A group of 12 rats was fed a measured amount of raw soybean oil meal and another group the same amount of heated soybean oil meal. At intervals up to 18 hours after feeding, two rats from each group were sacrificed and the contents of the gastro-intestinal tract analyzed for the amount of protein remaining. It was found that the soybean protein disappeared from the gastro-intestinal tract at about the same rate in each group.

Purification of the trypsin inhibitor. Continued attempts to prepare crystalline trypsin inhibitor by available methods were unsuccessful. Investigations were made to obtain a highly purified preparation. By the use of acid extraction of raw soybean oil meal, followed by papain digestion of the extract, and precipitation of the inhibitor by ammonium sulfate, an inhibitor preparation was obtained which was approximately 50 times more concentrated than the original meal. When this preparation was fed with heated soybean oil meal to rats, it did not produce the usual growth inhibition which results when a more crude preparation of trypsin inhibitor is fed.

Feeding acid extracted soybean oil meal. It was previously reported that extraction of raw soybean oil meal with dilute acid left an insoluble residue which compared favorably with heated meal when fed to chicks for a short period. To investigate the value of this method of processing soybean oil meal under more practical conditions, a sufficient quantity of raw soybean oil meal was extracted with dilute acid to give enough insoluble residue to feed 150 chicks for eight weeks. When this material was fed at a 23 per cent level in a practical chick ration, the average eight-week weight of the chicks was 650 grams compared with an average of 678 grams for chicks receiving 23 per cent heated soybean oil meal.

Feeding sprouted soybeans. Soybeans were sprouted in the laboratory, dried, ground, and mixed in a practical chick ration. When this ration was fed to chicks, the growth value of the ration was not im-
proved over that of the ration containing unsprouted, raw soybeans. Autoclaving of the soybeans had the usual effect of marked improvement in growth value. The trypsin inhibitor in the soybeans was not diminished by the sprouting.

**Feeding soybeans heated for various periods.** Since the exact conditions for adequate heating of raw soybean oil meal have not been established, four lots of soybean oil meal were prepared: raw and autoclaved at 15 pounds pressure for 4, 10, and 30 minutes, respectively. These were mixed in practical chick rations at a 23 per cent level and fed to lots of chicks from hatching to six weeks with each lot receiving the same amount of feed. It was found that the lot receiving the soybean oil meal which had been autoclaved at 15 pounds pressure for 30 minutes gave the best growth.

**Raw and heated soybeans in poult rations.** A comparison was made of the growth of day-old poult s on rations which contained 24 per cent of raw soybean meal in one lot and an equal amount of meal autoclaved at 15 pounds pressure for 20 minutes in another lot. The turkeys in the lot fed the autoclaved meal made gains which were significantly greater than those fed raw soybean oil meal.

**Studies on Alfalfa**

**Assay of alfalfa juice.** A clarified liquid was obtained from fresh alfalfa by pressure and centrifugation. One sample of this juice was found to contain 13 per cent dry matter and 39 grams protein, 3 mg. riboflavin, 6 mg. pantothenic acid, and 1 mg. folic acid per 100 grams dry matter.

**Feeding alfalfa juice.** The clarified alfalfa juice was dried and included in a chick ration containing no animal protein supplements at a 5 per cent level. Average four-week weight of chicks receiving this ration was 170 grams, compared with 123 grams for the controls.

**Nutritional Value of Molds**

A molded feedstuff was prepared by growing a gold Aspergillus on a mixture of bran, corn, and soybean oil meal. This material was mixed at a 10 per cent level in a chick ration containing no animal protein supplements. Chicks on this ration gave an average four-week weight of 238 grams. Chicks on a ration without the mold but containing 3 per cent each of meat scraps and fish meal gave 214 grams, and on a ration containing supplements of choline, riboflavin, niacin, pantothenic acid, and pyridoxine gave 212 grams.

This work was done in cooperation with George L. Peltier of the Department of Bacteriology.

**Determination of Lactose in Milk Products**

The Blish and Sandstedt modification of the Hagedorn-Jensen ferrocyanide method for determination of sugars has been extended to lactose in milk and milk products. The ferrocyanide reduced is determined by titration with thiosulfate and the amount of lactose present is determined from a standard curve prepared by readings given by varying amounts of a standard solution of lactose.
Determination of Calcium

In the preparation of some plant material for estimation of calcium a wet ashing procedure using perchloric acid is used. In some of these preparations the methyl red indicator used is destroyed. To assure the proper pH of the solution for precipitation of the calcium as the oxalate, a line-operated pH meter was used successfully to give a final reading of 5.0. The method is simple and direct, and excellent agreement is obtained among duplicate determinations.

C. W. ACKERSON, B. D. HITES.

Bleaching Agents in Flour

For the past several years the flour milling industry has emphasized the production of whiter flours by adding either solid or gaseous bleaching agents to destroy the color. Certain of these agents not only destroy the color but also improve the bread-making characteristics of flours to which they are added. Bakers also stress the production of whiter

Exteriors and interiors of loaves of bread made from unbleached flours that had received (A) no oxidizing or improving agent, (B) a mild treatment and (C) a heavy treatment.
bread with fluffier texture and thinner cell walls by using bleached flours and dough improvers.

Flours made from winter wheats usually require heavier treatments with both bleaching agents and dough improvers than do those produced from spring and soft wheats.

Bleaching agents and dough improvers are (or contain) oxidizing agents which not only destroy the coloring matter but most likely act upon a very labile sulfur group (thiol) which is directly or indirectly associated with the flour proteins, and may greatly affect the properties of the flours or doughs. Up until the present time, no satisfactory methods have been presented that quantitatively measure the amount of this group or the changes which it undergoes during oxidation. This is due to the presence in flour of a mixture of reducing groups and the inability of methods to differentiate between them.

A spectrophotometric method has been worked out in this laboratory for the quantitative determination of thiol groups in flour preparations. It is based on the fact that the total reducing value in flour (thiols plus other reducing substances) can be determined by oxidizing with a dilute ferricyanide solution and on the further fact that active thiol groups may be covered or rendered inactive by reaction with certain organic mercury compounds, such as phenylmercuric acetate. After covering in this way the non-thiol reducing groups may then be determined with dilute ferricyanide. The difference between the two reducing values is equivalent to the thiol that has been covered. The effects which oxidizing and reducing agents have on flour and doughs and the change which the thiol groups undergo during fermentation and aging are being studied by this method.

R. M. Sandstedt, B. D. Hites.

Factors Involved in Bread Staling

To the consumer, bread staling appears to be largely a drying-out process with some accompanying changes in flavor. However, bread undergoes these staling changes even though sealed in a container to prevent moisture loss. Accordingly bread staling is now considered as a change in the character of the starch of the bread which causes the bread crumb to become hard and crumbly and causes a loss of natural flavor and the development of a stale taste.

Staling is the cause of considerable economic loss. In 1942 the return of "stales" (stale bread from the store to the bakery) was said to have been responsible for waste equivalent to 250,710,000 loaves of bread or the waste of about 184 million pounds of flour. The present critical food situation with the consequent need for food conservation serves to emphasize the importance of bread staling as a food conservation problem. Despite starvation in other parts of the world countless loaves of day-old bread are being discarded or sold as livestock feed in the United States. Consequently, an intensive study of the fundamentals of bread staling and of methods of preventing staling is in progress in this department.

In order to interpret the changes that occur in the starch of bread on staling it was first necessary to obtain information concerning the changes that occur in normal starch during treatments simulating the baking of bread. This leads to an extensive study of starch gelatinization (gelatinization is a term denoting the swelling and solubilization of
starch due to heating in water). This study has yielded valuable information and has furnished a foundation for further staling studies.

The study is cooperative with the Committee on Food Research of the Quartermaster Food and Container Institute for the Armed Forces.

R. M. Sandstedt, B. D. Hites, Robert Gates.

**Proteolysis in Wheat Flour Doughs**

The studies reported last year were extended to show the effects of oxidizing and reducing agents on the proteolytic enzymes and on the susceptibility of the flour proteins to enzyme attack.

The activity of the naturally occurring flour enzyme system was found to be unaffected by the presence of moderate amounts of bromate, sulfite, glutathione, salt or sugar in yeasted and non-yeasted doughs. On the other hand the activity of papain (a proteolytic enzyme of plant origin) was found to be increased by the presence of glutathione but its activity was not affected by sulfites. This is additional evidence that the softening effect of reducing agents on dough is not necessarily due to proteolytic enzyme activation since both glutathione and sulfite will cause soft, sticky doughs.

Papain attacked the protein of flours which had been moderately bleached with agene and benzoyl peroxide to about the same extent as it did the proteins of unbleached flours. But heavy treatment with these agents produced changes in the proteins making them more resistant to proteolytic attack. It was expected that heat treatment also would produce more resistant proteins. However, this did not happen; the heat treated proteins were about as susceptible to proteolysis as the untreated.

R M. Sandstedt, B. D. Hites.
Insect Control Experiments

Department of Entomology

Insect Surveys

Wheat and alfalfa were the crops most seriously damaged by grasshoppers during 1947. Following these in order of their importance were corn, truck crops, beans, barley, potatoes, sugar beets, oats, clover and other legumes.

The long, cool, wet spring failed to cause heavy mortality of grasshopper nymphs, but did delay hatching of eggs. This delay retarded the control program. Natural enemies and diseases were of minor importance in control during the summer.

A total of 1,920 farmers in 22 counties used approximately 688 tons of bait (dry weight) in baiting and rebaiting an estimated 155,800 acres of crops, pasture and marginal land areas.

Chinch bugs were numerous in hibernation during the winter of 1946–1947. The wet, cold spring with heavy rains reduced the population until there was no damage reported and no barrier material used. The 1947 fall survey showed the lowest hibernating population in several years.

Serious damage by Hessian fly in the fall of 1946 and spring of 1947 was reported from Dundy, Chase, Perkins and Keith counties with moderate infestations reported in Hitchcock, Hayes, Deuel and Cheyenne. The summer survey, made during July, showed heavy infestations in Chase, Perkins and Keith counties, with light to moderate infestations in several others. The extremely hot weather of August and early September, however, all but wiped out the infestation before seeding time. A survey of the southeastern quarter of the state in late July and early August showed a very low Hessian fly population. No county in that area had enough Hessian fly to constitute a serious problem and it was noted that the almost universal sowing of fly resistant Pawnee wheat had practically eliminated Hessian fly in many counties.

In general the potato insect infestation was relatively light throughout the state. However, potato leafhoppers were responsible for considerable injury in eastern Nebraska. Flea beetles continued to become more troublesome in the early commercial potato areas, where some tuber injury occurred. In western Nebraska psyllid populations remained extremely low throughout the season and tuber flea beetles caused less trouble than they have for a good many years. Grasshoppers were the most serious potato pests over the entire western area.

Following an increase in the number of requests for knowledge of the biology and control of alfalfa insects, surveys were initiated to determine presence and populations of economic species. In 1947 alfalfa fields on irrigated and dryland were sampled throughout the state. It is hoped that this survey will give information on pollinating insects, as well as injurious insects.

The European corn borer was found in 27 Nebraska counties in 1947 compared with six infested counties in 1946 and none in 1945. The infestation is not great enough to cause immediate serious damage. Spread has been mostly along the river valleys. Control measures should not be necessary in 1948, but some of the eastern counties that were infested in 1946 may have serious injury in sweet corn.
In 1946 serious damage to first-year plantings of sweetclover by the sweetclover weevil, *Sitona cylindricollis* Fahr, was reported for the first time in Nebraska. Early in 1947 preliminary surveys revealed heaviest damage and highest weevil populations in the eastern border counties with spotted and light infestations of this or a closely related species throughout the eastern half of the state. Moderate infestations were also found in several localities in the vicinity of Curtis and McCook.

Research studies on the control of this insect were indicated. Some testing of varieties of sweetclover for resistance to weevil damage was begun and plans were made for insecticidal tests with some of the new chlorinated insecticides.

Following the discovery of a joint worm damaging rye in Holt county in 1946, surveys were conducted. In 1947 surveys, damage from the insect was found to be localized and confined mainly to rye in a small area north of Atkinson. A number of fields were rather heavily infested. Specimens were collected for rearing to determine the exact species present.

An outbreak of the garden webworm, *Loxostege similalis* Guenee, on alfalfa and sugar beets in the southern and eastern parts of the state occurred during the year. Surveys were conducted to determine the size and extent of the infestation and the number and species of parasites present in the fields. It was found that two braconid parasitic wasps were present in large numbers and insecticidal treatment was not recommended. The parasites controlled the infestations and reduced populations to the point where little or no damage is expected in 1948.

**Experiments**

**Grasshopper control with new insecticides.** Tests with new insecticides for the control of grasshoppers were continued. In field experiments benzene hexachloride and chlordane were used in both the dust and spray form with excellent results. The materials were applied with power sprayers and dusters to alfalfa and sweetclover fields, weedy grain stubble and irrigation ditch banks. Forty-eight hours after application, population reductions of 85 and 88 per cent were recorded for plots treated with 1 pound of chlordane per acre compared with reductions of 97 and 99 per cent where ¼ pound of gamma benzene hexachloride was used per acre. Twenty-six days following the treatments, there was still an average of 74 per cent fewer grasshoppers in the chlordane plots and 81 per cent fewer in plots treated with benzene hexachloride than was present at the time the materials were applied. Comparable untreated check areas showed a reduction of only 16 per cent after 26 days. Although the residual effectiveness tended to be greater when the materials were used in dust form, differences between sprays and dusts were not statistically significant. Likewise, there was no apparent difference in the residual toxicity between benzene hexachloride and chlordane in these tests.

In limited outdoor cage tests chlordane (1 per cent) and benzene hexachloride (1 per cent gamma) dusts were compared with a dust containing 20 per cent chlorinated camphene and a 1 per cent parathion dust. Parathion and benzene hexachloride gave the quicker kills but after 48 hours the mortality was essentially equal in all cages.

Roscoe E. Hill, Ephriam Hixson,
Chinch bug barrier tests. In some barley rotation plots at the Have­lock farm, chinch bugs developed in considerable numbers. Several chemicals were tested to determine their effectiveness in preventing migration of the bugs into corn.

Barriers of 1 to 1 1/2 inches in width were made with Dinitro-O-Cresol, a standard barrier dust, benzene hexachloride gamma 1 per cent and 6 per cent, parathion (3422) 1 per cent and chlorinated camphene 20 per cent.

The benzene hexachloride at both 1 per cent gamma and 6 per cent gamma prevented the chinch bugs crossing for eight days after application. On the second day after application it rained 0.47 inch and on the fourth day 0.46 inch. After the two rains, bugs were passing only where the barrier was washed away. The bugs were killed in large numbers as far as 2 feet inside the barrier.

The chlorinated camphene held well for two days but the first rain reduced its effectiveness. Its killing power was much less than the benzene hexachloride. Parathion (3422) was an effective repellent, but was completely eliminated by the first rain. Its killing power was lower than the other two chemicals.

Ephriam Hixson.

Potato insect control with DDT and chlordane. Two tests designed to compare the effectiveness of chlordane and DDT dusts and sprays were conducted on non-irrigated plots of Red Warba potatoes at Lincoln. In one plot sprays only were used and the formulations were (1) one pound of chlordane (emulsion form) per 100 gallons of water, (2) one pound chlordane (emulsion form) plus 1 1/2 pounds cuprous oxide per 100 gallons of water, (3) one pound of DDT (wettable powder) per 100 gallons of water, (4) one pound of DDT plus 1 1/2 pounds cuprous oxide per 100 gallons of water, and (5) untreated check. In the second plot a spray containing 1 pound of DDT per 100 gallons of water was compared with dusts composed of 3 per cent DDT in sulfur and a commercial mixture containing 3 per cent chlordane.

Light to moderate insect infestations were present. All treatments significantly controlled flea beetles and Colorado potato beetles. DDT gave excellent control of the potato leafhopper and correspondingly reduced hopperburn, but chlordane was ineffective against this insect and did not reduce the amount of hopperburn. Although the plants treated with DDT averaged larger in size, the differences were not statistically significant.

Both sprays containing DDT increased the yield of A-size potatoes 35 per cent in the first test. In the second experiment the yields were increased 7 per cent by DDT spray and 26 per cent by DDT dust. Chlordane failed to increase yields. In fact slight decreases were recorded in both experiments. At harvest the specific gravity of potatoes from plots sprayed with DDT was significantly higher than that recorded for potatoes from untreated check or chlordane-treated plots.

A replicated field test was conducted at the Box Butte Experiment Farm to determine the value of using DDT on dryland potato fields as a regular yearly practice irrespective of local insect infestations. This was a continuation of the work begun in 1946. Three dustings of 3 per cent DDT in sulfur were compared with no treatment. As in 1946, a very light insect infestation was present. An insignificant gain of 5 per cent or 4.8 bushels per acre was harvested from the treated plots.
Response of potato varieties to control of insects. A test was initiated for the purpose of obtaining information regarding the effects of insect control with DDT on the growth, quality and yields of various potato varieties. Fourteen varieties of potatoes were planted in eight plots in a non-irrigated field at Lincoln. Four of the plots were sprayed four times during the season with DDT and four were left untreated. The potato leafhopper was the most important pest present. Tubers were harvested on two different dates. The mean average increase in total yield due to spraying (all varieties) was 11.5 per cent (or 31.4 bushels per acre) for the early harvest date and 32.8 per cent (or 92.3 bushels per acre) for the late harvest date. Similarly, per-acre increases in A-size potatoes were 12.2 per cent (or 24.4 bushels) and 37.7 per cent (or 77.1 bushels), respectively.

The growing season of the early maturing varieties was lengthened materially by spraying. Greatest responses, as measured by yield increases, were recorded for Triumph and a variety numbered 97.41–1. Leafhopper infestations were heaviest on these two varieties. Red Warba, Katahdin, Nebraska 2, Teton, Irish Cobbler and 85.41–1 responded well to spraying with respect to yield.

The quality as expressed in specific gravity seemed to be improved in certain varieties by spraying. There also was some evidence from these preliminary data indicating that the ascorbic acid content was greater in those tubers harvested from plots where insects had been controlled. This study, which will be continued, is being conducted in cooperation with the Department of Horticulture.

Biological studies of the tuber flea beetle. For three years the tuber flea beetle has been of little importance in western Nebraska. Spring weather conditions have been unfavorable for emergence and early seasonal development. Lack of extensive plantings of early potatoes, and the use of DDT are contributing factors.

Further biological studies were made during the past season. Cage studies under controlled laboratory conditions indicated that fertility of the soil is a factor in the fecundity of tuber flea beetles. Beetles fed potato foliage from plants following three years of alfalfa in a six-year rotation laid significantly more eggs than did those fed foliage from potatoes in a two-year rotation in which potatoes are alternated with sugar beets. Intermediate numbers of eggs were laid in cages by beetles fed potato foliage from a three-year rotation without alfalfa and a four-year rotation where potatoes followed one year of alfalfa.

Approximately 170 potato seedling lines were tested at the Scottsbluff Substation for resistance to larval damage by tuber flea beetles. In this particular plot a heavy infestation of flea beetles occurred so that a severe test was possible. Tuber examinations at harvest time revealed nine lines that appeared to have some degree of resistance. These may have some merit in a breeding program. This study is cooperative with the Department of Horticulture.

Control of corn rootworms with insecticides. Although the northern and western corn rootworms are effectively controlled by crop rotations, attempts to develop supplementary control measures have been undertaken during the past few years. In 1947 experiments were conducted with soil applications of benzene hexachloride and DDT on an irrigated farm near Lexington and at the North Platte Substation under dryland

Roscoe E. Hill.
Representative roots from corn plants growing in soil near Lexington which was treated with benzene hexachloride gamma isomer for the control of corn rootworms. Root at left was taken from plot treated at the rate of 2 pounds per acre, and root in the center is from a plot treated at the rate of one-half pound per acre. Root at the right is from an untreated check plot.

conditions. In one experiment, designated as a pre-plowing test, the materials were sprayed on the surface of the ground one day ahead of plowing and about a week before the corn was planted. In another—a side-dressing test—applications were made with a fertilizer applicator just prior to the first cultivation. At North Platte benzene hexachloride was sprayed on the soil between the rows of corn at the time of first cultivation.

Technical DDT at the rate 5 and 10 pounds per acre was no better or only slightly better than the untreated plots on the basis of larval counts made on July 31. Benzene hexachloride gamma isomer at the rate of ½, 1 and 2 pounds per acre applied before plowing, or 0.8, 1.6 and 2.4 pounds by side-dressing just prior to the first cultivation, materially reduced the larval population and almost eliminated lodging and root injury. Actual yields did not show significant increases due to any treatment. However, when yields were corrected in the side-dressing test so as to exclude ears on stalks lodged 60 degrees or more, they were shown to be significant.

At North Platte stalk damage in untreated corn following corn was significantly greater than in plots where corn followed wheat or was treated with benzene hexachloride. However, the yields failed to differ. The latter test was in cooperation with the North Platte Substation.

