1947

60th Annual Report of the Agricultural Experiment Station May 1947

W.W. Burr
University of Nebraska at Lincoln

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60th Annual Report

Agricultural Experiment Station
University of Nebraska College of Agriculture
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Agriculturally speaking, Nebraska had another good year in 1946, as this 60th annual report of the Agricultural Experiment Station will show. Farmers harvested the largest winter wheat crop in the history of the state, almost ninety million bushels. Their cornfields produced another bumper yield. Alfalfa acreage was back up to almost a million acres at a value in seed and forage estimated to be thirty million dollars. Although production and labor costs were high, a combination of good yields and high prices resulted in a financially profitable year for farms over most of the state.

As in every growing season in Nebraska, weather was a prime factor in crop production. Timely, though moderate, rain fell over most of the land. A late freeze did some damage but there were few bad storms and not a great many days of extreme heat. Damage from insects and disease was light over almost the entire state.

Not least among factors that contributed to the high production of the year was intelligent management by the farmers. A large part of their success resulted from the use of new and improved varieties of crops, good breeds of livestock, and good management of their farms generally. It is estimated that new crops and varieties have increased crop yields in Nebraska by 20 per cent in 25 years.

Of the factors that combined in 1946 to give the farmers a good year, prices and weather are not within the control of the individual farmer. Through careful farm management, however, the man on the land can help to overcome adverse weather and prices. It is here that the Experiment Station, through its research, can give greatest assistance. ‘Good years or bad, research seeks to find the answer to the farmer’s problems. After that it is up to the farmer himself to determine the use he will make of the results of research.’ A statement in the entomology report is a terse reminder. Reporting on Hessian fly in wheat fields, it says: ‘In areas of high infestation the fly-free planting date has been largely ignored.’

Rural economists who have been studying Nebraska problems through the war years have suggested that many soil conservation projects have been neglected because of the great need of large production. They point
out that too high an acreage of row crops is being planted, and that there is need for more grasses and legumes. Farm livestock reports show that the number of cattle in the state is high, but that the number of hogs is lower than seems desirable.

It is evident from this report that a great deal of progress was made during the year in the research program of the Station. The answers were obtained to some problems and the projects can be closed, but in a considerable number of projects a definite answer cannot be found. Changing conditions in general management always entail new problems. An improved crop leads to the search for one yet better. New chemicals for control of insects or weeds, new fertilizers, or new equipment may remind research to determine their value in the general farm practice.

Considerable work was continued on the study of native grasses in an effort to use their greatest feeding value and also in the maintenance of pasture and meadow. The growing of grass is increasingly important in the maintenance of the soil and the general agriculture program in Nebraska. Important soil conservation work in other lines has been continued, including experiments in subsurface tillage and the use of fertilizers.

Research on the long established crops was intended, as in previous years, to improve old and introduce new varieties. The world shortage of oils has resulted in increased interest among agriculturalists in some of the so-called chemurgic crops. There appears a possibility of their increased acreage in Nebraska.

Many projects and lines of work are discussed here in the form of progress reports. In other words, the work has not yet reached the point where conclusions or even general trends can be stated. Other experiments are farther along and in some cases afford definite answers to questions. Some studies may lead even to so-called negative results, but the entire research program is set up to contribute to a permanent and better system of agriculture in the state.

Some of the new insecticides show promise of great value. Yields of potatoes were increased significantly by use of a DDT spray. Cows and calves sprayed with DDT to control horn flies gained considerably more weight during the summer than those not sprayed. Hog mange was controlled effectively with certain 666 sprays. Promising results were obtained with 666 for control of grasshoppers.

A reading of the report will show that the program is broad, as broad in fact as the resources and personnel of the Station can support. It covers the work at the substations as well as at the main station. The splendid cooperation continues with farmers, the Extension Service, and federal bureaus. Exchange of ideas and joint attack of some problems, in cooperation with other states, is becoming increasingly important.

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 Sixtieth Annual Report of the Agricultural Experiment Station of Nebraska.

W. W. Burr, Director.

February 1, 1947.
Soils Research
Department of Agronomy

Erosion Control and Moisture Conservation

Research activities that began in 1938 under cooperative agreement with the U. S. Department of Agriculture, Soil Conservation Service, Office of Research, have expanded in scope and importance each succeeding year. Emphasis continues to be centered on the role of organic material in conserving soil and moisture. This work has previously indicated that crop residue left on the surface has much more effect in reducing runoff and erosion than where it is plowed under. Accordingly, the studies in 1946 have been concerned largely with conservation practices that make use of residue on the surface.

The season of 1946 at Lincoln was not well suited for showing the effect of residue on runoff and erosion. About the average number and quantity of runoff-producing rains occurred but they were of unusually moderate intensity. The total runoff for the year in the absence of residue was 0.55, 0, and 1.18 inches for corn, oats, and wheat, respectively. The average of these for the rotation as a whole was practically as low as heretofore ever recorded in any one year, even with residue protection.

Runoff and soil loss from residue-protected and unprotected land at Agronomy Farm, Lincoln, in 1946, are shown in the table below, in comparison with the means of five preceding seasons.

<table>
<thead>
<tr>
<th></th>
<th>1946</th>
<th>Mean of Five Previous Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residues,</td>
<td>No Residues, Plowed</td>
</tr>
<tr>
<td>Residues,</td>
<td>Subtilled</td>
<td>Plowed</td>
</tr>
<tr>
<td>Runoff— inches</td>
<td>0.63</td>
<td>0.58</td>
</tr>
<tr>
<td>Soil loss— tons per acre</td>
<td>0.07</td>
<td>1.00</td>
</tr>
<tr>
<td>Runoff— relative</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Soil loss— relative</td>
<td>1</td>
<td>14</td>
</tr>
</tbody>
</table>

Some of the outstanding experiments involve the use of sweet clover residues in the production of wheat, oats, corn, and sorghum. Basic treatment is sweet clover material left on the surface either by the subsurface tillage of green growth in the spring of the second year, or dead growth in the fall or spring following. The check or comparative treatment is the same material plowed under. The following yields were obtained at Lincoln and at the Soil Conservation Service Hastings Hydrologic Project in northern Webster County.

Crop yields in 1946 following sweet clover and comparative yields on land not previously in sweet clover.

<table>
<thead>
<tr>
<th>Residue treatment</th>
<th>Wheat</th>
<th>Oats</th>
<th>Corn</th>
<th>Pink kaffir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residues subtilled</td>
<td>49.2</td>
<td>61.6</td>
<td>38.5</td>
<td>50.2</td>
</tr>
<tr>
<td>Residues under</td>
<td>50.5</td>
<td>54.8</td>
<td>83.7</td>
<td>36.5†</td>
</tr>
<tr>
<td>Following 2-year sweet clover at Lincoln</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residues subtilled</td>
<td></td>
<td>68.5</td>
<td>50.6</td>
<td></td>
</tr>
<tr>
<td>Residues under</td>
<td></td>
<td>69.5</td>
<td>44.3†</td>
<td></td>
</tr>
</tbody>
</table>

Following 1-year sweet clover at Lincoln
A—Mowing sweet clover for residue for wheat. 21.75 tons green weight, 4.25 tons dry weight per acre. Wheat yield, 49.2 bushels per acre.

B—Dry second-year sweet clover residue being treaded. Later subtilled for corn. 4.25 tons dry weight per acre. Corn yield, 88.5 bushels per acre.

C—Bromegrass seeded on eroded soil after sweet clover. Residue left on surface to protect soil while grass is starting.

D—Subtilling sweet clover in spring of second year. Corn yield, 68.5 bushels per acre.
Comparative yields at Lincoln on land not previously in sweet clover

<table>
<thead>
<tr>
<th></th>
<th>Residues subtilled</th>
<th>Residues under</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>33.9</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
<td>39.0</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>44.7</td>
<td>57.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Following 2-year sweet clover at Hastings Project

<table>
<thead>
<tr>
<th></th>
<th>Residues subtilled</th>
<th>Residues under</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20.1</td>
<td>17.1</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>45.7</td>
<td>40.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparative yields at Hastings Project on land not previously in sweet clover

<table>
<thead>
<tr>
<th></th>
<th>Residues subtilled</th>
<th>Residues under</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13.4</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Crop failure due to drought.
† These low yields were due mainly to poor stand resulting from temporary dry surface soil conditions that were worse on plowed than on subsurface tilled land.

The foregoing results demonstrate a conclusion that is gradually beginning to appear both at Lincoln and at Hastings, namely, that the highest efficiency of subsurface tillage and the use of residues on the surface is to be obtained on land that is well supplied with the elements of fertility. Apparently when land has reached a stage of depletion such that every little incident of weeds, time of operation, or stand is reflected in final yields, the plow system has the advantage over the subsurface tillage system. However, this is not to be interpreted as preference for plowing. The improvement of fertility makes subsurface tillage equally effective as regards yields, and the residue cover makes it superior as regards preservation of the soil.

Agronomy Farm Field 27-I continues to be an excellent demonstration of the practicability of residue protection. This field, a tract of two acres, with the most extreme slopes of any land on Agronomy Farm (10, 15, and 20 per cent over much of the area) was seeded to alfalfa in 1930 as a means of holding the soil and was scheduled for permanent seeding to grass. After being relinquished for a demonstration field in the spring of 1940, it was subtilled and put to a cultivated crop. Because of the sparseness of the alfalfa residues, it was top-dressed that year with two tons per acre of straw. Since 1940 it has produced seven crops. All stalks and straw have been left on the field and all operations have been done with machinery that left these on the surface. The field has not been plowed since it was planted to alfalfa in 1930, nor has it had a disk, lister, harrow, or shovel cultivator on it during the last seven years. It has been farmed exclusively with machinery adapted to working through residues, and always with no less satisfaction and no more cost than by common methods. To this date, it has developed neither adverse soil structure nor displayed any disadvantages with respect to weeds, insects, plant diseases, or nutrient deficiencies.

Crop yield in Field 27-I, which has been farmed with continual residue protection for seven years, Agronomy Farm, Lincoln, Nebraska.

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Grain yield, Bushels per acre</th>
<th>Air dry stover or straw yield, Pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>Club Kaif</td>
<td>65.1</td>
<td>5935</td>
</tr>
<tr>
<td>1941</td>
<td>Western Blackhull Kaif</td>
<td>46.6</td>
<td>2310</td>
</tr>
<tr>
<td>1942</td>
<td>Otoe oats</td>
<td>52.7</td>
<td>2265</td>
</tr>
<tr>
<td>1943</td>
<td>Ohio 92 corn</td>
<td>104.4</td>
<td>4890</td>
</tr>
<tr>
<td>1944</td>
<td>Ohio 92 corn</td>
<td>101.7</td>
<td>4695</td>
</tr>
<tr>
<td>1945</td>
<td>Cedar oats with sweet clover</td>
<td>48.0</td>
<td>1890</td>
</tr>
<tr>
<td>1946</td>
<td>Ohio 92 corn</td>
<td>101.2</td>
<td>4355</td>
</tr>
</tbody>
</table>

F. L. DULEY, J. C. RUSSEL.
**Central Nebraska Watershed Project**

A soil and moisture conservation research project is being operated in the northern part of Webster County to determine, under field conditions on small watersheds, the effect of different land use on the amount and rate of runoff, and to study flood flows and flood characteristics on mixed-cover watersheds up to 3,490 acres. In the results to date, land in corn, oats, and wheat planted on the contour has lost less water by runoff than where these crops have been planted in straight rows. Moderately grazed native pasture has lost only about one-third as much water as where heavily grazed. Where pasture land was furrowed and moderately grazed, the runoff was reduced to 0.05 inch per year. Native meadow mowed twice a year lost 0.25 inch per year. Watersheds ranging from 411 acres to 3,490 acres and used in mixed farming lost approximately three inches a year. Corn land in small watersheds had the highest runoff, about four inches annually.

J. A. Allis, Ivan W. Bauer.

**Soil Microbiology and Crop Residue Management**

**Percolation as influenced by soil microorganisms.** A laboratory study was made of the treatments that might be applied to a six-inch layer of Peorian loess material in order to increase the rate of percolation of water. The rate was increased by adding organic material, such as crop residue, especially if it was in the process of decaying. Water-soluble organic substances like starch and sugar were not directly effective in increasing percolation. However, these substances supplied energy material for soil organisms which themselves had a direct effect in increasing the percolation rate. The organisms supply gelatinous material and the mycelium of fungi bring about stable aggregates that tend to increase the rate at which water can pass through a soil.

Coarse organic substances such as straw, cornstalks, and soybean straw increased the percolation rate by holding up the soil lumps so the water could run down between them. Sawdust or finely ground lignocellulose, added in a fresh condition, did not increase the percolation rate. Any of these substances increased percolation after the decay processes were well under way.

**Microbial populations with stubble mulch.** Soil samples were taken at depths of zero to one and one to six inches from plots on the Agronomy Farm at Lincoln for the purpose of studying the effects of kind of residue (wheat straw and sweet clover) and the method of tillage (plowing and subtilage) upon the distribution of microorganisms in the soil. Samples were taken from two to four months following the plowing or subtilage of sweet clover in the spring and approximately one year after the harvest of wheat when the plots (corn, oats, wheat rotation) were in corn.

No significant effect of the wheat straw residue on the distribution of bacteria or fungi was obtained on either the plowed or subtilled plots. Sweet clover residue had a significant effect upon microbial populations in the soil. The zero to one-inch depth of soil contained the largest numbers of microorganisms where the sweet clover was allowed to decompose on the surface, whereas the one to six-inch layer of soil contained the greatest concentration of organisms where the sweet clover was plowed under.

The method of tillage (plowing and subtilage) had little effect upon the total number of microorganisms in the entire six-inch layer, but did
have a pronounced effect on their distribution. The largest number of organisms was found where there was the greatest concentration of readily decomposable organic material.

Decomposition of crop residues by soil fungi. Laboratory studies indicated that the rate of decomposition of crop residues varied with the kind of residue and fungus involved in the decomposition process. Alfalfa was decomposed at a greater rate than wheat straw. Lignocellulose was highly resistant to decomposition by all of the fungi tested. Ammonia loss during the decomposition of wheat straw was negligible. Ammonia losses from alfalfa during decomposition by various fungi in pure cultures were very small, while relatively large amounts were lost from alfalfa during decomposition by a mixed flora consisting of bacteria, actinomyces, and fungi.

Nitrification. Results of nitrification studies in the field show that where residues were left on the surface of the soil, the nitrate content to a depth of six feet was usually slightly lower than on land where the residues were plowed under. On land following sweet clover, nitrate content was higher than on land in a grain rotation.

Generally, there is sufficient nitrate developed on mulched land for adequate crop growth. However, on land low in fertility, nitrate deficiency probably will be more pronounced on subtilled than on plowed land, even though there may be a deficiency where both types of tillage are used. The nitrogen deficiency occurring on subtilled land may be overcome by using a rotation that includes a legume.

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

T. M. McCalla.
Fertilizers for Corn

_Results_ obtained from the application of nitrogen fertilizers for corn were similar to those obtained in 1944 and 1945. In the studies on rates of nitrogen application, a 20-pound rate increased the yield of corn significantly when applied as a side-dressing at the last cultivation, but was decidedly less effective than the higher rates. In most tests, a 40-pound rate was as effective as an 80-pound rate and in all tests the 40-pound rate was more profitable. Ammonium nitrate was found to be more beneficial when applied as a side-dressing at the last cultivation than when applied at the time of planting. In two of the three tests where ammonium sulfate was applied in bands on the bottom of the plow furrow, the increases in yield were as large as the increases obtained from an equal quantity of nitrogen applied as ammonium nitrate at the last cultivation, but in the third test, the application of nitrogen at the last cultivation was superior.

Emphasis was placed upon “starter” fertilizers for corn followed by an application of ammonium nitrate at the last cultivation. In two tests, an application of a mixed fertilizer at planting time followed by ammonium nitrate at the last cultivation gave higher yields than ammonium nitrate applied alone at the last cultivation, whereas in two other tests the starter fertilizer gave no additional benefit. In no case was a starter fertilizer applied alone effective in increasing the yield of corn.

Only three of the seven tests conducted with non-irrigated corn showed significant increases in yield from applications of commercial fertilizers. In one of the four tests showing no increase in yield, a fertility problem did not exist, but in the other three tests, factors other than fertility, such as thickness of stand and cultural practices, limited the yield more than did the lack of fertility.

In 1944, a series of 0.2 acre plots was established on an irrigated farm in central Nebraska to compare the benefits derived from various fertility practices. Marked residual effects of sweet clover plowed in the spring of 1945 and of a 10-ton application of manure in the spring of 1945 were noticeable in the yields of corn in 1946. However, an application of 125 pounds of ammonium nitrate per acre at the last cultivation in addition to either of these treatments increased the yields significantly. Plots receiving 10 tons of manure per acre in 1945 and 1946 yielded 83.2 bushels of corn per acre compared to 70.1 bushels per acre for the plots receiving 10 tons manure in 1945 only. Plots receiving ammonium nitrate in addition to 10 tons of manure in 1945 and 1946 yielded 100.5 bushels per acre. The highest yield of corn was obtained following two full seasons of sweet clover.

Studies were initiated to build a machine which would apply anhydrous ammonia gas satisfactorily to the soil and to compare benefits derived from anhydrous ammonia gas and crystalline ammonium nitrate when applied to corn. Results indicated it is possible to apply anhydrous ammonia gas safely and economically to the soil insofar as the equipment is concerned. More studies are needed to determine the optimum time and rate of application of the anhydrous ammonia. The increases in yield of corn were sufficiently good to warrant further research, but not to make recommendations for the use of anhydrous ammonia in the immediate future.

J. W. FITTS, F.V. PUMPHEY.
Fertilizers for Small Grains

Four fertilizer experiments were conducted with winter wheat in eastern Nebraska. An application of superphosphate alone had no significant effect upon the yield of wheat in any of the tests, but superphosphate applied in combination with nitrogen increased the yield of wheat in all the tests. The largest increases in yield were obtained from an application of superphosphate in the fall at the time of planting, followed by an application of nitrogen in the form of ammonium nitrate in the spring as a top-dressing.

Three fertilizer tests with barley and one with oats were conducted in central Nebraska. In all tests a fertilizer containing both nitrogen and phosphorus was more effective than fertilizers containing either nitrogen or phosphorus alone. Seed treatment with New Improved Ceresan alone or in combination with fertilizer had no effect upon the barley yields.

John Hanway, J. W. Fitts.

Fertilizers for Potatoes and Sugar Beets

Three fertilizer experiments with potatoes following sweet clover were conducted in western Nebraska. The yields of No. 1 potatoes without fertilizer were 264, 331, and 413 bushels per acre. Fertilizers had no effect upon the yield in two of the tests. In the other test (field yielding 331 bushels without treatment), increases in yields were obtained from the use of nitrogen fertilizers alone, phosphorus fertilizers alone, combinations of nitrogen and phosphorus fertilizers, and combinations of nitrogen, phosphorus, and potassium fertilizers. Fertilizers containing applications of 40 pounds nitrogen and 40 pounds P₂O₅ applied singly increased the yields of potatoes 77 and 74 bushels per acre, respectively, compared with a maximum increase of 105 bushels per acre for a fertilizer containing 80 pounds nitrogen, 40 pounds P₂O₅ and 40 pounds of K₂O. Potassium fertilizer had no effect upon the yield when applied alone and only a relatively small effect when applied in combination with nitrogen and phosphorus fertilizers.

Three tests were conducted in western Nebraska to study the effects of phosphoric acid applied in the irrigation water at the second irrigation upon the yield and sugar percentage of sugar beets. On the basis of past performance, the fields had a moderately high level of fertility and were expected to produce an average or lower sugar percentage. The treatments included phosphoric acid alone, a nitrogen fertilizer alone, phosphoric acid plus a nitrogen fertilizer, and phosphoric acid plus nitrogen and potassium fertilizers. Relatively large yields ranging from 18.1 to 23.9 tons per acre were obtained on the untreated plots. Small increases in yield were obtained for most of the treatments in two of the tests. Phosphoric acid applications had no effect upon sugar percentage in any of the tests. No consistent effect of the nitrogen fertilizer on sugar percentages was obtained.


Nitrification Rates of Soils Growing Corn

Because of the large acreage of corn grown in Nebraska and the marked increases in yields that have been obtained from the use of commercial nitrogen fertilizers, it was considered desirable to initiate a study on nitrate production in soils where different cropping and cultural practices are used for growing corn. Accordingly, in 1945 three sets of plots
were selected for study on the Agronomy Farm at Lincoln. Nitrate production was measured by determining nitrification rates in the laboratory on soil samples taken at different times during the season in relation to the growth of corn: at planting time, when the corn was 15 to 18 inches high, just prior to tasseling, approximately three weeks following tasseling, and at harvest time. In 1946, nitrification rates were determined only for samples taken just prior to tasseling on the rotation plots at Agronomy Farm.

Nitrification rates were influenced significantly by time of sampling and by the cropping practices followed. As the season progressed, nitrification rates decreased progressively regardless of the cropping practice followed. Considerably higher nitrification rates were obtained in the soils where a legume crop had been grown or manure had been applied than in soils where no legume or manure had been used. Relatively similar nitrification rates were obtained in soils where corn followed different grasses and in soils where corn followed immediately after a legume. Nitrification rates of soils growing corn where different methods of residue disposal were followed (subtilage compared with plowing) were of the same magnitude throughout the season. Nitrification rates of soils and yields of corn grown on those soils were positively but not significantly correlated. Apparently, other factors in addition to nitrate production affected corn yields.

**Maintenance of Soil Organic Matter Under Grass Sod**

An experiment designed to determine the effectiveness of grass in the cropping system for the maintenance of soil organic matter has been in progress at the North Platte Substation since 1935. For this investigation, plots were seeded to grass each year from 1936 to 1944, while during the same period, a second series of plots was being plowed out of sod established in 1936. In 1945, these plots along with a series of plots under a cropping system without grass were sampled for determining total nitrogen and organic matter contents.

The data obtained indicate that during the nine-year period there has been a continuous decline in total nitrogen and carbon contents in the surface six-inch depth of all plots except those remaining in sod more than six of the nine years. Data for the six to twelve-inch depth showed similar trends, but the results were not as pronounced as for the surface depth.

The results would indicate that, under conditions similar to those at North Platte, the use of grass in the cropping system does not offer a satisfactory method for the complete maintenance of soil nitrogen and organic matter. More than two-thirds of the rotation period would need to be grass if complete maintenance is to be accomplished. This period of time in grass would undoubtedly not be desirable from the standpoint of economic returns where those returns are based on the other crops.

An increase in the effectiveness of the grass cover is believed possible. Nitrogen fertilizers, manure, or legumes may be capable of increasing the soil nitrogen and organic matter produced under grass cover. This would enable maintenance of a suitable level of soil nitrogen and organic matter by fewer years of grass. Increased grass production and resultant greater additions to the soil organic matter level may also be accomplished by the selection of other grasses.
Infiltration Rate of Irrigation Water

Studies were continued in Phelps County relative to the rate and depth of penetration of irrigation water. Soil moisture was measured by determining electrical resistance in buried plaster-of-Paris blocks by means of a moisture bridge developed by Bouyoucos. Measurements were taken prior to, during, and after periods of irrigation. Studies were made on corn, alfalfa, and bromegrass.

Differences in topography, growing crop, and previous soil management practices were found to be reflected by differences in relative rates and depth of moisture penetration. Sod crops such as alfalfa and bromegrass were more conducive to rapid and deeper penetration of moisture than was corn.

Comparisons of rates and depths of penetration of moisture under irrigation were made for small changes in topography. Three kinds of micro-relief were examined, small depressions, small elevations, and uniform slopes of less than 0.75 per cent. The maximum difference in elevation of the micro-depressions or the small elevations from the average slope of the field was less than two inches. In general, the rate and depth of moisture penetration after irrigation was greatest in the small depressions, and least in the small elevations. Such data emphasize the fact that for economical use of the farmers' time and the available water, fields should be leveled.

The influence of various soil management practices on the permeability of the soil under growing corn was investigated. Comparisons were made of plots growing continuous corn without fertilization, continuous corn with manure applications, continuous corn with ammonium nitrate applications, corn following second year sweet clover, and corn the second year after sweet clover. Rate and depth of moisture penetration were least in the untreated continuous corn plots and greatest in the plots where corn followed sweet clover or where ammonium nitrate was applied. The manured plots were intermediate as regards moisture penetration.

The 1946 work substantiates previous work conducted in that micro-relief and differences in soil type appear to be more important factors in influencing rate of moisture intake of the soil than is the distance from the field lateral.


Kind of Clay in the Scott and Pawnee Soils

An investigation was initiated in 1944 to study the mineralogical composition of the coarse clay (2 to 0.2 microns) and the fine clay (less than 0.2 micron) in different horizons of soils developed in the sub-humid and semi-arid sections of Nebraska. Thermal analyses, cation exchange capacity, silica, potassium, magnesium, iron, and free iron oxide determinations were made to characterize the clay fractions. Results have been obtained for Scott silt loam and Pawnee silt loam, two Planasols developed in eastern Nebraska on loess and glacial materials, respectively. According to the criteria used, the type of clay is similar in all horizons of both soils. A montmorillonite type clay containing marked amounts of crystal lattice iron along with an illite type clay are dominant in the fine-clay fractions. An illite type clay is the predominant clay mineral in the coarse-clay fraction. No evidence was obtained to indicate the presence of notable amounts of kaolinite type clays. Some evidence was obtained to indicate a weathering of the coarse-clay fractions in the surface horizons of the Scott soil.

Standard Crops for Nebraska

The search of the Experiment Station for new kinds of crops has been well repaid by the introduction and wide adoption of several with special value. Such additions during the present century include sweet clover, sudan grass, bromegrass, crested wheatgrass, grain sorghum, and soybeans. New forage and chemurgic crops are being considered as possibilities for regional production.

For further improvement of crops suitable for Nebraska the greatest opportunity now lies in the development of superior varieties through modern breeding methods. Recent outstanding examples of such improved crops for the regions of their special adaptation are hybrid corn, Pawnee and Cheyenne winter wheat, Cedar and Osage oats, Velvon barley, Mida spring wheat, Ranger alfalfa, Midland and Martin grain sorghum, Axtell forage sorgo, Madrid and Spanish sweet clover, Lincoln bromegrass, and Lincoln soybeans. It is estimated that the yielding power of Nebraska crops has been increased an average of 20 per cent in the last 25 years through the development and introduction of superior new crops and varieties.

Most of the crop improvement work of this Station has become regionally cooperative with other state agricultural experiment stations and the U. S. Department of Agriculture. Cooperative testing by farmers and experiment stations in several states greatly expedites obtaining dependable information as to the worth of a new crop or variety. Cooperation with the Agricultural Extension Service, the Nebraska Crop Improvement Association, the Nebraska Grain Improvement Association, and the Nebraska Certified Hybrid Seed Corn Producers Non-Stock Cooperative Association aids in the dissemination and maintenance of seed supplies of superior new crops.

Pasture and Meadow Grasses

Experimental work on the improvement and management of pasture and meadow grasses continued with emphasis on the breeding of 10 prominent grasses and two uncommon legumes, and on studies of pollination in relation to grass improvement. Investigations were made of the seasonal carrying-capacity of bromegrass and grama grass pastures, and of the pasture value of various grasses and mixtures. New pastures were seeded for grazing experiments with sheep and cattle, and the effects of time of cutting on the yield, composition, and quality of prairie hay were studied.

These studies involved cooperation of the Department of Agronomy and Animal Husbandry and the Division of Forage Crops and Diseases, U. S. Department of Agriculture.

Bromegrass seed production. Approximately 87,000 pounds of Lincoln bromegrass were produced in 1946 by 35 growers who completed seed-certification on 830 acres. Average yields were relatively low and certification was completed only on the better yielding fields. Because of scarcity, certified bromegrass seed commands a very good price.
The effect of nitrogen fertilization on the seed production of sodbound bromegrass was studied in a field near Lincoln. Applications consisted of 40, 60, 80, 100, and 120 pounds of nitrogen and 40 pounds of triple superphosphate applied alone, as compared with a mixture of 100 pounds of nitrogen and 40 pounds of superphosphate, applied in late March. Because of a very dry spring, the treatments had little response until too late to have much effect on seed yield. There were no visible effects of the phosphate applications. The higher rates of nitrogen gave the larger yields of seed and forage, but these yields did not greatly exceed that produced by the 60-pound rate. Seed yields were increased only 17 to 50 pounds per acre by nitrogen fertilization of this extremely low-yielding field, whereas forage yields were doubled later in the season. The plots receiving nitrogen produced 1.67 tons of cured forage per acre as compared with .82 ton for the untreated plot. The percentage and yield of protein were markedly increased as indicated by the dark green color of the forage in the treated plots.

Although the yield of seed under nitrogen fertilization was very low under the prevailing drouthy conditions, the increases were generally profitable on certified-seed fields because of high seed prices. Results indicate that an application of 60 pounds of nitrogen early in the spring is most suitable. A combination of seed harvest and pasturing of the leafy stubble after removal of a seed crop appears to be the best means of obtaining a good return from the land in all years.


Seed increase of new grass strains. The need for seeding waterways and roadways on land recently acquired at Lincoln for experimental work in agronomy has provided opportunity for increasing the seed supply of new strains of grasses. Isolated plantings have been made in such a way as to avoid intercrossing.

Seed of six experimental varieties of bromegrass and two strains of intermediate wheatgrass is obtained in this way in sufficient quantity for performance tests. Several superior strains originating in the breeding and selection program at this Station are being increased by the Soil Conservation Service Nurseries at North Platte and Waterloo, Nebraska. These include selections of crested wheatgrass, switchgrass, sideoats grama, blue grama, sand lovegrass, and big bluestem.

L. C. Newell, F. D. Keim.

Studies of grass pollen. The microscopic identification of grass pollen was undertaken in connection with studies of pollen dispersal in its relation to the production and maintenance of pure seed stocks of 40 cross-pollinated species. Grass pollen proved to be easily distinguished from that of other plants. No definite "earmarks" for the various sorts were found.

Shape and natural color proved of little value in identifying the spherical, transparent pollen grains. The species could be classified into five major groups based on pollen size. Mean diameters ranged from 25 microns for sand lovegrass to 100 microns for a variety of popcorn. Thirty of the 40 grasses studied fell in a group measuring 30 to 50 microns. The size of pollen was found to vary somewhat from year to year according to growing conditions.

For the study of pollen dispersal in relation to grass improvement, the known pollination habits, such as the time of year and time of day...
of the pollen dispersal of each species growing in the vicinity, have been sufficient aids for identification.

MELVIN D. JONES, L. C. NEWELL.

Composition and yield of prairie hay meadows. The survey of the vegetation on the Dalbey Memorial Land in Gage County was completed during 1945 and 1946, in connection with an experiment designed to measure the effects of time of cutting on the yield and composition of native meadows. The average density and percentage composition of the vegetation as determined from 72 line transects, 10 meters in length, located at random over the meadow, show that big bluestem, prairie dropseed, Kentucky bluegrass, and little bluestem are the predominant grasses. Of minor importance are sideoats grama, June grass, Indian grass, and switchgrass. Plants of many broad-leaved species are scattered rather uniformly throughout the meadow. Most abundant of these are the prairie sunflower and two native legumes, leadplant and wild alfalfa or many-flowered Psoralea. In 1945, the broad-leaved plants made up 18.9, 13.8, and 9.3 per cent of the hay cut at early, mid-season, and late dates, respectively. The aftermath contained only 4.4 per cent broad-leaved plants. The decrease in percentage of forbs with delay in cutting was due almost entirely to reduction in the amount of Psoralea.

The protein content of the hay in 1945 averaged 7.2, 5.7, 4.1, and 5.3 per cent for that harvested in July, August, and September, and the aftermath, respectively. When fed in an overwintering ration for calves, this hay produced gains closely associated with its quality as described in the Animal Husbandry section of this report.

Yields of hay obtained in 1946 were lower than those of the previous year, but gave similar results for the different cutting treatments. The early cutting when considered alone gave the lowest yield and the highest quality of hay. The total yield from the early cutting and its aftermath was greater than that from the other cutting treatments. The average yields in 1946 for the various lots on the basis of 12 per cent moisture were as follows:

<table>
<thead>
<tr>
<th>Cutting Date</th>
<th>Tons per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early cutting (June 25-29)</td>
<td>0.78</td>
</tr>
<tr>
<td>Aftermath (Sept. 12-14)</td>
<td>0.52</td>
</tr>
<tr>
<td>Total for two cuttings</td>
<td>1.30</td>
</tr>
<tr>
<td>Mid-season cutting (Aug. 5-9)</td>
<td>1.03</td>
</tr>
<tr>
<td>Late cutting (Sept. 9-10)</td>
<td>0.96</td>
</tr>
</tbody>
</table>

An evaluation of the various treatments over a period of several years will be necessary to determine the cumulative effects of time of cutting on the yield and composition of the meadow.

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

Seed yields of two perennial legumes. Interest in the two legumes, birdsfoot trefoil and milk vetch, centered around the possibility of obtaining sufficient seed of several promising selections to continue testing and improvement. Seasonal conditions favored seed production in 1946. Of 25 selections of birdsfoot trefoil selected for desirability of forage type and resistance to disease, 10 were harvested for seed. Yields obtained from spaced rows ranged from 13 to 154 pounds per acre. This variation offers much promise for establishing an adapted forage strain that yields sufficient seed to warrant production under eastern Nebraska conditions. The other legume, Astragalus cicer, produced seed at the rate of 105
pounds per acre. This seed is to be used for further increase and testing in mixtures with grasses under pasture conditions.


Alfalfa Investigations

Production of alfalfa in Nebraska dropped from a high of over 1 1/4 million acres in the later 1920's and early '30's to about 600,000 acres in 1939. Since then it has gradually increased and the area is now approaching one million acres. The average yield of cured forage in 1946 is estimated at 1.9 tons per acre compared with 1.6 tons as a 10-year average, and 2.15 tons in 1945. Conditions were generally favorable for seed production. Yields of seed were estimated at 78 pounds per acre which is about equal to the 10-year average. Seed was harvested from 177,000 acres, which is 2 1/2 times as much as the average during 1935-44. Total production of thresher-run seed is estimated at over 13 million pounds for an all-time high, with a value of about $5,000,000. Thus the combined value of seed and forage is over $30,000,000 for the 1946 Nebraska alfalfa crop.

New plan for distribution of Ranger alfalfa seed. Three classes of seed—foundation, registered, certified—are to be grown and recognized by the official seed-certifying agencies. These represent progressive stages in commercial seed production. Fields producing foundation seed must have been planted with foundation seed and isolated from other alfalfa at least 120 rods. Registered seed-fields must be planted with foundation seed and be isolated at least 60 rods if less than five acres, and 30 rods if more than five acres. Both foundation and registered seed may be produced only in the adapted region designated for Ranger by executive committee of Alfalfa Improvement Conference as north of the 40th degree north latitude which coincides with the Nebraska-Kansas border. Certified seed can be grown in any state, but fields must be planted with foundation or registered seed. Certified seed is therefore not eligible for further certification.

Limited supplies of foundation seed are distributed according to the recommendation of a committee appointed by the Alfalfa Conference. Only those states in agreement with the plan are eligible to receive such seed. The committee fills requests for seed according to the intended use, giving preference in the order of foundation, registered, and certified production.

According to this new plan, foundation seed can be produced from foundation seed without regard to the number of generations removed from the original synthesis. This plan will shorten the time required for improved varieties to get into general production, and in the case of Ranger will make the seed more generally available. It is anticipated that the portion of the plan involving Nebraska growers will be made effective July 1, 1947.

Factors affecting alfalfa seed production. It is now generally agreed that alfalfa is largely cross-pollinated and that tripping by beneficial insects is necessary for successful seed production. Wild bees of various species are the most efficient pollinators, although if the population of honey bees is large they may, by repeated visits, trip enough flowers to increase seed production materially. In dry years when the deep-rooted alfalfa plant is about the only source of pollen, honey bees may be efficient pollinators. There is also some evidence that alfalfa infested with a heavy population of Lygus bugs is less attractive to pollinating insects, although
this may be associated with the type of growth which is preferred by harmful insects and unattractive to bees rather than any direct antagonism.

Individual plants or clonal lines are known to differ greatly in their capacity for seed production. This difference can be attributed to at least two factors. The first is a direct inherent tendency for the production of more flowers per plant and more seeds per pod. The second, a greater attractiveness to bees, suggests new methods of attacking the seed production problem. There is some evidence that the variability in attractiveness may be associated with the forces involved in the tripping mechanism, and with variation in the quantity and quality of pollen and nectar. Some work is being done to incorporate these differences in a breeding program. Part of this research is financed by funds made available by the American Seed Trade Association through the International Crop Improvement Association.

Environment not only influences the activity of insects but it also has an important effect upon the physiology and development of the plant. If other factors are favorable, maximum seed yields are obtained when soil moisture and fertility are high enough to maintain a steady uniform growth. Not only do plants under these conditions produce more flowers but the flowers are more attractive to bees, especially if the soil tends toward moderate dryness while the crop is in bloom. Thin stands are usually more productive of seed than are thick stands. They are less likely to be heavily infested with harmful insects and are preferred by beneficial insects. In addition the greater space and light have important effects upon the plant.

Every year grasshoppers damage alfalfa-seed fields and no very satisfactory method of control has been available. In the near future satisfactory control may be possible through the use of new insecticides. For the control of most other harmful insects of alfalfa-seed fields, twenty pounds of 10 per cent DDT per acre have proved effective. Care must be taken to avoid killing beneficial insects by its use at flowering time. The application appears entirely satisfactory if done in the pre-bloom stage. Experience on a field scale is still somewhat limited and more information is needed, especially on the danger to livestock from residue left on the straw.

Alfalfa seed should be harvested when about two-thirds of the pods are black or brown. At this stage rainy weather is very harmful to the crop, especially if the pods become alternately wet and dry or remain wet for more than a few hours. Under these conditions many mature pods shatter and much seed germinates.

Polycross performance records. Further evidence is available as to the importance of the polycross performance test in predicting the combining ability of clonal lines for use in hybrid and synthetic combinations. In 1945 two synthetic varieties were produced, one with four clones having low polycross performance and another with four clones having a relatively high polycross performance. In 1946 these synthetics differed by more than three times the amount necessary for significance. The synthetic made from low combining lines was much inferior.

Research with alfalfa is in cooperation with the Division of Forage Crops and Diseases of the U. S. Department of Agriculture.

Sweet Clover Research

Sweet clover seed crop. Average annual production of sweet clover seed in Nebraska for the period 1934 to 1944 was 44,000 bushels, as compared with 56,000 bushels in 1945 and 88,000 bushels in 1946. Estimated value of the 1946 seed crop was $546,000. The average yield of seed per acre was estimated at 2.5 bushels. A much higher seed yield would have been obtained through general use of the best harvesting and threshing procedures.

Of the 1946 acreage in sweet clover, 288,000 acres were second-year stands, and 866,000 acres were first-year seedings with small grain, making a total of 1,154,000 acres. Assuming that the rate of seeding sweet clover is 12 pounds to the acre, 173,200 bushels of seed would be required for an acreage such as was sown in 1946. This is 85,200 bushels more seed than was produced in Nebraska this year.

Conditions for high seed yields. Seed yields of sweet clover vary greatly from year to year. Included among those factors most favorable for high yield are fertile soil, a moderately thin but uniform stand, abundant and well-distributed precipitation, abundance of pollinating insects, and good harvest practices.

Soils of Nebraska are generally of sufficient fertility for the successful production of sweet clover seed. Lime deficiency occurs in some soils which may be corrected through application of ground limestone. There must be present in the soil an abundance of the symbiotic nodule-forming bacteria necessary for inoculation. It is advisable to inoculate the seed with suitable cultures wherever experience has not indicated that this is unnecessary. Favorable moisture supply at all stages of growth is required for first-year survival, and vigorous plant growth and high seed yield in the second year.

Thickness of stand is an important factor in seed setting and development, particularly under the drier farm conditions. Stands may be relatively thick on moist, fertile soils and yet produce good seed yields. From two to three plants to the square foot may be regarded as a good stand under such conditions. Soils of low fertility and moisture, however, require somewhat thinner stands for the best results. Weed growth must be controlled, which cannot be accomplished on most soils with an average stand of less than one plant to the square foot. Field weediness may also result from too intense grazing or clipping in early spring of the second year, practices that tend to reduce seed yields.

Growing in widely spaced rows is not a practical method of producing seed where soil and moisture conditions are favorable. It is a satisfactory practice for the rapid seed increase of new varieties while quantities are very limited, and also where the moisture supply is deficient. In plantings at this Station with the rows spaced 4, 20, and 40 inches apart, the weeds became more numerous as the space increased and the respective seed yields were 6.33 bushels, 5.17 bushels, and 4.82 bushels per acre.

Intense shading in thick stands and the reduction of moisture available to the individual plants will result in reduced seed yields, due to the death of axillary buds and a failure to produce branches at the lower portion of the stems. The visitation of insects to flowers produced on the lower stems is also prevented to a greater degree in dense stands. Where early spring grazing or clipping is practiced and a second growth is taken for seed, a stubble of at least 12 inches should be left in thick stands and 10 inches in thin stands and widely spaced rows.
Combining sweet clover cured in the windrow.

The seed yields of sweet clover vary with the abundance and activity of pollinating insects, and with the degree to which other flowering plants may attract these insects at the time sweet clover is in flower. Included among the more commonly known insects that visit and pollinate sweet clover flowers are the honeybee, sweat bee, bumblebee, and leaf-cutter bee. Its large numbers and the many flowers visited in a relatively short time make the honeybee most valuable of the pollinating agents. Hives of honeybees placed near the sweet clover field, about one hive to the acre, have been found to cause greatly increased pollination and seed production. Continued cloudy, wet, and muggy weather during flowering reduces the activity of bees and the amount of pollination that takes place.

**Time of cutting the seed crop.** Adapted varieties of biennial sweet clover differ widely as to time of flowering and ripening. The early maturing Madrid and Common Yellow varieties generally reach the full-flower stage between June 15 and 20, the intermediate sorts as Spanish and Common White about July 1 to 5, and the late varieties as Evergreen, Sangamon, and Iowa Late White about July 15 to 25.

Local experiments have shown that the optimum stage for seed harvest is when 60 per cent of the seed pods have turned brown or black, although cutting as early as the 40 per cent stage is practically as good. The time for harvest normally falls approximately a month after full bloom, though the period is somewhat shorter for the yellow varieties. Delay of harvest beyond the optimum stage subjects the crop to excessive seed loss from shattering.

Grazing or clipping sweet clover in the spring of the second year delays the time of flowering and seed harvest, the delay increasing with the
severity of the treatment. Various clipping treatments at this Station have brought delays in harvest of from 5 to 26 days.

**Breeding.** Breeding work and related studies were continued for the purpose of developing sweet clover varieties with lower coumarin content, later maturity, greater leafiness, finer stems and larger seeds, in addition to increased vigor. Most of these objectives have been reached, and the breeding work is now largely directed toward combining several of these desirable characteristics into a single variety.

Several plants have been isolated with coumarin contents believed to be below the toxicity level. These plants are expected to form the basis of a non-bitter, non-toxic variety of sweet clover.

The development of a leafy and fine-stemmed sweet clover has centered mainly around the variety designated as N1. It is highly susceptible to infection by the anthracnose disease.

Hybridization between the *M. alba* and *M. polonica* species has resulted in plants which appear to possess the combination of vigor and large seeds. Some interesting developments are anticipated from these crosses.

In the varietal testing program, the Nebraska certified varieties—Madrid, Spanish, and Evergreen—continue to show their superiority. Foundation seed of these varieties was grown on 25 acres by the Agronomy Department. These varieties, particularly Madrid, have been in great demand by farmers in the state. Seed has increased to the point where it was possible to grow 150 acres of certified seed in 1946.

These sweet clover studies are cooperative with the Division of Forage Crops and Diseases of the U. S. Department of Agriculture.

**SAMUEL GARVER, J. M. SLATENSEK, T. A. KIESSELBACH.**

**Improvement of Small Grains**

For most of the state the season of 1946 was generally favorable for small grain. Large acreage and high yield resulted in the largest winter wheat crop in the state's history. Oats have been gaining in favor over barley so that the acreage was about five to one this year. The yields of both of these spring crops were generally high, although somewhat lower than in 1945.

Spring growth began approximately three weeks earlier than normal because of exceptionally high temperatures. Considerable winter wheat had reached the initial heading stage by May 11, when a drop in temperature to 28°F. at Lincoln and as low as 24° in the West caused some freezing injury to the stems and to exposed heads by way of causing partial sterility. This was most pronounced among the early varieties of winter wheat and winter barley. Thereafter, sub-normal temperatures prevailed so that the small grains ripened at about the usual time. A severe hail storm ruined the oats and barley tests at the Box Butte Experiment Farm at Alliance.

The small grain improvement work is in cooperation with the Division of Cereal Crops and Diseases, of the U. S. Department of Agriculture.

**Winter wheat.** Pawnee continues to be popular on farms in southeastern Nebraska. About one million acres of this variety were grown in Nebraska in 1946. To a rather limited extent it was grown west of the recommended area and some complaints of shattering and freezing injury were received.

Yields of the field plots at Lincoln ranged from 36.3 bushels per acre for Pawnee to 27.1 bushels for Turkey. Triumph, a new and very early
maturing wheat from Oklahoma, gave a very poor yield, due in part to freezing injury. Based on long-time records Pawnee, Cheyenne, Nebred, and Tenmarq have given the highest yields. A few new selections now in the nursery tests look very promising from the standpoints of yield, winter hardiness, and disease resistance.

In tests at Alliance the varieties ranged from 29.1 to 21.3 bushels per acre. The later ripening, more hardy varieties, as Cheyenne and Nebraska No. 60, gave the highest yields, while the earlier sorts such as Pawnee, Blackhull, and Wichita gave the lowest. A new selection, Cheyenne x Turkey 1062 (C. I. 12142) ranked fourth in yield. This is best described as a bunt-resistant Cheyenne, but has outyielded Cheyenne by nine per cent for the past two years. For the period 1931–46 Cheyenne and Nebraska No. 60 have the highest average yields at the Box Butte Experiment Farm.

**Spring wheat.** Yields of the spring wheat varieties at Lincoln ranged from 15 to 6 bushels per acre and the quality of the grain was poor. Thin stands and high temperatures of 106° and 109° in the second week of June were responsible for the poor performance of the crop. Kearney gave the highest yield followed by Thatcher, Ceres, and Marquis. Such good varieties as Pilot, Cadet, and Regent averaged less than nine bushels per acre.

At Alliance the highest yielding spring wheat varieties gave yields almost equal to those of winter types. They ranged from 24.4 to 11.6 bushels per acre. The best performance was by Ceres, Pilot, Merit x Pilot (C. I. 12315), Rival, and Mida. Mida has been an outstanding variety for three years and was increased this year for seed distribution.

**Barley.** Velvon 11 (C. I. 7088) was first distributed to Nebraska farmers in 1946. Most of the seed was planted by growers in the north-central and northeastern counties and in general a good crop was reported. A further increase of this new variety was made at the Box Butte Experiment Farm and the Scotts Bluff Substation.

The barley plots at Lincoln suffered some injury from chinch bugs and the foot rot disease. Yields ranging from 36.9 bushels per acre for Hybrid Composite Selection (C. I. 7114) to 10.6 bushels for Minnesota No. 184 were obtained. The malting types, Minnesota No. 184, Wisconsin No. 38, and Manchuria, gave their usual poor performance. The highest yielding variety, Hybrid Composite Selection (C. I. 7114) has good malting quality and some consideration is being given to its increase. Most varieties which are in demand for malting give inferior yields in Nebraska. For a 10-year period Spartan has exceeded Trebi by 15 per cent and for a 6-year period Velvon has exceeded it by 29 per cent. Since 1939 the highest average yields have been made by Lico, Spartan, Velvon, and Club Mariout. Considerable emphasis is now being placed on the breeding of disease-resistant varieties.

The average winter survival of winter barley at Lincoln was 58 per cent. A few Nebraska selections had a higher survival than the most hardy varieties now being grown commercially. Ward and Reno are most extensively grown in this state but are far less winter hardy than is winter wheat. As an average for tests at Lincoln, North Platte, and Scottsbluff, best performances were by Ward, Woodwin, and Tennessee Winter. Ward has a better yield record than Reno. Winter varieties planted at Alliance have always winterkilled.

**Oats.** Cedar oats continued to be popular in 1946 and apparently suffered very little from the new *Helminthosporium* disease which was so
prevalent in some other states. This year in Nebraska 11,226 acres of Cedar were grown for seed certification, producing 236,000 bushels. Clinton has been added to the list of recommended varieties for the eastern part of the state, and Osage for the southeastern and south-central counties.

The oat yields at Lincoln ranged from 44.7 to 23.5 bushels per acre. There was a shortage of moisture throughout most of the growing season and the freeze on May 11 caused some injury. For the second year Clinton ranked first in yield, averaging five bushels above Cedar. A new selection, Victoria-Richland x Morota-Bond (C. I. 4301), yielded nearly as well as Clinton and is nearly a week earlier in heading. If that performance continues, it may be distributed for farm use. It is resistant to Helminthosporium disease.