A test of the effectiveness of DDT mixtures applied by airplane in the control of corn rootworm adults was conducted at Cozad. Ten acres of a moderately infested 30-acre field were dusted at the rate of 30 pounds to the acre with 3 per cent DDT in pyrophyllite in early August, 10 acres were dusted in late August and 10 acres were left untreated. Adult mortality in the treated plot approached 100 per cent but signifi-
cant increases in yield of treated over untreated plots were not obtained. Results of the treatments on the following year's crop and infestations will be obtained in 1948.

RoScoe E. Hill, ephriAM hixson, Martin h. MumA.

Alfalfa seed production studies. To test the efficiency of 10 per cent DDT dust in increasing alfalfa forage and seed yields by insect control, replicated plots were established on the Stevens Creek and Rogers Memorial Farms. Plots were dusted at the 6-inch growth and pre-bloom stage and ranged from no dust to one, two or four applications. Results of the various tests were as follows:

1. There was no noticeable increase in plant growth in the treated plots, although a large population of pea aphids was controlled. No forage yields were obtained due to the excessive rainfall.

2. There was a fair seed set on the first crop, but due to the length of time required and the increased lygus bug population, no good quality seed was produced. Therefore yield data were not taken.

3. Control of insects in the first crop had no effect on seed yield of the second crop.

4. Insect control during the second crop growth did reduce the lygus bug population. However, there was no significant increase in seed yield. The cleaned seed yield ranged from 169 pounds to 225.5 pounds per acre on the Stevens Creek Farm and from 339 to 399 pounds at Rogers Farm. The number of applications did not always affect the yield.

5. The only important pollinators at the two tests were wild bees, mostly Megachile species known as leaf-cutter bees.

6. Honey bees placed within about 250 yards of the Rogers Farm test showed no interest in the alfalfa during full bloom. Competition from clover was a factor early, but during the midsummer period when clover was not in bloom, the honey bees still showed no interest.

This work was cooperative with the Department of Agronomy.

ephriAM hixson, c. a. sooTer.

Effects of pollen substitutes on spring package bees. The purposes of this experiment were to determine the value of the use of pollen substitutes in Nebraska, compared with no substitutes, and the comparative value of various types and mixtures of substitutes. Tests were conducted on 100 colonies started as package bees in the spring of 1947. Various proportions of ingredients in pollen substitutes were used. The two main divisions in types of substitutes were soybean flour-yeast and distillers' solubles-yeast mixtures.

While unfavorable and unusual weather conditions of the 1947 season did much to nullify many of the possible indicative results of this experiment, certain trends seem sufficiently in evidence to warrant attention to the future:

1. The manner in which the bees readily used the pollen substitutes prior to the appearance of natural pollen and the slowing down and their later neglect in the use of the substitutes seems definite proof that pollen substitutes should be provided as early as possible in the spring. Perhaps the receipt of package bees as early as March 15 might be feasible.

2. The use of soylflour alone in the cake form is not satisfactory compared with the other mixtures.
3. Pollen substitutes composed of distillers' solubles and yeast provided the best average gains, the highest total gains, and the least loss due to queen failure. Such performance is worthy of further investigation.

ROBERT J. WALSTROM, EPHRIAM HIXSON.

Carrot weevil control tests. The carrot weevil, Listronotus oregonensis (Lec.), has become an increasingly important pest in eastern Nebraska within the past few years. In some localities it is almost impossible to raise carrots free from larval damage. Experiments have been started in an effort to develop better control measures for this insect. In 1947 a small replicated test was conducted at Lincoln to determine if a 3 per cent DDT-pyrophyllite dust applied at various times during the season to the plants and soil surface could reduce the injury. The carrots were planted May 6 and dust applications were made on June 14 and 27 and July 28. Some plots received only the first, second or third applications and others were given all three or combinations of these. On September 23 the carrots were harvested. From 26 to 59 per cent of the carrots from the various plots had been injured. None of the treatments had been effective. This may have been due to improper timing of application and indicates that additional control and life history work is needed.

ROSCOE E. HILL.

Hog mange control with new insecticides. The sarcoptic hog mange control tests conducted during 1947 represented a continuation and expansion of the experimental program initiated in 1946. In addition to benzene hexachloride, which is proving effective for the control of sarcoptic mange, two additional chemicals, sulfur emulsion and chlordane were tested. Hand spraying equipment and lower dilutions of benzene hexachloride were emphasized.

Sulfur emulsion, 1 gallon in 9 gallons of water, failed to give complete control in a single treatment. Chlordane used at a dilution of 0.25 per cent in the emulsion form gave control in one test but in the wettable dust form failed to control in another test. The following table gives some of the results of the benzene hexachloride tests.

<table>
<thead>
<tr>
<th>Number animals</th>
<th>Per cent gamma is over dilution</th>
<th>Equipment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>89</td>
<td>0.25</td>
<td>Power</td>
<td>Clean after 5 mos.</td>
</tr>
<tr>
<td>29</td>
<td>0.25</td>
<td>Power</td>
<td>Clean after 1 mos.</td>
</tr>
<tr>
<td>12</td>
<td>0.50</td>
<td>Power</td>
<td>Clean after 2 mos.</td>
</tr>
<tr>
<td>63*</td>
<td>0.50</td>
<td>Hand</td>
<td>Infested after 3 mos.</td>
</tr>
<tr>
<td>55</td>
<td>0.50</td>
<td>Hand</td>
<td>Clean after 1 mos.</td>
</tr>
<tr>
<td>68</td>
<td>0.12</td>
<td>Power</td>
<td>Clean after 3 mos.</td>
</tr>
</tbody>
</table>

* Treatment believed to have been incomplete.

A test to determine the possible absorption of benzene hexachloride into hogs was conducted in cooperation with the Animal Husbandry and Home Economics Departments.

Animals treated with 0.25 per cent gamma benzene hexachloride were compared with untreated animals of the same size. Slaughters were made 17 and 56 days after treatment. Hams, shoulders and rib roasts under code numbers were roasted at even temperatures in separate
ovens and tasted by a group of six persons. Opinions of off-flavor and odor were evenly divided between treated and untreated animals and it was decided that no detectable odor or taste due to benzene hexachloride existed.

**Ephriam Hixson, Martin H. Muma.**

**Benzene hexachloride absorption by poultry meat.** Accidental discovery that chickens retained in chicken houses treated with 0.25 per cent of the gamma isomer of benzene hexachloride picked up a strong chemical taste led to a test to determine the mode of entrance of the chemical.

Twenty White Leghorn two-pound cockerels were divided into four lots. Five were fed a 1 to 200 mixture of benzene hexachloride containing 6 per cent gamma isomer in mash-grain feed, five were sprayed with 0.25 per cent of the gamma isomer of benzene hexachloride, five were retained in a house previously treated with 0.25 per cent of the gamma isomer of benzene hexachloride and five were left as untreated controls.

Comparative samplings of roasted birds showed that all treated lots became contaminated and retained the taste and odor for 10 weeks while the control birds remained untainted. This test was cooperative with the Departments of Poultry Husbandry and Home Economics.

**Ephriam Hixson, Martin H. Muma.**

**Chicken mite control tests.** While conducting control tests in 1946 on the chicken mite, *Dermanyssus gallinae* DeGeer, differential residual kill periods with the same insecticide were observed. The various kill periods were found to be connected with the various solvents used. Test work designed to determine the cause of this variation was initiated and will be continued in 1948. Tests to determine the effects of complete and incomplete or intermittent treatments with DDT and pentachlorophenol on chicken mite populations were also initiated but will not be completed until some time in 1948.

**Martin H. Muma, Ephriam Hixson.**

**Barn sprays for housefly and stablefly control.** The rapid development of new chlorinated insecticides with the accompanying favorable commercial claims concerning their effectiveness has indicated the need for comparative tests of these chemicals. During the past year the Department conducted an exploratory test of DDT, DDD, chlordane, chlorinated camphene and methoxy DDT as premises treatments for the control of houseflies and stableflies.

Ten dairy barns were used in the test and each insecticide was used at a 2 per cent concentration in two barns. The population sampling method consisted of exposing fly paper on hanging laths 18 inches long at a rate of 1 square foot of fly paper to 1,000 square feet of barn ceiling. Samplings were made at weekly intervals for a 24-hour period. Fly populations were sampled three times prior to treatment and 12 times following treatment. The last reading was made on October 11.

Although not considered conclusive due to the limited and exploratory nature of the test the following results seem to be indicative.

DDT reduced housefly populations below 10 flies per sample for seven to ten weeks, and methoxy DDT for five to six weeks. DDT took five weeks to reduce stablefly populations below 20 flies per sample, methoxy DDT five weeks, DDD four weeks, chlorinated camphene six weeks and chlordane eight weeks.
Cattle Feeding Investigations

Relation of the ration to incidence of lithiasis, anasarca, and pathological liver condition. This work was a continuation of work previously reported. Six lots of 10 steer calves were fed for 140 days on ground white corn and low-carotene roughages plus 1.15 pounds of supplement per head daily. The supplements were pelleted mixtures of the following in per cent by weight: 94.7 soybean oil meal, 5.3 steamed bone meal; 82.75 dehydrated alfalfa meal, 8.99 urea, 8.26 steamed bone meal; 23.1 soybean oil meal, 62.57 dehydrated alfalfa meal, 6.75 urea, 7.58 steamed bone meal; 46.6 soybean oil meal, 42.03 dehydrated alfalfa meal, 4.57 urea, 6.8 steamed bone meal; 46.82 soybean oil meal, 41.57 ground oats, 5.24 urea, 6.37 steamed bone meal; and 46.47 soybean oil meal, 40.29 dehydrated sorghum, 6.18 urea, 7.06 steamed bone meal.

Two of the supplements contained no carotene, two averaged 21 mg., one averaged 13 mg., and one averaged 5 mg. carotene per pound. The trial was terminated after a shorter feeding period than in former trials due to difficult feed conditions. The effect of low-carotene diets was not reflected in significantly lower average gains but the lots fed the low-carotene diets did show somewhat more evidence of symptoms usually ascribed to A-avitaminosis, as evidenced by poor coats, slight anasarca, and some impairment of vision.

Dehydrated alfalfa meal and urea; ground oats and urea; and dehydrated sorghum and urea were satisfactory as partial or complete substitutes for soybean oil meal in the supplements used in this trial.

Marvel L. Baker, V. H. Arthaud, L. E. Hanson, W. J. Loeffel.

Use of dehydrated alfalfa meal and urea. Eight lots of fleshy yearling steers with an average initial weight of 675 pounds were fed from May 23, 1947, to October 10, 1947, a period of 140 days.

The basic ration consisted of a full feed of corn silage, and ground ear corn plus 0.10 pound steamed bone meal per head daily. The pelleted supplements fed per head daily to the eight lots were respectively,
1.5 pounds soybean oil meal; 2 pounds of a mixture of equal parts, by weight, of soybean oil meal and dehydrated alfalfa meal; 2.5 pounds of a mixture of one part soybean oil meal and four parts dehydrated alfalfa meal by weight; 3 pounds dehydrated alfalfa meal; 1.5 pounds dehydrated alfalfa meal; 1.5 pounds of a mixture of 47.5 per cent each of soybean oil meal and dehydrated alfalfa meal and 5 per cent urea; 18.4 per cent soybean oil meal, 73.6 per cent dehydrated alfalfa meal, and 8 per cent urea; 90.2 per cent dehydrated alfalfa meal and 9.8 per cent urea.

Performance of all lots from the standpoint of rate and economy of gain was satisfactory. The rate and economy of gain tended to increase as the proportion of dehydrated alfalfa meal in the supplement increased, which resulted in very good feed replacement values for the alfalfa meal. The substitution of urea for alfalfa meal and soybean oil meal was entirely satisfactory from the standpoint of rate of gain, and feed required per unit of gain.

Supplements fed the eight lots of steers contained respectively: no carotene, 59, 95, 116, 116, 54, 82, and 105 mg. of carotene per pound at the beginning of the trial. The loss of carotene from the pellets containing it as well as from samples of the dehydrated alfalfa used in their preparation ranged from 73 to 81.5 per cent during the trial. There was some loss of carotene in the pelleting process.

With the exception of the steers in Lot 5 fed one-half as much supplemental protein as the other lots, there was little difference between lots in market and slaughter data.


**Use of pasture in producing finished cattle.** Three lots of 11 Hereford yearling steers with an average initial weight of 484 pounds were placed on a 20-acre bromegrass pasture April 30, 1947. They had been wintered on prairie hay cut at three stages of maturity without supplemental feed. The calves wintered on early-cut hay made an average winter gain of 44 pounds per head; the calves wintered on hay cut in midseason made an average winter gain of 18 pounds per head; and the calves wintered on late-cut hay lost an average of 11 pounds per head during the winter. Calves from each winter lot were distributed among the summer lots.

After 56 days on bromegrass, Lot 2 was moved to a 10-acre grama grass pasture and Lot 3 to a 10-acre buffalo grass pasture. Lot 1 was continued on the bromegrass pasture for a total of 98 days and then moved to a 10-acre grama grass pasture. The total grazing period for each lot was 140 days. Lot 1 made an average gain per head for the season of 243 pounds, of which 188 pounds were gained on bromegrass pasture and 55 on grama. Lot 2 gained an average of 96 pounds per head on bromegrass pasture and 140 pounds per head on grama grass, or a total of 236 pounds per head. Lot 3 gained an average of 101 pounds on bromegrass pasture and 127 pounds on buffalo grass, or a total of 228 pounds per head.

The bromegrass pasture provided an average of 115 days grazing for one steer per acre and produced an average of 212 pounds live weight gain per acre. The buffalo grass pasture was grazed an average of 92 days per acre by one yearling steer and produced an average of 140 pounds gain per acre. Two grama grass pastures were involved. The pasture grazed by Lot 2 was grazed an average of 92 days per acre by one steer and produced an average of 154 pounds gain per acre. The
grama grass pasture grazed by Lot 1 was grazed for only 42 days and was not fully utilized. It was grazed an average of 46 days per acre by one steer and produced an average of 61 pounds of gain per acre. This project was cooperative with the Department of Agronomy.


**Feeding corn cobs to fattening steers.** The third trial in this series was completed January 17, 1947. It was begun August 30, 1946, with yearling steers with an average initial weight of 740 pounds and continued for 140 days.

Basic ration for the three trials was sorgo silage, 1.5 pounds of soybean oil meal, and approximately 0.1 pound of ground limestone per head daily. In addition, one lot in each trial was full-fed ground shelled corn; one lot was full-fed ground ear corn; and a third lot was fed ground ear corn to which approximately 20 per cent of its weight of ground corn cobs had been added.

As an average of the three trials, the steers fed ground shelled corn made an average daily gain of 2.42 pounds; the steers fed ground ear corn, 2.35 pounds; and the steers fed additional ground corn cobs, 2.13 pounds.

Average daily corn consumption for the three groups, respectively, was 13.54 pounds ground shelled corn; 16.57 pounds ground ear corn which contained 13.5 pounds of corn; and 16.06 pounds of ground ear corn which contained 13.09 pounds of corn. The third group also was fed an average of 3.21 pounds of additional ground corn cobs per head daily.

Average daily consumption of silage per head for the three groups was 27.28, 16.73 and 6.11 pounds.

Average feed requirement for 100 pounds gain in live weight for the three lots respectively was 559 pounds ground shelled corn, 1,126 pounds sorgo silage, and 62 pounds soybean oil meal; 705 pounds ground ear corn (containing 574 pounds corn), 712 pounds silage and 63 pounds soybean oil meal; 753 pounds ground ear corn (containing 613 pounds corn), 151 pounds additional cobs, 286 pounds silage, and 70 pounds soybean oil meal.

The steers fed ground ear corn thus consumed 15 pounds more corn and 1 pound more soybean oil meal for 100 pounds of gain than the steers fed ground shelled corn, but consumed 414 pounds less silage. The steers fed additional corn cobs consumed 426 pounds less silage, but 7 pounds more soybean oil meal and 39 pounds more corn for 100 pounds of gain than the steers fed ground ear corn. They also consumed 151 pounds of corn cobs for 100 pounds of gain.

Shrink in shipment to market for the three lots averaged 5.68, 6, and 4.07 per cent; the carcass yield was 61.56, 61.25, and 59.61 per cent, respectively.

Market conditions were abnormal at the time of sale of these cattle and with one exception the three lots in each trial sold at the same price. In the first trial the three lots sold at $27.00; in the second trial the lot fed ground ear corn sold at $27.50, with the other lots at $27.00; and in the third trial all lots sold at $23.00. Carcass grades indicated that the steers fed ground shelled corn were somewhat superior to the other carcasses, whereas carcasses from the steers fed additional cobs were definitely inferior to carcasses from the other steers.

**Marvel L. Baker, V. H. Arthaud.**
Effect of time of cutting on the feeding value of prairie hay. This work was a continuation of work first reported last year. Agronomic data including yields of hay from different dates of cutting are presented under Field Crops Research in this report.

Eleven lots of steer calves with an average initial weight of 465 pounds were fed from November 27, 1946, to April 30, 1947, a period of 154 days. Three lots were fed on early-cut hay (June 25–29); three on hay cut in midseason (August 5–9); and three on late-cut hay (September 9–10). Two lots were fed on aftermath or second-cutting hay, cut on September 9 and 10 from the plots which produced the early-cut hay. One lot each of those fed the three regular cuttings of hay was wintered without supplemental feeding; one lot fed each of the regular cuttings of hay and one fed the second-cutting hay also were fed 0.63 pound of a 33 per cent protein linseed pellet per head daily. The other four lots were wintered on the four cuttings of hay plus 1.22 pounds linseed pellets per head daily.

Results were in general agreement with results from the work reported previously. In the 154-day period calves wintered on early-cut, and midseason-cut hay, without supplement made an average gain per head of 44 and 18 pounds, respectively, whereas the calves wintered on late-cut hay lost an average of 11 pounds per head.

The calves wintered on these three cuttings of hay (early, midseason, and late), plus 0.63 pound linseed pellets per head daily made an average gain per head of 126, 115, and 66 pounds, respectively. The calves wintered on the second-cutting hay plus 0.63 pound linseed pellets made an average gain of 118 pounds per head.

The calves fed 1.22 pounds linseed pellets made an average gain per head of 183 pounds where fed early-cut hay; 162 pounds on midseason-cut hay; 137 pounds on late-cut hay, and 173 pounds on second-cutting hay.

Crude protein contents of the hays, 12 per cent moisture basis, were; early-cut, 6.51 per cent; midseason-cut, 5.53 per cent; late-cut, 4.69 per cent; and second-cutting hay, 5.73 per cent. The lignin contents of the four hays were respectively 12.62, 14.21, 14.33, and 14.35 per cent.

This project was cooperative with the Department of Agronomy.


Improvement of dual-purpose cattle through breeding. This project for the improvement of milk and beef producing qualities of dual-purpose cattle and for study of factors involved in production of milk and beef was further developed. The transfer of the Milking Shorthorn herd from Valentine to Lincoln was virtually completed and the first milking of cows in the project was begun in the fall of 1946.


Improvement of beef cattle through application of breeding methods. This project was developed further in cooperation with the Western, and with the North Central states, and with the Bureau of Animal Industry.

Work with two lines of Herefords, one of Shorthorns and one of Angus at Lincoln was continued and foundation stock for several lines of Herefords at North Platte was obtained.

Feeding Milking Shorthorn steers. Seven Milking Shorthorn steers with an average initial weight of 680 pounds, from the herd at the Valentine Substation were fed for 168 days from September 24, 1946 to March 11, 1947.

During this period the steers consumed an average of 33.07 pounds of sorgo silage, 11.29 pounds of ground shelled corn, 1.52 pounds linseed pellets (33 per cent crude protein) and 0.14 pound ground limestone per head daily. They made an average gain per head of 371 pounds and an average daily gain of 2.21 pounds per head for the period. An average of 1,497 pounds of sorgo silage, 511 pounds of ground shelled corn, 69 pounds of linseed pellets and 6.5 pounds of ground limestone were consumed for 100 pounds of gain.

For the first 56 days of this feeding period, the steers were fed no grain. During this period they made an average gain of 127 pounds per head; consumed an average of 59.44 pounds of sorgo silage and 1.47 pounds of linseed pellets per head daily and required an average of 2,627 pounds of silage and 65 pounds of linseed pellets per 100 pounds of gain. During the last 112 days of the period the steers made an average gain of 244 pounds per head; consumed an average of 19.88 pounds of silage, 16.94 pounds of ground shelled corn, and 1.54 pounds of linseed pellets per head daily. In this period they required an average of 911 pounds of sorgo silage, 777 pounds of ground shelled corn and 71 pounds of linseed pellets for 100 pounds of gain.

The steers sold for $24.00 per hundred. It was not possible to obtain slaughter data on them but it was estimated that they would grade from "good" to "choice" in the carcass.


Swine Investigations

Distillers' solubles in dry lot rations. Two additional dry lot experiments with growing fattening pigs were completed in 1947. Results were somewhat different from those obtained in previous experiments, but they do support the previous findings that distillers' solubles are a useful protein supplement for swine feeding.