Of the varieties grown at Alliance for several years, Kanota, Fulton, Trojan, Brunker, and Cedar have given the highest average yields.

K. S. Quisenberry, O. J. Webster, T. A. Kiesselbach.

Seedbed Preparation for Winter Wheat

An experiment was started in the fall of 1933 to determine the comparative effects of early and late seedbed preparation for winter wheat on medium fertile and fertile soil on the Agronomy Farm at Lincoln. The difference in soil fertility was obtained by applying manure to part of the land at the rate of 12 tons per acre before the wheat during the first six years of a three-year rotation consisting of corn, oats, and wheat. The test was in triplicate and all crops were represented each year. Early seedbed preparation consisted of plowing six inches deep and harrowing July 27, as an average, followed by disk ing August 20 and September 20. The late preparation was done by plowing, disk ing, and harrowing on September 20. The date of planting averaged September 28.

During the 13 years, 1934–1946, which included the eight-year drouth period of 1934–1941 and the five-year period with favorable precipitation, 1942–1946, the early plowing yielded 28.5 bushels as against 18.9 bushels for the late plowing on soil of medium fertility at the Agronomy Farm. This is a gain of 51 per cent. As an average for the last five favorable years on this same soil, early plowing yielded 40.4 bushels compared with 23.6 bushels for the late preparation—a 71 per cent increase. During the eight years of drouth, the early plowing yielded 20.6 bushels as against 16 bushels for the late plowing—a 29 per cent increase. Thus the early preparation was able to contribute 16.8 bushels more than the late plowing in the favorable years, and only 4.6 bushels more in the dry years.

In similar comparisons on soil of higher fertility, early plowing yielded 28.3 bushels compared with 21.8 bushels for the late plowing—an increase of 30 per cent for the 13-year period. During the five favorable
years, the respective yields were 45.3 bushels and 33.5 bushels—a difference of 35 per cent. Averaging the eight drought years, the respective yields were 17.6 and 14.6 bushels—a difference of 21 per cent.

Averaging both early and late seedbed preparation, during the eight drought years the fertile soil yielded 12 per cent less wheat per acre than did the medium fertile soil. In the more favorable five-year period, the fertile soil yielded 27 per cent above the less fertile soil.

The corn and oats in this corn-oats-wheat rotation received no variable treatments. As an average for all soil and seedbed conditions, during the drought period wheat, oats, and corn yielded 17, 28, and 8 bushels per acre, respectively, compared with 36, 49, and 54 bushels in the favorable years. From these data it is apparent that the early ripening small grain crops yield with greater continuity than does corn.

T. A. KIESSELBACH, W. E. LYNES

Corn Improvement

NEBRASKA experienced another bumper corn crop during 1946 in spite of drouthy conditions in some areas during the growing season. Harvest was somewhat retarded by frequent rains but spoilage did not seem to be a serious factor. Hybrid seed producers in central Nebraska reported loss of considerable seed through low germination caused by rather high moisture content and low temperatures while seed was still in the fields. Wet fields made it impossible to harvest seed early for artificial drying as is normally done.

In the Experiment Station testing program, corn hybrids were tested at 44 locations within the state in 81 different experiments as follows: 12 top-cross tests of new lines, nine single-cross tests, 56 tests of double-cross hybrids, and four experiments involving special problems.

New hybrids for commercial production. In the Experiment Station corn breeding program, new hybrids are included in preliminary tests at Lincoln. Those that appear promising are tried a second year at Lincoln in an advanced test. Hybrids having a high two-year performance rating in comparison with standard hybrids of comparable maturity are then included in the corn performance tests in widely distributed areas over the state. If on the basis of the three-year data obtained any hybrid shows definite superiority in some one or more important respects it may be released as a certified hybrid for commercial production. A new, mid-season, yellow hybrid, designated as Nebraska 502 and having the pedigree (Wf9 x 187-2) X (N6 x A), is approved for release in 1947. It has a rather outstanding record in the class requiring 110 to 114 days from planting to maturity at Lincoln, and is especially suited to irrigation in central Nebraska.

Comparative performance of the new hybrid, Nebraska 502, and other standard hybrids, 3-year averages, 1944-46.

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Maturity rating</th>
<th>Moisture in grain at harvest</th>
<th>Plants erect at harvest</th>
<th>Yield per acre</th>
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</thead>
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<tr>
<td>Iowa 4316</td>
<td>106-110</td>
<td>21.1</td>
<td>89</td>
<td>75.3</td>
</tr>
<tr>
<td>Nebraska 502</td>
<td>110-114</td>
<td>23.5</td>
<td>92</td>
<td>83.9</td>
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<tr>
<td>Iowa 4059</td>
<td>110-114</td>
<td>22.2</td>
<td>88</td>
<td>73.3</td>
</tr>
<tr>
<td>Iowa 398</td>
<td>110-114</td>
<td>22.6</td>
<td>90</td>
<td>73.3</td>
</tr>
<tr>
<td>Nebraska 601</td>
<td>114-118</td>
<td>23.4</td>
<td>92</td>
<td>84.7</td>
</tr>
<tr>
<td>U. S. 35</td>
<td>114-118</td>
<td>23.3</td>
<td>92</td>
<td>79.4</td>
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New white hybrids. A number of new white hybrids were tested for the first time in 1946 in comparison with Kansas K2234, a late white hybrid of excellent performance adapted to southeastern Nebraska.

Performance record of four new white hybrids in comparison with the standard K2234, 3-year averages, 1944-46.

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Maturity rating</th>
<th>Moisture in grain at harvest</th>
<th>Plants erect at harvest</th>
<th>Tillers per 100 plants</th>
<th>Yield per acre</th>
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</thead>
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<tr>
<td></td>
<td>Days</td>
<td>Per cent</td>
<td>Per cent</td>
<td>No.</td>
<td>Bushels</td>
</tr>
<tr>
<td>5029B</td>
<td>118-122</td>
<td>24.9</td>
<td>85</td>
<td>36</td>
<td>85.6</td>
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<tr>
<td>5027B</td>
<td>118-122</td>
<td>24.6</td>
<td>88</td>
<td>30</td>
<td>84.7</td>
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<tr>
<td>5010C</td>
<td>118-122</td>
<td>24.5</td>
<td>88</td>
<td>43</td>
<td>84.5</td>
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<tr>
<td>K2234</td>
<td>122-126</td>
<td>26.0</td>
<td>90</td>
<td>48</td>
<td>82.4</td>
</tr>
<tr>
<td>387C</td>
<td>122-126</td>
<td>26.4</td>
<td>95</td>
<td>42</td>
<td>80.8</td>
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</tbody>
</table>

These hybrids are a few days earlier ripening and yet as good or better in yield than K2234. Still earlier white hybrids are needed to fill the demand in south-central and southwestern Nebraska where most of the white corn is now grown.

Popcorn hybrids. Tests of new popcorn hybrids were planted at Lincoln and in Valley County. The yields of some of these were very satisfactory but their popping quality did not surpass that of K4, an outstanding three-way hybrid now in commercial production. A test of single crosses made up of Kansas and Indiana lines was planted at Lincoln.

Waxy corn. Favorable progress was made toward the development of high-combining inbred lines carrying the waxy endosperm character, and suitable for use in making waxy hybrids. The starch of waxy corn is now being used to a limited extent in substitution for imported tapioca. It appears to be as good or better than tapioca for many industrial and food uses. A waxy-corn breeding program was started at this Station five years ago and has reached the stage of testing waxy lines both in topcross and single crosses. Seventy waxy topcrosses, having a white waxy variety (Nebraska 5) as a common tester parent, were grown in six replications in 1946 in comparison with the best commercial waxy hybrids now available. A number of these yielded as well as the waxy hybrids which is suggestive of high combining ability of the lines involved. Yield increases went as high as 20 per cent above the tester variety. Several single crosses between lines originating as backcrosses with prominent non-waxy Corn Belt lines yielded close to the corresponding non-waxy single crosses.

In a test with six replications, “U. S. 13 Waxy” obtained from the U. S. Dept. of Agriculture yielded 55.9 bushels compared with 52.5 bushels and 48.2 bushels for Iowax 2 and Iowax 1, two waxy hybrids obtained from the Iowa Agricultural Experiment Station.

Effect of time of planting. Grown in 1946 at the rate of three plants per hill, hybrids U. S. 13, Iowa 4059, and Iowa 306 matured, respectively, on Sept. 18, Sept. 15, and Sept. 11 when planted on May 16. The corresponding yields of grain per acre (15 per cent moisture) were 72.3, 71.5, and 68.2 bushels. The moisture percentages of the ear corn at time of husking were 25.3, 22.5, and 19.5. When these same three hybrids were planted June 3, their ripening dates were Sept. 27, Sept. 23, and Sept. 18. The respective yields were 66.8, 65.9, and 62.6 bushels while the moisture contents ran 32.2, 31.1, and 26.5 per cent. U. S. 13 is regarded as the standard full-season type for this territory.

J. H. LONQUIST, T. A. KIESSELBACH.
Sorghum Improvement

A coordinated sorghum improvement program, cooperative with the U. S. Department of Agriculture, is conducted at three widely separated points—the Nebraska Agricultural Experiment Station at Lincoln, the North Platte Substation, and the Box Butte Experiment Farm. A good crop was produced at all stations in 1946, even though precipitation was below normal. At Lincoln a heavy chinch-bug infestation was a limiting factor for susceptible varieties. The North Platte test was planted on fallowed land and an excellent crop was harvested. Results of this test are included in the North Platte section of this report. The season at Alliance was from two to three weeks longer than normal, and nearly all varieties were matured by the time of the first killing frost.

Grain varieties. Grain yields at Lincoln ranged from a complete failure to 70 bushels per acre. Chinch bugs completely killed the plants in many plots of the milos and milo-hybrids. The season gave an excellent opportunity to study the varietal reaction to this pest. A corn hybrid (U. S. 35), grown in comparison, yielded 62.2 bushels per acre. Only the four varieties, Pink kafir, Club, Hegari and Caprock, produced higher average yields than that of corn. As usual at Lincoln the highest yields were made by varieties that require the full season to mature. Early Kalo gave a yield of 25.8 bushels per acre as compared with 46.1 bushels for Midland. Its yield was materially reduced as the result of chinch-bug injury. In a test of experimental varieties, an early Club selection developed by the Fort Hays Branch Experiment Station (Kansas) and a Weskan x Greeley selection were especially promising. This latter selection also gave a good performance in the North Platte and Alliance tests.

At Alliance grain yields ranged from 18.2 bushels per acre for Early Kalo to 38.9 bushels for Weskan x Greeley (66-3-1). A new variety, Double Dwarf Sooner from Lubbock, Texas, yielded 32.1 bushels and seems well adapted to the state.

Forage varieties. Yields of the forage varieties at Lincoln were not as high as those recorded for the two previous years. As usual the yields were closely correlated with time of maturity. On a 70 per cent moisture basis they ranged from 9.46 tons per acre for Fremont to 15.44 tons for the late ripening Kansas Orange. The corn yield was 11.02 tons. An early ripening selection of Atlas has averaged one-half ton less forage per acre (15 per cent moisture basis) than Atlas but its grain yield for this period is 63.8 bushels compared with 56.4 bushels for Atlas. This early Atlas selection was developed by Mr. Conable, Axtell, Kansas, and has been named Axtell by the Kansas Agricultural Experiment Station. It is now eligible for certification in Nebraska as well as in Kansas.

Five early maturing forage varieties were tested at Alliance. Yields on a 70 per cent moisture basis ranged from 6.74 tons per acre for Rancher to 9.52 tons for Norkan.

Sudan grass. The Sudan grass yield test was continued this year. All of the varieties and numerous selections were analyzed for prussic acid content. Relative prussic acid content in eight comparisons was from 30 to 50 per cent lower for Wheeler than for Texas Sweet. These results are similar to those reported for the past two years. Whether this relatively higher prussic acid content of Texas Sweet is sufficient to make this variety unsafe as a pasture crop in Nebraska is still an unanswered question. Under normal conditions it should be as safe as Wheeler for pasturing. For the past two years Texas Sweet has been pastured suc-
successfully to a limited extent by several Nebraska farmers but general recommendation would not yet be warranted. A Kansas sel. 433 was the most promising of all strains tested this year from the standpoint of vigor, yield, forage quality, lodge resistance, and chinch-bug resistance but it has a prussic acid content even higher than that of Texas Sweet.

Breeding. Work is being continued toward the development of improved grain and forage varieties. Several grain selections from the crosses Western Blackhull x Day and Sooner x Club have appeared especially promising in yield tests during the past two years. A few selections from the cross Atlas x Highland show promise as dual-purpose types—good for both forage and high grain production.

O. J. Webster.

Soybean Improvement

Industrial demand for soybeans has continued at a high pitch and very attractive prices prevail. In spite of this, the Nebraska production dropped to approximately 25,000 acres. Development of new varieties that are more productive under local conditions would appear essential for a greatly increased acreage.

Performance tests were conducted at Lincoln and Wayne. They included the best standard varieties available and a number of outstanding new selections that were developed in the cooperative soybean improvement program with other states and the U. S. Department of Agriculture. An early summer drought resulted in a near failure at Wayne. The Lincoln tests materialized satisfactorily and above-average yields were obtained.

One of the most promising new strains included in the Nebraska tests goes by the number A4-107-12. In tests conducted cooperatively between the U. S. Regional Soybean Laboratory and various state experiment stations in the Corn Belt, this strain averaged 35.7 bushels per acre during 1945-46 compared with 30.5 for standard Richland. It has the same maturity date as Richland, grows three inches taller, and has the same lodge resistance.

An unusual virus disease by the name of "bud blight" was observed in the test plots both at Wayne and Lincoln. It does not cause death of the infected plants, but prevents development of pods and seed. The pods remain in a rudimentary form.

J. L. Weihing, J. M. Slatensek.

Production Practices with Soybeans

It has been suggested that one reason for the relatively small acreage of soybeans in Nebraska is inexperience as to the best methods of growing the crop. Accordingly a new series of cultural tests was started at the Agronomy Farm at Lincoln and three years' data are now available. These included time, rate, and manner of planting; row spacing; and surface vs. furrow planting. A standard, well-adapted, medium early variety, Dunfield, was grown throughout the tests.

Time of planting. Replicate plots were planted at the rate of 60 pounds seed per acre in 35-inch cultivated rows at four different dates. A similar test was made in solid-drilled plots sown at 120 pounds seed per acre. In spaced rows, May 16 planting yielded 15.4 bushels per acre; May 26, 16.9 bushels; June 7, 18.0 bushels; and June 19, 18.3 bushels. When solid drilled, the corresponding yields were 17.2 bushels, 17.7 bushels, 19.4 bushels, and 21.8 bushels per acre. In every year, the June plantings outyielded those in May. Averaging both methods, planting in the first
half of June yielded 19.4 bushels per acre compared with 16.8 bushels for planting in the second half of May. May 20 to June 5 is commonly regarded as a most suitable period for planting this crop, and a delay after June 5 is especially inadvisable if a full-season variety is used. In years of less favorable rainfall than prevailed during this test, the crop may require a longer time to mature and thereby be subjected to the hazard of frost injury. Reasonably late planting has the advantage of providing a longer preliminary period for thorough weed control by tillage.

**Spacing of rows.** At 60 pounds of seed per acre, rows spaced 21 inches apart gave a three-year average yield of 20.3 bushels per acre; 28 inches, 18.8 bushels; 35 inches, 18.3 bushels; and 42 inches, 16.8 bushels. If planting and tillage implements are available for handling rows spaced from 21 to 35 inches apart, wider spacing appears inadvisable, as the midseason types may then be unable to fully occupy the land.

**Surface vs. furrow planting.** A comparison was made during the three years of planting in 36-inch rows on the surface and in furrows made both by disk furrow-openers and a lister. The seed was drilled at the rate of 60 pounds per acre and covered one inch. The surface planting yielded 20.4 bushels; two-inch furrows, 21.4 bushels; and five-inch listing, 19.7 bushels. Use of loose-ground furrow-openers appears very successful from the standpoint of yield and ease of covering weed seedlings in the row by early harrowing. Listing is at some disadvantage because the base of the plants is excessively buried by cultivation. Surface planting is a satisfactory method.

**Manner and rate of planting.** In a comparison of 35-inch cultivated rows and solid drilling, rows planted to 40 pounds of seed per acre gave the highest net yield (amount produced less amount planted) of 20.1 bushels, while the second highest yield was 19.8 bushels from solid drilling with 90 pounds of seed. The actual yields in cultivated rows planted at 25, 40, 60, and 80 pounds per acre were 19.6, 20.8, 20.4, and 20.8 bushels, while solid drilling gave 21.1 bushels from 90 pounds of seed and 21.5 bushels from 120 pounds of seed per acre. It is apparent that there may be considerable leeway as to the manner and rate of planting without greatly affecting the yield per acre, provided weeds are properly controlled by well-timed tillage. Except on relatively weed-free or sloping land, cultivated rows usually are to be preferred. Whether grown in rows or solid drilled, the soybeans should be harrowed or rotary-hoed several times up to a plant height of about eight inches, and thereafter row plantings will normally require two more cultivations.

As a precautionary measure, seed should be inoculated with a suitable nodule-forming bacterial culture before planting, unless experience has shown this to be unnecessary for the formation of an abundance of nodules on the roots.

W. E. Lyness, T. A. Kiesselbach.

**Improvement and Testing of Special Chemurgic Crops**

The shortage of vegetable oils, especially drying oils, in most parts of the world has contributed toward an active commercial interest in safflower, castor beans, sesame, and mustard production in Nebraska. Because of these conditions, the next few years should provide exceptional opportunity for the establishment of any meritorious new oil crops.

**Safflower.** Tests in cooperation with other states were established in 1946 and will be continued during the coming year. These tests, in addi-
tion to determining possible new areas of safflower adaptation, provide additional information on the relative yielding ability and other characteristics of new selections and promising introductions.

Small increase plots of two new lines, Nebr. 478 and Nebr. 852, were grown in 1946. Seed from Nebr. 478 contains 30 to 32 per cent oil and 40 per cent hull. This line is characterized by good yield and a high tolerance to grasshoppers. Seed from Nebr. 852 contains 33 to 35 per cent oil and 40 per cent hull. This line does not form a rosette in early growth as do most others, and this non-rosette character is of considerable importance in weed competition. It is, however, more susceptible to grasshoppers than is Nebr. 478. The safflower mixture now grown in western Nebraska contains 28 to 29 per cent oil and 46 to 48 per cent hull and thus is of decidedly inferior quality. Because of very slow growth in early spring it affords little weed competition.

**Mustard and rape.** During the 1946 season approximately 4,000 acres of yellow mustard were grown under contract in far western Nebraska for a commercial firm. The yields of these commercial fields ranged from complete failures to 350 pounds per acre, and averaged approximately 100 pounds. Experimental results with mustard and rape in that area have been erratic. All *Brassica* species grown have been very susceptible to fleabees in early spring and to grasshoppers later in the season. Since 1942 when tests were begun, yields in western Nebraska have ranged from complete failures to 500 pounds per acre. In 1946 at Alliance yellow mustard averaged 88 pounds per acre, Argentine annual rape 146 pounds, compared with 620 pounds per acre for safflower grown in the same test. On non-irrigated land at Holdrege in 1946, yellow mustard averaged 429 pounds per acre, while the Argentine annual rape yielded 857 pounds. From these results it is questionable if available varieties of rape and mustard can become a profitable crop in western Nebraska.

**Castor beans.** The work with castors was continued with nurseries located at Lincoln on dry land and at Holdrege under irrigation. While the objectives of the program remain about the same as in previous years, special emphasis in 1946 was placed on the selection of non-shattering plants. For this purpose a "kick test" was employed which proved useful in determining which plants had this desirable characteristic. The selections grown in comparative tests included lines from the Belgian Congo, Ethiopia, Brazil, Argentina, Peru, Columbia, Australia, and India. While most of these were too late in maturity to be of immediate value, a few gave promise of being useful in further breeding experiments. In replicated tests the yield of castor beans varied from 728 to 1,166 pounds per acre at Lincoln. At Holdrege, under irrigation, the same selections yielded about 300 pounds more per acre. The Chemurgy Project cooperated with the Department of Agricultural Engineering in work on the construction and testing of a castor bean harvester.

**Sesame.** It was apparent as early as 1942 that one of the major objectives of the sesame program would need to be the development of earlier maturing varieties. Fortunately, it has been possible to isolate a number of lines that mature within the growing season characteristic of the eastern half of the state. By selection it has been possible also to obtain pure lines with additional seed colors. This year tan, reddish-brown, and dark gray were added to the primary colors of white, brown, and black.

Sesame was grown for the first time under irrigation at Holdrege. In a replicated yield test six selections were compared. Average yields
varied from 740 pounds for a white-seed variety to 1,415 pounds for one with brown seeds.

**Chufa.** Observation plantings of chufa were made at Lincoln on dry land and at Holdrege under irrigation. As might have been expected, since the crop belongs to the sedge family, growth was much better at Holdrege. The average yield of nutlets from triplicate plots was at the rate of 418 pounds per acre at Lincoln and 816 pounds at Holdrege. Chufa may have possibilities as a food for hogs or for certain forms of wild life. However, the difficulty of harvesting the small nutlets which are formed in the crown of the plant definitely limits its usefulness as an agricultural crop.

**Other chemurgic crops.** Tests were conducted with chicory, perilla, sunflower, and flax. Oil crops grown for the first time included Chia, *Eruca sativa,* and *Xanthium strumarium.* The results showed that these crops were not suited to the climatic conditions of Nebraska.

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

Outstate Testing

**Field crops.** Crop variety tests and soils studies were conducted on farms in all regions of the state. Each field location was chosen as being representative of that region. As in past years, publications summarizing results of the corn and the small grain variety tests have been issued.

**Crop varieties.** Winter wheat tests were completed at 12 locations. An experimental strain, Cheyenne x Tenmarq (C. I. 11972), was outstanding in most of the tests. Of the certified varieties, Pawnee has the highest average yield for the southeastern districts and Cheyenne and Nebred for the western districts over the last three-year period.

Eleven oat tests were harvested. An experimental strain, Victoria-Richland x Morota-Bond (C. I. 4301), was at or near the top in most of the tests. Osage has the highest average yield in the southeastern, central, and western districts; Clinton in the east-central; and Cedar in the northeastern districts.

Six barley tests materialized. Velvon 11 was outstanding in all areas except in the south-central district, where it was matched by Ezond and Feebar, and in the western district where Beecher was highest.

Corn tests were harvested at nine locations. In most of these only certified and experimental hybrids were included. Of the late maturing hybrids tested in southeastern Nebraska, Ill. 201 and U. S. 13 were most productive. In tests of midseason hybrids, several experimentals yielded most. Ohio C92, Nebr. 601, and Nebr. 501 gave higher yields than did other certified hybrids of the midseason type. Nebr. 501, Iowa 306, and Ind. 608C were the highest yielding early maturing hybrids. Tests also were conducted with popcorn, sorghum, rye, winter barley, and sweet clover varieties.

**Soils.** Studies conducted as part of the Outstate Testing Program on the use of commercial fertilizers and moisture penetration during irrigation were in cooperation with other soils projects. Results obtained are given earlier in this report.

G. T. Webster, J. W. Fitts.

2.4-D in Weed Control

The new growth-regulating chemical 2,4-dichlorophenoxyacetic acid, commonly known as 2,4-D, continued in 1946 to show increasing promise
as an effective herbicide for weed control in Nebraska. Intensive experimentation was conducted by many workers throughout the United States, in Canada, and the United Kingdom to determine the possibilities and limitations of this newly discovered weed killer.

Experiments with 2,4-D in Nebraska were conducted according to a uniform plan arranged by the research committee of the North Central Weed Control Conference for use in 1945 but with revisions for 1946. While most of the experimental work was carried on at the Bindweed Experiment Farm and elsewhere in the vicinity of Lincoln, some outlying plots were treated in various sections of the state. The experiments near Lincoln were conducted by the Department of Agronomy. Tests on outlying plots were cooperative with the Noxious Weed Division of the State Department of Agriculture and with the county agents and weed district supervisors in the respective counties. Demonstration plots were established by Noxious Weed Division personnel, by county agents, and by weed-district managers and supervisors.

Duplicate plots of the deeply-rooted perennial weeds were treated with 500, 1,000, 1,500, and 2,000 parts per million of 2,4-D at the rate of 1½ gallons per square rod or 240 gallons per acre. Three types of 2,4-D formulations were used, namely, the sodium salts of 2,4-D, the esters of 2,4-D, and the triethanolamine salts of 2,4-D. These were applied in several different combinations. Tests were conducted to determine the reaction of corn, sweet corn, wheat, oats, grain sorghum, forage sorgo, Sudan grass, alfalfa, sweet clover, soybeans, bromegrass, Kentucky bluegrass, and buffalo grass to the different types of 2,4-D.