In one experiment, five lots of 15 pigs each were self-fed shelled yellow corn and a protein supplement, free choice. Each lot also was self-fed a simple mineral mixture. The protein supplement fed to the control pigs consisted of equal parts, by weight, of tankage, soybean meal, and artificially dried alfalfa meal. For Lots 2, 3, and 4, distillers' solubles were substituted for the alfalfa meal, soybean meal, and tankage, respectively. For Lot 5, the supplement consisted of equal parts of tankage, soybean meal, alfalfa meal, and distillers' solubles.

In the second experiment, five lots of 10 pigs each were self-fed a mixed ration according to the same scheme used in the first experiment. In this test, however, the various mixed supplements were added to ground yellow corn at levels sufficient to insure that all rations contained the same level of crude protein. The amounts of supplement used were sufficient to provide levels of protein as follows: pigs from 40 to 125 pounds in weight, 18 per cent; from 125 to 200 pounds, 14 per cent. The average protein content of the various rations for the entire feeding period was about 16 per cent.

The distillers' solubles used in these experiments were produced from 90 per cent corn and 10 per cent barley malt, according to the manu-
It will be noted that none of the rations produced outstanding results. The extremely hot weather during much of the feeding period probably was a factor in the slow rate of gain. The rations fed to the controls in these experiments produced relatively better results than in the experiments reported last year. The alfalfa meal used in the 1947 experiments was of exceptionally high quality. It was harvested only a short time before it was used and contained 22.4 per cent protein.

Results obtained with the mixed ration fed to Lot 5 are of doubtful value. During the first phase of the feeding period (i.e., from a weight of 40 pounds to a weight of 125 pounds), this lot of pigs grew at a more rapid rate than any of the other lots except Lot 1, and they were equal to this lot. However, during the latter part of the last phase of the feeding period their performance was very poor, due at least in part to influenza.

Again the "all plant" supplement fed to Lot 4 produced as rapid gains as any of the other mixtures. At current feed prices, this mixture of distillers' solubles, soybean meal, and alfalfa meal was the most economical of all of the mixtures used.

Rearing pigs in a restricted environment. Production of pigs, in confinement, was continued in 1947. Good growth was obtained on the rations fed, but more breeding difficulties were encountered than in 1946. The use of 20 per cent alfalfa meal in the gestation rations did not produce satisfactory results during the lactation period.

Five gilts which were farrowed in April and May, 1946, were fed with four littermate barrows. Their record up to November 16, 1946, was reported last year. From November 16, 1946, to April 12, 1947 (147 days), the gilts grew from an average weight of 181 pounds to a weight of 468 pounds, at a rate of 1.95 pounds daily per head. They required 456 pounds of feed per 100 pounds of gain. The ration was composed of ground corn, 10 per cent alfalfa meal, 5 per cent distillers' solubles, tankage, soybean meal, linseed meal, bone meal, salt, and irradiated yeast. They were bred in December, 1946, and January, 1947. Two of the gilts did not farrow, and they showed no signs of recurring estrus. The other three gilts farrowed 22 pigs and weaned 15, 10 of these by one gilt. None were stillborn. Weaning weights of the large litter varied from 9 to 24 pounds, with most of the pigs weighing less than 20 pounds. The other five pigs were raised by one sow and

<table>
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weighed from 25 to 45 pounds at weaning (eight weeks). Eight gilts from these litters are being used in a study of the vitamin E requirements of swine. Seven of the pigs were boars.

The boars, at weaning, were placed on a ration similar to that of their dams, but including more tankage and soybean meal and less corn. In all of these tests the protein content of the rations was varied by altering the proportions of corn, tankage, and soybean meal. The alfalfa meal usually was fed at a 10 per cent level, and distillers' solubles made up 5 per cent of the mixture. Linseed meal was fed at a 2 per cent level, 0.5 per cent each of steamed bone meal and salt was used, and 6 grams of irradiated yeast were added to each 100 pounds of mixture.

The boars had an initial weight of 37.7 pounds and were fed for 105 days. They made an average daily gain of 1.44 pounds and required 359 pounds of feed per 100 pounds of gain. Late in the feeding period it was noted that one of the pigs was a cryptorchid. This pig made very poor gains, especially during the last several weeks of the feeding period. The average gain for the other six boars was 1.55 pounds daily. These boars were used to breed a group of surplus gilts, and later were sold to farmers who agreed to supply breeding records. Results of these fertility tests will not be available until 1948.

Forty-two pigs were raised in the 1946 fall crop reported last year. Ten gilts from this group were selected to continue the stock, and nine gilts were used in the vitamin E study reported in the following section. Of the ten gilts selected to continue the stock, three were third-generation animals (on concrete), and the rest were second-generation stock. These gilts were fed rations similar to those fed to the pigs mentioned above except that 5 per cent alfalfa meal was fed during the growing period, 20 per cent alfalfa meal was fed during the gestation period, and 10 per cent alfalfa meal was fed during the lactation period.

Two of the second-generation gilts had not shown any signs of estrus by July 11 (nearly 11 months of age) and they were discarded. One third-generation gilt was bred on two consecutive days in each of two consecutive estrous periods, but did not settle. She was discarded. Of the remaining seven, two that appeared to be pregnant were discarded, and a third gilt which had been bred, but was not pregnant, was discarded.

The remaining four gilts farrowed 43 pigs, four of which were still-born. They weaned 20 pigs at weights ranging from 7.5 to 26 pounds. These pigs were large, vigorous pigs at birth, weighing as much as 3.8 pounds. At weaning many of them were lacking in vitality and several succumbed to infections at various intervals later. Six of the gilts are being fed to continue the stock.

L. E. Hanson.

**Vitamin E requirements for growth and reproduction in gilts.** Preliminary experiments were initiated in 1947 in an effort to determine whether or not gilts require vitamin E for growth and reproduction. Nine gilts, whose dams were reared in confinement, on concrete floors, and fed a ration of natural feedstuffs, were used in this first trial. The gilts were placed in three pens. One group was fed a ration of natural feedstuffs, previously shown to be adequate for growth and fertility, according to accepted standards. The other two groups were fed equal amounts of a purified ration. The three gilts in one of these groups were fed a weekly supplement of alpha tocopherol which was placed in gela-
tin capsules and given with a balling gun. Both groups of gilts fed the purified diet were given cod-liver oil once weekly, poured over the feed in amounts sufficient to insure adequate vitamin A and D intake. During the latter part of the trial a vitamin A and D concentrate (supplied by Distillation Products, Inc., Rochester, N. Y.), was substituted for the cod-liver oil. This product was placed in gelatin capsules and given once every 14 days.

The purified diet was composed of crude casein, corn starch, lard, brewers' yeast, and a complex salt mixture.

Rat assays were made on the brewers' yeast, and on the complete diet at various intervals. The brewers' yeast used would not support gestation in rats when fed in an otherwise E-free diet at the level used in the gilt rations. The complete gilt ration gave negative results with the rats only during the August assay. At that time the weather was exceedingly warm and the rations became very rancid.

Exceptional growth rates were obtained on the gilts fed the purified ration, whether or not they received the alpha tocopherol supplement. The best record was made by one gilt in the negative control group. She gained 437 pounds from March 1 to September 20 (203 days).

No difficulty was encountered in feeding this dusty, low-fiber ration. The gilts preferred to have water poured over the mixture before eating it. They reached a maximum consumption of 10 pounds daily per head. This consumption rate was reduced sharply with the advent of hot weather. The fecal output was rather small in comparison with the gilts fed the natural ration. Likewise, the feces were rather hard and more or less pelleted. However, no difficulty was encountered due to constipation.

Gilts in each lot farrowed and raised some pigs to weaning age. The boars from these litters are being fed according to the same plan as their dams.

Eight additional gilts, from sows reared in confinement on natural rations, are being fed according to the plan followed in the first test.

L. E. Hanson, I. L. Hathaway.

Improvement of swine through breeding. Fifteen crossbred gilts produced by Line 10 dams (North Platte herd), and 34 crossbred gilts from outbred dams (Lincoln herd), were selected to produce the 1947 crop of fall pigs. These gilts were sired by two Danish Landrace boars (U.S.D.A.) Of the 49 gilts, 14 were back crossed to two Danish Landrace boars (Iowa Station), 10 were back crossed to two Duroc boars, 12 were mated with crossbred boars of the same stock as the gilts, and 12 were outbred to two Berkshire boars. One gilt was not bred.

From these matings only two litters were sired by the Landrace boars, six litters were sired by the Duroc boars, seven litters were sired by the crossbred boars, and eight litters were sired by the Berkshire boars.

The 23 gilts farrowed 232 pigs, of which 20 were stillborn. From the 23 litters, 176 pigs were weaned. Twenty-two of these litters are being fed, by litters with a maximum of six pigs in a lot, according to the plan followed last year. Rate of gain, and feed consumption records are being secured.

This project is cooperative with the Regional Swine Breeding Laboratory.

M. L. Baker, L. E. Hanson, C. T. Blunn.
Sheep Investigations

Improving Corriedale sheep. The sheep breeding project to test ten Corriedale rams annually for more valid data to be used in selecting future sires was completed for the lamb-crop year of 1946, after shearing the lambs in January of 1947.

Average birth weights for the lambs by sires ranged from 10.06 to 12.23 pounds. Average fleece weights of the lambs by sires ranged from 5.28 to 7.71 pounds in the grease at approximately nine months of age. A shrinkage determination of a composite fleece sample by sires gave a range from 44.8 to 50.1 per cent. The samples were taken from the side of the shoulder at shearing time and averaged about one-fourth pound per lamb. After applying the shrinkage per cent, the clean wool produced per lamb by sires ranged from 2.85 to 4.09 pounds. When the lambs were marketed January 20, 1947, the average live weight of the shorn lambs by sires ranged from 82 to 107.6 pounds.

This year one of the sires ranked first in siring lambs with the largest birth weight, the largest fleece weight in the grease, the largest clean fleece weight and the largest final live weight per lamb when the lambs were marketed. Another ram ranked second in these measurements with the exception of fleece weight in the grease in which he was third, and in birth weight of lambs in which he was last of the 10 rams tested.

Of the rams tested this year, two were outstanding in performance when compared with all the rams in the test. Results this year show a greater range in performance than that shown by sires in previous experiments.

M. A. Alexander.
Improvement of Dairy Cattle

Factors affecting reproduction in a dairy herd. Studies of factors affecting reproduction in cows were continued. As cows in the University herd developed difficulties in regular breeding they were studied and a treatment was used which seemed to be indicated from the diagnosis. In general, if a cow or a heifer was bred three times without conceiving, she was examined on the fourth heat period to determine the trouble. If infection was found, efforts were made to eliminate that before other treatment was given. In some cases the corpus luteum was expressed (removed), and this started a new cycle. Cows and heifers with underactive ovaries had their ovaries massaged before a hormonal preparation was given. Animals that failed to show heat (estrus) over a long period of time were usually found to have persisting corpus luteum or corpus luteal cysts which, when discovered, were removed. Ovarian cysts were ruptured in females which showed signs of nymphomania. During the year 50 cases were treated (10 heifers and 40 cows). In a few cases animals failed to conceive on the first treated service and received further treatment. Each treatment was counted as a definite case. Altogether, 10 animals which had either normal or delayed estrous cycles and had small and apparently underactive ovaries were treated at the first sign of estrus with an injection of from 500 to 1,500 units of Gonadin (pregnant mare serum extract), and seven conceived.

Thirty-four females which showed follicular cysts and overactive ovaries were treated. Treatment consisted of intramuscular injections of Follutein (human pregnancy urine extract), the dosage varying from 1,000 to 10,000 I. U. on the second and third day after the estrous period. Treatment was considered successful if the females conceived on the day just prior to the treatment. Altogether, 18 animals conceived, a conception rate of 52 per cent.

One great difficulty in studying reproduction is that it is impossible to be sure that treatment is successful since there can be no certain way of determining that the animal would not have conceived normally without treatment.

H. P. DAVIS, A. B. SCHULTZE, J. A. McCROY.

Artificial insemination of dairy cattle. Operation of a bull stud containing more than 30 bulls, which during 1946 furnished semen for the insemination of more than 12,000 cows in 10 breeding associations, offered unusual opportunities for studying various phases of artificial insemination. For the year 1946 the conception rate was 56.54 per cent for the first two inseminations, based on non-returns at the end of 90 days. This is a slightly better record than was obtained the previous year when the figures were 51.35 per cent. A continuation has been made of a study to determine the rate of decline of semen fertility upon storage, and data will soon be presented for publication based on a study of approximately 20,000 inseminations in breeding associations throughout the state. It may be said that there was a steady decrease in fertility which was quite regular with semen stored up to four days before being used for inseminations.
Preliminary results on the effects of adding d, 1-thyroxine to bull semen used for breeding purposes indicate that the fertility of most semen samples is thus improved. Based on more than 1,600 inseminations a 6 per cent increase in conception rate resulted, but more work will be done before definite conclusions are drawn. A study of the effect of adding d, 1-thyroxine to bull semen has indicated that 1 microgram added to 10 ml. of diluted semen will increase oxygen consumption up to 30 per cent over control semen samples, when the sperm concentrations of the original semen samples are above 800,000 per milliliter. Semen samples having 600,000 sperm per milliliter or less did not show an increase, but in some cases showed a decrease in oxygen consumption by the addition of the same quantity of d, 1-thyroxine.

Various methods have been proposed for the evaluation of semen fertility, but unfortunately most of them are not highly correlated with breeding results in the field. A somewhat different approach has been made by the use of a physiologically inert cellulose solution of which a definite percentage solution has a fairly definite viscosity. By adding samples of semen to such solutions the viscosity level at which the motility of the sperm is stopped, is recorded. These results will be correlated with breeding results obtained with artificial breeding using the same sample.

H. P. Davis, A. B. Schultze.

Thyroid inhibitors for fattening dairy calves. Study was continued to determine if thyroid inhibitors would bring about more rapid fattening of dairy calves in three months of feeding at an average of approximately 2.5 grams of thiouracil daily per calf, beginning with the third day. Thirty bull calves of the Holstein, Guernsey, and Jersey breeds were started on this experiment. Half of these were fed thiouracil, a thyroid inhibiting substance, and the other half were used as controls. At the end of 14 to 15 weeks the animals were slaughtered and the carcasses placed in a cooler for a few days. The meat was then removed from the bones, ground, wrapped in oil paper, and stored at zero degrees F. The meat from the control animals and from those fed thiouracil has been fed to young rats to determine the effect of thiouracil upon the meat and the effect on the growth rate of rats, and on the size of their thyroid glands, livers, and kidneys. The first phase of this experiment will soon be finished and the data tabulated. This experiment is cooperative with the Animal Husbandry Department.


Improvement of Dairy Products

Cheese ripening. Ordinary American cheese (cheddar) was for many years made entirely from raw milk, but the present trend is to manufacture it from pasteurized milk. With the use of pasteurized milk, ripening of the cheese has been retarded—probably because the starter cultures used did not contain all the types of bacteria present in raw milk. At any rate the ripening of cheese made from pasteurized milk has presented certain problems. The slow ripening of cheese requires large inventories during ripening and makes production costly. Efforts have been directed toward the selection of bacterial cultures which might bring about more rapid ripening. Preliminary studies indicate that Streptococcus liquefaciens or similar “acidoproteolytic” cocci when added to the regular starter apparently slightly affected the rate of
ripening when the cheese was held at 65° F. for partial curing. No consistent increase could be attributed to these organisms when cheese was ripened entirely at 50° F. The flavor of the cheese in which the ripening had been accelerated was pleasing in general, although in some instances a "volatile acid" flavor was present. Cause of this flavor has not yet been determined. It may be stated that holding cheese at a temperature of 65° F. for from four to six weeks and then continuing the cure at 50° F. definitely increased the rate of ripening compared with cheese cured entirely at 50° F. Apparently no definite flavor defects were brought about by the partial curing at the high temperature. It was found, however, that ripening for only two weeks at 65° F. brought about no appreciable effect on the speed of ripening.

D. D. DEANE, H. P. DAVIS.

Cheddar cheese in Nebraska. Information gathered during the war when much cheese was made in the state for export is being adapted to the manufacture of domestic-type cheese. Principal factors in the production of a high-grade cheese have been found to be: complete pasteurization of the milk, suitable plant sanitation, and a uniform cheese making system. It has been proven that high-quality cheese can be made, and it no doubt will be produced in greater quantities in this state when milk supplies are available.

Suitable packaging and curing of such cheese has been given further study. The coliform count of dairy products by the violet red bile agar method has been found to be a valuable index of post-pasteurization contamination.

Inclusion of cottage cheese as a milk product in certain cities by the public health authority has made it desirable to study the process of manufacture from the sanitary viewpoint. Work thus far completed indicates that this cheese can be produced and marketed so as to meet the requirements for coliform count.

P. A. DOWNS.

Home milk pasteurizers. Electrical home milk pasteurizers are being studied in cooperation with the Home Economics Department. Special attention is being given the question of satisfactorily meeting public health standards.

P. A. DOWNS.

Vitamin content of commercial butter. Studies of the vitamin A value of Nebraska butter have been completed. Mean vitamin A potency for the 25 months studied was 18,876 ± 368 International Units (I. U.) per pound. During the winter months this mean was 13,692 ± 294 I. U. per pound, but during the summer months it was 22,465 ± 323 I. U. per pound. Average fat content of all samples was 81.2 ± 0.06 per cent.

I. L. HATHAWAY, H. P. DAVIS.

Vitamins in cheese. Forty-six different varieties of cheese were fed to rats to determine the thiamin (vitamin B₁) content. All of the samples contained less than 0.44 U. S. P. units of vitamin B₁ per gram of cheese. These data indicate that the cheeses were not rich sources of this vitamin.

I. L. HATHAWAY.
Extraneous matter in cream. Objectives of this project are (1) to standardize a procedure with respect to size of the sample and diluting medium for determining extraneous matter in churning cream, (2) to determine the types of extraneous matter in churning cream and (3) to determine the sources of extraneous matter in churning cream in order to suggest means of elimination and prevention.

A method which involves the dilution of the cream with two volumes of water at 180°F. or above followed by the addition of sodium hexameta phosphate (Calgon) and sodium bicarbonate has proven the most satisfactory of the methods tried. Very few samples have been encountered which could not be filtered after this treatment, but when filtering was impossible or difficult the results of the Parson mold test were usually in the lower grades. Yeasty cream, if free of mold, presented no filtering difficulty.

Filtering a 4-ounce sample of cream through a ½-inch disc permits retention of the extraneous matter on one disc in the case of cream which requires two or more discs for filtering a 1-pint sample. The grade of the disc obtained from the 4-ounce sample filtered through a ½-inch disc is similar to that obtained with a point sample filtered through a 1-inch disc where fine sediment is involved.

A relatively small quantity of filterable material was obtained by gravitation from barn air. Rodent-like hairs were found in barn air samples and also in samples taken in similar manner in cream stations. There appeared to be no relationship between barn structure and cleanliness, and the amount of extraneous matter obtained by gravitation from the air. Practice of recognized methods for producing clean milk reduced the extraneous matter in the milk appreciably.

The centrifugal separator was very effective in removing heavier pieces of extraneous matter. Cream separated from milk which had been run through a standard strainer pad was free from extraneous matter. Cream from farms where the freshly separated cream was clean showed some extraneous matter when received at the cream stations.

Microscopic examination of sediment discs of 2- or 4-ounce samples from 159 samples of cream received at the creamery during the months of July and August were made. Percentage of all sediment discs showing various types of extraneous matter was as follows: rodent-like hairs, 6.7 per cent; feather barbules, 9 per cent; insect fragments, 15.6 per cent; hairs (other than rodent), 25.3 per cent; manure fragments (exact identification impossible), 42.6 per cent; plant fragments, 85.5 per cent; threads (all colors), 87.3 per cent.

The project is being continued and the results reported must be considered as preliminary.

L. K. Crowe.
Rations for Poultry

Utilization of proteins by growing chicks and poults. Previous experiments have shown increased efficiency in the use of several different protein concentrates in rations for growing chicks and poults. In planning feeding programs, economic and nutritional principles are of equal significance, so a distribution of demand over several concentrates tends to maintain logical cost relationships. The use of several concentrates blended to provide additional proteins, vitamins and minerals to supplement farm-grown feedstuffs seems a logical approach to the poultry feeding problem.

Four combinations of ingredients were used in experimental rations. These are identified in the following table as concentrate formulas 24-C, 25-C, 26-C and 27-C.

<table>
<thead>
<tr>
<th></th>
<th>24-C</th>
<th>25-C</th>
<th>26-C</th>
<th>27-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Alfalfa meal (17 per cent plus)</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Meat scraps</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Fish meal</td>
<td>50</td>
<td>50</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Dried buttermilk</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Dried fermented solubles</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Salt mix No. 45</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Protein level, per cent</td>
<td>36.5</td>
<td>37.3</td>
<td>37.8</td>
<td>38.1</td>
</tr>
</tbody>
</table>

Growth-promoting value of the four concentrates is illustrated by the data in the table below.