**Bindweed.** Plots of bindweed near Lincoln were treated at three stages of growth at the above concentrations and rate. These were (1) full emergence, (2) at appearance of first bud, and (3) full bloom. No accurately measurable differences could be noted from either the types of

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An example of a low cost homemade sprayer. It consists of heavy pressure tank, power takeoff tire pump, pressure gauge, pop-off valve, and hose and gun for delivering the spray.
2,4-D or between concentrations at the full emergence stage treated on May 7. A range of from 4 to 24 plants per square rod remained on the plots treated at the full emergence stage when observations were made 150 days following treatment. The average number of plants on the area at the time of treatment was 1,125. Somewhat poorer results were evident from treatments at the appearance of first bud on June 4. Differences between types and between concentrations were not consistent. The range of surviving plants was from 3 to 78 plants per square rod 120 days after treatment whereas the stand at treatment was 1,215. The results from treatments at the full bloom stage on June 22 were the poorest of the three sets of data. There was considerable variation between the two replications, but no consistent differential was expressed between either the type of chemical or between concentrations. The range of survival was from 0 to 660 plants per square rod 90 days after treatment where the original stand averaged 600 plants per square rod. In no case was it found that seed of bindweed had matured on any of the plots treated. From these and other data on bindweed the conclusion has been drawn that 2,4-D can be used for effective control of bindweed, but repeated treatments once per year for several years will be necessary for complete eradication.

**Hoary cress.** Treatments on hoary cress were applied at the appearance of the first bud on April 6. Only the butyl ester was used but this was applied at 500, 100, 1,500, and 2,000 parts per million and 1½ gallons per square rod. After 210 days two out of three treated plots showed no surviving plants where given the lowest concentration. Greater numbers of surviving plants were evident on the plots treated at the higher concentrations. The reason for this is not clear at present. Greatest survival was 50 plants per square rod after 210 days where the original stand was 720 plants. From these and other data it appears that hoary cress can be controlled effectively by 2,4-D.

**Canada thistle.** An infestation of Canada thistle near Wahoo, Nebraska, showed only about 50 per cent reduction in stand after two treatments with 2,4-D of either the sodium salt or ethyl ester type. Only 10 plants of an original stand of over 500 plants per square rod remained where the area was treated with four pounds per square rod of sodium chlorate in 1945. The indication is that this species is only moderately susceptible to 2,4-D and that small patches might be more practically treated with sodium chlorate.

**Leafy spurge, Russian knapweed, dogbane, and tanweed.** These species have proved very resistant to 2,4-D and it is doubtful if any reduction in stand can be accomplished by the use of 2,4-D even though seed production can be eliminated with each spray at or before full bloom.

**Whiteweed.** This species is susceptible to 2,4-D in the ester form, but is quite resistant to the other forms. Satisfactory control of the plant can be accomplished with one spray per year of the ester type in water, but repeated sprays are necessary for complete eradication.

**Lawn weeds and many broad-leaved species of annual weeds.** Such species as dandelion, the plantains, most mustards, most pigweeds, curled dock, cockle bur, kochia, sunflower, and many other species are susceptible to 2,4-D and can be eliminated in large percentage by the use of this chemical in water spray. Species of grasses, both cultivated and weedy, are extremely resistant to 2,4-D. Airplane spraying with highly concentrated 2,4-D of the ester type in diesel fuel at low rate per acre has proved
very promising for the elimination of annual weeds, such as the mustards, from fields of small grain. This method of application is in the experimental stage.

**Corn and sweet corn.** Where 2,4-D of the sodium salt and triethanolamine salt types were sprayed on entire plants of field corn and sweet corn at knee-high and laying-by stages, the plants were very seriously affected and yield was reduced over 50 per cent in most plots. On the other hand where field corn was treated so that only portions of leaves and the base of the stalks were wetted by the spray, no reduction in yield could be observed.

**Wheat and oats.** No serious effect from the spray could be noted either on the plants or germination of the seed of wheat and oats treated with the triethanolamine salt of 2,4-D when the plants were in the early heading stage of growth. From eight to ten per cent mechanical injury from the application equipment was noted. Treatment at earlier stages of growth would permit the crop plants to recover from such injury.

**Sorghum and Sudan grass.** Epinastic curvature of the plants of forage sorghum at the lower nodes was evident where entire plants were sprayed. This was somewhat more intense from the triethanolamine salt than from the sodium salt. The grain sorghum was less affected than the forage sorghum. Little evidence of injury was noted on Sudan grass.

**Legumes.** Plants of alfalfa, sweet clover, and soybeans were killed when treated in the seedling stage. Established plants of alfalfa showed some tolerance to the effects of 2,4-D under some conditions. Differential susceptibility between varieties of alfalfa may be existent. Established plants of sweet clover and soybeans were readily killed by the chemical.

**Cultivated grasses.** No serious injury has been observed on Kentucky bluegrass with concentrations as high as 2,000 parts per million of 2,4-D. Some leaf spotting has been noted on plants of bromegrass and buffalo grass at concentrations of 1,500 and 2,000 parts per million, especially of the esters. In no case has actual killing of either of these species been observed.

NOEL S. HANSON.
Ascorbic Acid Content of Nebraska Potatoes

Place and storage. The ascorbic acid content of the tubers of 12 varieties of potatoes grown at three places in Nebraska was analyzed at harvest time in the summer of 1945 and at regular intervals during the nine months thereafter. It was found that ascorbic acid content varied because of:

1. Place where tubers were grown.
2. Maturity of tubers and time in storage. The mean ascorbic acid content of 12 varieties grown at Alliance and Scottsbluff and harvested in early September was 36.5 milligrams per 100 grams of fresh weight of potatoes. When harvested in early October from vines that were nearing maturity, their ascorbic acid content was 15.6 per cent less. The ascorbic acid continued to decrease in 40°F. storage. It was less by 32.3 per cent on November 10, 80 per cent by December 17, 83.2 per cent by February 15, 84.4 per cent by April 24 than in the tubers harvested in early September.

Varieties grown at one place differed in much the same order throughout the storage period. However, the differences among tubers grown at Lincoln varied widely from those of the same varieties grown at Scottsbluff and Alliance, where they held essentially the same relationship to each other at both places.

Production for high ascorbic acid content. There is reason to believe that tubers with higher ascorbic acid content can be developed. In recent years tubers of several varieties (especially Kasota and Nebraska 2) have consistently had high ascorbic acid content and others (such as Irish Cobbler) have been low. Samples of 20 tubers of 70 varieties grown on the Box Butte Farm in 1946 and analyzed two to four weeks after harvest contained from 19 to 41 mgs. ascorbic acid per 100 grams fresh weight of tubers.

Although some of these differences result from harvesting tubers of different degrees of maturity from the different lines, the distribution of high and low lots indicates that many of the differences are due to intrinsic heritable differences.

Maturity of tubers. During the period of initial tuber enlargement, the ascorbic acid content of Triumph and Kasota tubers produced at Alliance varied greatly. After the plants attained maturity and tubers reached maximum size, the ascorbic acid content diminished with almost equal rapidity and continued to decrease throughout the storage life of the tubers. In another test, tubers harvested from mature vines, where maximum ascorbic acid content had been attained, possessed more ascorbic acid throughout the storage period than those harvested on the same date from immature vines.

Storage at constant temperatures. Losses of ascorbic acid from tubers of three varieties (Triumph, Red Warba, Kasota) stored at seven constant temperatures ranging from 40 to 90°F. were least at 50°, very slightly greater at 60, increasing further at both 75 and 90°F. Losses were increasingly greater with each drop of 2.5°F. from 50 to 40°. However, losses at 90° were not as great as those at 45°. About as much ascorbic
Acid remained on February 1 in tubers stored constantly at 50° as was found in mid-November in those stored at 40°.

Transferring from high to low storage temperatures. In the three varieties that were used in controlled storage tests, ascorbic acid was lost rapidly when they were transferred to 40° on various dates from initial storage of either 50, 60, 75, or 90°. Losses with Kasota appeared to take place more slowly than with the two other varieties. When tubers were held at these higher temperatures until after January (when the rest period was completed) and then moved to 40°, the ascorbic acid content on June 12 was as high as it was in February with tubers kept continually at 40°F.

Position within a bin. Triumph potatoes removed in late May from the portion of the bin that was coldest during the winter had 20 per cent less ascorbic acid than those removed from the warmest portion. In other portions of the bin, the ascorbic acid content was relatively high or low depending upon whether the temperature was generally high or low.

Ascorbic Acid in Tomatoes

Analyses were made of fruits of a number of varieties to locate those that consistently produce fruits with high ascorbic acid content. Red Cloud tomatoes produced by plants grown at Lincoln under a muslin shade had about one-third less ascorbic acid than those grown in full sunlight. Fruits from plants sprayed five times during July and August with Cuprocide contained slightly less ascorbic acid in the early part of the season than those from unsprayed plants, but toward the end of the productive period the fruits from the sprayed plants contained slightly more than those from the controls. Cultural treatments such as straw mulching or irrigation did not alter ascorbic acid content.

Ruth M. Leverton, H. O. Werner.

Potato Storage

Retarding sprout growth of potatoes by chemical means. In several tests with Irish Cobbler potatoes at Lincoln and Triumph potatoes at Alliance, it was found that the growth of sprouts could be delayed a number of weeks and then greatly retarded by dusting or spraying tubers with the methyl ester of alpha-naphthaleneacetic acid. This may be applied anytime between the harvesting of the tubers and just after their rest period is completed. The growth-retarding effect was found to continue even after the potatoes were washed. The treatment costs between five and eight cents a bushel. It might be very useful for home gardeners who do not have cold cellars that will prevent the growth of sprouts when potatoes are held beyond mid-winter. It can also be used by the commercial grower to prolong the storage life of his crop. Potatoes kept at 50° storage temperature have better cooking quality and retain more ascorbic acid than those stored at 40° or less. Now with the aid of this treatment potatoes may be stored at this higher temperature without danger of sprouting. Until more is known about it, however, this treatment should not be used on seed potatoes.

H. O. Werner.

Potato Breeding

Five selections were planted in 11 replicated yield tests located at Lincoln, Gibbon, North Platte, Scottsbluff, and Alliance in comparison with six named varieties. These tests were on irrigated and dry land
Potatoes at left were dusted in March to inhibit sprouting. Photo taken last of May in potato cellar.

and those in the West were planted on three different dates. In addition to the customary data as to stand of plants, total yield, weight of tubers of each grade, and various types of defects, the mean specific gravity and ascorbic acid contents were determined from samples of tubers harvested from each of these plats.

These tests showed one line (SND48-2, henceforth to be designated as Nebraska 2) producing high yields of white tubers that were unusually uniform in shape and size and that generally possessed high specific gravity and high ascorbic acid content. Relatively early, it seems suited to all parts of the state. Another selection (24.38-3, to be recognized as Nebraska 3) produces deep red tubers that are medium size, shallow eyed, uniform, and that may possess some resistance to scab and fusarium. It seems adapted to western Nebraska but not to central and eastern Nebraska. As both of these selections seem superior to present-day varieties, they are being increased in seed plats of several acres each at the Box Butte Experiment Farm.

H. O. Werner.

Potato Cultural Methods

Advance cutting of seed potatoes. When held under proper conditions, seed potatoes cut at intervals from March until planting time in June showed no greater losses than whole potatoes stored under the same conditions. Stands of plants and yields of tubers were practically the same regardless of the time the seed was cut. The Triumph variety was used, and the test was conducted at the Box Butte Experiment Farm.

Rate of production of Triumph potatoes. In 1946 the tenth successive annual record of rate of production of Triumph potatoes on dry land was acquired at the Box Butte Experiment Farm. This record shows that 75 per cent or more of the tuber crop has been produced prior to September 16 in eight of the ten years, and that in most years relatively few
Potatoes on top of ground at Scotts Bluff are SND 48-2, a promising variety.

bushels of potatoes are added after September 15. Seldom are more produced after October 1. Potato farmers gain little or nothing for the risk of delaying harvest until the middle of October.

H. O. WERNER.

Tomato breeding. Red Cloud tomatoes were grown by different combinations of irrigation, straw mulching, shading, spraying, supplemental nitrogen applications, staking, and time of seeding to determine the best procedure for growing determinate varieties of that type. The combination of methods that stimulated most vegetative growth, such as irrigation of straw-mulched plants that received supplemental nitrogen and fungicidal spraying, produced greatest yields of large tomatoes over the longest period.

H. O. WERNER.

Vegetable Experiments

Sweet potatoes. In an irrigated yield test at Lincoln including nine varieties, yields of No. 1 grade tubers ranged from 29 cwt. per acre with Yellow Jersey to 262 cwt. with Red Bermuda.

Other high yielding varieties were Florida White, a seedling designated North Carolina No. 1, and Maryland Golden. This last variety produced a high percentage of smooth No. 1 grade tubers at the rate of 155 cwt. per acre. Yields of Porto Rico were 109 cwt. per acre of No. 2 grade. The yields of Nancy Hall, Yellow Stem Jersey, and Orange Little Stem were all relatively low and the grade quality was inferior.

The importance of early planting was shown by the total yields produced, which for each 10-day planting interval for the Porto Rico variety were as follows: May 21—175, May 31—144, June 10—69, and June 20—38 cwt. per acre. For these several dates the percentages of No. 1 grade tubers harvested in early October were 58, 56, 50, and 23 respectively.

Yield and percentage of No. 1 Porto Rico tubers increased steadily during September and early October, the yields on September 17, 27, October 7, and 16 having been 46, 54, 59, and 69 cwt. per acre and the percentage of No. 1 tubers 36, 38, 46, and 43 respectively.
Because of their high food value and satisfactory yields, sweet potatoes should be grown more extensively in the warmer parts of Nebraska. From the standpoint of food value, these yields of 150 to 250 cwt. per acre of sweet potatoes represent greater production of food per acre than the 250 to 400 bushels per acre (150 to 240 cwt.) produced under irrigation by Irish or white potatoes, because the dry matter content of the sweet potatoes is generally five to eight per cent greater.

**Peas.** On the basis of a test of 52 varieties at Lincoln, the varieties that appeared most promising to provide a succession of peas were the following: First early—Alaska, Surpass, Early Harvest; Second early—Early Badger, Little Marvel, Glacier; Main season—American Wonder, Pride, Climax, Canner King, Perfection; Late—Merit, Major. Of these, Alaska is most suitable for early canning, whereas Climax, Canner King, and Perfection are the late varieties most suitable for commercial canning. The varieties that produced the largest peas were Glacier, Little Marvel, American Wonder, and Canner King, with those of Major being largest of all. All of the varieties listed have produced satisfactorily high yields in at least two of the three years during which they were tested.

**Lima beans.** A test of 11 varieties of bush lima beans was made at Lincoln. The selection 243 supplied by the U.S.D.A. and recently named Peerless was the most desirable variety from the standpoint of yield and quality. Another high producing variety was the Early Baby Potato lima from the Illinois Agricultural Experiment Station. Other good varieties were U.S.D.A. 343, Green Seeded Henderson, and Fordhook 242.

H. O. Werner

**Orchard Spraying**

The delayed-action spray test started in July, 1945, gave the following results in 1946. Often the buds, definitely smaller as a result of 2,4-D or alpha-naphthaleneacetic acid, either died or produced weak twigs or flowers. These effects were usually accompanied by retarded bud opening and shoot growth of the other vegetative buds in these treatments. No delay was observable in the opening of peach and apricot buds.

Delayed blooming of cherries and apples was effected by 2,4-D at a concentration as low as 50 p.p.m., but was not consistent until 150 or 300 p.p.m. of 2,4-D or 800 p.p.m. of alpha-naphthaleneacetic acid were applied. The opening of flower buds on Early Richmond cherries was delayed about five days and on English Morello about eight. Great variability in the blooming of untreated Wealthy apples made difficult the estimation of delay in the blooming of treated branches, but delays of seven days or more probably occurred.

The blooming of Virginia Crab was definitely delayed as much as 14 days. Leaves developing on treated branches of Virginia Crab were frequently narrow, twisted, and cupped; marginal teeth were prominent; veins were relatively broad; green tissue between the veins was correspondingly reduced. This general malformation and reduction of size of leaves was more marked under 2,4-D than under alpha-naphthaleneacetic acid treatment. The other varieties of fruits showed only traces of such effects.

Carbowax 1500, recommended to increase the effectiveness of 2,4-D and alpha-naphthaleneacetic acid, had been used to prepare half of the sprays. When Carbowax 1500 was included, the active ingredients were only slightly more effective than they were without it. The two active ingredients reduced the number of flowers and fruits per cluster as indi-
cated in the accompanying table. Counts of the number of apple fruits per cluster were made on July 29.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of flowers per cluster</th>
<th>No. of fruits per cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Apples</td>
<td>Cherries</td>
</tr>
<tr>
<td>Control</td>
<td>5.3</td>
<td>3.0</td>
</tr>
<tr>
<td>2,4-D, 10 p.p.m.</td>
<td>4.4</td>
<td>2.7</td>
</tr>
<tr>
<td>2,4-D, 50 p.p.m.</td>
<td>4.5</td>
<td>2.5</td>
</tr>
<tr>
<td>2,4-D, 150 p.p.m.</td>
<td>3.9</td>
<td>2.3</td>
</tr>
<tr>
<td>2,4-D, 300 p.p.m.</td>
<td>3.3</td>
<td>2.2</td>
</tr>
<tr>
<td>a-NAA, 800 p.p.m.</td>
<td>4.2</td>
<td>2.4</td>
</tr>
</tbody>
</table>

At the time the sprays were applied, a wind shunted the spray drift from a cloth guard to branches not scheduled for treatment. The mist received by these branches definitely delayed the opening of flowers but did not kill buds and twigs as did the thorough coverage of experimental branches. Following this lead, 2,4-D was applied at 25 and 150 p.p.m. to entire trees of four varieties of cherries, two varieties of plums, and one variety each of apricots, peaches, and apples at Lincoln on July 18. 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. All of these sprays were applied lightly enough to avoid run-off and no attempt was made to wet the buds as in 1945. None of the trees was visibly affected by the treatment during the remainder of the 1946 growing season.

“Fermate” (ferric dimethyldithiocarbamate) was compared with Bordeaux mixture in a replicated experiment on Duchess apple trees at the University Fruit Farm. Because of delay in the receipt of the Fermate, Bordeaux mixture was used on all trees for the cluster-bud and petal-fall sprays. Fermate was applied at the rate of 1½ pounds per 100 gallons for the first cover spray, and at half of that rate for the remaining five cover sprays. Fermate and lead arsenate were used together in the spray schedule. Apple scab and blotch were completely prevented in the entire Duchess block. Near the close of the growing season, less vigorous trees in the Fermate-sprayed replicates had healthier foliage than similar trees in the Bordeaux-sprayed replicates. The above spray schedule was duplicated to control scab and cedar-apple rust on Wealthy trees at Lincoln. Scab lesions were entirely prevented by both spray materials. Extremely few rust spots developed on Fermate-treated trees, but a considerable number of them appeared on Bordeaux-sprayed trees.

“Nugreen,” a urea compound having 43 per cent nitrogen, was added to the standard lead arsenate spray schedule used on old Winesap and Jonathan trees at the University Fruit Farm. Beginning with the second and ending with the sixth cover spray, Nugreen was applied at rates of three and six pounds per 100 gallons of spray mixture. All trees were growing in sod, and the Winesaps were particularly in need of invigoration. No beneficial response was noted on any of the trees to which Nugreen was applied. The color of leaves not damaged by the spray containing the foliage fertilizer was apparently the same as that of leaves on control trees. Vegetative growth, fruit color, and size were not visibly affected. A marginal leaf scorch appeared on the older leaves of Winesap trees, especially in replicates that received the more concentrated spray. The most seriously damaged leaves turned yellow, except for the brown margins, and fell off prematurely. Jonathan leaves were less affected
than Winesap leaves, possibly because Jonathan trees were in a more vigorous condition.

The cooperative experiment on the use of DDT to control codling moth is reported by the Department of Entomology.


**Fruit-Stocks Investigations**

Topworking the young orchard of Hibernal and Virginia Crab planted at the University Fruit Farm in 1943 was practically completed, except for a few replacement trees set out this spring. An average of 2.6 bud shields was added to each tree in July. Measured at the end of the growing season, these averaged 0.9 and 3.4 inches on Hibernal and Virginia Crab, respectively. Scions of Jonathan grew more than those of other varieties, averaging 1.5 inches on Hibernal and 6.1 inches on Virginia Crab. Scions of the 1945 budding had often branched so much that measurement of their total length was not attempted. The main stems of these scions averaged approximately three feet in length. Both kinds of interstocks now have an average of 11 scions per tree.

North-south trunk measurements, made at the end of the growing season, showed that Hibernal averaged 1.59 inches and Virginia Crab 1.45 inches in diameter one foot above the soil line. Hibernal had increased 17.1 per cent more in diameter than had Virginia Crab during 1946. Referred to scion varieties, the increases in favor of Hibernal amounted to 43.4 per cent for Jonathan, 21.1 per cent for Delicious, and 19.1 per cent for Golden Delicious. Increases in diameter favoring Virginia Crab amounted to 8.9 per cent for Winesap and 4.5 per cent for Grimes Golden. A much smaller number of trees was topworked to Winesap and Grimes Golden than to the other scion varieties.

At the present time, only Hibernal and Virginia Crab are being topworked in Nebraska orchards. To study the adaptability of other varieties as interstocks, a replicated experiment involving 3,210 trees was begun at the University Fruit Farm this spring. Spaced five or seven feet along terraced rows 15 to 20 feet apart, 2,305 trees will be topworked to 17 standard scion varieties during the next two years. The 20 varieties in this phase of the test are Beacon, Cortland, Red Duchess, Fireside, Haralson, Hibernal, Hawkeye, Malling I, Malling II, Malling XII, Malling XIII, Malling XVI, Minjon, Prairie Spy, Rescue, Secor, Sharon, Turley, Virginia Crab, and Wealthy. Many of these are notably winter-hardy varieties introduced by other experiment stations in recent years. The remaining 905 trees were planted about 18 inches apart in nursery rows to study their capacity to root by trench and mound layerage. All of the above-named varieties except Fireside, Minjon, Rescue, and Turley were included in the layerage study. Hibernal and Virginia Crab are being used in both phases of the experiment as standards for comparison. An observation period of four or five years is anticipated.

R. H. Moore, C. C. Wiggans.

**Supplemental Water for Orchards**

Rainfall during the growing season was very sporadic and in general only about 70 per cent of the amount which fell during 1945. March with a precipitation of 5.57 inches, June with 7.19, and October with 5.89 were the wet periods and produced nearly one-half of the season's rainfall which, up to December 1, had amounted to only 29.88 inches. In both quantity and distribution the season's moisture supply could be termed inadequate to supply the needs of mature apple trees.

C. C. Wiggans, E. E. Brackett.
General Diseases

**Injury from late spring freeze.** A late spring freeze, occurring just as the winter wheat was approaching the heading stage, caused considerable total and partial head sterility. Some sterility occurred in all varieties but it was more severe in those nearest pollination. The stage of development of the wheat had a greater influence on the amount of floral injury than did varietal susceptibility. For example, in two separate plantings of Pawnee wheat in Polk County with a slight variation in heading date, the earlier heading plot had over twice as much injury as the later planting. In general, the earlier heading varieties were injured most due to being in a more susceptible stage of development at the time of the freeze.

In western Nebraska where the temperature dropped to 24°F. and where the wheat was much later in development, there was only a small amount of sterility. There was, however, considerable injury to the stems near the ground in the form of split and rotted internodes.

Fortunately, a high percentage of the acreage in central and western Nebraska was planted to the late varieties, which escaped serious damage, so that the over-all loss probably did not exceed three per cent.

**Barley fertilizer and seed treatment tests.** The tests conducted in 1945 using combinations of Uramon, superphosphate, and seed treatment at planting time were continued with plots in Buffalo and Hall counties. Significant increases in yield were obtained with the fertilizer tests when nitrogen and a combination of nitrogen and superphosphate were applied. Seed treatment with New Improved Ceresan had no effect either on stand or yield. In contrast to the 1945 test in Merrick County, the New Improved Ceresan seed treatment gave an added increase over that obtained from the fertilizer.
Smut identification. Nine new collections of stinking smut of wheat were tested and, with one exception, could be placed in the five groups established by previous tests. The sorghum-smut collections were re-tested in an attempt to definitely identify the strains being studied.

Seed treatments. A sample of Kanota oats was inoculated by the vacuum method, then portions treated with New Improved Ceresan, DuBay 1452 F, and Spergon. New Improved Ceresan and DuBay 1452 F gave nearly complete control of smut. Spergon reduced the amount of smut from 18.6 per cent in the check to 9.5 per cent when planted on March 23. When planting was on April 8, Spergon reduced the percentage of smut in the heads from 12.2 per cent in the check to 4.1 per cent.