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>775</th>
<th>776</th>
<th>777</th>
<th>778</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal Base C 1</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Concentrate 24-C</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>25-C</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>26-C</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>27-C</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Act. Sterol Blend (200 A. O. A. C. per g.)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Protein level (per cent)</td>
<td>21.13</td>
<td>21.45</td>
<td>21.64</td>
<td>21.76</td>
</tr>
<tr>
<td>Number chicks per lot</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Average weight at start (g.)</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Average weight at 28 days (g.)</td>
<td>320</td>
<td>329</td>
<td>332</td>
<td>313</td>
</tr>
<tr>
<td>Average weight at 56 days (g.) (male and female)</td>
<td>824</td>
<td>831</td>
<td>847</td>
<td>793</td>
</tr>
</tbody>
</table>

1 Yellow cornmeal, 300; millrun, 200; pulverized oats, 100.

The combinations of concentrates used in these experiments to supplement a typical cereal base of corn, wheat milling by-products and oats, were equally satisfactory. Relative cost and availability of ingredients will be the factors determining choice of these for use in poultry rations.

F. E. Mussehl, C. W. Ackerson.
Rations for Leghorn broilers. Further experiments were carried on to determine protein, vitamin and mineral requirements for growing Leghorn cockerels from four weeks to ten weeks of age. The particular problem was to investigate the need for supplemental riboflavin when certain low cost rations which included from 5 to 10 per cent of good quality alfalfa and 3 per cent of fermentation dried solubles were included in the basal ration. The following table summarizes the results of experiments with four lots of 100 Leghorn cockerels each.

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>779</th>
<th>780</th>
<th>781</th>
<th>782</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow cornmeal</td>
<td>23</td>
<td>22.75</td>
<td>19.75</td>
<td>28</td>
</tr>
<tr>
<td>Shorts</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Bran</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Pulverized oats</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>.....</td>
</tr>
<tr>
<td>Alfalfa meal (17 per cent protein)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Meat scraps</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fish meal</td>
<td>.....</td>
<td>.....</td>
<td>3</td>
<td>.....</td>
</tr>
<tr>
<td>Perurbation by-product solubles</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mineral mixture No. 45</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ribo-blend (1,000 gamma per g.)</td>
<td>.....</td>
<td>0.25</td>
<td>0.25</td>
<td>.....</td>
</tr>
<tr>
<td>D blend (200 D per g.)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Protein level (per cent)</td>
<td>21.7</td>
<td>22.3</td>
<td>23.3</td>
<td>22.1</td>
</tr>
<tr>
<td>Number cockerels per lot</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Average weight at 28 days (g.)</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>298</td>
</tr>
<tr>
<td>Average weight at 70 days (g.)</td>
<td>997</td>
<td>990</td>
<td>999</td>
<td>984</td>
</tr>
<tr>
<td>G. feed consumed per g. gain</td>
<td>4.1</td>
<td>4.2</td>
<td>4</td>
<td>4.1</td>
</tr>
</tbody>
</table>

All four of the rations used in the experiment gave excellent growth results with Leghorn cockerels. These rations have the dual virtue of relatively high biological value and generally low cost. With good equipment for brooding and feeding, the investment of seven pounds of low-cost feed to produce a two-pound "plus" Leghorn broiler at ten weeks can usually be anticipated as profitable.

The inclusion of Ribo-blend at a 0.25 per cent level in the ration did not improve the growth rate. Lot 782 demonstrates the practicability of leaving out the pulverized oats while increasing the alfalfa meal.

F. E. Mussehl, C. W. Ackerson.

Mineral requirements of chicks. Growing chicks have considerable adaptation to variations in mineral levels in the diet when most favorable conditions for mineral utilization are provided. A most important factor in mineral nutrition is vitamin D3, which can be provided with fish oils of proper quality, activated animal sterol or ultraviolet irradiation of the chicks.

For earlier experiments on mineral utilization (Sixtieth Annual Report) the most favorable conditions for calcium and phosphorus utilization were provided through inclusion of twice the usual amount of vitamin D3, plus exposure to direct sunshine when weather conditions permitted. It seemed possible that a better reflection of the optimum conditions for mineral utilization would be obtained if a ration believed to be adequate for all other factors but deficient in vitamin D3 were used. Such a ration was prepared using the same ingredients otherwise as were used in the earlier experiments. Three salt mixtures identified as
Nos. 45, 46, and 47 were used at 3 per cent levels. In each of the three lots were 158 pullorum-clean White Rock chicks. No vitamin D₃ was included in the initial rations and chicks were kept back of glass during the “D₃ deficient” period. Evidence of a nutritional deficiency soon appeared in all lots, the first case observed being in the lot receiving Ash Mix No. 47, 17 days after the experiment started. The following table summarizes the number of cases of apparent rickets in each lot at the end of 28 days. The deficiency first expressed itself in the larger chicks but at the end of the first 28-day period the rickets disorder was almost universal.

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>772</th>
<th>773</th>
<th>774</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash mix at 3 per cent level</td>
<td>45</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td>Number chicks per lot</td>
<td>158</td>
<td>158</td>
<td>158</td>
</tr>
<tr>
<td>Average weight at start (g.)</td>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Average weight at 28 days (g.)</td>
<td>202</td>
<td>191</td>
<td>205</td>
</tr>
<tr>
<td>Cases rickets at 28 days</td>
<td>101</td>
<td>102</td>
<td>99</td>
</tr>
<tr>
<td>Average weight at 56 days</td>
<td>637</td>
<td>646</td>
<td>637</td>
</tr>
<tr>
<td>Cases rickets at 56 days (D₃ added at 28 days)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The growth rate observed cannot be considered normal because of the arrested growth rate during the first 28 days.

The ash mixtures used (45, 46, and 47) were all adequate when vitamin D₃ was provided. No advantage was observed for any one mixture over the others when an inadequate amount of vitamin D₃ was provided.

F. E. Mussehl, C. W. Ackerson, R. Borchers.

Dried cow manure in rations for growing chicks. Certain of the B-G complex vitamins are synthesized in the rumen of the cow. Growth stimulation has been reported when dried cow manure was used to replace alfalfa leaf meal in certain poultry rations. In experiments at this Station, manure from lactating cows was dried at 110°F, and included in the ration at 2½ and 5 per cent levels. A control ration contained no manure. One hundred White Rock chicks were used in each lot with results as summarized in the following table.

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>789</th>
<th>790</th>
<th>791</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs.</td>
<td>100</td>
<td>97.5</td>
<td>95</td>
</tr>
<tr>
<td>Dried cow manure</td>
<td>2.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Average weight of chicks at start (g.)</td>
<td>42</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Average weight of chicks at 28 days (g.)</td>
<td>306</td>
<td>299</td>
<td>280</td>
</tr>
<tr>
<td>Male</td>
<td>786</td>
<td>781</td>
<td>737</td>
</tr>
<tr>
<td>Average weight of both males and females (g.)</td>
<td>734</td>
<td>722</td>
<td>681</td>
</tr>
</tbody>
</table>

It was concluded that growth depression rather than stimulation results from the addition of dried cow manure to a ration of the type used in these experiments.

F. E. Mussehl, C. W. Ackerson.

Egg Production

Improving egg production in single-comb White Leghorns. This project was initiated in order to evaluate the use of incrossing as a
method of bringing about improvement in the egg producing ability of single-comb White Leghorns.

A preliminary test was conducted with six single crosses of inbred lines of White Leghorns. These birds were hatched in two groups, the first on February 27, 1946, and the second group on March 6, 1946. The single-cross chicks were placed in brooding and rearing quarters along with other Leghorn chicks hatched on the same date. The mature pullets were housed in the same quarters with random-bred birds, and were distributed through eight laying pens.

There was very little selection for vigor and size in the incrosses, while the random-bred birds were rigidly selected. The Experiment Station flock has been selected on a family basis for more than 20 generations, and no individuals have been retained for breeding purposes that did not produce at least 200 eggs during the first year of production.

Inbreeding coefficients of the inbred lines from which the single crosses were derived are as follows:

<table>
<thead>
<tr>
<th>Inbred</th>
<th>Inbreeding coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>210</td>
<td>60 +</td>
</tr>
<tr>
<td>220</td>
<td>60 +</td>
</tr>
<tr>
<td>230</td>
<td>50 +</td>
</tr>
<tr>
<td>520</td>
<td>50 +</td>
</tr>
<tr>
<td>420</td>
<td>75 +</td>
</tr>
</tbody>
</table>

Individual records for the first eight months of egg production have been summarized in the following table for the single crosses and the random-bred birds in the Station flock.

<table>
<thead>
<tr>
<th>Cross</th>
<th>Number of birds</th>
<th>Average eggs per bird</th>
<th>Average egg size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>240 day period</td>
<td></td>
<td>Grams</td>
</tr>
<tr>
<td><em>Male Fem.</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>420x220</td>
<td>7</td>
<td>144.5</td>
<td>54.5</td>
</tr>
<tr>
<td>220x210</td>
<td>4</td>
<td>115.0</td>
<td>58.0</td>
</tr>
<tr>
<td>220x230</td>
<td>6</td>
<td>143.1</td>
<td>56.1</td>
</tr>
<tr>
<td>520x230</td>
<td>14</td>
<td>141.7</td>
<td>55.5</td>
</tr>
<tr>
<td>520x210</td>
<td>1</td>
<td>116.0</td>
<td>.....</td>
</tr>
<tr>
<td>420x320</td>
<td>8</td>
<td>155.7</td>
<td>58.1</td>
</tr>
<tr>
<td>Average</td>
<td>40</td>
<td>139.38</td>
<td>58.6</td>
</tr>
<tr>
<td>Random-bred Leghorns</td>
<td>833</td>
<td>113.23</td>
<td>58.6</td>
</tr>
</tbody>
</table>

Two severe outbreaks of disease during the year resulted in a decreased average egg production. Both incrosses and random-bred pullets were subjected to the same influences from this cause, however.

Although the number of incrosses is small, the results indicate that certain crosses of inbred lines of birds may respond with increased egg production over the average of a carefully selected random-bred flock. The egg size of the incross birds in this test was slightly smaller than that of the random-bred birds.

I. L. WILLIAMS, H. WIEGERS.

**Improvement of Strains**

**Development of a rapid feathering, rapid growing, well fleshed strain of White Plymouth Rocks.** White Plymouth Rocks are generally recognized by processors as having inherently desirable market qualities. The finished carcass of this breed is usually more heavily fleshed and contains a more even covering of fat and fewer objectionable pinfeathers than several other general purpose breeds.
Many producers have not, however, been so favorably impressed with White Plymouth Rocks, since most strains develop feathers at a slow rate and are extremely variable in growth rate and fleshing qualities.

The mode of inheritance of factors for rate of feather development has been determined, but the time of selection, as recommended, has not accomplished the desired results. Three thousand chicks, examined in 1947 on the basis of wing-feather development at hatching time (as previously recommended), resulted in considerable error. Fifteen per cent of these chicks, judged as fast feathering, were later observed to develop feathers at a slow rate.

Selection of birds with tail feathers at least one-half inch long at 10 days of age, and selection again at four to six weeks of age for feathering over the back, appears to give the best results. The incidence of slow feathering has been reduced from 62.5 per cent in 1946 to 15 per cent in 1947 in the Station flock by following this procedure. Some of the slow feathering was probably the result of environmental factors.

Practically no information is available relative to inheritance of growth rate in chickens. Males grow more rapidly than females, and the rate of growth is variable in all breeds. Rapid growth rate is very important to the broiler producer, as rapid growing individuals are more efficient. Uniformity is also essential as such a strain would enable the producer to market a particular age within a limited time, rather than over a period of weeks as they attain the desired weight.

In September 1946, three White Plymouth Rock males were selected on the basis of their weight at eight weeks of age. (Early growth rate is most important as an expression of feed converting efficiency.) These males were mated to one-year-old hens selected for uniformity. Eight-week weights were not available for the yearling females. The weights of the males at eight weeks were 1.5, 2.2, and 2.6 pounds.

The progeny was housed, fed and managed under conditions as nearly identical as possible.

The results are as follows:

<table>
<thead>
<tr>
<th>Male No.</th>
<th>Wt. of male at 8 weeks</th>
<th>Female progeny</th>
<th>Male progeny</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Av. weight at 8 weeks</td>
<td>Weight range</td>
</tr>
<tr>
<td>4301</td>
<td>1.5</td>
<td>56</td>
<td>1.42</td>
</tr>
<tr>
<td>4302</td>
<td>2.6</td>
<td>44</td>
<td>1.34</td>
</tr>
<tr>
<td>4303</td>
<td>2.2</td>
<td>41</td>
<td>1.47</td>
</tr>
</tbody>
</table>

The above results indicate that the genetic constitution of the three males used in this study of growth rate is of such a heterogeneous nature that one cannot predict the growth rate of the progeny on the basis of that of the male. There was very little difference in the average eight-week weights of the progeny of the males used in this study. Growth rate was also extremely variable. The method of breeding will have to be directed toward the fixing of those hereditary factors which influence growth rate and uniformity of growth before improvement for these characters can be expected.

I. L. Williams, H. Wiegers.
Swine Diseases

Swine erysipelas. Tests for acceptability of commercially prepared culture vaccines used in Nebraska were continued. The tests were made by examination for viability in culture media and virulence by testing a .25 ml. dose in pigeons and a .1 ml. dose in mice. A dead vaccine or one low in virulence at expiration date was considered not acceptable. The test of virulence in mice was continued as a parallel study since mice have been used by others interchangeably with pigeons for tests of pathogenicity. Results were as follows:

<table>
<thead>
<tr>
<th>Producer</th>
<th>Acceptable</th>
<th>Not acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>H</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>24 (68.5%)</td>
<td>11 (31.4%)</td>
</tr>
</tbody>
</table>

Seven of the nonacceptable vaccines were of low virulence and four were not viable. It will be noted that one producer failed to supply an acceptable product for these tests. This producer was informed of the results and took steps to correct the condition. Because of the poor showing of one producer, the per cent of acceptable vaccines tested was lower than it has been since 1943. The comparison of mice and pigeons as test animals indicated that mice were somewhat more susceptible. Four of the vaccines considered nonacceptable by pigeon test would have been considered acceptable on the mouse test.

C. Olson, I. C. Blore.

Diagnostic Laboratory

Laboratory examination was made on 10,449 lots of specimens received during the year. These came from farmers having disease problems in their livestock or from veterinarians desiring laboratory assistance with disease problems.

Early in the year, rabies was diagnosed in a dog from Omaha. An epidemic of rabies in this area followed and positive diagnosis was made in 20 dogs.

Newcastle disease, (avian pneumoencephalitis) presented a problem for the diagnostic laboratory. During the winter months a survey was made on blood samples from turkey breeding flocks submitted to the office of the State Veterinarian to be tested for pullorum disease. Our diagnostic service also tested these blood samples for evidence of Newcastle disease. Three of the 39 flocks showed evidence of having had this infection. During the spring and summer months, considerable infection with Newcastle disease was found by farmers among young chickens purchased from hatcheries. In some instances the mortality amounted to approximately 80 per cent. Most outbreaks were traceable to chicks that had been held at the hatchery for the first week of their life. Only a relatively few hatcheries seemed involved.

F. R. Woodring, C. Olson, I. C. Blore.
## Animal Diseases

### Summary of Diagnoses on Animals and Specimens Submitted for Examination in 1947

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**TOTAL** 688 799 845 8,559 20 32 13 10 11 19,997

* Includes specimens submitted for specific examination and found negative.
Farm Equipment

Heating drinking water for livestock. An automatically heated small-volume stock watering trough has completed its third year of service on a small dairy farm near Lincoln. This small rectangular trough is made of redwood and has a capacity of about 20 gallons. The water is heated by means of soil heating cable, a 60-foot length of which makes a 400-watt heater when used on the usual 115-volt electric power supply. Water temperature is maintained at approximately 40° F. by an immersion type thermostat. A float valve holds the water at constant level.

The electric energy consumption for the three seasons is as follows:

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Out of the total of 61.4 kilowatt-hours used during the 1944-45 season, 26.7 kilowatt-hours were consumed during a five-day period of increased water temperature. During this five-day period the temperature of the drinking water was increased to approximately 60° F., but no increased milk production was obtained and no change in the drinking habits of the cows was observed.

Automatic watering trough. The trough is made of redwood and has a capacity of about 20 gallons. The water is heated with soil heating cable controlled by a thermostat.
A low-cost immersion-type thermostat, developed for temperature control of electric stock tank heaters, is now in its sixth year of service on a farm near Lincoln. The heat-sensitive element of the thermostat is a three-inch double wafer similar to those used in brooder thermostats. The submerged wafer actuates an above-water snap-action switch by means of a brass rod. The housing is made of standard electric conduit, boxes and fittings. Total cost of materials is less than five dollars.

F. D. Yung.

Farm refrigeration. Observations have been continued on a 74-cubic-foot, side-opening, three-zone farm refrigerator and a top-opening, 20-cubic-foot zero storage cabinet. Electric energy consumption during an 18-month period beginning February 1, 1946, averaged 6.16 kilowatt-hours per month per cubic foot of storage space for the side-opening refrigerator. For the same period the top-opening cabinet used an average of 5.72 kilowatt-hours per month per cubic foot. During this period the side-opening refrigerator was defrosted three times while the top-opening cabinet was not defrosted at all. Freezing and low-temperature storage compartments in both boxes were maintained at approximately zero degrees F.

An additional evaporator plate has been installed in the zero side of the three-zone refrigerator for the purpose of observing the effect on cost of operation. An improvement has been noted but the period of observation has not been sufficiently long for definite conclusions.

F. D. Yung.

Unit electric plants. A new model 110-volt wind-electric plant was installed for observation and study on the College of Agriculture campus in June, 1947. The generating plant, driven by a four-blade propeller 12 feet in diameter, is mounted on a 105-foot tower located near the tractor testing laboratory. The battery and control assembly are housed in the Agricultural Engineering building.

At present the load on the plant is four kilowatt-hours per day, or approximately 120 kilowatt-hours per month. This quantity of electric energy is sufficient to enable an average farm family to enjoy many of the common household electric appliances. Exceptions are such major appliances as electric ranges and automatic water heaters.

The plant has operated continuously since its installation. Weather conditions have included wind and electric storms, icing due to freezing rain, and periods of little or no wind. Continuous records from June through November, 1947, show no shut-downs because of weather conditions or low battery reserve. The plant has been stopped only for routine examination and servicing.

At present the period of operation has been too short to warrant definite conclusions.

M. P. Brunig, F. D. Yung.

Differential thermostat. A bimetal differential thermostat, developed for control of ventilating equipment in potato storages, is in its fifth year of service at the Box Butte Experiment Farm. This year is the second during which the thermostat has been used to control the temperature of air that is continually circulated around the exterior of a specially constructed enclosed, or "shell-cooled," experimental potato storage bin. Air temperature control is through an automatic motor-operated damper which opens to admit outdoor air whenever the tem-
Temperature of the outdoor air is lower than that of the air within the bin. The damper closes whenever the outdoor temperature is equal to or above that of the air in the bin.

A complete damper control unit was constructed and installed in a 10,000-bushel storage near Gering prior to the 1947 potato harvest. The unit contained a 24-inch axial flow fan driven by a 3-horsepower electric motor. While in service the fan ran continuously, either bringing outdoor air into the air ducts or recirculating the air within the storage space. The damper which opened and closed the air inlet was controlled by a bimetal differential thermostat.

An electrical differential thermostat is now being developed for more effective control of potato storage temperatures. It has the advantage of flexibility over the bimetal type which is mechanical in operation and must have its heat-sensitive elements within a few feet of each other. In the electrical thermostat the temperature elements can be separated by the entire length of the storage if necessary for best use of the ventilating equipment.

F. D. YUNG

**Farm Machinery**

**Castor bean harvester.** Two major problems are encountered in the mechanical harvesting of castor beans. The first problem results from the shattering characteristics of the present varieties. Our approach to this problem has been to get the plant to move into the harvesting machine with a minimum amount of shock. The second problem is to prevent injury to the bean during the picking and conveying operations. Cracks in the beans greatly reduce the value of the oil yielded.

Results from this project indicate that the harvest of castor beans can be successfully mechanized.

The present machine involves a closed compartment for surrounding the plant. The bottom of the gathering compartment is fitted with flexible sections which permit the plant to enter with a minimum of shock. Shields and baffles are used to reduce the loss of burrs through the frontal opening.

The burrs are stripped from the plant by use of from two to four elongated rubber paddles operating in pairs.

A small separating unit serves to separate the sticks and leaves from the burrs and beans.

A recent field test of the present experimental model showed a ground loss of 6 per cent. No burrs remained on the plants.

M. F. Arms, E. E. Brackett, C. W. Smith, Harry Miller, E. V. Staker.

**Grain Drying**

A project on grain drying, cooperative between the Departments of Agricultural Engineering, Dairy Husbandry and Agronomy, has been previously reported with the following objectives:

(a) To determine the effects of the high temperatures encountered in the artificial drying of grain upon its marketability, industrial utility, and feeding value.

(b) To study methods and equipment suitable for grain drying on the farm.

In the fall of 1946 separate lots of U. S. 13 hybrid ear corn furnished by the Agronomy Department were dried in a specially constructed electric drier at temperatures of 120°, 140°, 160°, 180°, 200°, and 240° F. The corn was husked and dried between September 27 and October 7.
Castor bean harvester developed by the Agricultural Engineering Department.

Initial moisture averaged 32 per cent and final moisture was 14 to 17 per cent.

The corn was fed to experimental rats by the Dairy Husbandry Department for the purpose of observing indications of the effect of drying temperatures on feeding value. A feeding test with 17 to 19 rats in each group was first made to observe the rate of gain in weight. This was followed by a second test involving similar numbers of rats in which the corn was fed without supplemental protein. Each test was continued for eight weeks.

Conclusions will not be drawn from the feeding trials until the study has been repeated with 1947 corn.

A definite indication in favor of the lower temperatures was found in the commercial grading of the dried samples. All graded No. 1 Yellow except those dried at 200° and 240° F. The 200° sample graded No. 4 and the 240° sample was a grade lower. These low scores were due to heat damage.

Cost of Producing Farm Crops

Records on the cost of producing wheat were obtained from 133 farmers in six counties in 1947. Corn records were secured from 49 farmers in three counties. Twenty-three farmers in the Tri-county area submitted data from which the cost of growing sugar beets was calculated and 29 farmers returned records showing the cost of operating sugar beet harvesters and beet loaders. Analysis of these records shows that the cost of pulling, topping and loading sugar beets can be reduced about 50 per cent by the use of mechanical equipment.

In the summer of 1947 data were obtained from 395 farmers for calculating the cost of operating various machines in common use on farms. Analysis of this information shows that the cost per acre or per hour of operating farm equipment is high if a machine is used very little during the season. The cost declines progressively as the machine is used to its seasonal capacity. The desire to keep production costs low is one of the fundamental reasons for the increase in size of farms.

Scarcity of labor and high wages have caused many farm operators to turn to labor-saving equipment as a means of keeping production costs down. The fact that machinery is scarce has resulted in a material increase in joint ownership of such machines as corn pickers and combines. Custom work has also increased. Numerous inquiries concerning division of costs when machines are jointly owned, and charges for custom work with individually owned equipment come to the Experiment Station. Data obtained in these cost studies are indispensable in answering these inquiries.

H. C. Filley, Frank Miller, A. G. George.

Farm Organization

In 1947, income and expense records were summarized for 110 farms. The results show clearly that good management pays dividends. The following factors are essential to a satisfactory level of income on an individual farm:

1. A business large enough and sufficiently diversified to keep the labor force continuously employed throughout the year.
2. Maintenance of soil productivity, selection of varieties of crops, and use of tillage practices that will result in good crop yields.
3. Proper care of livestock to obtain efficient gains or high rates of production per animal.
4. Use of farm equipment to its seasonal capacity in order to keep costs low.
5. The influence of these factors on income is cumulative. Farmers who maintain a high standing in most phases of the business have incomes well above the average. Those who are low in all factors get small returns.

Agricultural Productive Capacity of Nebraska

No special report showing the capacity of the state to produce agricultural commodities was published in 1947. The committee assigned to this work reviewed goals submitted by the Department of Agriculture for the 1948 crop season and suggested some modifications. It appears that the world need for food is causing the wartime pressure for full production to be continued. As a result a shift to conservation farming cannot be made, if the requested acreages of such crops as wheat, corn and dry edible beans are to be grown.

Livestock numbers have been reduced by the slaughter of animals to supply current demand for meat. Neither beef nor pork production is keeping pace with the population increase. Under these conditions, development of our water resources to increase feed production on the land that can be farmed intensively so pressure can be removed from the rolling and sandy areas is essential to the preservation of the agricultural resources of the state.

FRANK MILLER.

Agricultural Credit

High prices for farm commodities and good crops since 1941 have improved the financial position of farm people. The farm operator who has an adequate basis for credit can obtain funds to meet all of his requirements at comparatively low rates of interest. This situation is a marked improvement over the conditions which prevailed from 1929 to 1942. In those years funds to meet all needs, particularly of the man who had accumulated very little capital, were hard to get and interest payments were difficult to meet.

Analysis of farm records from six counties in southeastern Nebraska shows that 78 per cent of the operators on farms smaller than 171 acres would have been unable to meet interest payments on real estate mortgages equal to 65 per cent of the inventory value of land and buildings at 4 per cent and interest on one-half of their non-real estate capital at 6 per cent after deducting normal expenditures for family living from the net farm income. The proportion of operators who could not have met these obligations was increased to 59 per cent on larger farms. This situation explains why land transfers from forced sales and related defaults reached a peak of 63.9 per thousand farms in the state in 1933.

In 1930, 67,953 farms in the state were mortgaged for $510,453,000. By 1945 the number of encumbered farms had dropped to 41,113 and the mortgage debt to $204,174,000. In the 1930's the mortgage debt was reduced by foreclosures, by debt adjustments in which the amount of the obligation was reduced and the mortgage often transferred to a new lender, and by voluntary deeds to creditors. In 1940, 54,246 farms in the state were mortgaged for $309,826,000. Since that date the reduction in debt has been made primarily through payments out of income.

Analysis of farm records for the 1930-1946 17-year period shows that crop yields and prices are important factors in the ability of farm operators to meet interest payments. However, a business large enough for efficient operation and good management is also an important factor. Some operators were able to meet interest payments out of net farm income in the worst years of the drought and depression period. Type of crops grown, feed reserves and the livestock organization seem to be the most important factors determining the level and stability of income.

FRANK MILLER.
Land Tenure

For several years the Nebraska Experiment Station has cooperated with the Experiment Stations of the North Central and Northern Great Plains states and with representatives of the Bureau of Agricultural Economics, U. S. Department of Agriculture, in studying land tenure problems. Findings of these groups reveal the following facts:

1. A commercial farm large enough to justify the use of modern labor-saving equipment represents an investment which is much larger than the savings of most young men who want to start farming.

2. Net returns to landlords over a period of years average between 3½ and 4 per cent while interest rates on standard loans are 4 per cent or more.

3. The fluctuations in commodity prices and variability in crop yields make loans of more than 50 per cent of the purchase price of a farm hazardous to the borrower.

Under these conditions the setting up of profitable farm businesses for young men requires cooperation between investors who want to own land and men with limited savings who want to farm. The objective of both groups should be to establish profitable farm businesses where competent renters can accumulate savings and become owner-operators. This procedure is in operation, but there are too many farms where the acreage is either too small or the land is not sufficiently productive to provide a satisfactory level of income without resorting to a cropping system which causes serious damage from erosion and soil depletion. The solution of this problem requires widespread understanding of the intensity of use that can be made of the various classes of land and still preserve the soil in each class as a productive resource. Considerable adjustment in the size of operating units and in the organization of farms is needed.

Frank Miller.

Land Use Adjustment

Development of water resources in the Missouri valley will result in irrigation of one million or more additional acres in Nebraska. Application of irrigation water to fields already being operated under dryland conditions will bring about some sweeping changes in Nebraska agriculture. Stabilization of yields of such crops as corn and alfalfa will guarantee a more constant feed supply to carry livestock enterprises than can be produced under dryland conditions. New crops like sugar beets, potatoes and vegetables to be sold fresh from the field or to be canned will become important on irrigated farms. An increase in the hours of labor expended on old crops and a shift to these new crops will result in sweeping changes in operating units in the areas when irrigation water becomes available.

In order to appraise these changes and to obtain data which can be used in directing the shift to irrigation the Nebraska Experiment Station and the Bureau of Agricultural Economics is conducting a study of cropping practices and farm organization in the Tri-county area where irrigation is expanding rapidly and in nearby areas in the Platte and Republican river valleys where water has been available for several years. The information obtained suggests the following conclusions:

1. Irrigation will increase the volume of production materially. It will also stabilize production both in the area receiving water and in
the surrounding dryland territory where a nearby feed supply will prevent liquidation of livestock in dry years.

2. Use of intensive crops will reduce the acreage required to produce a satisfactory level of income for a farm family. As a result farms will be reduced in size in the irrigated sections.

3. Under a cropping system which retains corn and alfalfa as the major crops, a 160-acre farm with 120 acres irrigated will return about the same amount of income as a 320-acre dryland farm. Sugar beets, potatoes and vegetables can be grown on the irrigated land to raise this level of income. These crops cannot be grown successfully on dryland farms.

In order to get additional information on the changes in farm organization that take place when irrigation water is made available, farm account books have been placed with farmers in the Republican valley below the site of the Harlan county reservoir. These records will be collected and summarized over a period of years so the changes that take place as irrigation water is made available can be noted.

FRANK MILLER, A. G. GEORGE.

Land Use Planning

According to the land classification of the Soil Conservation Service, there are 20,949,240 acres in the state physically suitable for cultivation. This is over two-fifths of the total area. In 1942 approximately 20,156,658 acres were in crops, idle or tilled fallow. For the state as a whole, it appears that no drastic reduction in the crop land base is needed. A decrease in the acreage of intertilled crops and a material increase in grasses and legumes are the principal changes that would result from the use of the recommended cropping systems. A regrassing program is needed in some crop adjustment sections and on many individual farms. The study points out the exploitive nature of farming practices in the state. If erosion is to be controlled and present productivity maintained, extensive changes in cropping practices are needed.

Conservation and Soil Survey and the Soil Conservation Service are cooperating with the Nebraska Experiment Station in this project.

FRANK MILLER.

Effect of a Soil Conservation Program on Farm Organization

Records of Pawnee county farm operators indicate that farmers with a relatively high percentage of Class III, IV, and VI land have as high income as farmers on the better grades of land. However, farmers on the lower grade land need to make the most severe adjustments in their cropping systems in order to comply with the recommended use of their soil.

Adoption of recommended soil conservation practices will result in a decrease in corn acreage, some increase in small grain, and a material increase in the acreage in grasses and legumes. An increase in the number of roughage-consuming livestock can be expected. It will be necessary to make dairying the major enterprise on many of the smaller farms in order to maintain an adequate income. Some adjustment in size of farms will probably be necessary when conservation practices are adopted and when farm prices return to a more normal level.

A. W. EPP, H. C. FILLEY, A. G. GEORGE.
Marketing

Cost of marketing corn and wheat. Audits of about 50 elevator companies have been secured annually for the past 10 years. These records will be summarized, and a report prepared setting forth the operating costs of the elevator companies and the reasons for any variation in efficiency of operation.

H. C. Filley.

Price differentials for livestock. This is a cooperative project in which Nebraska and 11 other North Central states, Kentucky, Oklahoma, and the Bureau of Agricultural Economics took part.

Data were assembled showing comparative differentials between daily, weekly, monthly and yearly prices of hogs on the Omaha and Chicago markets. Other experiment stations worked out differentials between other markets.

Some markets were superior for heavy hogs and others were superior for light hogs. The price differentials between certain markets fluctuate with the seasons. As a result of the fluctuations some markets are better at some seasons of the year and other markets at other seasons.

L. B. Snyder.

Marketing feeder cattle and sheep. Objective of this project is to secure the basic information essential to formulation of a program for increasing the efficiency of marketing feeder cattle and sheep. This involves information on sources of supply of feeder animals, areas of greatest demand, and marketing channels through which animals pass from farms and ranches to feed lots and pastures.

The 12 agricultural experiment stations of the North Central states, the Western states, Kentucky, Oklahoma and Texas, and the Bureau of Agricultural Economics are cooperating on the project. This is one of the most comprehensive research projects ever undertaken by the agricultural experiment stations.

L. B. Snyder.
Nutrition Research

Nutrition and performance. Work is continuing on the project designed to study the relationship between nutritional status and ability and performance of the individual. Evaluation of the data from last year suggests marked differences in stability and motor coordination, endurance and resistance to fatigue, as well as in adequacy of the diets and the utilization of dietary essentials. Girls who served as subjects last year will be studied again this year and 20 others will be added. It is the plan to study 100 different girls over a five-year period.

Weight reduction of young women. There has long been a need for a scientific study of weight reduction to demonstrate (1) that excess body weight can be lost on a diet restricted only in calories, (2) that a low calorie diet can be planned to furnish optimum amounts of all other dietary essentials, and (3) that a high standard of health and morale can be maintained on such a diet. Twenty-four over-weight girls in the Women's Residence Halls volunteered to be subjects on such a study from late September to mid-December. The diet was adapted from the regular Residence Hall menus to furnish only 1,200 calories and generous amounts of other essentials. The girls were not permitted to eat any food in addition to what was served to them. Daily records were kept of weight, basal metabolism tests were taken at three-week intervals, nitrogen metabolism and utilization were determined weekly, and blood tests were taken at the end of the study. The loss in weight during the nine-week period varied from 4 to 19 pounds with an average of 14.1 pounds, which meant an average loss of 1.5 pounds per person per week. Morale of the group remained high for it was possible to serve attractive, tasty meals even on a restricted calorie allowance. Plans are being made for publicizing the menus and the general routine of the diet in order to offer help to those who wish safe and sane reducing practices.

Strained meat for infants and additional meat for toddlers. In a study conducted at the Child Saving Institute at Omaha, strained meat has been added to the formula for infants beginning as early as one month. In the group of toddlers from one to two years of age, 100 grams of meat has been added to their routine diet. A full-time dietitian is in charge of the work, a pediatrician examines the children regularly, and a pathologist takes frequent blood tests. Indications are that additional protein aids in the maintenance of high hemoglobin and red cell values and contributes to a generally high nutritional status.

RUTH M. LEVERTON.

Household Equipment

Coal and wood ranges. This investigation has been continued from last year. Two ranges have been in operation and data regarding oven temperatures, cooking top temperature, exterior temperatures, and time of heating have been observed. Experimentation on constricted flue passages around the oven are in progress. Particular attention is being given to a type of fire and stove operation that can provide high temperatures for surface cooking and at the same time a low oven temperature.
Kitchen utensils, menus, and home food practices. Field work and summarization of data for this investigation have been completed and conclusions for Part II, dealing with the minimum set of kitchen utensils, have been formulated. Since this is a cooperative study, the first report is to be made by the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture. This report will summarize the results for the three cooperating experiment stations—Nebraska, California, and Rhode Island. Analysis of the utensil data in Part I is in progress to determine whether there is a relation between the utensils used in Parts I and II. A report of the Nebraska part of the study will be made in the spring of 1948.

Liquid loss from glass jars processed in the pressure cooker. This investigation originated from requests from women who wanted to know why liquid was sometimes lost from glass jars of food processed in a pressure cooker. Experiments are being performed in a pressure cooker equipped with a window through which glass jars connected to pressure-vacuum gauges can be observed. Processing technique is varied to simulate different practices that might occur during home canning. The experiments are being performed with pint jars containing water or food sealed with zinc lids, lightning or E-Z seal lids and two-piece closures. It is hoped that results can be obtained in time to aid women with their 1948 canning problems.

Home pasteurizers. Information on the performance of home pasteurizers was desired by members of the dairy and extension staffs in order to furnish reliable information to those requesting it. Experiments are being conducted on three batch-type electrically operated pasteurizers with particular emphasis being given to air space temperatures above the milk. Temperature determinations using water as the test fluid are made first. Then raw, whole milk is used. Results of the investigation should be ready in 1948.

ARNOLD BARAGAR.

Family Life

Campus leaders. The study of leadership in college women through the use of free association, and comparison of personality traits of leaders, non-leaders, and those of their families, was concluded in 1947.

Leaders and non-leaders did not differ significantly on psychological masculinity-femininity, as measured by the Goodenough Speed-of-Association Test, although rural leaders tended toward masculinity. Leaders, objectively selected, had significantly higher leadership scores than non-leaders, and their families also had higher scores than those of non-leaders' families. Leaders scored higher on commonality (an index of social participation) than non-leaders. Scores of leaders were most similar to those of their fathers.

A qualitative analysis of responses to stimulus words revealed that leaders responded more quickly, wrote more legibly, and spelled more correctly than non-leaders. They used shorter words, more verbs, and more words expressing action. They mentioned other kinds of leaders, such as teachers and doctors, more frequently, used fewer emotionally-toned responses, and expressed broader interests.

Intelligence of rural and urban children. Collection of data for the comparison of intelligence test performance of rural and urban children was also concluded. Analysis of results from six counties on approximately 4,000 children in grades 1 through 9, indicated that differences
between counties are greater than differences between rural and urban samples from the same county, and that none of these differences are statistically significant. There was no consistent trend with age, and therefore no evidence of a cumulative environmental handicap, for either urban or rural groups. Sex differences were very slight and probably due to shifts in test content. The commonly found relationship between child I.Q. and parental occupation held for the city samples but broke down for samples of children for communities of less than 2,500 population. Sub-test differences are small and easily explained in terms of specific environmental stimulation.

The study found no evidence that intelligence test performance, or the underlying abilities sampled by the tests used, differs in any significant manner between rural and urban children, when tests are given under adequate conditions and when the influence of race, geographical location, and familiarity with the English language are controlled. The Kuhlmann-Anderson Group Intelligence Tests appear to be equally suitable for the mental evaluation of rural and urban children.

Katharine M. Maurer.
Weather conditions were erratic the past year. The soil went into the winter of 1946 in very good condition as a result of 6.29 inches of surplus precipitation from July to December. The winter was mild with less snowfall than normal. However, the spring was late with above normal rainfall during May and June. A killing frost May 29 severely damaged winter wheat and rye. Rainfall from July 1 to October 31 was 4.27 inches below normal with temperature considerably above normal. The late spring followed by a hot dry summer and fall resulted in a very poor corn crop.

Yields of oats and barley in this locality were exceptionally good. In the variety test plots Marion and Osage oats averaged 60.5 bushels. Clinton and Cedar yielded 57 bushels. Brunker lodged badly and yielded only 49 bushels. Of the four varieties of barley, Velvon II ranked highest, yielding 61.2 bushels per acre.

Sub-Irrigated Meadow Investigations

During March the water level in 10 different meadows in this area averaged 10.6 inches nearer the surface than a year ago. Good stands of red and Alsike clover were obtained from broadcasting seed on native meadow where the water level was within 2 feet of the surface.

Use of a subsurface tiller and rotary hoe in preparing sod for clover and alfalfa seeding proved worth further trial where the sod is not dense and tough.

Applying ammonium nitrate and superphosphate separately on a seeding of alfalfa had no visible effect on growth, but where they were both added the alfalfa was almost twice as tall.

Yield of native hay was doubled by applying both nitrogen and phosphorus but showed no apparent increase where they were applied separately.

Dual-Purpose Cattle Project

Twenty-two Milking Shorthorns of various ages completed lactation periods during the year with an average of 4,562.4 pounds of milk and 18.2 pounds of fat in 254 days.

Fat produced varied from 63.6 to 332.6 pounds. There were six records over 250 pounds and nine under 150 pounds. Six cows milked less than 200 days and only six over 300 days.

The feed requirement exclusive of pasture for producing 1 pound of fat was 8.36 pounds of grain, 20 pounds of prairie hay and 16.7 pounds of cane silage.

The steer calves were sent to Lincoln to be used in a feeding test. This fall the females of all ages were transferred to Lincoln and will be managed there as a dual-purpose herd.

Supplements to Prairie Hay for Wintering Range Calves

Eleven lots of 10 heifer calves weighing approximately 400 pounds per head were wintered on prairie hay (ad lib) with various supplements. The protein content of all supplements was approximately the
Calves at the Valentine Substation wintered on prairie hay plus 1 pound per head daily of a pelleted supplement of alfalfa, urea and steamed bone meal.

same. Alfalfa meal (sun cured) in pellet form was fed at the rate of 2.5 pounds per head to one lot. All other supplements in pellet form were fed at the rate of 1 pound per head. The soybean oil meal pellet containing 7 per cent steamed bone meal produced the greatest gain.

Mixtures of urea, soybean oil meal, corn and steamed bone meal produced almost as much gain as soybean oil meal plus steamed bone meal. The urea content of the pellets was 5 per cent, 7.5 per cent, and 10 per cent. The amount of soybean oil meal varied from 20 to 55 per cent. There was no significant difference in the gain produced by the various mixtures. Three lots fed similar rations, except that the steamed bone meal was not added, averaged 62 pounds less winter gain per head. However, when weighed off grass in the fall there was only 26 pounds difference.

Feeding 1 pound of a pellet containing 10 parts urea, 80 parts alfalfa meal and 10 parts steamed bone meal produced a few pounds more total winter and summer gain than feeding 2½ pounds of alfalfa meal. Reducing the urea to 5 parts and alfalfa meal to 40 parts and adding 45 parts soybean oil meal resulted in an increased total gain of 12 pounds per head. The gains from the above ration were comparable with those where corn was used instead of alfalfa meal in the pellets.