J. E. Livingston.

Corn root rots. Tests indicated that seed of U. S. 13 corn decreased in germination in greenhouse soil from a high of 86 per cent when the seeds were kept continually at a temperature of 70°F. to 50 per cent when the seeds were first placed at 40°F. for eight days following seeding. Shorter exposures to 40°F. produced somewhat less injury. When steam-sterilized soil was used instead of a greenhouse soil that contained pathogenic fungi, there was much less injury following cold treatment. With sterile soil, a germination of 84 per cent was obtained following exposure to eight days at 40°F., while the germination in sterile soil at 70°F. was 92 per cent.

A somewhat more severe cold test was made when the seeds were allowed to remain in a warm temperature (70°F.) for three days following seeding, thereafter being exposed to a 40°F. temperature for periods up to eight days. Germination dropped to 33 per cent when the seeds were kept at 70°F. for three days and then exposed to 40°F. for eight days; but a similar test using steam-sterilized soil gave a germination of 75 per cent.

It seems evident that pathogenic fungi, under conditions adverse for the corn plant, are primarily responsible for the poor germination. *Pythium ultimum* has been isolated from decayed corn seeds in cold soil and has been shown to be pathogenic.

Additional evidence to indicate the importance of soil-borne fungi in destroying germinating corn seed has been obtained by treating seed with Arasan (50 per cent tetramethyl thiuram disulfide). Such treated seed, even with the most severe cold test, i.e., three days at 70°F. followed by eight days at 40°F., gave a germination of 81 per cent.

The development of standardized cold tests will permit a more accurate evaluation of the ability of corn hybrids to germinate under adverse conditions and will facilitate the production of cold-resistant corn lines and varieties.

Ian W. Tervet.

Potato Diseases

Diseases in central Nebraska. The killing frost of May 10 in the early potato districts was a most important factor in determining the extent of seedpiece rot and ultimate size and habit of plant growth, as well as final yield. Emergence was rapid with excellent stands common previous to the frost; however, after this damage, the seedpieces of many of those plants most advanced when frosted failed to produce another vigorous plant. In some instances such pieces rotted in the soil. In every instance poor stands could be attributed to one of the following factors: (1) black-leg attacking spindly plants arising from depleted seedpieces of frosted
plants, (2) ring-rot seed lots, (3) Fusarium dry rots which became active in the tubers because of poor handling previous to planting.

Ring rot was the most serious potato disease in central Nebraska. The long growing season permitted its full development with consequent severe tuber rots. A number of fields planted with seed apparently carrying only small percentages of the disease produced from 10 to 20 per cent of infected tubers. All ring rot incidence was traceable either to diseased seed lots or to contamination of healthy lots by cutting knives, planters, or sacks.

Only small amounts of pink rot were found and then only in potatoes grown in fields over-irrigated late in the season or in scattered low spots within a field.

No late blight (*Phytophthora infestans*) was found on plants or tubers and early blight was slight. Adverse temperature and moisture conditions were probably responsible for the failure of either of these blights to develop.

**Diseases in western Nebraska.** Neither early nor late blight was present in large enough amounts to cause trouble this year. No reports of late-blight tuber rots in storage have been received. Leaf roll, spindle tuber, and ring rot have occurred in scattered seed lots. Small amounts of pink rot have been found in bins containing potatoes from over-irrigated fields but nothing has developed to approach the storage losses of last year.

**Pink rot.** Greenhouse experiments have shown that this disease is favored by high soil moisture and low soil temperature. Varietal tests in the greenhouse, in inoculated soil, indicated that the Triumph, Pawnee, Mesaba, Warba, and White Rose varieties were much more susceptible to the disease than Irish Cobbler and Kasota. Isolations from rotted potato tubers showing pink-rot symptoms have yielded two pathogenic fungi, *Phytophthora erythroseptica*, the organism causing typical pink rot which affects both the growing plant and the tubers, and *P. drechsleri* which causes a similar tuber rot after harvest but which was not capable of infecting the growing plants and causing wilt. This is the first report of *P. drechsleri* from Nebraska, while *P. erythroseptica* was first reported in 1943.

**Rotation experiments.** During the winter of 1945–46, records were made of the occurrence of scab and Fusarium wilt in the potatoes from the Box Butte Experiment Farm rotations. No significant differences were obtained in the amount of Fusarium wilt from the three-year and five-year rotations, compared with the continuous potato plots, as determined by an examination of the tubers for stem-end rot and internal discoloration. The effect of the length of time between potato crops on the occurrence of scab was evident for the first time since the establishment of these plots in 1940. In previous years the greatest amount of scab has occurred in the continuous potato plot but no differences have been found previously between the three-year and the five-year rotations. In 1945 the continuous potato plot produced tubers showing 38 per cent scab, the three-year rotations 10 per cent, while the potatoes from the five-year rotations had only two per cent scab.

**Effect of environment on development of leaf-roll symptoms.** Inconsistencies in leaf-roll readings in certified fields planted from the same
parent seed lots prompted investigation into the factors affecting development of leaf-roll symptoms. Based on leads from field observations, experiments were conducted in 1945 and 1946 on the effect of temperature, moisture, and nitrogen on the rate of symptom development in Triumphs affected with leaf roll. Where known leaf-roll plants and healthy checks were planted at 60° and 70°F. in dry and wet soils, first leaf-roll symptoms distinguishing the diseased plants appeared seven days after emergence in the wet series and two weeks later in the dry series. At 80°F. in the wet series the first leaf rolling appeared only after six weeks and at no time did definite leaf rolling, distinguishable from the checks, appear in the dry series at this temperature. When the plants were grown in sand culture with artificial nutrients, an exaggerated rolling as distinguishable from a folding and cupping of leaves on the healthy checks appeared at six days at the 60° and 70°F. temperatures, and at ten days at 80°F. In the plus-nitrogen series, rolling at the two lower temperatures appeared at approximately two weeks, while at 80° no definite and permanent rolling ever appeared. However, the leaf-roll plants were more erect, with stiff, straight petals, a characteristic which might aid in distinguishing leaf roll at high temperatures.

While healthy and leaf-roll plants could not be distinguished with certainty in the plus-nitrogen series at 80°F., the total yield of the leaf-roll plants was still less than half that for healthy plants.

It would appear from these experiments that certain combinations of temperature, moisture and fertility may delay the appearance, or even mask certain symptoms of leaf roll.

M. W. Felton.

Stem-end discoloration in storage. Previous experimental evidence has indicated no appreciable increase of stem-end discoloration in winter storage or in artificial cold storage. However, unusually high percentages of stem-end discoloration in samples held for an extended period at room temperatures suggested the possible effect of high temperatures. In 1945, 100 lb. samples from 24 different rotation plots at the Box Butte Experiment Farm were divided equally, half of each sample being placed at 45°F., and the other half at 75°F. After approximately eight weeks, the samples were graded for stem-end discoloration. The lots held at 45° averaged 3.4 per cent, while those at 75° averaged 24.0 per cent severe stem-end discoloration.

In 1946, potatoes from the Box Butte Experiment Farm held in cold storage until March were mixed thoroughly and divided into five lots. One lot was immediately graded; the others were placed at four temperatures: 40°, 50°, 60°, and 70°F. After seven weeks the lots were graded. The initial 0.8 per cent of stem-end discoloration remained unchanged at 40°; there was a slight increase to 2.0 per cent at 50°, a marked increase to 12.0 per cent at 60°, and a large increase to 22.0 per cent at 70°F. From this it would seem that marked increases in stem-end discoloration might be expected at storage temperatures above 50° or 55°F.

The stem-end discoloration found in these tubers was severe, dark brown to black, and restricted to the vascular bundles. Isolations from these tubers yielded uniformly a Fusarium, the identity of which is being determined.

M. W. Felton, John P. Hollis.

Tomato Diseases

A wide variation in symptoms, resulting from variations in the causal organisms of bacterial spot isolated from tomato, as well as from pepper,
was reported in 1944. Greenhouse experiments have demonstrated that these differences in ability to produce symptoms remain through inoculation and re-isolation on the same and other hosts. Laboratory tests have uncovered no consistent differences between isolates from the same host on artificial media. However, the pepper isolates differ consistently from the tomato isolates on two different media. All tomato isolates hydrolyze starch readily, whereas the pepper isolates lack this ability. While cultures on both pepper and tomato produce hydrogen sulphide, the pepper isolates are distinctly more active. These cultural differences of the pepper strains remain unchanged by passage through tomato. This difference between tomato and pepper isolates agrees with the reports in literature by other investigators.

M. W. Felton.

Sugar Beet Diseases

A survey of sugar beets on 45 farms in the North Platte Valley was made from early summer through late fall of 1946. About 50 per cent of the beets were replanted because of a spring freeze. Damping-off, seedling diseases, and environmental factors caused abandonment of about 10 to 20 per cent of the beet acreage. The majority of the acreage abandoned because of damping-off was in fields that had been replanted. Root rot was noted in many fields, averaging about two per cent, with some fields running as high as 25 per cent. Fusarium Yellows was found to a limited extent in many fields, with one field showing 50 per cent infection. Two leaf spots caused by Cercospora beticola and Phoma betae were found in 50 per cent of the fields, with one field showing as high as 90 per cent of the former and another field with 20 per cent of the latter type. Alkali and hard-pan were found to be causing poor stands on several farms, and traces of iron deficiency, mosaic, and savoy type of disease were noted. The root knot nematode caused considerable damage in a few fields which showed 100 per cent infection. In the rotation plots at the Scotts Bluff Substation, the amount of root knot on the different plots ranged from 47 to 79 per cent. There is some indication that rotation systems using sweet clover show less root knot than those using alfalfa.

M. L. Schuster.

Bean Diseases

Breeding for resistance to halo blight. Seed from crosses between resistant and susceptible beans was increased for genetic and inheritance studies. The F₁ plants from a Mexican Red (resistant) x Asgrow Stringless (susceptible) and the reciprocal cross indicate that the factor, or factors, for halo blight carried by the Mexican Red parent is dominant. Three hundred F₂ lines, resulting from crosses involving seven varieties as parents, were tested for halo-blight resistance in the greenhouse in the winter of 1945-46 and in the field at Scottsbluff in 1946. Twenty-five individual selections were made on the basis of resistance, plant type, yielding ability and earliness and will be tested further. Two resistant selections in the F₂ were green-podded and one was wax-podded. These will be given further tests in the greenhouse for resistance and in the field for quality and yield.

Field bean yield tests. Replicated yield tests were conducted in 1946 at the Scotts Bluff Substation with four lines of white field beans in the F₁. One of these proved superior in yield to U.I. 59.

M. L. Schuster.
Chemical Studies with Plant Materials

Department of Agricultural Chemistry

Baking Properties of Flour

Extensive studies of the methods for determining proteolysis in doughs were carried on during the year. Methods involving the determination of amino nitrogen, non-protein nitrogen and protein solubility were compared. For the determination of carboxylic acid and amino nitrogen groups, the acetone and alcohol methods were found unacceptable. As now adapted for use in this laboratory, the formal titration method gives good results. All of the methods indicate that little or no proteolysis occurs in doughs made from normal wheat flour.

It was found that wheat flour contains an inhibitor which is effective in stopping the action of small amounts of the proteolytic enzyme papain. Reducing agents have no effect on this inhibitor. Whether this inhibitor is also effective in stopping the action of the naturally occurring flour proteases remains to be determined. The presence of the proteolytic inhibitor may be the explanation for the absence of proteolysis in normal flour doughs.

The ferricyanide method for the determination of reducing and non-reducing sugars in flour, as developed in this laboratory, was adapted to the determination of sugars in bread.

The baking properties of flour are not entirely determined by the properties of the gluten. Properties of the starch play a more important role than is generally realized. A laboratory picture shows how the characteristics of bread may be varied by replacing the wheat starch with other types of starch. Such results indicate the need for further fundamental studies of starch properties and the relation of these properties to the baking properties of flour.

The changes which take place in the properties of the starch of bread during and after baking are responsible for the changes in the character and flavor of bread, generally known as staling. The staling of bread became an important problem for the Quartermaster Corps during the war. Accordingly, studies of the starches of wheat, flour, and bread are now receiving support from the Quartermaster Food and Container Institute for the Armed Forces.

R. M. Sandstedt, B. D. Hites, O. C. Beckord.

Trypsin Inhibitor of Raw Soybeans

A factor has previously been demonstrated to be present in unheated soybeans which inhibits digestion by trypsin (an enzyme which digests protein in the intestinal tract). When this factor, called a trypsin inhibitor, is fed to chicks, their growth rate is decreased. It is believed that the trypsin inhibitor present in unheated soybeans but not in those adequately heated is the cause of the poor nutritional value of raw soybeans.

Measurement of the trypsin inhibitor. A method for measuring the trypsin inhibitor was devised. Unheated, fat-free soybean meal was extracted with cold dilute acid. A portion of this extract was added to a mixture of trypsin and protein. The extent of digestion was then de-
A difference in gas-holding properties of various flours. 9—Cassaba, 10—Kaffir, 11—Waxy Sorghum.

determined. Extent of digestion was likewise determined in a similar mixture which lacked the inhibitor. The difference between the two determinations was used to calculate the amount of inhibitor present. Reliability was established for the method by suitable tests with varying concentrations of inhibitor, trypsin, and protein.

**Stability of the inhibitor.** Samples of unheated, fat-free soybean meal were heated in the pressure cooker (moist heat) and in the oven (dry heat) at several different temperatures and time intervals. It was found that the inhibitor could be destroyed with moist heat at a temperature of 212°F. in 90 minutes, at 227°F. in 60 minutes, at 240°F. in 30 minutes, at 248°F. in 20 minutes, and at 257°F. in 10 minutes. Dry heat at a tempera-
ture of 275°F. for four hours did not destroy all of the inhibitor. A number of expeller-type soybean meals were examined and found to contain the inhibitor in various amounts. Several samples of soybean seed from one to five years old were examined for the presence of the trypsin inhibitor. All of the five-year-old samples gave a zero germination test. However, the inhibitor was present in constant amount.

**Inhibitor in legume seeds and other materials.** A number of seed samples of the legume family as well as several other materials were examined for the presence or absence of the inhibitor. It was found in soybeans, alfalfa seed, golden mung bean, scarlet runner bean, lima bean, common garden bean, cowpeas, honey locust, and Kentucky coffee bean. The trypsin inhibitor was not found in the Siberian pea tree, guar bean, Korean lespedeza, blue lupine, lentils, white or yellow clover, garden pea, mammoth red clover, horse bean, vetch, tung bean, jack bean, corn, wheat, or rye.

**Trypsin inhibitor and other protein-digesting enzymes.** The trypsin inhibitor from soybeans was not digested or destroyed in vitro by the protein-digesting enzymes of the intestinal tract, that is, pepsin, trypsin, or erepsin, nor by papain from the papaya tree; but it was digested by ficin from the fig tree. Conversely the trypsin inhibitor does not inhibit pepsin or papain but does inhibit trypsin and erepsin. After feeding unheated soybean meal to rats, the inhibitor could be quantitatively recovered from the gastro-intestinal tract four hours later and then gradually decreased to zero at 18 hours after feeding.

**Inhibitor in purified form.** Available methods for preparing pure trypsin inhibitor from soybeans proved to be too tedious and time-consuming for large-scale work. Acid extraction and precipitation of the inhibitor by acetone gave about 10-fold increase in concentration of the inhibitor over the original soybean meal. Acid extraction followed by ammonium sulfate precipitation gave a 30-fold increase over the original meal.

**Feeding unheated soybeans with mold bran.** An ordinary chick-starting ration containing 21 per cent unheated soybean meal was fed to a group of 20 chicks. A similar diet which included also 10 per cent mold bran was fed to another group. The average weight of the chicks at four weeks was practically identical in the two groups, indicating that the digestive enzymes of mold bran did not improve the nutritional value of the unheated soybean meal.

**Digestibility of soybean meal with sulfaguanidine.** A group of six rats was fed a diet containing unheated soybean meal. Analysis of the diet and of the feces showed that 77 per cent of the protein was digested. A similar group was fed heated soybean meal which gave 84 per cent of the protein digested. Heated soybeans are hence more digestible than unheated soybeans. When 0.5 per cent sulfaguanidine, a chemical inhibiting the growth of intestinal microorganisms, was included in the ration, the results were unchanged, indicating that bacterial action plays little or no part in the different digestibility of the heated compared with the unheated meal.

**Studies on Phytase**

Half or more of the phosphorus present in plant materials occurs in a chemical form known as phytic acid. Phosphorus is essential for animal
nutrition and whether or not phosphorus in the form of phytic acid can be digested and used by animals is widely disputed. An enzyme called phytase is able to digest phytic acid.

**Occurrence of phytase.** Three methods for determining the presence of phytase were devised. The first involved mixing phytic acid with the substance being tested for phytase and measuring the amount of digested phosphorus formed. The second was similar except that the amount of phytic acid remaining undigested was measured. The third involved feeding the phytic acid to animals and measuring the amount of phytic acid remaining undigested in the intestinal tract. Phytase was found in wheat, corn, alfalfa, and soybeans but not in dehydrated (heated) alfalfa meal or in heated soybean meal. Phytase was also found in the intestinal wall of the rat, chick, cow, pig, and dog. Theoretically these animals should be able to digest and obtain the phosphorus from phytic acid. Other practical conditions may, however, prevent the utilization of phytic acid phosphorus.

**Chick growth with phytic acid.** A partially purified ration low in phosphorus was prepared. One group of chicks was fed this ration plus inorganic phosphorus (a readily digested form). Another group was fed this ration plus phytic acid. The purified ration proved to be inadequate for optimum chick growth and livability. Tentatively, the results indicated that the ration plus inorganic phosphorus was better than the same ration plus phytic acid phosphorus.

**Nutritional Value of Molds**

**Feeding studies.** Mold bran, prepared by growing *Aspergillus oryzae* on bran, was included in a typical chick-starting ration containing animal protein supplements. When this ration was fed to chicks, the average four-week weight of 231 gm. was practically the same as that of a group fed a similar ration without the mold bran. As a second trial, a typical chick ration without animal protein supplements was fed to chicks. The average four-week weight was 114 gm. When 10 per cent mold bran was included, the average four-week weight was 154 gm. When mold corn was fed, the average four-week weight was less than that of the group not fed mold. The feeding of a moldy mixture of bran and soybean meal resulted in an average four-week weight of 188 gm.

In the final trial, 10 different mold isolates were used. These were grown on a mixture of bran, corn, and soybean meal. The chicks on the ration without mold had an average four-week weight of 155 gm. while the groups fed the moldy bran-corn-soybean mixture had an average four-week weight of 219-231 gm. The molds used in these feeding trials had no apparent toxic effects on the chicks. This cannot, of course, be implied to be true of all molds, since some have been shown to be harmful.

**Vitamin analysis.** Approximately 300 mold isolates were analyzed for riboflavin by the microbiological procedure. Values found varied from no riboflavin produced by the mold up to 10.8 mg. per 100 gm. of dried mold preparation. Values for pantothenic acid varied from zero to 8.1 mg. per 100 gm., and for folic acid from zero to 2.2 mg. per 100 gm. of dried mold preparation.

This work was done in cooperation with Dr. George L. Peltier of the Department of Bacteriology.
Insect Control Experiments
Department of Entomology

Potato Insects

Seasonal insect survey. A continuous seasonal potato insect survey was conducted during 1946 in cooperation with the Nebraska Potato Development Division. It extended from June 1 through August 31 and included eight counties in the early-potato growing region of central Nebraska and nine counties in the late-potato growing region of western Nebraska. Information secured from this survey, along with specific control recommendations, was relayed each week to the Potato Development Division which notified commercial potato growers of the state.

A relatively light insect infestation was present throughout most of the state. In central Nebraska, the Colorado potato beetle required control measures. Although quite abundant early in the season, potato leafhoppers failed to develop in large numbers. Locally rather heavy infestations of potato flea beetles occurred and some damage resulted. In western Nebraska a few psyllids were present in early plantings, but the population remained at an extremely low level throughout the season. The tuber flea beetle and aphid populations also were generally low. In dry-land areas, tomato hornworms became unusually abundant in certain fields and caused some concern. Grasshoppers proved to be the most serious pests over the entire western area, and ragweed plant bugs also were very abundant and may have been causing more damage than was suspected.

Test with 666 and DDT. A test designed to compare the effectiveness of dusts and sprays of hexachlorocyclohexane (666) and DDT was conducted on a non-irrigated planting of White Warba potatoes at Lincoln. The formulations, all applied with hand equipment, were (1) three per cent DDT-sulfur dust, (2) DDT spray (one pound of DDT per 100 gallons of water), (3) 0.58 per cent hexachlorocyclohexane dust, and (4) hexachlorocyclohexane spray (two pounds of a wettable powder containing five per cent gamma isomer per 100 gallons of water).

In general, a light to moderate insect infestation was present. All treatments gave significant control of flea beetles, Colorado potato beetles, and ragweed plant bugs. Hexachlorocyclohexane was ineffective against the potato leafhopper and a species of white fly (Aleyrodidae), whereas DDT gave excellent control of both species. Plants treated with DDT remained green longer and were larger, as measured by length of stems, than were those left untreated or to which 666 had been applied.

Total yield increases of 11 per cent (666 dust and spray), 22 per cent (DDT dust), and 40 per cent (DDT spray) were obtained. Perhaps as a result of the unfavorable moisture conditions prevailing during the season, significantly large numbers of knobby potatoes were produced in the DDT-treated plots, especially where the spray was used. Some of the experimental data follows:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average length-of stems (inches)</th>
<th>Green foliage on July 24 (per cent)</th>
<th>Knobby &quot;A&quot; size tubers (per cent)</th>
<th>U. S. No. 1 Potatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yield per acre (bushels)</td>
</tr>
<tr>
<td>DDT dust</td>
<td>20.5</td>
<td>52.4</td>
<td>11.9</td>
<td>170.5</td>
</tr>
<tr>
<td>DDT spray</td>
<td>22.0</td>
<td>62.0</td>
<td>17.0</td>
<td>187.4</td>
</tr>
<tr>
<td>666 dust</td>
<td>17.9</td>
<td>25.8</td>
<td>8.8</td>
<td>161.8</td>
</tr>
<tr>
<td>666 spray</td>
<td>18.2</td>
<td>15.0</td>
<td>7.4</td>
<td>164.3</td>
</tr>
<tr>
<td>Untreated check</td>
<td>16.5</td>
<td>11.4</td>
<td>4.4</td>
<td>149.6</td>
</tr>
</tbody>
</table>
Further DDT experiments. Replicated field experiments were conducted in 1946 to determine, first, the value of using DDT on potatoes as a regular yearly practice irrespective of local insect infestation and, second, to test the validity of recommending insecticide applications based on the species and the number of insects present each season. Most of these tests were made under a wide range of field and soil conditions at the Substations at Mitchell, Alliance, and North Platte.

Because of the general effectiveness of DDT against most potato insects, and since large yield increases often follow its use, the justification for surveys and the advisability of recommendations based on them becomes questionable. Evidence obtained during 1944 and 1945 indicated that a regular control program involving several applications of DDT sprays or dusts would be the most practical procedure for growers to follow under present conditions.

At the Scotts Bluff Substation, 21 ⅛-acre plots of potatoes growing under the various rotation systems were split. Half of each received one application of three per cent DDT-sulfur dust; the other half was given four dustings. On the basis of the light insect population present, a survey would have indicated that insecticide applications were not necessary. However, plots receiving four dustings outyielded those dusted once by an average of 9.6 bushels per acre.

At the Box Butte Experiment Farm, four dustings of three per cent DDT in sulfur were compared with no treatment. Here again in the presence of a very light insect infestation, an average yield increase of 5.7 per cent (or 10.2 bushels per acre) was obtained in dusted plots.

In a similar test using 10-acre plots in a large commercial field near Alliance, three applications of the DDT-sulfur dust produced a 15.5 per cent increase (20.7 bushels per acre) as compared to the untreated checks. In a small plot of Cobbler potatoes at North Platte two applications of DDT spray indicated a 22.9 per cent increase in yield over plots receiving one application of zinc arsenite.

Tuber flea beetles. For the second straight year, spring weather conditions were unfavorable for the emergence and early seasonal development of the tuber flea beetle in western Nebraska. The somewhat erratic weather (April, very warm and dry; May, very cool and wet; June, warmer and drier than normal; July, dry and warm) undoubtedly played some part in reducing the 1946 beetle population. Of greater importance, however, is the fact that more potato growers now are following the recommended control program.