All supplements containing urea were readily eaten by the calves except the mixture containing 10 parts urea, 80 parts alfalfa meal and 10 parts steamed bone meal and the mixture containing 10 parts urea, 70 parts corn and 20 parts soybean oil meal.

E. M. Brouse.
Box Butte Experiment Farm

The spring of 1947 will be remembered by the farmers of this area as the season of late heavy snowfalls. On May 28, 12 inches of wet snow caused serious breakage of trees and shrubs. Another snowfall of approximately 4 inches occurred on June 11.

Rainfall for the first 11 months of 1947 was 15.34 inches, or .41 inch below average. January, February, and March were extremely dry, followed by heavy rainfall in May and June. Temperatures were generally higher during the summer months than in 1946.

All crop yields were excellent except potatoes, which were planted in very wet soil and developed during the hot dry period in July and August.

Dryland Crop Rotations

The study of western Nebraska dryland crop rotation systems is being continued. Permanent grass in a long rotation system to improve soil physical and chemical properties is being started. Winter wheat yields following summer fallow were generally more than double those following small grain or corn.

Seed Increases

There was further increase in fields of several acres of each of two new potato varieties and foundation Triumphs. Approximately 500 bushels of certified Velvon II barley and 170 bushels of Mida wheat were produced. About 2,300 pounds of a new high oil-content safflower line was grown.

Experimental Work

The Box Butte Farm provides facilities for breeding and experimental work done by or in cooperation with several of the departments of the Nebraska Agricultural Experiment Station. Most of these projects are reported elsewhere in this bulletin, but brief summaries are included here.

Potatoes. An extensive potato breeding program involved testing of hundreds of seedling lines. The Experiment Farm is used for all seed potato increase purposes. Replicated variety yield tests were planted on three dates.

Cultural experiments included the study of date of potato harvest as a measure of crop development rate; seed piece size and planting distance; relative value of cutting seed potatoes early when handled properly; use of 2,4-D as a pre-emergence potato spray for weed control; and various blind tillage methods to loosen soil in which tubers are to develop.

Storage experiments involved methods of holding seed potatoes into late spring; roof color effects on cellar temperatures, and effects of various types of cellar construction on bin temperatures.

Small grains. Varietal trials of winter and spring wheat, oats, and barley gave high average yields, equaling any previously recorded on this experiment farm. Selection and testing in early hybrid generations was confined to wheat.
Pure certified seed of Velvon II barley (9 acres) and Mida spring wheat (1 acre) was produced for further increase.

L. P. Reitz, O. J. Webster, Harold Chapman.

Sorghum trials. The yield trials included nine grain varieties and five forage varieties. The cool weather during June delayed plant growth and none of the varieties were fully matured at the time of the first killing frost the middle of September. Only Early Hegari and Coes were mature enough to harvest. The forage varieties made a good growth but only Fremont and Black Amber matured seed. In addition to the yield tests a small breeding and observational nursery was planted.

O. J. Webster, Harold Chapman.

Corn investigations. Several open pollinated and hybrid varieties likely to be suitable in this area were tested.

John Lonnquist, Harold Chapman.

Grass. Study was continued on the adaptation and forage yield of several grasses and subsequent effect on soil physical and chemical properties.

E. C. Conard, Harold Chapman.

Oil crop investigations. Breeding and selection of safflower was continued to secure desirable characteristics. There are trial plots of many new crops having possible industrial uses.

C. E. Claassen, Harold Chapman.
Climatic Conditions

Precipitation during the year totaled 17.68 inches, compared with the 38-year mean of 13.73 inches. During the growing season, April 1 to September 30, precipitation amounted to 14.07 inches, compared with the 38-year mean of 11.12 inches. The precipitation recorded for the months of April, May, and June amounted to 12.05 inches, or 85.6 per cent of the total for the six-months growing season and 68.2 per cent of the total for the year. Rain and hail which fell during June amounted to 7.87 inches. This was the most precipitation ever recorded for any one month in the history of this station. A hail storm on June 28 completely destroyed barley, safflower, and early-planted beans, and severely damaged beets, corn, and alfalfa. The area affected by this storm extended from Torrington, Wyoming, to Bridgeport, Nebraska.

Temperatures were 4 degrees below normal in June and near normal during the remainder of the growing season. Evaporation for the growing season was 34.61 inches, somewhat below the 37-year mean of 35.95 inches. Evaporation was low during May, June, and September and near normal the other three growing months.

Wind movement was below normal every month of the year except January and February. Damage by wind erosion was unusually low.

The last frost in the spring occurred on May 29 and the first in the fall on September 15, leaving a frost-free growing period of 109 days. The 37-year mean growing season is 136 days.

Experimental Work

Crop rotation. Crop rotation experiments include studies of the value of farm manure, phosphate and nitrogen commercial fertilizers, alfalfa as a green manure crop, and sweetclover as a pasture and green manure crop. Several rotations have been designed specifically to study the development of scab on potatoes. In addition to continuous plots, the experiments comprise rotations from two to six years in length. Part of the rotations have been in operation since 1912, a period of 36 years. Those dealing with commercial fertilizer and scab were started in 1942.

During 1947 the continuous untreated corn plot produced 35.4 bushels per acre, compared with 64 bushels from the manured plot. The continuous untreated plot of beans yielded 33.5 bushels per acre and the manured plot, 40.3 bushels. The untreated, continuous plot of sugar beets produced 4.4 tons per acre compared with 10.9 tons on the plot treated with phosphate and nitrogen. Sugar beet diseases caused great loss of plants on these plots during the season, reducing the stand from 92 per cent at thinning time to 31 per cent on the untreated plot at harvest and to 38 per cent on the plot treated with phosphate and nitrogen. The reduction in stand on the continuous, treated plot during 1947 was less than during previous years, and the yield, consequently, was higher this year. Farm manure, nitrogen, and phosphate and nitrogen together, increased the total yield of potatoes on continuous plots, but failed to influence quality favorably, since no No. 1 potatoes were produced in 1947 on any of these plots. This was chiefly because of the abundance of scab on practically all of the tubers.
Highest yields of sugar beets (17.4 tons) were obtained from alfalfa rotations treated with farm manure, and lowest yields (6.6 tons), from untreated, short, non-legume rotations. The mean yield from four non-legume rotations treated with phosphate and nitrogen was 16.8 tons per acre, compared with 15.5 tons in four comparative rotations treated with manure. The mean yield from untreated alfalfa rotations was 13.7 tons, and 14.8 tons from alfalfa rotations treated with phosphate and nitrogen.

A pastured sweetclover rotation produced 15.2 tons, compared with 17.5 tons from a similar rotation treated with phosphate and nitrogen. The mean yield from two beet crops in a pastured sweetclover rotation in which the second crop received manure, was 16.8 tons per acre. The first-year crop following sweetclover pasture yielded 16 tons and the second-year manured crop, 17.7 tons. The yield of beets from a three-year rotation where sweetclover was used as green manure for potatoes followed by beets, was 13.1 tons compared with 18.5 tons from a similar rotation treated with farm manure.

Beans yielded 43.8 bushels per acre in an alfalfa rotation treated with manure, compared with 42.2 bushels in a similar rotation treated with phosphate and nitrogen. In non-legume, manured rotations beans yielded 38 bushels per acre, compared with 38.5 bushels from similar rotations treated with phosphate and nitrogen.

Highest total yields of potatoes (391 bushels per acre) came from alfalfa rotations treated with farm manure, and the lowest yield (151 bushels), from untreated, non-legume rotations. Scab was extremely severe on tubers from all rotations during 1947. Because of scab, the yield of U. S. No. 1 potatoes was less than 10 bushels per acre from most of the rotations. The highest yield of No. 1 potatoes, which was only 29 bushels per acre, came from an alfalfa rotation treated with farm manure, yet the total yield from this rotation was 391 bushels per acre. Scab was much more severe during 1947 than any year since 1942. Alfalfa rotations, four and six years in length, which normally have produced at least fair yields of No. 1 potatoes under the worst conditions, failed by a wide margin in 1947 to produce expected results based upon long-time experience, chiefly because of the prevalence of scab. The percentage of irregular tubers was also higher during 1947 than any year since 1942.

The barley crop on the rotation plots was destroyed by hail late in June, 1947, and no yields were obtained.

**Sugar beet top silage.** During the past six years (1942–1947) sugar beet tops from most of the irrigated rotations have been harvested for silage production. The tops were harvested from one to ten days after the beets were topped, with the exception of 1947 when snow delayed the harvest of tops for approximately thirty days. When the tops were stacked on the ground, 63 per cent of the original green weight was removed as edible silage compared with 78 per cent edible silage when the tops were placed in a pit silo. Yields of edible silage have been determined for beets from each rotation, based upon silage production in a pit silo.

Yields of edible beet top silage ranged from 2.04 tons per acre in the untreated, non-legume rotations to 8.41 tons in alfalfa rotations treated with farm manure. Edible silage per ton of beets ranged from 668 pounds to 1,022 pounds in the rotations listed above. The yield from alfalfa rotations treated with commercial fertilizer amounted to 7.38 tons, compared with 7.24 tons from sweetclover rotations treated in a
like manner. The yield from untreated alfalfa and sweetclover rotations was 5.51 tons; from non-legume, manured rotations, 5.30 tons; and from non-legume rotations treated with commercial fertilizer, 4.97 tons per acre.

**Lamb feeding.** Lamb feeding experiments during 1947 included studies of corn silage, sugar beet top silage, and potato-corn silage in various rations with and without alfalfa hay. The experiments were conducted with 12 lots each containing 50 lambs having a mean initial weight of 60 pounds, and one lot of 427 lambs with a mean initial weight of 50 pounds.

The potato-corn silage was made by mixing approximately 4 tons of potatoes with 1 ton of dry corn fodder (ears on). The two feeds were mixed as they were run through an ensilage cutter into a pit silo. The sugar beet top silage was made by placing whole green beet tops in a pit silo, and the corn silage was made by running green corn fodder (corn in pre-denting stage) through an ensilage cutter into a pit silo.

The 427 light lambs received a ration of potato-corn silage, grain mixture (equal parts by weight of corn, barley, and dry sugar beet pulp), soybean meal, bone meal, and alfalfa hay. The lambs gained 0.38 pound each daily, and consumed less feed per 100 pounds gain than any of the lambs in the main test. Death loss amounted to 5.6 per cent from listerellosis, a disease of the brain and nervous system caused by *Listerella monocytogenes*, and 2.1 per cent from other causes, mostly overeating.

In the main test comprising the twelve lots of 50 lambs each, sugar beet top silage, grain mixture, soybean meal, bone meal, and alfalfa hay produced a mean daily gain per lamb of 0.37 pound, compared with 0.35 pound for corn silage, and 0.34 pound for potato-corn silage. Death loss amounted to 6 per cent on the beet top silage ration, 4 per cent on corn silage, and 14 per cent on potato-corn silage. Most of the death loss on the latter ration resulted from lambs affected with listerellosis. One lamb (2 per cent) on the corn silage ration died from this disease, and none on the beet top silage ration. Another comparison of beet top silage and corn silage was made with two lots of lambs fed a basic ration of corn, cottonseed meal, bone meal, and alfalfa. The lambs fed corn silage with this ration gained 0.34 pound each daily, and those fed beet top silage gained 0.35 pound. In producing 100 pounds of gain the lambs fed beet top silage consumed less concentrates, but more silage, than those fed corn silage. On the corn silage ration, three lambs died from urinary calculi, and three from over-eating, compared with three lost from urinary calculi and one from listerellosis on the beet top silage ration.

Heavy death loss from listerellosis occurred when corn silage was fed with grain, protein supplement, and bone meal, but no alfalfa hay. Lambs on a ration of corn, soybean meal, bone meal, and corn silage gained only 0.24 pound each daily, and 12 (24 per cent) died from listerellosis. Three additional lambs died from other causes making a total death loss of 30 per cent on this ration. Heavy death loss from listerellosis also occurred with two similar rations where corn silage was used as the only roughage during the first month of the test. The addition of alfalfa hay to these rations after the lambs had been on test 34 days proved to be of little value in checking the disease. This is in contrast to comparative lots where alfalfa was fed from the start, and the death loss from listerellosis was very small.
Beet top silage as the only roughage was fed to four lots of lambs. One lot received a ration of corn, cottonseed meal, bone meal, and beet top silage. In past years this ration has produced heavy death loss from urinary calculi. In 1947 four lambs (8 per cent) died from urinary calculi, and five lambs (10 per cent), from listerellosis. Daily gain amounted to 0.29 pound per lamb. In the second lot soybean meal was used in place of cottonseed meal. The lambs on this ration gained 0.32 pound daily. Two lambs (4 per cent) died from urinary calculi, and six (12 per cent), from listerellosis. The use of grain mixture in place of corn, with cottonseed meal as the protein supplement produced 0.34 pound daily gain, and one death from urinary calculi, while grain mixture and soybean meal produced 0.35 pound daily gain and no death loss from urinary calculi.

Dairy herd. The mean production of 16 cows in the official herd improvement testing program during 1947 amounted to 503.9 pounds of butterfat per cow, on twice-a-day milking. This is the thirteenth year the herd has been on official test.

High producers include S. B. Lavix Nora, age 6 years, with 678 pounds of butterfat; S. B. Pontiac Rose, age 14 years, with 670 pounds of butterfat; and S. B. Komer Verona, age 6 years, with 666 pounds of butterfat.

During the year a combine milking system was installed in the milking parlor to increase the efficiency of operation and to improve the quality of the milk produced.

The dairy herd at the Scottsbluff Substation has been included in a state-wide program to improve dairy cattle through breeding. The herd will represent one of the inbred lines in this project.

Moisture-spacing-fertility experiment with potatoes. An experiment was conducted to determine the influence of soil moisture level, spacing, and soil fertility level on the yield and quality of Red Triumph potatoes. The various plots were irrigated whenever the soil moisture tensions reached certain prescribed values. These values were such that some of the plots were irrigated sixteen times, some of them seven times, and the balance only four times. The three different row spacings used were 36, 30, and 24 inches with the potatoes being planted 12 inches apart in the rows. A heavy crop of alfalfa was plowed under a few days prior to planting. Fertility treatments in addition to this green manure crop were as follows: (1) none, (2) barnyard manure, 15 tons per acre, (3) nitrogen, 60 pounds per acre applied as ammonium nitrate, (4) nitrogen, 120 pounds per acre as ammonium nitrate, and (5) same as (4) with 200 pounds P₂O₅ applied as superphosphate (45 per cent P₂O₅). All fertilizers were applied at planting time.

The highest yields, both total and U. S. No. 1 grade, were in the high-moisture plots. These plots averaged 524 bushels per acre total yield with 91 bushels per acre of U. S. No. 1 grade. The medium-moisture plots averaged 448 bushels per acre total yield with 57 bushels per acre of U. S. No. 1 grade, and the low-moisture plots averaged 425 bushels per acre total yield with only 21 bushels per acre of U. S. No. 1 grade. The differences in yield of No. 1 potatoes were largely due to the effect of the high moisture treatment in reducing scab. On the average, more than 50 per cent of the tubers were severely infected with scab. Fifty bushels per acre more potatoes were rejected in grading because of scab in the plots that were irrigated only four times than in those that were irrigated sixteen times.
Plant population per acre had an influence on the yield of potatoes. The plots with 36-inch spacing averaged 449 bushels per acre, including 41 bushels per acre of U. S. No. 1 grade. The plots with 30-inch spacing yielded 452 bushels per acre with 46 bushels of U. S. No. 1 grade, and the plots with 24-inch spacing yielded 496 bushels per acre with 82 bushels of U. S. No. 1 grade. High moisture level and close spacing was the combination that produced the highest yields in this experiment, with an average of 566 bushels per acre, including 130 bushels of U. S. No. 1 grade. Spacing had an influence on the number of potatoes damaged by sunburn. There were 30 bushels per acre of sunburned potatoes in the plots with 24-inch spacing, 17 bushels per acre in the plots with 30-inch spacing, and 12 bushels per acre in the plots with 36-inch spacing.

In this experiment, the fertilizers applied in addition to the green manure crop showed only slight response. Barynyard manure lowered the quality somewhat without a corresponding increase in total yield. High nitrogen and phosphorus applications improved quality and yield, but the greatest average differences were only about 15 bushels per acre.

Cooperative Investigations
These projects included hybrid corn, and winter and spring barley variety tests, insect control studies, and breeding and variety testing work for the improvement of potatoes, safflower, and field and garden beans. These projects were carried on in cooperation with various departments at the Agricultural Experiment Station of the University of Nebraska.

LIONEL HARRIS.
Dryland Crop Rotations

A good carry-over of subsoil moisture from high rainfall of the previous fall supplemented by above normal rainfall during spring and early summer supplied ample moisture for crop needs to beyond mid-season. Crops were well advanced for the season when set back severely by freezing temperatures in late May. Cool, cloudy weather with excess rainfall during June delayed recovery of row crops and maturity of small grains. Small grain harvest was late and slow development of corn indicated that much of the crop would not reach maturity. The occurrence of high temperatures and limited rainfall during late summer and fall reversed these conditions. Corn yields were reduced somewhat, but the crop matured well and was of good quality. Weed growth developed rapidly in stubble fields that were not tilled immediately after harvest, and late tillage operations were performed with difficulty.

For the fourth successive year, crop yields were above long-time averages. For all tillage practices and crop sequences, average yields of the various crops in bushels per acre were: winter wheat, 35.8; spring wheat, 16.2; oats, 44.6; barley, 23.7; corn, 30.2; Early Kalo, 35; potatoes, 182.6. Forage crop yields in tons per acre were sorgo 5.1; alfalfa 2.5; bromegrass 0.7.

Summer fallow showed less gain over cropped land than in years of less moisture. Yields after fallow compared with averages for all methods under continuous cropping were (in bushels per acre): winter wheat, 46 and 27; spring wheat, 20 and 16; oats, 56 and 43; barley, 34 and 22; Early Kalo, 42 and 37; corn, 23 and 30; potatoes, 214 and 167. Different methods of tillage for fallow, including plowing at different dates, sub-tilling, listing and disking produced only small differences in yields of winter wheat.

In 12-year rotations, winter wheat yields after fallow preceded by four years of idle land or four years of bromegrass were of about the same order as from the eight-year check rotations without the four years of special treatment. With sweetclover as the conditioning crop, straw yields were increased but the grain yield was depressed to 35.5 bushels in comparison with 46.5 in the check rotation. There was no increase in winter wheat after two years of fallow in comparison with fallowing for one year.

In four-year rotations, winter wheat after fallow produced 4 bushels per acre more than the average yield following three green manure crops. For the 11-year period 1937-47, average yields after fallow, rye, peas, and sweetclover are 27.2, 24.5, 22.8, and 20.1 bushels per acre, respectively.

For winter wheat, the crop immediately following the treatments, better moisture after fallow has had a greater influence on yield than the improvement of fertility resulting from the green manures. That is, the moisture used in producing the green manure crops has more than counterbalanced their beneficial effect. This is further evidenced by the descending order of winter wheat yields with lateness of plowing under of the green manure crops. Average plowing dates have been May 15 for rye, June 16 for peas, and July 15 for sweetclover. With moisture differences more nearly leveled off, yields of other crops in
these rotations have been generally but not greatly higher in the green manure rotations than in the one using fallow. Corn yields after wheat in the rotations using fallow, rye, peas, and sweetclover were, for the 11-year period, 20.6, 26.8, 21.6, and 20.5 bushels per acre, respectively. Barley yields after corn in these rotations were 15.7, 16.3, 17.1 and 16.6 bushels. For small grains continuously cropped or in rotations after other small grains, early after-harvest tillage shows beneficial results. For winter wheat, comparative yields from early and late fall plowing were 27.1 and 20.2 bushels per acre in 1947, and 14.5 and 11.5 for the 11-year period. For oats, comparative yields from early fall and spring plowing were 49.7 and 39.5 in 1947, and 28.8 and 23.6 for the 11-year period. For barley, the comparisons were 24.6 and 16.6 in 1947, and 17 and 14.9 for the 11-year period.

In two-year rotations of corn and winter wheat, wide spacing of corn rows has decreased the yield of that crop but increased the yield of wheat. Between 40- and 80-inch spacing, these effects have been in fair balance. For 120-inch rows the increased wheat yield has not made up for the loss in corn yield. In 1947, from corn rows spaced at 40, 80, and 120 inches, yields were 24.2, 18.1 and 8.5 bushels. Wheat yields after corn in these spacings were 18.5, 26.9, and 28.5 bushels. For the 11-year period, the corn yields were 16.2, 14.4, and 7.6 bushels and wheat yields 14.3, 17.3, and 18.1 bushels.

In rotations in which the land was in sod for varying periods of from one to nine years, there was a tendency in 1947 for increased yields to be associated with the increased number of years the land had been in grass. For winter wheat after corn and previous periods in grass of 0, 2, and 7 years, yields were 23.3, 28.2, and 36.4 bushels. For winter wheat after fallow and periods in grass of 0 and 5 years, yields were 46.5 and 49.7 bushels. For corn after wheat and grass for 0, 4, and 9 years, yields were 26.6, 33.1 and 34.9 bushels. For corn after corn and grass for 0, 3, and 8 years, yields were 27.6, 28.1, and 31.2 bushels. The preceding yields are averages of six plots from the check rotations where no grass was used and of four plots from rotations with grass for varying numbers of years. On the series of plots in which grass was seeded in succeeding years until all ages of sod from one to nine years were represented, all broken out and fallowed in 1945, and used for winter wheat in 1946, there was no relationship between yield of wheat and age of sod. In 1947 corn yields were 30.9, 31.6, 34.3 and 35.5 bushels per acre in order of age of grass from 1 to 4 years. Beyond 4 years in grass, yields ranged from 34.2 to 35.9 bushels with no regularity of increase with increased number of years in grass.

An unusual effect of previous cropping was the high yield of 47.3 bushels per acre for winter wheat after potatoes, in comparison with 23.3 bushels after corn in the same rotation, and 46 bushels after fallow for all fallow wheat sequences in the same field.

L. L. ZOOK, MILTON GREENWOOD.

Small Grain Varieties

**Winter wheat.** Fifteen varieties were grown on disked corn stubble and fallow preparation. Considerable damage was done by erosion during the heavy rains of October, 1946, but fair stands survived. For the first time, damage by Hessian flies was observed. The range in yield between varieties was from 20.7 to 36 bushels per acre, with differences of less than 5 bushels not considered significant. Classified on this basis,
the varieties fall into three divisions, the best division containing eight varieties, the next six, and the last only one. The best division with yields of 32 to 36 bushels is made up of Pawnee, Cheyenne, NP Turkey, Wichita, Nebraska 60, and three new hybrids—C.I. Nos. 11972, 12122, and 12133. The second division with yields of 27.8 to 30.8 bushels is made up of Tenmarq, Nebred, Kharkof, Red Chief, Comanche, and Blackhull.

The yield of Triumph, the lone variety in the third division, was 20.7 bushels. The rank of nine varieties grown for the 10 years 1938–47 is in the following order. Pawnee, NP Turkey, Cheyenne, Nebred, Comanche, Tenmarq, Nebraska 60, Kharkof, and Blackhull. 

Winter barley has been grown in nursery tests for the three years 1945–47. The three-year average yields of six varieties grown for that period was from 57.9 to 47 bushels. In order of yield rank the varieties were Ward, Purdue 21, Woodwin, Tennessee Winter, Reno, and Missouri Early Beardless. The highest yield in 1947 was 63.6 bushels per acre made by Purdue 1101 grown for the first time this year.

Spring barley. The plot test of 12 varieties was on bean land broken from sod two years previously. In the highest yielding group with yields ranging from 77.3 to 70.6 bushels per acre named in order of rank are Ezond, Velvon II, Trebi, Lico, and SD 262. In the second group with yields from 69.4 to 60 bushels are Gem, Feebar, Hybrid Comp., Spartan, Mars, and Beecher. Munsing, the only variety in its yield class, produced only 53.3 bushels. For the three-year period 1945–47, the yield rank of the highest four varieties was the same as that of 1947. Promising new varieties on the basis of disease resistance and freedom from lodging are Feebar and SD 252.

Oats. The test of 14 varieties was on bean land broken from sod two years previously. Yields were high and lodging of most varieties severe. Harvest was delayed by wet weather, and a high wind just previous to harvest threshed out an estimated 15 to 30 per cent of grain. Yields of the highest yielding group of five varieties ranged from 94.1 to 80.3 bushels. In order of yield rank these are Neosho, Cedar, Clinton, Ventura, and Osage. In the second group, with yields ranging from 78.4 to 70 bushels, are Fulton, Kherson, Brunker, Nemaha, and Hybrid C.I. 4140. In the lowest group with yields ranging from 65.6 to 55.6 bushels are Otoe, Hybrid C.I. 3846, Trojan, and Kanota. Varieties lodging 40 per cent or less were Clinton, Trojan, Neosho, Nemaha and Hybrid C.I. 3846. Varieties lodging 60 per cent or more were Cedar, Ventura, Fulton, Kherson, Brunker, Hybrid C.I. 4140, and Otoe.

Of varieties grown in plots for three years or more only, three have outyielded Brunker. These are Ventura, Neosho, and Fulton. In resistance to lodging, Neosho and Fulton are superior to Brunker, but on the basis of both plot and nursery tests they are inferior in this respect to Clinton and Nemaha.

Spring wheat. Comparisons were made between 19 varieties in nursery tests. Yields ranged from 25.6 to 11.4 bushels per acre, stem rust from 0 to 60 per cent, leaf rust from trace to 75 per cent, and maturity dates July 26 to 30. Of eight varieties grown for eight years or more, the yield rank is in the following order: Pilot, Rival, Kearney, Thatcher, Reward, Mindum, Ceres, and Marquis. All of these are inferior in yield to eight newer introductions. The most promising of these are Mida and an unnamed selection designated as C.I. 12263. For the four-year period 1944–47, the yields of these varieties have been 24.4, and 23.5 bushels.
per acre in comparison with 14.8 bushels for Ceres. Because of early maturity and good quality, C.I. 12263 is promising for use in replanting thin stands of winter wheat.


**Hybrid corn tests.** Plantings on dryland and under irrigation were made of 38 commercial hybrids, representing most of those in general use in this part of the state. On account of injury by the freeze of late May, stands were uneven, and the irrigated test abandoned. Yields were secured from 33 of the hybrids grown on dryland. These were scored on the basis of yield and maturity judged by moisture content at harvest time. Yields ranged from 55.6 to 28.8 bushels per acre and moisture content from 14.3 to 22.7 per cent. There were 10 hybrids that produced yields above 40 bushels per acre and with moisture content below 20 per cent. These are Pioneer 339, Tekseed 85, DeKalb 642, Cornhusker 85, Funk G114A, United 4, Funk G59, Nebraska 463, Standard 405, and DeKalb 398.

L. L. Zook.

**Grain sorghums** were grown on fallowed land. Early growth was slow because of cool June temperatures. High late-summer temperatures and delayed fall frost permitted all varieties to reach maturity. Yields were lower than those of the previous year. The range of 17 varieties was from 58.7 to 33.6 bushels. The highest yield was made by DD White Sooner N 218. This was followed by Early Kalo with 58.3. Of 10 varieties grown for four years 1944–47, the five with highest yields are Early Kalo, Early Hegari, Martin, Bonita, and Midland. The Weskan x Greeley crosses 66–3–1 and 20–5 which made the highest grain yields in the 1946 test were relatively low in 1947. Their two-year averages are above Early Kalo, as are those of DD White Sooner N218, DD White Sooner N224, and Early Hegari.

**Forage sorghum.** Of 10 varieties grown, four—Waxy Atlas, Rox Orange, Atlas, and Axtell—produced more than 4 tons per acre of forage with 15 per cent moisture. Waxy Atlas and Axtell also produced grain yields of 47.4 and 48.2 bushels per acre. Neither variety produced mature grain in 1946. The most promising variety for good forage yield, and high yield and good quality of grain, is Norkan. For the nine-year period 1939–47, Norkan occupies third place of six varieties in forage production with a yield of 3.37 tons, and first place in grain production with a yield of 37 bushels.

L. L. Zook, O. J. Webster.

**Moisture-Fertility-Spacing Experiment With Irrigated Corn**

The Nebraska Outstate Crops and Soils Testing Program in cooperation with the North Platte Substation conducted a preliminary study of the effect of varying the intensities of soil fertility, available soil moisture, and plant population on the yields of corn. Seven levels of soil fertility were established. They consisted of applications of 80 pounds of nitrogen per acre, 240 pounds of nitrogen per acre, and 20 tons of manure per acre alone and in combinations with 100 pounds of phosphorus (as $P_2O_5$) per acre and 100 pounds of potassium (as $K_2O$) per acre. Nitrogen was applied as ammonium nitrate, phosphorus as treble superphosphate, and potassium as potassium chloride. The manure was plowed under in the spring. The phosphorus, potassium, and one-fourth of the nitrogen were applied at planting time, and the balance of the nitrogen was applied at the last cultivation.
Three levels of soil moisture were maintained. Soil moisture was measured by determining electrical resistance in buried plaster-of-paris blocks by means of an electrical bridge developed by Bouyoucos. Tensiometers were also used in the high moisture plots. The three levels of soil moisture were maintained by irrigating when the electrical resistance of the block buried 1 foot deep reached 1,000 ohms for the high moisture level, 10,000 ohms for the medium moisture level, and 100,000 ohms for the low moisture level.

Three plant populations were established. They were 13,080, 19,620, and 26,160 plants per acre. These populations were obtained by planting in rows spaced 40 inches, 30 inches, and 20 inches apart with spacings within the rows of 12 inches, 10.7 inches, and 12 inches, respectively.

The average yield of the plots receiving no fertilizer application was 100 bushels per acre. Application of manure alone had no effect on yield. However, application of manure plus phosphorus resulted in lower yields. The application of phosphorus had no effect on yields of plots receiving applications of nitrogen in addition to the manure. Yields were increased by applications of nitrogen, but the application of 80 pounds per acre was just as effective as 240 pounds per acre. The application of potassium fertilizers had no effect on yield.

The higher moisture levels resulted in increased yields with average yields of 100, 104, and 110 bushels per acre for the low, medium and high moisture levels, respectively.

Increasing the plant population had no appreciable effect on yields, but did have an effect on the size of the ears produced. The closer spacings resulted in more but smaller ears.


Experimental Work With Cattle

Relation of winter feeding to growth and reproduction. Lots 3 and 5 of the five lots of 20 grade Hereford heifers, described in the 57th and subsequent Annual Reports, were dropped and the other three lots—1, 2, and 4—were continued on trial, with the number reduced by the disposal of cows that failed to reproduce. Rations were the same as for the previous year. Lot 1 was fed prairie hay, Lot 2 was fed prairie hay plus 1 pound of soybean pellets, and Lot 4 was fed 6 pounds of alfalfa hay, 25 pounds of silage, and prairie hay ad lib. All lots received salt, ground limestone, and steamed bone meal.

The number of cows bred per lot, respectively, was 16, 14, and 16; the number of calves produced 14, 14, and 12; the average birth weight of the calves 73, 75, and 74 pounds; and the average weaning weight at 195 days, 371, 388, and 393 pounds. From November 14, 1946 until May 3, 1947, during which time practically all of the calves were dropped, the cows producing calves in Lot 1 lost an average of 35 pounds per head. The cows in Lots 2 and 4 gained an average of 16 and 100 pounds per head during the same period. During the 1947 grazing period, the cows in Lot 1 gained an average of 107 pounds; those in Lot 2 gained 49 pounds, and those in Lot 4 lost an average of 26 pounds per head.

Wintering steer calves. Ten lots of 12 steer calves with an average initial weight of 470 pounds were fed for 126 days, from December 11, 1946 to April 16, 1947. Lots 1 to 5, inclusive, were full-fed corn silage and the following supplements per head daily, respectively: 2 pounds dehydrated alfalfa meal; 1 pound of a mixture of 88.1 per cent dehydrated alfalfa meal, 9.54 per cent urea, and 2.35 per cent steamed bone
meal; 43.49 per cent dehydrated alfalfa, 4.73 per cent urea, 48.22 per cent soybean oil meal, 0.66 per cent steamed bone meal, and 2.8 per cent ground limestone; 5.87 per cent urea, 47.52 per cent soybean oil meal, 41.64 per cent ground corn, 0.65 per cent steamed bone meal, and 4.30 per cent ground limestone; and 100 per cent soybean oil meal.

Lot 6 was fed 6 pounds of chopped alfalfa hay and Lot 7, 4 pounds of chopped alfalfa hay plus 0.33 pound of soybean oil meal per head, with all of the silage they would consume. Lots 8, 9 and 10 were fed all of the chopped alfalfa they would consume and 23.9, 16, and 8 pounds of silage per head daily.

In the 126-day period, the 10 lots made average gains per head of 176, 156, 179, 170, 187, 173, 191, 201, and 168 pounds. The average feed consumed for 100 pounds of gain for the 10 lots was: Lot 1, 2,256 pounds of silage and 143 pounds of pelleted dehydrated alfalfa meal; Lot 2, 3,063 pounds of silage and 81 pounds of pellets; Lot 3, 2,568 pounds of silage and 70 pounds of pellets; Lot 4, 2,591 pounds of silage and 74 pounds of pellets; Lot 5, 2,359 pounds of silage and 65 pounds of soybean oil meal pellets; Lot 6, 1,564 pounds of silage and 405 pounds of chopped alfalfa; Lot 7, 1,930 pounds of silage, 292 pounds of chopped alfalfa, and 24 pounds of soybean oil meal; Lot 8, 1,581 pounds of silage and 396 pounds of chopped alfalfa; Lot 9, 1,001 pounds of silage and 629 pounds of chopped alfalfa.

**Use of pasture in producing finished cattle.** The 120 steers used in the wintering trials were divided into twelve lots of ten steers for summer feeding investigations. The twelve lots were fed in pairs, Lots 1 and 2 in dry lot; Lots 3 and 4 on alfalfa pasture; Lots 5 and 6 on Kochia pasture; Lots 7 and 8 on native grass pasture; and Lots 9 and 10 on bromegrass pasture. The odd-numbered lots were fed 9 pounds of ground ear corn plus as much ground shelled corn as they would consume. Lot 1, in dry lot, was fed corn silage and alfalfa hay plus 0.5 pound of soybean oil meal per head daily in lieu of pasture. The even-numbered lots were fed 9 pounds of ground ear corn until July 7, when ground shelled corn was added to their ration. The full-fed pasture lots were continued on pasture until August 28 and then fed in dry lot until October 25. The lots fed a limited concentrate ration on pasture were continued on pasture until September 30 and then fed in dry lot until December 3. Lots 11 and 12 were fed and handled to correspond with Lots 3 and 4, except that 7.2 pounds of dried beet pulp per head daily was substituted for the 9 pounds of ground ear corn fed Lots 3 and 4.

Approximately the same results were obtained from the use of dried beet pulp as from ground ear corn, on a shelled corn basis. In the full-fed series, the steers fed in drylot made an average gain per head of 325 pounds and the steers fed on pasture, 336 pounds in the total 152-day feeding period. The gains made on pasture required an average of 28 days grazing for 100 pounds of gain but also required 109 pounds less alfalfa hay, 370 pounds less silage, 36 pounds less soybean oil meal, and 22 pounds less carbonaceous concentrates (shelled corn basis) for 100 pounds gain than the steers fed in dry lot.

In the series in which the steers were fed a limited feed of concentrates until July 7, the dry lot steers made an average gain of 393 pounds and all of the steers fed on pasture, an average gain of 375 pounds in the total 191-day feeding period. An average of 33 days grazing for one steer was required for 100 pounds of gain by the steers in this series fed on pasture. They also required 30 pounds more carbonaceous concen-
trates, but they required 203 pounds less alfalfa, 333 pounds less silage, and 28 pounds less soybean oil meal for 100 pounds gain than the steers fed in dry lot.

The steers fed on limited concentrate rations for a time made somewhat more economical gains, especially from the standpoint of concentrates required, than the steers full-fed for the entire period. All of the pastures were satisfactory.

The steers were in approximately the same market condition when sold for slaughter.

**Wintering and fattening heifer calves.** Three lots of 16 heifer calves were fed growing rations for 84 days from November 21, 1946, to February 13, 1947. Lot 1 was fed 1 pound of soybean oil meal and an average of 28.15 pounds of corn silage per head daily; Lot 2 was fed an average of 4.1 pounds alfalfa hay and 19.59 pounds of corn silage; and Lot 3 was fed an average of 3 pounds ground shelled yellow corn and 11.6 pounds alfalfa hay. Average gains per head for the 84-day period for the three lots respectively were 126, 100, and 128 pounds. Lot 1 required an average of 67 pounds soybean oil meal and 1,873 pounds corn silage; Lot 2 an average of 364 pounds alfalfa hay and 1,656 pounds of corn silage; and Lot 3 an average of 199 pounds ground shelled corn and 767 pounds alfalfa hay per 100 pounds of gain.

The heifers were then fed for an additional 70 days. During this period, Lot 1 consumed an average of 8.2 pounds ground shelled corn, 1.47 pounds soybean oil meal, and 20.76 pounds corn silage; Lot 2 an average of 8 pounds ground shelled corn and 11.4 pounds of alfalfa hay; and Lot 3 an average of 8.2 pounds of ground shelled corn and 11.4 pounds alfalfa hay per head daily. The average feed requirement for 100 pounds of gain was for Lot 1, 436 pounds of ground shelled corn, 78 pounds of soybean oil meal, and 1,242 pounds of corn silage; for Lot 2, 383 pounds of ground shelled corn and 543 pounds of alfalfa hay; and for Lot 3, 411 pounds of ground shelled corn and 572 pounds alfalfa hay.

**Feeding beef cows for slaughter.** Two lots of sixteen beef cows from Lots 3 and 5 of the trial on the relation of winter feeding of beef cows to growth and reproduction were removed from that experiment and fed for 60 days, from November 14, 1946, to January 13, 1947. These cows had an average initial weight of 1,011 pounds at the beginning of the feeding period. Lot 1 was fed an average of 17.1 pounds ground ear corn, 4.6 pounds chopped alfalfa hay and 31.7 pounds corn silage; Lot 2 was fed an average of 17 pounds of ground ear corn and 17.7 pounds of chopped alfalfa hay, and 884 pounds of corn silage for Lot 1; and 537 and 190 pounds in the 60-day period at an average feed requirement per 100 pounds of gain of 474 pounds ground ear corn, 128 pounds chopped alfalfa hay, and 884 pounds of corn silage for Lot 1; and 537 pounds ground ear corn and 557 pounds of chopped alfalfa hay for Lot 2.

**Growing Holstein steers.** The three lots of Holstein calves referred to in the 60th Annual Report were removed from the calf-rearing rations in which they had received, respectively, blood meal, tankage and skim milk as protein supplements, and placed on pasture May 1, 1947. At that time the average weight per head of the steers by lots was: Lot 1, 399; Lot 2, 410; and Lot 3, 502 pounds. From May 1 to November 17, a period of 200 days, the three lots made an average gain of 173, 188, and 183 pounds per head, respectively. The steers are to be fed for slaughter in the spring of 1948.

Guy N. Baker.
Swine Investigations

Improvement of swine through breeding. Work under this project was continued at North Platte and at Lincoln. In the spring of 1947, 82 litters of pigs were farrowed at North Platte in four inbred lines and three crosses of inbred lines. The average inbreeding of litters farrowed in the four lines was 38, 30, 25, and 6 per cent. There generally was a negative correlation between per cent of inbreeding and the number of pigs farrowed and weaned per litter. Correlation between the average level of inbreeding and loss between farrowing and weaning was positive.

Performance generally was superior to that obtained in years immediately preceding 1947.

In the fall of 1947, 77 litters were farrowed at North Platte in four lines and in one cross of two lines. The average inbreeding of the litters farrowed in the four lines was 34, 25, 29, and 5 per cent. Farrowing performance of the sows and survival of the pigs were quite good and the effect of inbreeding upon performance was not as apparent as in the litters farrowed in the spring.

Twenty-three litters were farrowed in the fall of 1947 at Lincoln. These were all from F\textsubscript{1} females (Landrace x Duroc-Jersey) and were sired by Landrace, Duroc-Jersey, Berkshire, and F\textsubscript{1} boars.

Cooperation in obtaining data on the value of inbred boars under field conditions was continued or established with the Iowa and Wisconsin Stations. Boars also were supplied to the South Dakota station for use in its swine breeding program. Boars were supplied to a limited number of Nebraska breeders interested in developing purebred herds based on the use of inbred boars and also to commercial producers. Small herds from Lines 10 and 11, respectively, were established at the Valentine Substation and at the School of Agriculture at Curtis.

Studies on carcass data from 416 animals from hogs produced at North Platte and slaughtered at a weight of approximately 225 pounds were made. Three correlations, gains from 56 to 112 days, from 112 days to slaughter, and 56 days to slaughter with depth of back fat, length of hind leg, and ham circumference were obtained. Hereditary factors accounted for 12 per cent of the variance for depth of back fat and 24 per cent of the variance for length of hind legs. Estimates of heritability for the other characters were between these extremes.

Simple correlations between gain and depth of back fat and gain and ham circumference were low and positive. Between gain and length of hind leg, the correlation was negative. Genetic correlations were not significant but indicated a negative correlation between gain and depth of back fat and leg length, but a positive correlation between gain and ham circumference. The results from this study were published in the Journal of Animal Science, Vol. 6, No. 4, November, 1947.

Heritability estimates obtained from studies of sow productivity were—number of pigs farrowed per litter, 0.138; number of pigs farrowed alive per litter, 0.240; pigs per litter alive at 21, 56, and 168 days, respectively, 0.150, 0.153, 0.224; total litter weight at 56 and 168 days, respectively, 0.186 and 0.110.