Further information regarding the influence of moisture on the development of flea beetles was obtained in an irrigation experiment at the Scotts Bluff Substation. Three moisture levels (obtained by irrigating plots one, two, and five or six times) were replicated 18 times in a late planted field. Averages of 17.4, 52.4, and 134.4 blemishes per 20-tuber sample were obtained, damage being greatest in plots irrigated most often.

The departments of Agronomy and Horticulture and the United States Department of Agriculture, Division of Western Irrigation Agriculture, and the Nebraska Certified Potato Growers Association cooperated to obtain these data.

Roscoe E. Hill, C. A. Soother.
Plant Insects

Grasshopper control program. Grasshopper injury was again confined largely to the Panhandle section of the state where the damage was most serious to such crops as corn, alfalfa, fall wheat, and potatoes.

Unusually warm and dry weather in April permitted early development of grasshoppers which started to hatch the latter part of the month. On May 9 and 10 cold rain and snow were received throughout western Nebraska. Temperatures dropped to 22° above zero. This adverse weather delayed hatching for several days and caused a mortality of approximately 35 per cent of the *Melanoplus mexicanus* nymphs.

Thirty-one counties participated in the cooperative control program and 2,350 farmers used a total of 20,457 sacks of mixed bait on approximately 177,780 acres of crop land.

Tests of new insecticides. Promising results were obtained with hexachlorocyclohexane (commonly referred to as Gammexane, benzene hexachloride, or 666) for the control of grasshoppers. This material was applied in dust form with rotary hand guns, a power dusting machine, an airplane, and as a fog produced with a thermal fog machine. Dusts tested contained 0.58, 1.0, 1.15, 2.0, or 5.0 per cent of the gamma isomer. For the fog, five pounds of a wettable product containing five per cent gamma isomer were used in 10 gallons of water. When these formulations were applied at varying rates in the field, kills ranging from 70 to approximately 100 per cent were obtained. Large numbers of grasshoppers were usually down on the ground three hours following exposure. The material was found to remain effective for at least two or three days, and in one test 1.15 and five per cent gamma dusts were killing grasshoppers six days after application. Grasshoppers escaping death at the time of dusting later obtained lethal doses when they returned to the foliage to feed or rest. When applied at rates of 25-30 pounds per acre, dusts containing one or two per cent of the gamma isomer caused no visible injury to alfalfa, corn, or potatoes. However, a five per cent dust (and a two per cent dust when applied unevenly) produced a definite chlorosis of potato foliage.

A dust containing two per cent 1068 also was tested against grasshoppers in a preliminary way with promising results.

Ephriam Hixson, Roscoe E. Hill, Harold Hauke.

Corn rootworms continued to increase and to cause considerable injury. Once again field observations showed that growing corn in the same field year after year is responsible for building up large rootworm populations. Occasionally there are reports of damage to corn the first year following wheat or alfalfa. A possible explanation for this was secured from field observations in Dawson County on August 28. At that time the Colorado corn rootworm was found to be quite abundant in pastures and stubble fields, feeding on pollen of various weeds, such as the tumbling pigweed, Russian thistle, and kochia. Many beetles were seen in alfalfa fields where they probably were feeding on alfalfa pollen. If the beetles lay their eggs in such places, first-year corn might show rootworm injury.

To determine the effects of fertilizer on rootworm injury, records of such damage were obtained from the soil fertility tests being conducted by the Department of Agronomy at Wood River and Holdrege. Damage
was determined on the basis of the number of stalks lodged 30 degrees or more. At Wood River, where there was a large corn rootworm population consisting of both the northern and Colorado species, a highly significant correlation was found between the percentage of stalks lodged and the yield. The average percentage of stalks lodged under the various treatments ranged from 34.3 to 88.5 and the yields varied from 40.8 to 103.6 bushels per acre.

The lowest per cent of lodging caused by corn rootworms, and the highest yields, were found in plots given an application of 40 to 80 pounds nitrogen fertilizer (in the nitrate form) per acre at the time of the last cultivation. Lowest yields and the highest degree of rootworm injury occurred in plots without nitrogen. Corn growing in plots in which nitrogen was plowed under or applied at planting time showed an intermediate amount of lodging and yields. Although the rootworm population was considerably lower, similar results were obtained in the soil fertility and tilth plots at Holdrege. In a rotation experiment, the greatest amount of lodging was recorded in plots planted to corn for the past three years. The addition of manure and/or nitrogen fertilizers increased the yield and reduced the amount of visible rootworm damage.

Ephriam Hixson, Roscoe E. Hill, Martin H. Muma.

Codling moth control with DDT. This test was set up to determine effects of DDT in the control of the codling moth under Nebraska conditions. Two varieties of apples, Wealthy and Jonathan, were sprayed with two and three applications of various formulations and combinations of DDT and lead arsenate. These treatments were two pounds of a 50 per cent wettable DDT per 100 gallons of water, one pound of 50 per cent DDT per 100 gallons, one pound of 50 per cent DDT plus two pounds of lead arsenate per 100 gallons, ½ pound of 50 per cent DDT plus two pounds of lead arsenate, and 0.4 pound of DDT in an emulsion form plus four ounces of soybean flour per 100 gallons of water. All treatments were checked against a standard lead arsenate spray of three pounds of arsenate per 100 gallons of water.

Data collected on the percentage of clean fruit at harvest indicated the following facts. Control on the Wealthys was good, but the results obtained with the various treatments were not significantly different. In the Jonathan plots, there was no significant difference in clean fruit when three applications of the treatments were made. However, when only two applications were made, the larger dosages of DDT produced an increase in clean fruit. A comparable increase was also obtained with two applications of the DDT emulsion.

Further research on this problem is needed before definite recommendations can be made for Nebraska. These tests indicated that DDT does not greatly increase the percentage of clean fruit over that obtained with lead arsenate on early-maturing varieties, such as the Wealthy, and that more than three applications of DDT are needed on late-maturing varieties such as Jonathans.

Cooperative with the Department of Horticulture.

Ephriam Hixson, Roscoe E. Hill, Martin H. Muma.

Hessian fly. The summer Hessian fly survey showed a high infestation in Colfax, Platte, Polk, Butler, and Perkins counties. Lancaster and Richardson counties showed a moderate infestation. Other counties surveyed had a low infestation. In fields of Pawnee wheat the infestation was from low to absent. In areas of high infestation the fly-free planting
date has largely been ignored. Cooperative with U.S.D.A. Bureau of Entomology.

**MARTIN H. MUMA, O. S. BARE.**

**Chinch bugs.** The fall chinch bug survey covered 26 counties. Large populations of hibernating chinch bugs were present in York, Seward, and Fillmore counties, while moderate to threatening populations were present in Saunders, Lancaster, Johnson, Saline, Jefferson, Washington, Sarpy, and western Cass counties. In the other surveyed counties small populations were found.

Only 8,300 rods of barrier were constructed for chinch bug control during 1946.

**O. S. BARE, HAROLD A. HAUKE, MARTIN H. MUMA.**

**Corn borers.** In the 1946 fall survey, the European corn borer was found present in Cuming, Washington, Dodge, Sarpy, Nemaha, and Richardson counties.

The southwestern corn borer was not found in the 1946 fall survey in the south-central counties where it was found in 1943.

**MARTIN H. MUMA, C. A. SOOTER.**

**Animal Insects**

**Horn fly control.** A herd of cows and calves at the North Platte Substation was used in an experiment to demonstrate the value of applying DDT for the control of horn flies. The animals were divided into four equal-sized lots. Lot 1 served as an isolated check. Lot 2 was also an untreated check, but the animals pastured adjacent to Lot 3 and watered at the same tank as Lots 3 and 4. The animals in Lot 3 were sprayed over the backs and sides with a single-nozzle spray gun. Those in Lot 4 were driven through a chute having six nozzles on each side. Six applications of 0.25 per cent DDT water suspensions were made by a commercial spray outfit beginning May 27 and finishing September 24. The intervals between the six successive spray applications varied from 17 days to one month.

A moderate fly population was present during the season. Very few horn flies were noticed at the time the first application was made. On July 10, two days following the third application, the sprayed animals (Lots 3 and 4) were virtually “free” of flies, whereas in Lot 2 there was an average of about 500 flies per cow and the bull was being pestered by at least 2,000 of the insects. About twice this infestation was present on the animals in Lot 1. The calves in all lots seemed to be bothered very little by the flies. Recorded weight gains or losses for the season follow:

<table>
<thead>
<tr>
<th>Lot. No.</th>
<th>Treatment</th>
<th>Cows</th>
<th>Calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Isolated check</td>
<td>-12</td>
<td>202</td>
</tr>
<tr>
<td>2</td>
<td>Adjacent check</td>
<td>14</td>
<td>204</td>
</tr>
<tr>
<td>3</td>
<td>Sprayed-single nozzle gun</td>
<td>24</td>
<td>214</td>
</tr>
<tr>
<td>4</td>
<td>Sprayed in chute</td>
<td>12</td>
<td>219</td>
</tr>
</tbody>
</table>

**GUY N. BAKER, ROSCOE E. HILL.**
Spraying hogs for mange control. Note the driving spray at the left.

**Hog mange control tests.** Of the chemicals used in recent tests to control mange on hogs, hexachlorocyclohexane (666) was the most effective. In all tests the spray was applied at 200-250 pounds pressure using an orchard gun equipped with a 3/16-inch disc opening. About three quarts of spray were used per animal. In August one herd of 17 hogs was sprayed with a water suspension of hexachlorocyclohexane containing 0.082 per cent of the gamma isomer. There was no control of the mange by this treatment. Three herds of 66, 100, and 29 animals, respectively, were sprayed with a water suspension of hexachlorocyclohexane containing 0.25 per cent gamma isomer, and two herds of 100 and 13 animals, respectively, were sprayed with a 0.50 per cent gamma isomer. In all herds sprayed with 0.25 or 0.50 per cent concentration, the mange was completely cleaned up. There was no evidence of reinfection three months later in the first two herds sprayed. In one herd sprayed September 27, and reported clean October 17, six mangy animals were introduced October 25. On December 3 mange was present on some of the animals which were clean October 17.

Two herds of 40 and 33 animals, respectively, were sprayed with 0.50 per cent benzyl benzoate emulsified with Triton X 100. These animals were rubbing and mites were present after three weeks. Apparently no control was obtained. Similar animals on the same two farms, sprayed with hexachlorocyclohexane the same day, were completely free of mange.

Two herds were sprayed with a rotenone extract emulsion (patented brand) following directions on the container. Mites were present 20 days later and the infestation was apparently spreading. One herd of 15 sows and 130 small pigs and one herd of two sows and 10 pigs were sprayed with 0.50 per cent DDT emulsion. The DDT spray gave no control, while on the same farms hexachlorocyclohexane gave complete clean-up of mange. Cooperative with Dr. J. E. Peterman and Dr. A. G. Beagle of the Bureau of Animal Industry, who made the field readings, and Dr. W. T. Spencer of the Livestock Loss Prevention Board.
To test the toxicity of some possible mange control chemicals, two pigs were sprayed with a 5.0 per cent kerosene emulsion of azobenzene, DDT, pentachlorophenol, and benzyl benzoate. None of the pigs showed any injury from the spraying although pentachlorophenol was very irritating. Cooperative with Department of Animal Husbandry.

Ephriam Hixson, Martin H. Muma.

**Chicken mite control tests.** Several chemicals were tested for the control of chicken mites. Standard three-inch filter paper discs were sprayed with the various concentrations of the chemical, then dried. The mites were applied to the dry sprayed surface. No mites were sprayed directly. Mortality readings were made in 24 or 48 hours. The mites were then removed and new ones were placed on the sprayed paper.

The chemicals that killed 100 per cent of the mites for 14 days or longer were as follows:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Solvent</th>
<th>% toxicant by weight</th>
<th>No. days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbolineum</td>
<td>undiluted</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>DDT</td>
<td>water suspension</td>
<td>0.25</td>
<td>17</td>
</tr>
<tr>
<td>DDT</td>
<td>water suspension</td>
<td>0.50</td>
<td>23</td>
</tr>
<tr>
<td>DDT</td>
<td>water suspension</td>
<td>1.0</td>
<td>24</td>
</tr>
<tr>
<td>DDT</td>
<td>water suspension</td>
<td>2.0</td>
<td>47</td>
</tr>
<tr>
<td>DDT</td>
<td>water suspension</td>
<td>5.0</td>
<td>47</td>
</tr>
<tr>
<td>DDT</td>
<td>kerosene</td>
<td>0.25</td>
<td>16</td>
</tr>
<tr>
<td>DDT</td>
<td>kerosene</td>
<td>0.50</td>
<td>21</td>
</tr>
<tr>
<td>DDT</td>
<td>kerosene</td>
<td>1.0</td>
<td>47</td>
</tr>
<tr>
<td>DDT</td>
<td>kerosene</td>
<td>2.0</td>
<td>47</td>
</tr>
<tr>
<td>DDT</td>
<td>kerosene</td>
<td>5.0</td>
<td>47</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>alcohol</td>
<td>5.0</td>
<td>47</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>alcohol</td>
<td>5.0</td>
<td>41</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>kerosene</td>
<td>2.0</td>
<td>21</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>kerosene emulsion</td>
<td>2.0</td>
<td>26</td>
</tr>
</tbody>
</table>

Other chemicals tested by this method which gave 100 per cent mortality for one to 14 days were azobenzene, hexachlorocyclohexane, benzyl benzoate, and kerosene.

To determine the effect of various wood-building materials on the chemicals, tests were made on rough wood, smooth wood, and press board at a concentration of two per cent in kerosene, except water suspension of DDT, and carbolineum undiluted. The number of days of continuous 100 per cent mortality is shown in the following table:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Rough wood</th>
<th>Smooth wood</th>
<th>Press board</th>
<th>Painted smooth wood</th>
<th>Painted press board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azobenzene</td>
<td>14 days</td>
<td>-10 days*</td>
<td>18 days</td>
<td>-9 days</td>
<td>9 days</td>
</tr>
<tr>
<td>Hexachlorocyclohexane</td>
<td>14 days</td>
<td>-10 days</td>
<td>-14 days</td>
<td>-9 days</td>
<td>-9 days</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>21 days</td>
<td>21 days</td>
<td>18 days</td>
<td>18 days</td>
<td>18 days</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>21 days</td>
<td>21 days</td>
<td>18 days</td>
<td>18 days</td>
<td>18 days</td>
</tr>
<tr>
<td>Carbolineum</td>
<td>21 days</td>
<td>21 days</td>
<td>18 days</td>
<td>18 days</td>
<td>18 days</td>
</tr>
<tr>
<td>DDT kerosene</td>
<td>21 days</td>
<td>21 days</td>
<td>18 days</td>
<td>18 days</td>
<td>18 days</td>
</tr>
<tr>
<td>DDT water suspension</td>
<td>21 days</td>
<td>21 days</td>
<td>18 days</td>
<td>18 days</td>
<td>18 days</td>
</tr>
</tbody>
</table>

* A minus sign indicates that the exact number of days is not known but was less than the number given.

These tests were not completed because of mite hibernation, but DDT and pentachlorophenol are both superior to carbolineum in lasting effects. Both are more desirable to use and equally cheap. As a wood preservative the pentachlorophenol is superior to carbolineum. Cooperative with Poultry Husbandry Department.

Ephriam Hixson, Martin H. Muma.
Feeding Hogs, Cattle and Sheep

Department of Animal Husbandry

Hog Feeding Investigations

Distillers’ solubles in dry lot rations. The results of two additional dry lot experiments, completed in 1946, confirm the findings of last year that distillers’ solubles are useful as a protein supplement suitable 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 ground alfalfa hay (choice, 4th cutting). For Lots 2, 3, and 4, distillers’ solubles were substituted for the alfalfa, soybean meal, and tankage respectively. For Lot 5, the supplement consisted of equal parts of tankage, soybean meal, ground alfalfa, and distillers’ solubles.

In the second experiment, five lots of 15 pigs each were self-fed a mixed ration according to the plan used in the first experiment. This time, 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, averaging about 16.7 per cent for the entire feeding period. The amounts of supplement used were sufficient to provide levels of protein as follows: pigs from 52 to 75 lbs., 20 per cent; from 75 to 125 lbs., 18 per cent; and from 125 to 200 lbs., 15 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 manufacturer (Farm Crops Processing Corporation, Omaha). They had a protein content of 33.1 per cent with 5.0 per cent moisture.

The results are presented in the following table:

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>How Fed</td>
<td>Controls</td>
<td>Solubles for Alfalfa</td>
<td>Solubles for soybean meal</td>
<td>Solubles for tankage</td>
<td>Control mixture plus solubles</td>
</tr>
<tr>
<td>Av. daily gain, lbs.</td>
<td>1.41</td>
<td>1.33</td>
<td>1.36</td>
<td>1.47</td>
<td>1.45</td>
</tr>
<tr>
<td>Av. ration, lbs.</td>
<td>5.4</td>
<td>6.6</td>
<td>5.2</td>
<td>6.2</td>
<td>5.6</td>
</tr>
<tr>
<td>Feed required per 100 lbs. gain, lbs.</td>
<td>325</td>
<td>373</td>
<td>310</td>
<td>332</td>
<td>312</td>
</tr>
<tr>
<td>Corn &amp; Protein supplement</td>
<td>58</td>
<td>120</td>
<td>75</td>
<td>86</td>
<td>73</td>
</tr>
</tbody>
</table>

The amount of mineral consumed by each lot of pigs was small, but somewhat higher for Lot 4 than for any of the other lots. It will be noted that the pigs were much more efficient in balancing their own rations than we were in balancing their rations for them. Part of the reason for this was that the greater amount of protein supplement fed in the mixed rations apparently made these rations less palatable, and we were unable to prevent considerable waste of feed by these pigs. It will be noted also that the “all plant” supplement fed to Lot 4 produced as good gains as any of the other mixtures. At present feed prices, this mixture of distillers’ solubles, soybean meal, and ground alfalfa was the most economical of all of the mixtures used.
Growing pigs in a restricted environment. Pigs confined on concrete floors indoors have made excellent gains on a rather simple ration of natural feedstuffs. The same ration was adequate for fertility of males and females. However, it appears to be inadequate for lactation.

In January, 1945, five fall-farrowed gilts which had been kept on concrete floors since the age of 10 weeks were placed in a concrete-floored pen indoors. They were fed a ration composed of ground yellow corn, tankage, soybean meal, linseed meal, 10 per cent alfalfa meal, and 0.5 per cent each of steamed bone meal and salt. In addition, approximately six grams of irradiated dry yeast were added to each 100 lbs. of mixed feed as a source of vitamin D.

The gilts had an average initial weight of 78.6 lbs. and at the time of breeding in the latter part of April weighed from 178 to 237 lbs. each. Four of the five gilts conceived the first estrus they were bred. The fifth gilt was bred twice each estrus period for four consecutive periods, but did not conceive. At farrowing time, when they were from 10 to 11 months of age, they weighed from 421 to 510 lbs. each. The four gilts farrowed a total of 43 pigs, of which three were stillborn and eight were deformed in various ways. Only nine pigs were raised to weaning age and they were light in weight at weaning time.

After their pigs were weaned, the four sows were continued on the same ration except that five per cent of distillers' solubles was added to the diet. They were rebred in December to a different boar and farrowed a total of 59 pigs in their second litters. There were no gross deficiencies in the second crop of pigs. The pigs from three of the sows were vigorous at birth. They included a total of 43, one of which was stillborn. Failure in lactation resulted in a loss of all but nine of these pigs. The fourth sow refused to eat the last month of her gestation period and she lost 34 pounds. She farrowed 16 pigs, 13 of which were stillborn and the rest so weak that they lived but a few hours. When these sows farrowed their second litters they weighed from 634 to 781 pounds.

The nine surviving pigs from the first litters were fed out under the same conditions as their dams and on a diet of the same ingredients. With an average initial weight of 28 lbs. they grew to an average weight of 244 lbs. in 168 days, or at a rate of 1.29 lbs. daily per pig. They required 4.0 lbs. feed per pound of gain.

Of these nine pigs, seven were boars. They were tested for fertility by mating them with 31 gilts and one tried sow. All of the boars were fertile, although one settled only one gilt of the five to which he was bred.

The nine pigs from the second litters included five gilts and four boars. The boars were castrated and the nine head fed as one lot on the same diet fed to the other pigs earlier. They had an average initial weight of 34.3 lbs. and were fed to a weight of 201 lbs., which they reached in 126 days. They required approximately 5.0 lbs. feed per pound of gain.

In addition to these, five gilts farrowed under natural conditions last fall were placed in similarly restricted quarters last December at an average initial weight of 52.4 lbs. They were fed for 105 days and made an average daily gain per pig of 1.45 lbs. They required 4.1 lbs. feed per pound of gain.

They were bred in April and May to the boars mentioned above and farrowed a total of 55 pigs, two of which were stillborn. They raised 42 pigs. These were light at weaning, though they were large, vigorous pigs at birth. The sows weighed from 380 to 529 pounds each at farrowing time and ranged from 10½ to 12 months of age.

L. E. Hanson.
Improvement of swine through breeding. Twelve Duroc-Jersey gilts from Line 10, developed at the North Platte Substation, were mated to two purebred Danish Landrace boars for April and May farrow. Eleven of these gilts farrowed 85 pigs, seven of which were stillborn. Sixty-four pigs were weaned. The twelfth gilt did not conceive.

The pigs were fed out by litters and rate of gain and feed consumption records were kept. The ration was self-fed, free choice, and consisted of shelled corn and a protein supplement. The protein supplement was composed of equal parts by weight of tankage, soybean meal, distillers' solubles, and alfalfa meal. At the conclusion of the feeding period, 15 of the better gilts from the best-performing litters were selected as breeding stock for the next generation. Five boars from the best-performing litters, some by each sire, were also retained. They will be used for the production of the next generation to be farrowed in the fall of 1947.

Last spring 10 Duroc gilts and one tried Duroc sow from the Lincoln outbred herd were mated to the two Landrace boars mentioned above. These 11 females farrowed 106 pigs, 13 of which were stillborn. They raised a total of 83 pigs. These pigs are being fed, by litters, according to the same plan followed with the spring litters.

This project was cooperative with the Regional Swine Breeding Laboratory.

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

Cattle Feeding Investigations

Relation of feeding to lithiasis, anasarca, and pathological liver condition. Thirty steer calves, the light end of a string of weanling calves, were fed on feeds low in carotene from weaning on October 24, 1946, to January 3, 1947. Initial and final average weights for this period were 359 and 477 pounds per head. The steers were then divided into three lots of 10 head each and were full-fed ground Early Kalo, 4.0 pounds chopped alfalfa hay, and 0.5 pound soybean oil meal per head daily. The alfalfa hay fed Lot 1 was brown hay very low in carotene. A part of this hay was replaced with meal made from No. 2 sun-cured hay for Lot 2

Steer showing some of the typical symptoms ascribed to Vitamin A deficiency, after being fed for approximately 10 months on rations low in carotene or Vitamin A value.
and with dehydrated alfalfa meal for Lot 3. It was estimated that the calves in Lot 2 were fed 10 to 14 mgs. and those in Lot 3, 30 mgs. of carotene per head daily.

Lots 2 and 3 were fed for 210 days and Lot 1 for 280 days.

The lots fed carotene consumed more grain and made larger average daily gains than Lot 1. Clinical deficiency symptoms generally were not as pronounced in this trial as in trials previously reported. However, more difficulty was experienced with urinary calculi. Some difficulty was experienced in Lot 2 but more difficulty was experienced in Lot 1. Steers in Lot 1 also were affected with night blindness, some edema, and muscular incoordination.

Determinations on the blood plasma showed higher carotene values for Lots 2 and 3 in February but the differences were not significant. Determination in April showed significant differences in the vitamin A and carotene levels, with Lot 3 higher than Lot 2 and Lot 2 in turn higher than Lot 1.

The levels of carotene supplied Lot 2 and especially Lot 3 apparently produced increased gains in comparison with the deficient ration fed Lot 1, and protected the steers against clinical symptoms ascribed to a deficiency of carotene, at least to a considerable extent. The performance of the steers in Lot 1 generally was superior to that of steers fed deficient rations in previous years.

MARVEL L. BAKER, W. J. LOEFFEL, L. E. HANSON.

Use of pasture in producing finished cattle. Three lots of 12 yearling steers with an average weight of 495 lbs. were placed on a 20-acre brome-grass pasture April 26. They had been wintered on either prairie hay or prairie hay and soybean oil meal, and in the 106-day period preceding the grazing period gained an average of 45 lbs. per head. The pasture was established in the spring of 1942.

The pasture season was not as good as anticipated and after 40 days two lots of the steers were transferred to grama grass pastures. The third lot (Lot 13) was continued on the bromegrass pasture for a period of 48 days. It was then considered necessary to remove the steers from the pasture and, since other pasture was not available, they were placed on feed in dry lot.