Preliminary analysis of the relation between the number of services required per sow and the inbreeding of the sow and litter in the North Platte herd indicates that inbreeding and age of sow had no effect on the number of services required per conception. Results also indicated
NORTH PLATTE SUBSTATION

Inbred Duroc-Jersey gilts, seven to eight months old, at North Platte Substation.

little reason for retaining females which did not conceive at the first or second service.


Corriedale Sheep

The flock of Corriedale ewes consists of 80 head. Thirty head are bred to rams selected on the basis of progeny tests at Lincoln and 30 head are bred to rams selected on the basis of type, quality, and pedigree.

Twenty ewes and three rams were used as the basis for a closed flock. The flock is based on breeding tracing largely to a ram obtained a number of years ago from the Bureau of Animal Industry flock at Beltsville, Maryland.

Guy N. Baker.

Apiculture

Use of pollen supplements for bees. Brewers' yeast, dried skim milk, dried egg yolk, soybean flour, and combinations of these materials were used during the 1947 season as pollen supplements in tests with bees. Sixty colonies of bees were used. These included 30 colonies of wintered bees; ten 3-pound packages; and 20 nuclei.

Wintered colonies. Ten colonies received soybean flour plus 5 per cent dried egg yolk and produced an average of 58 pounds per colony. One unit was lost on June 23.

Ten colonies received no pollen supplement, and produced an average surplus crop of 78.3 pounds per colony, with two units being lost.

Ten colonies received soybean flour and dried brewers' yeast (nine parts soybean flour to one part yeast). There was no loss of units in this lot, and the bees produced an average of 130.1 pounds per colony.

Package bees. Five colonies received soybean flour and dried brewers' yeast mixed as above. Development was unsatisfactory although there were no supersedures of queens. Yields from this lot averaged 42.4 pounds per colony.
Five colonies received soybean flour and dried skim milk (six parts soybean flour to one part milk). Development in this lot was even more unsatisfactory, with one queen being superseded. The average yield per colony was only 16.4 pounds.

**Nuclei.** These were made up on May 19 and included three frames of brood, all bees remaining on the frames, and a tested queen.

Five colonies received soybean flour and dried skim milk mixed as above. Their development was fairly satisfactory, and the average yield per colony was 53.6 pounds.

Five colonies received soybean flour and brewers' yeast mixed as above. This was the best group in the test with an average yield of 71.2 pounds.

Five colonies received soybean flour plus 5 per cent dried egg yolk. This was the lowest producing group in the test with an average of only 40.8 pounds.

Five colonies received soybean flour only, and produced an average of 50 pounds per colony.

E. A. Wolfe.

**Poultry**

A laying flock of 860 White Leghorns was maintained through 1947, with an average production of 239.9 eggs per bird. This is the highest flock average record ever made at this station. Egg size and livability of birds also showed improvement.

**Different levels of protein in poultry mash.** In the spring of 1946, two lots of chicks were started on a test using a 17 and a 22 per cent protein mash. During the brooder period, the chicks on the latter mash consumed more feed and made more rapid gains. Death loss in the two lots was approximately equal. During the range period, this trend was reversed with the 17 per cent group consuming more feed, making greater gains, and at the close of the period weighing slightly more than those in the 22 per cent lot. However, the birds receiving the 22 per cent mash were more uniform.

These birds were put in laying houses on October 1, 1946. Average egg production per hen in the 17 and 22 per cent lots was 233.5 and 252.3, respectively. Death loss was considerably heavier in the 22 per cent lot. Consequently, total production of the 17 per cent birds was greater even though their average was lower. There was practically no difference in the hatchability of eggs or quality of chicks. However, size and quality of eggs favored the 22 per cent birds.

This test is being repeated.

E. A. Wolfe.

**Horticulture**

**Weed control.** Use of 2,4-D, for weed control in turf, is now past the experimental stage. Experience indicates that 1 pound of the free acid per acre is an adequate dosage for the control of most broad-leaved lawn weeds.

The use of ester formulations of 2,4-D for weed control in or near vegetable crops or susceptible ornamentals is not safe. 2,4-D effects were observed on tomato plants at a distance of over 600 feet from an area treated with the Isopropyl ester of 2,4-D. Esters of 2,4-D are volatile and fumes from this type of the herbicide may be carried for con-
siderable distances. The salts of 2,4-D are involatile and may be safely used near susceptible plants if precautions are used to prevent the spray material from reaching the plants.

No injury from 2,4-D to conifers was noticed except when applied directly to the young growth in early spring. The use of the herbicide in evergreen plantings appears safe if reasonable care is taken to avoid direct application to the trees.

**Testing program.** The cooperative testing program carried on in cooperation with some forty selected cooperators is proving to be a valuable tool for the rapid evaluation of new plant material under the widely divergent soil and climatic conditions of Nebraska. Selections put on state-wide trial in 1947 included six chrysanthemums, three tomatoes, and two strawberries. Under a plan worked out by the Departments of Horticulture at Lincoln and North Platte and the Nebraska Nurserymen, three varietal orchards were planted in the spring of 1947. They are located at Chappell, Ogallala, and Seneca.

Cooperative testing of sweet and white potatoes was carried on in cooperation with H. O. Werner of the Lincoln station. A field of the new variety Nebraska No. 2 potatoes was grown for seed increase on the dryland farm.

**Chrysanthemums.** Five new chrysanthemums, the result of the breeding program started in 1944, were named and introduced in the fall of 1947. A number of commercial nurserymen have purchased foundation stock and will offer plants to the public in 1948. Additional selections in various stages of testing are being carried in the program and a few will be ready for release in 1948. Approximately 2,000 seedling chrysanthemums were grown in 1947 from open pollinated seed of the Minnesota variety Chippewa and a number of F1 “Greenhouse x Hardy” hybrids. About 50 selections have been made for observation and preliminary testing. In order to obtain seed for known parentage, an estimated 30,000 hand pollinations were made in the fall of 1947. It is hoped this procedure will make possible the selection of superior parent varieties.

**Strawberries.** The scope of the strawberry project has been increased to include breeding as well as testing. About 4,000 seedling strawberries were received from the Cheyenne Horticultural Field Station for inclusion in the project and about 1,500 seedlings from matings made at North Platte were produced. Thirty-five progenies are represented in the plantings. The object of the program is the production of both June and everbearing varieties better adapted to Nebraska conditions. The production of hybrid seed for use in 1948 is under way.

**Sweet corn.** Forty lines of sweet corn have been selfed from one to three years in order to establish pure lines.

**Fruit understocks.** A collection of apple varieties of possible value as dwarfing stocks was secured from the U. S. Department of Agriculture and other sources. Most of this material is now established in the nursery.

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**GLENN VIEHMeyer.**

**Sugar Beets**

**Mechanical thinning and seed rate study with sugar beets.** This experiment was conducted and carried on cooperatively with the Sugar Beet Development Foundation, Fort Collins, Colorado; Outstate Testing; Agricultural Engineering Department; and Great Western Sugar Co.
Three rates of seeding were compared using cross cultivations with different center spacing of knives attached to the beet cultivator compared with hand blocking and thinning, long handle hoe and delayed thinning.

Emergence of seedlings was slow and erratic as some beets were in four-leaf stage while others were just coming through the ground due to dry weather immediately after planting. However, a close correlation between planting rates and pre-thinning counts was noted. Segmented seed was used and 2-4, 7-8, and 10-12 seeds per foot were planted. The pre-thinning count was 175, 235, and 310 seedlings per 100 feet of row, respectively. The lower seeding rates had fewer multiples and more singles and doubles, but had more and wider gaps in the stand.

Thinning was calculated on the stand basis for each of the planting rates so as to leave approximately 100 plants per 100 feet of row. According to after-thinning counts, all treatments came quite close to the desired stand. Mean of the three mechanical cross thinning treatments and three seeding rates left 64.3 per cent singles, 27.7 per cent doubles, and 8.5 per cent multiples with the medium seeding rate being slightly superior to the other two rates.

Hoe trimming after crossing with knives gave stands closer to the desired, but did not materially change percentages of singles or doubles. Average of the two hand thinning and blocking treatments gave a higher percentage of singles, 94.4 per cent; with 4 per cent doubles and 0.5 per cent multiples.

Very little difference in yields of the mechanically crossed treatments was noted either as to center spacing of knives or seeding rates. Delayed hand thinning did not reduce yield except in the high rate of seeding where it was the lowest of the treatments. Hand thinning at the 4–6 leaf stage yielded 25.70 tons, 25.45 tons and 26.78 tons compared with 24.56 tons, 23.55 tons, and 24.79 tons for the best mechanical treatments in the 2–4, 7–8, and 10–12 seeds per foot rates of seeding, respectively.

There was no appreciable difference in either sucrose or tare percentages of any of the treatments.

Number of both marketable and unmarketable beets increased with higher seeding rates and the average beet weight decreased 2.339, 2.074, and 1.923 pounds for low, medium and high rates, respectively.

**Dairy**

A herd of 35 purebred Holstein cows was milked during the year, averaging 11,728 pounds of milk and 441 pounds of butterfat with an average test of 3.76 per cent. Three cows, Nos. 852, 909, and 940, each having a lifetime record of over 100,000 pounds of milk were in the herd. No. 940 was sold in October. No. 920 reached the 100,000-pound mark during the year. This makes a total of 14 cows from the herd that have passed the 100,000-pound mark.

Alfalfa silage was used for the first time by the Dairy Department. This was made from first cutting alfalfa with 200 pounds of ground corn added to each ton of chopped hay. The cattle appeared to eat the silage quite well, but were slower taking to it than the corn silage.

Fifty head of cows and heifers were pastured for 170 days on 23 acres of brome and alfalfa pasture starting on May 15.
Raising young dairy calves on protein substitutes for skim milk.
Three lots of six Holstein steers each were started on the feeding trial November 15, 1946, and continued until April 14, 1947. All lots received a ration of 150 pounds ground yellow corn, 150 pounds whole oats, 6 pounds steamed bone meal, and 3 pounds salt in addition to green alfalfa hay.

The basic ration for Lot 1 was supplemented with 30 pounds blood meal; for Lot 2 with 50 pounds tankage; and for Lot 3 with 10 pounds skim milk daily. All lots were given their grain rations and alfalfa hay free choice. Cod liver oil was added to the basic ration for each lot.

The calves in Lot 3 made the greatest gains and looked somewhat more thrifty than those in the other two lots. They made an average gain of 241, 243, and 322 pounds for Lots 1, 2, and 3, respectively, with daily gains of 1.60, 1.62, and 2.15 pounds. Some difficulty was experienced in getting the calves to eat the ration containing blood meal. They ate a little less total feed than those in Lot 2. Lot 3 consumed more feed than the other two lots.

Myron Rumery, A. R. Sharrah, James C. Adams.
Experiment Station Publications

Annual Report
Sixtieth Annual Report, presented to the Governor February 1, 1947.

Bulletins

Research Bulletins

Circulars

Journal Series, Technical Articles and Papers *

* Dates following the names of journals refer to time of registration of articles and papers and not to publication dates.


### Experiment Station Administration and Staff

The Regents of the University

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<tr>
<th>Name</th>
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<tr>
<td>GEORGE LIGGETT</td>
<td>President</td>
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<tr>
<td>CHARLES Y. THOMPSON</td>
<td>Executive Clerk</td>
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<td>ROBERT W. DEVOE</td>
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<td>JAMES WELSH</td>
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<td>STANLEY D. LONG</td>
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<td>R. G. GUSTAVSON</td>
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<td>JOHN K. SELLECK</td>
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#### The Station Officers

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<tr>
<td>W. W. BURR, B.Sc.</td>
<td>Director</td>
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<tr>
<td>MARVEL L. BAKER, M.Sc.</td>
<td>Associate Director</td>
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<td>W. H. BROKAW</td>
<td>Director of Agricultural Extension</td>
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<td>Executive Clerk</td>
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<tr>
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#### The Technical Staff

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<th>Name</th>
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<td>Animal Husbandman, North Platte Substation</td>
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<td>MARVEL L. BAKER</td>
<td>Animal Husbandman and Associate Director of</td>
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<td>Station</td>
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<td>Associate Home Economist</td>
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<td>Assistant Agricultural Chemist</td>
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<tr>
<td>E. E. BRACKETT</td>
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<td>P. A. DOWNS, Ph.D.</td>
<td>Dairy Husbandman</td>
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1 By an act of the Legislature of the State of Nebraska approved and in effect February 15, 1899, the State Treasurer became ex officio custodian of the Experiment Station funds on and after July 1, 1899.

2 Deceased.

3 Resigned.

4 Resigned.
F. L. Duley, Ph.D., Senior Soil Conservationist
J. V. Dunlap, B.Sc., Assistant in Animal Husbandry
P. L. Ehlers, B.Sc., Assistant in Agronomy
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R. A. Mapes, Manager, Union Fruit Farm
R. P. Matelski, Ph.D., Assistant Agronomist
Katherine M. Maurer, Ph.D., Associate Home Economist

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5 Detailed from U. S. Department of Agriculture, Washington, D. C.
6 Detailed from U. S. Department of Agriculture, Washington, D. C.
7 Resigned.
8 Detailed from U. S. Department of Agriculture, Washington, D. C.
9 Resigned.
10 Resigned.
11 Resigned.
12 Resigned.
ADMINISTRATION AND STAFF

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RUFUS H. MOORE, Ph.D., Associate Horticulturist
R. F. MORGAN, M.Sc., Assistant Dairy Husbandman
MARY R. MORRIS, Ph.D., Assistant in Agronomy
M. H. MUMA, Ph.D., Associate Entomologist
F. E. MUSSEHL, B.Sc., Poultry Husbandman (Chairman)
L. C. NEWELL, Ph.D., Associate Agronomist
CARL OLSON, Jr., D.V.M., Ph.D., Animal Pathologist (Chairman)
G. W. OLSON, B.Sc., Assistant in Agricultural Engineering
G. M. PETERSON, B.Sc. A.E., Assistant Agricultural Engineer
C. R. PORTER, M.Sc., Assistant Agronomist
W. W. RAY, Ph.D., Mycologist
L. P. REITZ, Ph.D., Agronomist
H. F. RHOADES, Ph.D., Associate Agronomist
MYRON G. A. RUMERY, B.Sc., Assistant Dairy Husbandman, North Platte Substation
J. C. RUSSELL, M.Sc., Agronomist
R. M. SANDSTEDT, M.Sc., Agricultural Chemist
DORETTA SCHLAPHOFF, M.Sc., Assistant in Home Economics
J. F. SCHRUNK, Assistant in Agricultural Engineering
ANDREW B. SCHULTZE, Ph.D., Assistant Dairy Husbandman
MAX L. SCHUSTER, Ph.D., Assistant Plant Pathologist
ARDEN SHERF, B.Sc., Assistant Plant Pathologist
JOHN M. SLATENSEK, Ph.D., Assistant Agronomist
C. W. SMITH, M.Sc. M.E., Agricultural Engineer
L. B. SNYDER, Ph.D., Associate Rural Economist
C. A. SOOTER, Ph.D., Assistant Entomologist
E. V. STAKER, Ph.D., Assistant Agronomist
DON STOUT, B.Sc., Assistant in Dairy Husbandry
I. W. TERVET, Ph.D., Associate Plant Pathologist
L. VAN ES, V.S., M.D., D.Sc., Animal Pathologist, Emeritus
GLENN VIEHMeyer, Assistant in Horticulture, North Platte Substation
G. H. VOLKMER, B.Sc., Analyst
GILBERT WEBSTER, M.Sc., Associate Agronomist
O. J. WEBSTER, B.Sc., Associate Agronomist
M. D. WELDON, Ph.D., Agronomist
H. O. WERNER, Ph.D., Horticulturist
HOWARD WIEGERS, B.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., Assistant Animal Pathologist
F. D. YUNG, M.Sc. A.E., Assistant Agricultural Engineer
L. L. ZOOK, B.Sc., Agronomist, North Platte Substation

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13 Detailed from U. S. Department of Agriculture, Washington, D. C.
14 Detailed from U. S. Department of Agriculture, Washington, D. C.
15 Resigned.
16 Resigned.
17 Detailed from U. S. Department of Agriculture, Washington, D. C.
18 Detailed from U. S. Department of Agriculture, Washington, D. C.
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, 1947, 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, 1947, under act of Congress approved March 16, 1906. Total $15,000.00

Expenditures
For salaries ......................................................... $15,000.00
Total .................................................................... $15,000.00

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, 1947, under act of Congress approved February 24, 1925. Total $60,000.00

Expenditures
For Salaries and Wages
Regular employees ........................................ $39,507.16
Temporary employees ........................................ 3,027.68
Total .................................................................... $42,534.84

Supplies
Office ................................................................. $ 133.74
Laboratory supplies ........................................ 1,128.40
Institutional and household supplies ................. 201.94
Agricultural supplies ......................................... 2,092.77
Shop and plumbing supplies .............................. 106.36
Automotive, gas and oil ..................................... 26.90
Miscellaneous ..................................................... 240.33
Total .................................................................... $ 3,930.44

Expense
Postage .................................................................. $ 6.00
Telephone and telegraph .................................... 13.44
Freight, cartage and express ............................... 166.30
Traveling expense ................................................ 1,600.74
Publishing, printing and advertising .................. 121.69
Equipment rental and servicing ......................... 28.00
Special and temporary services ......................... 8,719.91
Miscellaneous ..................................................... 110.00
Total .................................................................... $10,766.68

Repairs
Buildings ............................................................. $ 171.60
Grounds ................................................................. 21.28
Equipment ........................................................... 696.66
Total .................................................................... $ 889.63

Equipment
Furniture and fixtures ........................................... $ 1,591.21
Agricultural and livestock .................................. 287.80
Total .................................................................... $ 1,879.01

Grand Total .......................................................... $60,000.00

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, 1947, under act of Congress approved February 24, 1925. Total $41,505.16

Expenditures
Salaries and Wages
Regular employees ............................................ $27,340.71
Temporary employees .......................................... 281.60
Total .................................................................... $27,622.31
FINANCIAL REPORT

Supplies
Office supplies .................................................. $ 62.18
Laboratory supplies ........................................... 232.93
Institutional and household supplies ......................... 1,739.35
Agricultural and veterinary supplies ......................... 4,272.88
Shop and plumbing supplies .................................. 65.04
Automotive and aircraft supplies ............................. 68.02
Miscellaneous .................................................. 36.48
Total ...................................................................... $ 6,498.88

Expenses
Telephone and telegraph .......................................... $ 4.47
Freight, cartage and express ..................................... 20.99
Traveling expense .................................................. 994.30
Printing, publishing and advertising ........................... 211.98
Equipment rental and servicing ................................ 61.00
Departmental expense ........................................... 4,444.59
Total ...................................................................... $ 5,737.21

Repairs
Buildings .................................................................. $ 312.57
Equipment .................................................................. 316.79
Total ........................................................................ $ 629.36

Equipment
Furniture and fixtures ................................................ $ 737.90
Agricultural equipment ............................................. 179.50
Total ........................................................................ $ 917.40

Fixed charges
Land, office and structure rentals ................................. $ 100.00
Total ........................................................................ $ 100.00

Grand Total ................................................................ $41,505.16

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, 1947 (exclusive of federal funds).

Salaries and Wages
Regular employees ................................................. $117,948.10
Temporary employees .................................................. 1,104.59
Total ...................................................................... $119,052.69

Supplies
Office supplies ......................................................... $ 2,718.18
Laboratory supplies .................................................. 7,163.03
Household, educational supplies, foods, etc. .......... 27,173.84
Agricultural supplies, feed, etc. ................................. 80,046.23
Shop and plumbing supplies ..................................... 1,452.24
Miscellaneous ........................................................ 3,490.98
Total ...................................................................... $130,444.69

Expense
Telephone ................................................................. $ 730.93
Freight, express and cartage ......................................... 1,901.19
Traveling expense ..................................................... 3,022.76
Printing, publishing and advertising ....................... 14,461.00
Equipment, rental and servicing ................................. 609.99
Light, heat, power and water ........................ .......... 2,997.15
Miscellaneous ........................................................ 87,282.88
Total ...................................................................... $119,343.76

Repairs
Buildings ................................................................. $ 10,039.99
Lands ....................................................................... 1,325.65
Total ...................................................................... $ 20,262.45

Equipment
Office furniture and fixtures .................................... $ 2,186.58
Laboratory apparatus ................................................. 5,566.56
Household furniture .................................................. 1,711.12
Farm machinery, automobiles ................................... 12,755.26
Livestock ................................................................ 18,434.33
Books ...................................................................... 105.77
Total ...................................................................... $44,179.62

Lands and Buildings
Building improvements ............................................ $ 1,228.45
Fixed Charges
Rentals, insurance, premiums .................................... $ 738.62
Total ...................................................................... $435,250.28

Dated at Lincoln, Nebraska .......................... JOHN K. SELLICK, Comptroller.