The 20-acre bromegrass pasture furnished a total of 1,536 steer days of grazing and produced 2,280 lbs. liveweight gain, or 77 steer days of grazing and 114 lbs. gain per acre of grass.

Lot 14 was grazed for an additional 86 days on a 10-acre grama-grass pasture used in work previously reported. The pasture supplied 1,032 steer days of grazing and produced 1,700 lbs. liveweight gain or 103 steer days of grazing and 170 lbs. liveweight gain per acre.

Lot 15 was moved from the bromegrass pasture to another 10-acre grama-grass pasture at the same time Lot 14 was moved, and was grazed for the same period. This pasture was established in the spring of 1943. It supplied 1,032 steer days of grazing and produced 1,935 lbs. liveweight gain.

The steers in Lot 14 made an average gain of 201 lbs. per head in the total 126-day grazing period, 59 lbs. of which were made in 40 days on bromegrass and 142 lbs. in 86 days on grama-grass. The steers in Lot 15 made an average gain of 218 lbs. per head, 57 of which were made on the bromegrass and 161 on the grama-grass pasture.

Nine steers with an average initial weight of 557 lbs. per head were grazed on a 10-acre bromegrass pasture from April 26 to August 30, a
period of 126 days. The pasture was established in the fall of 1943. The steers had been wintered on either prairie hay or silage and soybean oil meal and gained an average of approximately 90 lbs. per head in the 106-day period preceding the pasture period.

In the 126-day grazing period the pasture supplied 1,134 steer days of grazing and produced 2,200 lbs. liveweight gain. The steers made an average gain of 244 lbs. in the 126 days.

A similar lot of nine steers was grazed for the same period on a 10-acre mixed brome and alfalfa pasture established in the fall of 1944. This pasture was grazed late in 1945 and the alfalfa in the mixture was much reduced.

In the 126-day grazing period in 1946 it supplied 1,134 steer days of pasture and produced 1,975 lbs. liveweight gain. The steers on this pasture made an average gain of 219 lbs. per head.

This project was performed in cooperation with the Department of Agronomy.

MARVEL L. BAKER, V. H. ARTHAUD, L. C. NEWELL, E. C. CONARD.

**Effect of time of cutting on the feeding value of prairie hay.** Ten lots of 460-lb. steer calves were fed prairie hay in wintering trials which extended from January 10, to April 26, a period of 106 days.

The hay was made from native grass cut at three stages of maturity and from a second cutting from those meadows which produced the early cutting. The early cutting hay was cut in early July, a few days after the seed or needles of the needle grass had shattered. By this time the seed crops of junegrass and Kentucky Bluegrass were mature. At the time of the midseason cutting in August, big bluestem, little bluestem, Indian grass, and switchgrass had reached their maximum vegetative growth and were beginning to develop seed stalks.

Most of the plants were maturing rapidly when the late cutting was made in mid-September. Drought had stopped the development of the seed stalks of the warm-season grasses except on low ground. There, the big bluestem and Indian grass were still blooming, the prairie dropseed was beginning to head, and switchgrass was approaching maturity.

Three lots of the calves were fed on the early or July-cut hay, three on August-cut hay, and three on September-cut hay. One lot of calves in each series was fed hay without supplement, one was fed hay plus 0.5 lb. soybean oil meal per head daily, and one was fed hay plus 1.0 lb. soybean oil meal. One lot of calves was fed second-cutting hay plus 0.5 lb. soybean oil meal.

The crude protein (7.2, 5.7, 4.1 per cent) and phosphorus (.09, .08, .07 per cent) content of the three regular cuttings of hay decreased as the maturity of the grass from which they were made increased. The calcium content tended to increase with increasing maturity of the grass. The second-cutting hay resembled the August-cut hay in composition.

Generally, as the maturity of the grass increased, the consumption of hay by the calves decreased and a larger proportion of it was refused by the calves. Average daily gains of the calves decreased consistently as the maturity of the hay they were fed increased. This difference in average daily gains tended to be consistent and was striking whether the hays were fed without supplement, with 0.5 lb., or with 1.0 lb. soybean oil meal per head daily. The average gains per head in the 106-day period for the calves fed July-cut hay on the three levels of protein were 43, 108, and 138 lbs.; for the calves fed August-cut hay 21, 55, and 116 lbs.; and for the calves fed September hay a loss of 18 lbs. for the calves fed no
supplement and gains of 42 and 84 lbs. for the calves fed 0.5 lb. and 1.0 lb. soybean oil meal. The calves fed second-cutting hay and 0.5 lb. soybean oil meal made an average gain of 73 lbs. per head in the 106-day period.

The feed required per unit of gain increased strikingly as the maturity of the hay increased. In the three lots fed no supplement, the lot fed July hay required 3,050 lbs. for 100 lbs. gain, the lot fed August hay required 6,073 lbs., and the lot fed September hay lost weight. In the three lots fed 0.5 lb. soybean oil meal per head daily the hay requirements for 100 lbs. gain were respectively, 1,280, 2,532, and 3,233 lbs. and for the lots fed 1.0 lb. soybean oil meal they were 1,026, 1,231, and 1,662 lbs. The difference among the hays judged from feed required per unit of gain is further emphasized by the fact that in the three lots fed 0.5 lb. soybean oil meal, 49 lbs. soybean oil meal fed with July hay, 95 lbs. fed with August hay, and 127 lbs. fed with September hay were required for 100 pounds of gain. In the three lots to which 1.0 lb. of soybean oil meal was fed, 76, 91, and 124 lbs. soybean oil meal for 100 lbs. gain were required by the three lots respectively.

Although the three regular cuttings of hay produced 1.12, 1.43, and 1.51 tons per acre, with an additional yield of 0.44 ton from the second-cutting hay, the early-cut hay proved the most valuable from the standpoint of gains per acre of hay. Where fed with no supplement the three hays produced respectively 74, 47, and a loss of 42 lbs. for each acre of hay fed. Where fed with 0.5 lb. soybean oil meal daily the three hays produced 175, 113, and 93 lbs. gain per acre. The second-cutting hay also was fed with 0.5 lb. soybean oil meal and produced 47 lbs. gain per acre of hay. The three hays where fed with 1.0 lb. soybean oil meal produced 218, 232, and 179 lbs. gain per acre.

The project was in cooperation with the Department of Agronomy.

MARVEL L. BAKER, V. H. ARTHAUD, E. C. CONARD, L. C. NEWELL.

Prairie hay and sorgo silage for wintering calves. Four lots of steer calves with an average initial weight of 460 lbs. were fed wintering rations from January 10 to April 26, a period of 106 days. One lot was fed sorgo silage. The other three lots were fed prairie hay made from native grass cut at three stages of maturity, in July, August, and September. One pound of soybean oil meal per head daily was fed to all of the calves. In the 106-day period the calves fed sorgo silage, July-cut hay, August-cut hay, and September-cut hay made an average gain of 167, 138, 116 and 84 lbs. per head respectively. The four lots required respectively 2,004 lbs. silage and 63 lbs. soybean oil meal, 1,026 lbs. July hay and 76 lbs. soybean oil meal, 1,231 lbs. August hay and 91 lbs. soybean oil meal, and 1,413 lbs. September hay and 105 lbs. soybean oil meal for 100 lbs. gain.

MARVEL L. BAKER, V. H. ARTHAUD.

Feeding Milking Shorthorn steers. Seven steers from the Milking Shorthorn herd at the Valentine Substation were fed from an average initial weight of 576 pounds on September 24, 1945 to a final weight of 1,006 pounds on April 26.

For the first 102 days they were fed an average of 40.0 lbs. corn silage, 0.96 lb. soybean oil meal, and .08 lb. ground limestone per head daily. They made an average gain of 199 lbs. per head and consumed an average of 1,912 lbs. silage, 46 lbs. soybean oil meal, and 4.3 lbs. ground limestone for 100 lbs. gain. For the last 112 days of the 214-day feeding period,
the steers consumed an average of 19.7 lbs. silage, 15.03 lbs. ground shelled corn, 1.44 lbs. soybean oil meal, and .10 lb. ground limestone per head daily. They gained an average of 231 lbs. per head and required 1,019 lbs. silage, 73 lbs. soybean oil meal, and 778 lbs. corn for 100 lbs. gain. In the entire 214-day period, they gained an average of 430 lbs. per head, consumed an average of 3.15 tons corn silage, 257 lbs. soybean oil meal, 21 lbs. ground limestone, and 30 bushels corn per head. They required an average of 1,463 lbs. of silage, 60 lbs. soybean oil meal, 4.7 lbs. ground limestone, and approximately 7.0 bushels corn for 100 lbs. of gain. They sold for $16.50 per hundredweight on a market with a top of $17.25.

**Feeding corn cobs to fattening steers.** Two trials were conducted in which a basic ration of sorgo silage, 1.5 lbs. soybean oil meal, and approximately 0.1 lb. ground limestone were fed to yearling steers. In addition, one lot of steers in each trial was fed ground shelled corn; a second lot was fed ground ear corn; and a third lot was fed ground ear corn to which approximately 20 per cent of its weight in ground corn cobs had been added.

The first trial extended from May 24 to November 1, a period of 161 days. Three lots of steers with an average initial weight of 615 pounds were used. These steers had been wintered largely on prairie hay and, for the 28 days prior to the beginning of the feeding trial, were fed sorgo silage plus 1.0 lb. of soybean oil meal per head daily. In the 161-day feeding period the steers fed ground shelled corn consumed an average of 13.72 lbs. ground shelled corn, 22.98 lbs. sorgo silage, and 1.52 lbs. soybean oil meal per head daily; they gained an average of 400 lbs. per head and required an average of 553 lbs. shelled corn, 926 lbs. sorgo silage, and 61 lbs. soybean oil meal for 100 lbs. gain. The steers fed ground ear corn consumed an average of 16.47 lbs. ground ear corn (approximately 20 per cent cobs), 15.79 lbs. sorgo silage, and 1.50 lbs. soybean oil meal per head daily; they made an average gain of 372 lbs. per head and required an average of 712 lbs. ground ear corn, 682 lbs. sorgo silage, and 65 lbs. soybean oil meal for 100 lbs. gain.

The third lot was fed ground ear corn to which 20 per cent of its weight of ground corn cobs was added. This lot of steers made an average gain of 334 lbs. per head, consumed an average of 15.55 lbs. ground ear corn, 3.11 lbs. ground corn cobs, 7.74 lbs. silage, and 1.50 lbs. soybean oil meal per head daily, and required an average of 750 lbs. ground ear corn, 150 lbs. ground corn cobs, 373 lbs. silage, and 72 lbs. soybean oil meal for 100 lbs. gain.

The three lots of steers sold at the same price, $27.00 per cwt., although it was obvious that the lot fed ground corn cobs was not as well finished as the other lots of steers. The top for the day was $27.50.

In the second trial, three lots of 10 steers with an average initial weight of 687 lbs. were fed for 140 days from July 11 to November 28. These steers had been wintered largely on prairie hay, grazed for 48 days on bromegrass pasture, and fed for 28 days on sorgo silage and approximately 1.5 lbs. soybean oil meal per head daily, prior to the beginning of the trial. The results of the second trial followed those of the first trial very closely. The steers fed ground shelled corn made an average gain per head of 333 lbs., consumed an average of 13.26 lbs. ground shelled corn, 29.11 lbs. sorgo silage, and 1.5 lbs. soybean oil meal per head daily, and required an average of 558 lbs. ground shelled corn,
1,226 lbs. silage, and 63 lbs. soybean oil meal for 100 lbs. gain. The steers fed ground ear corn consumed an average of 16.28 lbs. ear corn, 16.00 lbs. silage, and 1.5 lbs. soybean oil meal per head daily. They gained an average of 315 lbs. per head and required 724 lbs. ground ear corn, 711 lbs. silage, and 67 lbs. soybean oil meal for 100 lbs. gain. The steers fed additional ground corn cobs made an average gain of 300 lbs. per head, consumed an average of 16.11 lbs. ground ear corn, 3.22 lbs. ground cobs, 5.38 lbs. silage and 1.5 pounds soybean oil meal per head daily. They required an average of 750 pounds ground ear corn, 150 pounds ground corn cobs, 251 pounds silage, and 70 pounds soybean oil meal for 100 pounds gain. The steers fed ground ear corn sold for $27.50 and the other two lots for $27.00 per cwt.

On the day these cattle sold, the load top was $32.50 with most finished cattle selling down from $27.00.

MARVEL L. BAKER, V. H. ARTHAUD.

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 1945, after the lambs were sheared in January.

The average birth weights for the lambs by sires ranged from 10.34 to 11.46 lbs. The average fleece weights of the lambs by sires ranged from 5.20 to 5.92 lbs. at approximately nine months of age. The live weight of the lambs at shearing time by sires ranged from 81 to 94.36 lbs. There was very little difference in the count grade of the fleeces. One-half of the rams sired lambs with fleeces grading 58 and 60. The other rams sired lambs with fleeces grading 60.

A sample of wool just back of the shoulder was taken from each lamb to make a composite sample by sires. The shrinkage of the samples ranged from 40.3 to 46.5 per cent.

The scoured fleece weights, by sires, ranged from 2.89 to 3.50 lbs. The ram siring lambs with the heaviest clean fleece weight was not the ram siring lambs with the heaviest fleeces in the grease.

Of the rams tested there seemed to be no outstanding rams in ability to sire superior offspring. All the lambs sold for the top of the market. In general, the group was a choice grade of lamb.

Lamb feeding practices. When dehydrated potatoes replaced one-half of the grain in a soybean meal, bone meal, corn silage, alfalfa hay ration, the daily gain per lamb was .38 lb. compared with .37 lb. for the check ration. The economy of gain was slightly in favor of the potato-fed lambs. When the dehydrated potatoes replaced two-thirds of the grain ration, the average daily gain per lamb was .40 lb.

Safflower meal, made from safflower seed grown in western Nebraska, was used to replace soybean meal in a lamb-fattening ration of grain mixture, bone meal, corn silage, and alfalfa hay. The safflower-fed lambs gained .38 lb. per day compared with .37 for soybean-meal fed lambs.

In another feeding experiment a ration of shelled corn, cured beet tops, and alfalfa hay produced a daily gain per lamb of .31 lb. compared with .37 lb. daily gain for lambs fed a ration of shelled corn, cottonseed meal, bone meal, beet-top silage, and alfalfa hay. The alfalfa was limited to one-half pound daily per lamb for both lots.

M. A. ALEXANDER.
Factors affecting reproduction in a dairy herd. Regular reproduction is of great economic importance in the successful operation of a dairy herd. The ideal towards which most dairymen are aiming is a lactation period of 10 months with a two-month dry period and regular calving every 12 months. This ideal is not attained in many instances because of the irregularity in reproduction of many females. In the University dairy herd such cases are studied to determine methods of prevention and treatment.

During the year, 23 cows that were shy breeders were treated by different methods in an effort to obtain conception. Both the manual treatment of the ovaries by massage and the injection of gonadotrophic hormones were used. For cows suspected of ovulating at an abnormally long period after estrus, the treatment consisted of breeding while in heat and then a second breeding approximately 24 hours after the end of heat. The luteinizing hormone (Follutein) was injected in this class of cows to induce ovulation and to help maintain the development of the fertilized egg. The follicle-stimulating hormone (gonadin) was injected to stimulate the maturation of follicles in cows with apparently underdeveloped ovaries. A few cases were treated with gonadin a day or two before expected estrum. To stimulate maturation of the follicles, Follutein was injected shortly after the end of estrum to induce ovulation and the maintenance of the corpus luteum. Cows evidencing a cystic condition by either constant estrus or by the recurrence of estrus every few days were treated with the luteinizing hormone to induce rupture of the cystic follicles.

Of the 23 cows treated which had been bred from four to 14 times before treatment, 17 became pregnant and six were sold as non-breeders. Of 19 treatments, consisting of breeding 24 hours after the end of estrus, six cows became pregnant with the treated service; of 12 cows treated with Follutein, six became pregnant; while of four treated with gonadin at the beginning of estrus and with Follutein near the end of estrus, two became pregnant.

Artificial insemination for dairy cattle. Efforts were made to (1) find satisfactory methods of evaluating semen for potential fertility; (2) restore fertility to bulls having a poor breeding record; and (3) treat semen so as to maintain high activity of the sperm cells. Regular tests have been made on the semen of an average of 16 dairy bulls of the Holstein, Guernsey, Milking Shorthorn, and Jersey breeds. Methods used for evaluating semen include (1) initial motility in estimated per cent; (2) survival time of sperm during storage at 40°F.; (3) per cent of abnormal sperm in a sample; (4) reduction time of methylene blue by the sample; (5) survival of cold shock; (6) calculation of dead and live sperm in the sample by the differential stain technique; and (7) check of the results obtained by these tests with the breeding results in the field, through examination of breeding records of cooperative breeding associations.
supplied with semen. More than 300 individual samples have been studied and more than 2,000 cows have been inseminated from these samples.

Several treatments have been used on bulls with poor breeding efficiency. Eight bulls have been treated with thyro-protein (Protomone) for 20 to 30 days. The results so far indicate that, after an initial depression lasting for possibly a week, the rate of conception from the treated bulls improved from five to 10 per cent and maintained such improvement during the short time of feeding. In a few cases the improved breeding efficiency was continued for a longer period. Other treatments for bulls have included the use of chlorotone and gonadin. Various compounds including thyro-protein and urethane have been used to treat experimental semen samples.

The growth of artificial breeding in Nebraska has been rapid. For 1945, the stud operated by the Dairy Husbandry Department furnished semen for the breeding of a total of 6,338 cows distributed in seven cooperative breeding associations as follows: Lancaster, York, Richardson, Johnson, Gage, Beauty Girl, and Hamilton. For 1946, it is estimated that there were 10,000 cows bred in 11 breeding associations supplied by the departmental stud. The conception rate for the first and second service was 51.35 per cent, or approximately 1.95 services for every conception. This can be compared with the 2.24 services for conception which is the long-time average of the University of Nebraska dairy herd. Two bulls will have more than 600 calves dropped from their services during 1946 and there will be several hundred calves dropped from services to other bulls. At present there are 30 bulls in the bull stud distributed as follows: 12 Holstein, seven Guernseys, six Milking Shorthorns, and five Jerseys. Each association supplied with semen is visited at least twice a year. Breeding records are checked and suggestions for improvement are made.

A study is being made of the breeding efficiency of semen used fresh and stored for one, two, three, and four days. This will involve approximately 10,000 breedings.

H. P. Davis, A. B. Schultze, R. C. Fossland.

The carotene content of native Nebraska grasses. The carotene content of 24 grasses native to Nebraska was determined at approximately monthly intervals from June to November. While the carotene concentration of most of the grasses was moderately high during the growing season, it declined to a rather low point by late November.

With the exception of switchgrass, hairy grama, little bluestem, and prairie dropseed, all of the grasses contained enough carotene to meet the needs of range cattle until late November. Only 18 of the grasses, however, contained enough carotene by the latter part of September to furnish the carotene required by dairy cows. Even as early as July, the northern reedgrass, buffalo grass, bluejoint, and lovegrass were unsatisfactory as a source of carotene for dairy cows. While the carotene values observed during the periods of greatest concentration varied from 511.6 p.p.m. (sandhill bluestem) to 122.6 p.p.m. (northern reedgrass), these values range from 60.7 p.p.m. (June grass) to 1.6 p.p.m. (little bluestem) during the periods of lowest concentration.

I. L. Hathaway.

Thyroid inhibitors for fattening dairy calves. In dairy herds there are many bull calves born for which there is no good market except for veal.
Frequently, the cost of producing veal is such as to eliminate that enterprise as a profitable one. In an attempt to determine the effect of thyroid-inhibiting substances, dairy bull calves are being fed from birth until three months of age with such substances to determine if either the rate of fattening can be increased or the character of the carcass improved.

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

Improvement of Dairy Products

Vitamin content of commercial butter. The vitamin A, carotene, fat, and moisture concentrations of Nebraska creamery butter were determined at monthly intervals for 25 months from samples obtained from 14 creameries throughout the state. The vitamin A and carotene determinations were made with the aid of a spectrophotometer and the fat and moisture analyses were determined by the A.O.A.C. methods. It was found that the mean vitamin A potency for the 25 months was 18,876± 368 International units per pound. During the winter months this mean was 13,692± 294 International units, whereas during the summer months it was 22,465± 323 International units per pound. From the data obtained it was observed that 79.5 per cent of the vitamin A value of butter was due to vitamin A per se and 20.5 per cent to carotene. The mean fat content of all samples combined was 81.18± 0.06 per cent and the mean moisture concentration was 16.01± 0.06 per cent. From a comparison of these data with the results of investigations in other states, it was concluded that Nebraska butter was at least equal in vitamin A value to that of average United States butter.

I. L. HATHAWAY.

Vitamins in cheese. Riboflavin (vitamin G) concentrations of 27 kinds of cheeses and cheese spreads were determined by feeding these products to rats whose body stores of riboflavin had been depleted by being fed a riboflavin-deficient diet. Fifteen experiments were made in which 1,223 rats were used. The results varied from 13.5 to 1.2 micrograms of riboflavin per gram of cheese or cheese spread.

I. L. HATHAWAY.

Nebraska cheese comparisons. An additional nine cars of export cheese consisting of 410 batches, more than 300,000 pounds, have been studied for a comparison of the pH with the quality. Thus a total of nearly ¾ of a million pounds of cheese, more than 900 batches, have been studied, and it was found that the lowest percentage of No. 2 cheese was found in batches with a pH of 5.30 to 5.50 when produced in one plant. One plant had 97.8 per cent of its cheese grading No. 1. In a second plant, where the pH observed ranged from 4.98 to 5.27, approximately 13 per cent of the cheese represented No. 2.

The coli count as indicated by the violet red bile agar method appears to be a good indication of recontamination of cheese milk and possible flavor defects in the ripened cheese.

P. A. DOWNS.
Rations for Poultry

Corn gluten meal and soybean meal for growing chicks. An experiment was carried on to determine the possible supplementing value of corn gluten meal and soybean meal in rations for growing chicks. A basal ration, adequate for vitamins and minerals, was used. Under the conditions of the experiment, it was shown that, when 40 per cent of the total protein was divided equally between soybean protein and corn gluten protein, the growth rate was significantly better than when the same amount of protein was provided by either soybean meal or corn gluten meal alone.

The presence of a proteolytic enzyme inhibitor in unheated soybean meal, as previously determined at this Station, suggested the possibility of improving the nutritive quality of corn gluten meal by rational heat treatment. An experiment with 111 chicks in each of two lots indicated a slight improvement in growth-promoting value when the corn gluten meal was heated for 30 minutes at 250°F. It is doubtful, therefore, that heat treatment is necessary for corn gluten meal when used in chick rations.

Mineral formulas for chicks and poults. Chicks and poults make a relatively rapid growth rate during the first eight weeks when essential proteins, vitamins, and minerals are provided. To support a rapid growth rate, a strong, skeletal structure must also be developed. The need for levels of calcium, phosphorus, sodium, and chlorine higher than are provided by many basal rations is recognized, but the need for trace elements is not so well established.

The effect of adding four specific mineral mixtures, varying in complexity, to a typical chick and poult ration was studied. For the first series of experiments the most favorable conditions for calcium and phosphorus utilization were provided. The basal diet contained 50 per cent more than the minimum amount of vitamin D and, in addition, chicks and poults were exposed to direct sunshine.

With the basal ration used for the chick experiments, three per cent of a relatively simple mineral mixture (No. 45) provided as good a growth rate as the same amount of the other more complex mixtures with a greater distribution of trace elements. The basal ration used included 3.1 per cent meat scraps, 3.1 per cent sardine meal, 1.55 per cent dried buttermilk, 2.17 per cent dried solubles, and 4.65 per cent alfalfa leaf meal as relatively good sources of the trace mineral elements.

Mineral Mixture No. 45 is composed as follows:

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<th>Mineral</th>
<th>Parts per 1000</th>
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<tr>
<td>Salt</td>
<td>330.55</td>
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<tr>
<td>Manganese sulphate</td>
<td>8.22</td>
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<tr>
<td>Stabilized potassium iodide</td>
<td>0.08</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1000.00</strong></td>
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</tbody>
</table>

Calcium sources in poult diet. The acid-base equilibrium is known to be of significance in mineral and protein utilization. An unsolved prob-
lem, however, is the extent of adaptation to positive or negative mineral excess in the poult diet.

Addition of Ca CO₃, as a source of calcium, would tend to turn the ration to the alkaline side, whereas Ca SO₄, when metabolized, tends to convert the diet to an acid reaction.

Using the same base ration, 1.1 per cent of additional calcium was provided in the form of Ca CO₃ and Ca SO₄ respectively. The same Ca-P ratio and vitamin D level were maintained for both lots of poults. There was toleration for the variation in acid-base relationships within the range of these additions, as reflected by a very favorable growth rate, low mortality, and no evidence of rickets or disturbance of mineral metabolism in either lot of 100 poults. Growth of the lot receiving calcium sulphate, as a source of added calcium, was slightly better than the calcium carbonate lot. The optimum level of calcium, when either of these salts is used to supplement a specific basal ration, remains to be determined. It is evident, however, that rapidly growing poults have a high quality of adaptation to variations in acid-base relationships.

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

Fermented alfalfa for chicks. Although the great variety of contributions made to the diet by alfalfa has long been recognized, birds differ from ruminants in that the latter have a digestive system permitting bacterial synthesis of certain growth-promoting essentials. The possibility was investigated of prefermenting a representative sample of alfalfa meal before including it in a specific ration at a seven per cent level. Four lots of chicks were used, including a control and three lots which received alfalfa meal fermented at room temperature for three, six, and nine days respectively with the natural organisms present. After fermentation, all lots of meal were dried quickly at 100°F. before inclusion in the ration.

For this series of experiments, an all plant diet, including soybean meal as the source of supplemental protein, was used as the base ration. This provided a better background for reflecting possible improvement in protein quality of the fermented alfalfa products.

There was no evident improvement in the growth-promoting value of the alfalfa meal when fermented as outlined. Riboflavin values of the fermented samples remained as in the original, but pantothenic acid and carotene losses were significant. Livability of all lots of chicks was excellent, indicating that no pathogenic factors were developed through fermentation.

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

Potato by-products for chicks. As a by-product of the processing of surplus potatoes for starch and syrup production, large amounts of dried solubles are available. This by-product is valued chiefly for its vitamin B complex and protein contributions. The product used in our experiment contained 29 per cent protein. Reports of research work with other animals indicated that potato protein has a relatively high biological value. To determine its value for growing chicks, a basal ration was used with proteins entirely from plant sources. In the basal ration, 59.74 per cent of the total protein was provided by soybean meal, the balance by corn, wheat milling by-products, oats, and alfalfa. In the experiment, soybean meal was replaced with dried potato-soluble protein in amounts to contribute 1.16 per cent, 2.32 per cent, and 3.48 per cent respectively. The growth-promoting value of the ration was improved very significantly as the amount of dried potato-solubles was increased.
Potato protein and the B complex vitamins in the dried potato-solubles have a high biological value when used to supplement a typical corn, wheat milling by-products, oats, alfalfa, and soybean meal base ration for chicks.

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

Field feeding for turkeys. Experimental work with the range system of raising turkeys at the Rogers’ Memorial Farm has indicated great possibilities for reducing production costs through field feeding of certain feedstuffs which can be grown in Nebraska. The feedstuffs used were alfalfa, oats, sudan grass, grain sorghum, and yellow corn.

Turkeys were started at the main station plant and moved to the Rogers’ Farm at an average age of nine weeks. Mortality was slightly over six per cent from the time the birds were moved to range until they were sold on the market or returned to the main plant for use as breeding stock. Feed consumed per bird for an average 18-week period, during which the birds were on range, was 64.64 pounds per bird exclusive of the feed which was available on the range.

It was observed that certain varieties of grain sorghum were well adapted for field feeding. A succession of grain sorghum crops, including some dwarfed, very early maturing varieties, together with some later maturing varieties, seems to hold the greatest promise for practical use. About 10 acres of grain sorghum can profitably be used for each unit of 2,000 turkeys. Grain sorghums are particularly recommended because of their drouth resistance, dependability, and palatability. Used in a turkey field feeding program, their difficult harvesting and storage problems are well solved.

Quality of the turkeys raised under the conditions provided at the Rogers’ Farm was very excellent. Two lots of turkeys which were processed averaged 95 per cent Grade A. Three hundred of the best birds were reserved for breeders.

F. E. Mussehl, I. L. Williams.

Field feeding grain sorghums to turkeys at Rogers’ Memorial Farm.
Swine Diseases

Swine erysipelas. Validity tests of commercially prepared culture-vaccines used in Nebraska were continued in cooperation with the Nebraska Bureau of Animal Industry. Tests were made by examination for viability in vitro and virulence of .25 ml. doses in pigeons. A dead vaccine or one low in virulence at expiration date was considered not acceptable. Results were as follows:

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<td>H</td>
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<tr>
<td>Total</td>
<td>34 (85%)</td>
<td>6 (15%)</td>
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</table>

Four of the nonacceptable vaccines were of low virulence and two were not viable.

This type of testing has been done over a five-year period. In 1942 only 39 per cent of 59 vaccines were acceptable; in 1943, 53 per cent of 88; in 1944, 76 per cent of 83; and in 1945, 73 per cent of 70. Thus there has been constant improvement of erysipelas vaccines since their commercial production was begun.

C. Olson, I. C. Blore.

Poultry Diseases

Neoplastic and neoplastic-like diseases. The effect of rate of freezing and storage on tumor pulp of a transmissible lymphoid tumor has received particular attention. Preliminary results show a definite influence of these procedures on the activity of the pulp when injected into susceptible chickens.

C. Olson, I. C. Blore.

Mortality in turkey flocks. More turkeys were examined for disease in 1946 than in 1945. Fowl cholera was encountered more frequently and accounted for more loss than usual in growing flocks.

A concomitant infection of both fowl cholera and erysipelas was found in two instances. In one of these an attempt was made to study the effect of anti-erysipelas serum prepared for horses on mortality rate in turkeys. The flock was separated in two lots and serum administered to one. An accurate estimate could not be made because of uncertainty of total numbers and inability to prevent birds from flying from one lot to the other. However, rough figures suggested a difference in mortality between serum-treated birds and non-treated turkeys of about three per 1,000 per day. The fowl cholera infection continued to cause loss in the serum-treated birds.

C. Olson, F. R. Woodring.

Diagnostic Laboratory

Laboratory examination was made on 8,166 lots of specimens received during the year. These came from farmers having a disease problem in their livestock or from veterinarians desiring laboratory assistance with particular problems. Diagnoses made on specimens are summarized in the following table.
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<th>Other Poultry</th>
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<th>Cattle</th>
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*Includes specimens submitted for specific examination and found negative.
Efficiency of corn pickers. Data were obtained in 1944 and 1945 on the efficiency of corn pickers as to different dates of harvest, speed of tractor, hybrid, moisture content, mechanical picker, and driver. Seventeen hybrids were used each year and 10 of them both years. After harvest, gleanings were taken from each row. Percentage by weight of the gleanings was used as a measure of the efficiency of the pickers.

Gleanings from corn harvested October 16, 17, and 18 in 1944 ranged from 0.3 to 2.2 per cent. When corn was harvested on November 2 and 3, 1945, gleanings varied from 1.8 to 8.8 per cent. On November 23 and 24, 1945, they varied from 4.7 to 11.5 per cent.

The corn was harvested by two single-row mechanical pickers of different make and with the tractors driven in both second and third gears. Average percentage of gleanings increased from 5.3 when the tractor was driven in second gear to 6.6 on the same day when the tractor was changed to third gear.

In 1944 there was no appreciable difference between the efficiencies of the two machines used, but in 1945 the efficiency of one machine was consistently better than that of the other. Keeping the row centered accurately between the gathering points was most important.

Moisture content of the shelled corn at time of harvest indicated a tendency for gleanings to increase as moisture content decreased.

Heating water for livestock. An automatically heated small-volume stock watering trough has completed its second year of service on a small dairy farm near Lincoln. In contrast to the commonly used stock tanks which hold relatively large quantities of water, this rectangular trough is made of redwood and has a capacity of about 20 gallons. It is heated by means of soil-heating cable. Water temperature is maintained at approximately 40°F. by an immersion-type thermostat. A float valve holds the water at constant level.

During the winter 1944-45, water was supplied through the trough to two horses and 14 milk cows, heifers, and calves. Electric energy consumption for the period November 13, 1944, to March 7, 1945, was 61.4 kilowatt hours.

In the winter of 1945-46 the trough was in use from December 3 to March 9 and supplied water for one horse, eight cows, and seven heifers and calves. Electric energy consumption for the period was 25.2 kilowatt hours.

Egg cooler for the farm. Cooling and short-time storage of eggs on the farm by means of equipment using deep well water as a cooling medium has been found feasible. Cooling is accomplished in an insulated cabinet equipped with a fin-and-tube type cooling coil and an electric fan. Air is circulated throughout the cabinet by the fan and must pass

73
Egg-cooling cabinet.

through the coil before it reaches the fan. Heat is removed from the air by water flowing through the coil.

Previous laboratory studies have shown that eggs cooled to below 65°F. can be kept in good marketable condition for a week or more. With water at approximately 57° the interior of the cabinet can be maintained at 60 to 65° when room temperature is as high as 110°. Fresh well water at 55 to 60° is available during the summer on many Nebraska farms and its usefulness for purposes such as watering livestock and irrigating gardens is not impaired by the additional job of egg cooling.

Provision is made in the cabinet for rapid cooling of eggs in mesh-bottom pails and there is additional storage room for three 30-dozen cases of eggs after cooling. Mesh bottom pails were found to be more satisfactory for egg cooling than open wire baskets. In the latter the eggs nearest the fan were cooled more quickly than those in other parts of the basket. When mesh bottom pails were placed over holes cut in the solid bottom of the cooling compartment, the air from the fan was forced to flow around the eggs as it circulated within the cabinet.

High relative humidity, desirable for satisfactory storage of eggs, was maintained by means of wet sand in a water-tight pan which lined the bottom of the cabinet.

F. D. Yung, F. E. Mussehl.

Farm refrigerators. A 74-cubic-foot side-opening 3-zone farm refrigerator and a 20-cubic-foot top-opening zero storage cabinet operated in the same laboratory during the past year have provided a comparison in electric energy consumption. The side-opening refrigerator used approximately 4.87 kilowatt hours per month per cubic foot of storage space, while the top-opening cabinet required 4.40 kilowatt hours per month per cubic foot.
Observations made while the 20-cubic-foot top-opening zero storage cabinet was operating in the laboratory have indicated that such equipment has definite limitations in freezing capacity. Unless special provisions for quick freezing are provided, the usual home-type frozen food storage unit should not be relied on for rapid freezing of large quantities of meat or other products. Compressors of the commonly used ¼ or ½ horsepower sizes which have ample capacity for the maintenance of sub-zero temperatures in relatively small, well insulated cabinets, are entirely inadequate for quantity sharp freezing. The most that should be expected of these units is the holding of sub-zero temperatures for frozen storage and the occasional freezing of a few packages of meat or other commodities. Definite distinction should be made between the double-purpose freezing and zero storage units and the single-purpose frozen food storage cabinets or zero storage boxes.

E. E. Brackett, F. D. Yung.

Thermostat for potato storage. The bimetal differential thermostat, developed for control of ventilating equipment in potato storages is in its fourth year of service at the Alliance Experimental Farm. The purpose of the thermostat is to enable the storage operator to take full advantage of cold outdoor air for cooling potatoes after harvest.

This year the differential thermostat was used to control the temperature of air continually circulated around the exterior of a specially constructed enclosed or "shell-cooled" experimental potato storage bin. The thermostat opens a motor-operated damper to admit outdoor air whenever the outdoor air has a temperature lower than that within the bin. The thermostat closes the damper whenever the outdoor air temperature is equal to or above that of the air in the bin.

F. D. Yung.

Grain drying on the farm. A project on grain drying cooperative among the Departments of Agricultural Engineering, Agronomy, Dairy Husbandry, and Agricultural Chemistry is in progress with the following objectives:

(a) To determine the effects of 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.

Separate lots of hybrid ear corn (U. S. 13) furnished by the Agronomy Department have been 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. Initial moisture averaged 32 per cent and final moisture was 14 to 17 per cent.

The corn is being fed to experimental rats by the Dairy Husbandry Department for the purpose of observing indications of the effect of drying temperatures on feeding value.

F. D. Yung, T. H. Kiesselbach, I. L. Hathaway.
Studies in Rural Economics
Department of Rural Economics

Farm Costs

Cost of producing crops. Records on the cost of producing wheat were secured from 101 farmers in five counties in 1945 and from 132 in six counties in 1946. Records were secured from 132 farmers in five counties on the cost of growing corn in 1945. The collection of records for the 1946 corn crop has not been completed. Data were returned by 25 farmers on the cost of growing sugar beets and by 24 farmers on the cost of operating a loader and topper for sugar beets. Sugar beet producers are interested in ascertaining the reduction in cost that results from the use of recently invented labor-saving equipment.

Production costs have increased rapidly during recent years. Wages paid farm labor in Nebraska during 1946 were nearly four times as high as in 1910–1914 and over three times as high as in the years 1935–1939. Production costs other than labor averaged more than twice as high during the year as in the years 1910–1914. Yields per acre were relatively high in the major part of the state in 1946 and as a result costs per bushel were not excessive, even though per acre costs were unusually high.

Farm organization. Account books were secured from 150 farmers for the year 1945 and have been summarized. The principal results secured are as follows:

The trend toward larger farm units has not yet ended.
Diversified farms paid better on the average than specialized farms.
Good farm management paid dividends. The well managed farm with labor well distributed through the year showed materially better financial results than poorly managed farms.
Relatively little labor was hired. Boys of 14 and even younger did a “man’s work” on many farms during the summer months.
The unusually good farm incomes can be attributed quite largely to four factors:
1. Favorable weather for crop production.
2. Higher prices than in prewar years.
3. Good farm management.
4. The farm operator and the members of his family worked an unusually large number of hours during the year.

H. C. Filley, Frank Miller, A. W. Epp.

Soil Conservation and Use

Economic and social effects of a conservation program. Farm records kept by 35 cooperating farmers in Pawnee County and adjacent portions of Gage and Johnson counties were secured. The individual farm records were summarized and a regional summary prepared.

The acreage of grasses and legumes is noticeably larger on the farms that are in the soil conservation program than on other farms in the same region. Less erosion has occurred in terraced fields than in fields not terraced although slope and other conditions are similar. Practically all of the farmers who are in the program believe that they are reducing erosion, conserving moisture and improving their land. The confidence of the cooperators in the value of their program is contagious. Acreage
of land contoured and improved with other soil and moisture conserving practices will probably increase.  

H. C. Filley, Gerald Abbenhaus.

Agricultural productive capacity of Nebraska. Members of the Agricultural Experiment Station and Extension Service staffs have cooperated with the Bureau of Agricultural Economics and other agencies since the beginning of World War II in preparing annual reports dealing with Nebraska's capacity to produce farm commodities. Estimates were made of the acres of crops, numbers of livestock, and quantities of animal products that can be produced in the state in 1947.

Analysis of the pattern of agricultural production in 1945 and 1946 led to the following broad conclusions:

1. Most of the desirable land that is tillable is being used for crop production.

2. The wartime demand for farm products has resulted in a higher acreage of row crops than should be maintained in the state.

3. Proper land use under conservation farming calls for crop rotations which include appreciably more grasses and legumes than are being grown at the present time.

4. Cattle numbers were at a relatively high level at the beginning of 1946, but hog numbers were lower than seemed desirable.

5. The state has produced an abundance of feed grains in 1946, but hay is short in some areas. The shortage of protein concentrates has increased the demand for alfalfa hay.

Estimates of acreage of crops and production of livestock were issued in mimeographed form by the Bureau of Agricultural Economics of the U. S. Department of Agriculture.

Frank Miller.

Agricultural Credit

Credit survey records secured in Johnson County have been analyzed to determine the extent to which farmers use credit and the principal sources from which they borrow. Continuous farm account records from southeastern Nebraska have been tabulated to find out how much debt operators on farms of various size could have carried successfully in the 1935–1944 period. The organization of the farms where credit could have been carried successfully and where deficits would have occurred in most of the years from 1930 to 1944 has been examined to see if successes and failures are traceable to differences in the enterprises that are included in the farm business.

In 1939, 84.8 per cent of the farm operators in Johnson County reported the use of credit from some source. Owner operators obtained a high per cent of their credit from local banks. Tenants, on the other hand, secured more credit from implement companies than from banks.

Most of the farm operators who kept continuous records from 1935 to 1944 would have made slow progress in liquidating debts prior to 1940, if they had spent the average amount for living expenses, paid four per cent interest on a debt equal to 65 per cent of the real estate investment and six per cent on one-half the value of the non-real-estate capital. Progress in liquidating debts would have been rapid between 1940 and 1945.

Frank Miller.
Marketing

**Elevator audit.** Audits of the books of 71 elevators were secured for 1943, and of 69 elevators for 1944. The audits will be summarized with audits secured from the elevators for previous years.

Nebraska is cooperating with 13 other Corn Belt states and the Bureau of Agricultural Economics in securing data upon the price differentials for livestock among different grades and weight groups of animals sold in the same markets. **Data have been tabulated for the principal Corn Belt markets and for several minor markets where stock is purchased for direct shipment.**

H. C. Filley, L. B. Snyder.
Household Equipment

Farm lighting with kerosene and gasoline lamps. The following results are of interest in this investigation. Mean horizontal candlepower (mhc) was determined for a two-mantle gasoline lamp, a one-mantle gasoline lantern, three brands of kerosene mantle lamps, a round-wick kerosene lamp and two ordinary flat-wick kerosene lamps. For the gasoline lamps, candlepower varied with the pressure, with other types the height of the flame was the controlling factor. Under conditions for maximum light, mhc was determined to be as follows: gasoline lamp at 25 pounds per square inch (psi) pressure, 144 cp; at 30 psi pressure, 167 cp; gasoline lantern at 25 psi pressure, 108 cp; mantle kerosene lamp 47 to 64 cp depending upon type of lamp and mantle; round-wick kerosene lamp, 19.5 cp; flat-wick kerosene lamp, 12.5 cp.

The relation between the number of pump strokes and pressure attained was determined for the gasoline lamps and the lantern. The number of strokes necessary to produce a desired pressure varied, of course, with the quantity of fuel in the lamp. When manufacturer's directions were followed, the number of strokes was too low to provide for optimum operating pressure.

Measurements were made on the various lamps to determine the torque necessary to upset the lamp.

Illumination measurements were made relative to the amount of light falling upon a certain area at various distances from the lamp. All of the lamps except the ordinary flat-wick lamp were equipped with shades and the light incident on a certain area naturally varied with the shape and kind of shade. For optimum illumination over a wide area it seems desirable that lamp heights should be increased for gasoline lamps. Comparative illumination intensities in foot candles, incident on a sheet of paper in a zone varying from one to two feet from the lamp, for the lamps studied, were: gasoline lamp with I.E.S. shade, 25; kerosene mantle lamp, 9 to 11; round-wick kerosene lamp, 4.7; and ordinary flat-wick kerosene lamp, 1.

Recommendations for adequate illumination still seem to be controversial, but if the levels of illumination formulated by Tinker (Amer. Jour. of Public Health, Sept., 1946) are used, it appears that the gasoline and kerosene mantle lamps can provide adequate illumination for general tasks and gasoline lamps can give sufficient illumination for tasks needing considerable light. Both the round-wick and ordinary flat-wick kerosene lamp provide insufficient illumination for all tasks. The use of two or more gasoline lamps or combinations of gasoline and mantle kerosene lamps can provide adequate general illumination in a room, according to good lighting practices.

Coal and wood ranges. In this investigation, attention is being given to the performance of coal and wood ranges of various types of construction when operated with Illinois bituminous coal, wood, and cobs as fuel. Tests cover such factors as temperature of cooking top, oven, outside surfaces, flues around oven, water reservoir, and stack gas; available cooking time per fuel charge; time required for pick-up; available baking
time in oven per fuel charge; rate of heating on cooking top using various utensils; use of pressure cooker on cooking top; rate of preheating oven; and ability to maintain uniform baking temperatures in the oven. Amount of fuel consumed and heat loss in stack are being determined as well as composition of stack gas. These tests are being conducted on five representative coal and wood ranges.

**Kitchen utensils, menus, and home food practices.** This investigation is being conducted in cooperation with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture. Data have been secured from 207 farm families in Cass, Lancaster, and Seward counties. Part of the study consists of determining the adequacy of a test set of utensils by actual use in chosen farm family kitchens. It is hoped that the minimum number of utensils necessary for use in Nebraska farm kitchens can be determined. Such data have particular significance in the development of adequate storage and cabinet space for farm kitchens.

**Arnold E. Baragar.**

**Human Nutrition**

**Nutrition and performance.** Healthy college girls are again serving as subjects for nutrition research projects, and this year 20 are being studied in great detail. In an effort to evaluate the performance and ability of the individual, a series of tests is being given to measure physical strength and endurance, resistance to fatigue, motor-coordination, and stability. The nutritional status of the subjects is being assessed by blood analyses, dietary records, and metabolism studies on self-chosen and controlled diets.

**Sirup in food preservation.** A maltose corn sirup produced in Nebraska has been used successfully as a sugar-saver in making jams, preserves, and catsup; in canning peaches and plums; and in making frozen desserts and ice cream. In most cases three-fourths of the sugar required in a recipe could be replaced by the sirup.

**Strained meat for infants.** In a study conducted at the Child Saving Institute in Omaha, strained meat has been added to the formula of infants to increase their protein intake 25 per cent. When this was done for infants for eight weeks, beginning at the age of six weeks, they had higher hemoglobin and red cell values than did the control infants who received no strained meat.

**Home-canned tomatoes.** Work has been continued on the home canning of tomatoes with special emphasis on reducing losses of ascorbic acid during blanching and storage and on investigating varieties which will retain their ascorbic acid during these processes. Sioux, Rutgers, Red Cloud, and Firesteel varieties were canned by the open-kettle method and are being stored through the winter. Indications are that tomatoes stored in quart jars retain ascorbic acid somewhat better than those stored in pint jars.

**Ruth M. Leverton.**

**Family Life**

**Personality traits in Nebraska families.** This year additional subjects have been tested to improve the Nebraska norms for adolescent girls on a personality test yielding scores for three traits: masculinity-femininity, leadership, and social participation. Results for 400 girls indicate that variations in score on these three traits are not related to residence (urban
Masculinity-femininity appears to be independent of leadership and social participation. Girls scoring high on leadership are likely to score above average on social participation also; but girls with high social participation scores do not necessarily have high leadership scores, showing that these two scores are related but measure different traits.

**Campus leaders.** The study of the personality traits of campus leaders, measured by the test mentioned above, has been completed. Campus leaders were matched with non-leaders on rural or urban residence, age, and college class (sophomore, junior, or senior). The status of each girl with regard to leadership or its absence was objectively verified; leaders were rated on quality of leadership and social participation by three of their associates, on a scale developed for the purpose by members of Phi Upsilon Omicron professional fraternity. Credits earned, scholarship, and ratings on college entrance tests were available from the university files.

The two groups did not vary on masculinity-femininity, but the leaders had significantly higher leadership scores than the control group, indicating that the test is a valid measure of leadership as we recognize it in college girls. High leadership scores were positively related to high ratings by associates. Leaders and non-leaders have earned approximately the same number of credits, but the leaders have somewhat higher average scholarship. Although this is partially explained by the fact that many positions of leadership are open only to girls of high scholarship, the leaders were somewhat superior also on their college entrance tests, in which verbal facility plays a prominent part. In order to determine whether or not leadership can be predicted from the test, a large group of freshmen are being tested this year. If prediction of leadership is successful, the test may be a valuable aid to college counselors.

**Intelligence of rural and urban children.** A preliminary analysis was made during the summer of the results of intelligence testing in three counties sampled last year, comparing the performance of children from urban and rural homes. There were no significant differences between rural and urban samples for three counties (Gage, Dodge, Douglas). Differences among counties were also small and insignificant, but larger than differences between rural and urban samples from the same county. In previous studies, rural children have tested consistently lower than urban children, and the results have been variously interpreted. Two explanations are offered for the contrary findings of this study: (1) unusual care has been taken in securing representative rural and urban samples, and (2) the new tests, used for this purpose for the first time, are remarkably free of urban bias. Two counties in western Nebraska (Holt and Dawes) were sampled this fall. To supplement the results of the group testing, some individual testing was done in these two counties. It is planned to use several more counties in order to secure a good geographical distribution of cases. In all, between 4,000 and 5,000 children are to be subjects of this investigation.

*Katharine M. Maurer.*
The Substations . . .

Valentine Substation

Climatic Conditions

Although precipitation for the year was 24.53 inches, 6.8 inches above normal, crop yields were about average. The fall of 1945 was very dry with only .20 inch of moisture from October to January. The winter was mild through January, February, and March, with temperatures averaging 10 degrees above normal. Snowfall was 26 inches short of the average; May and June precipitation was above normal with temperatures below normal.

Plant growth was retarded and many cattle lost weight the first month on grass. Fall rye yields were low, but oats were above average. Hybrid corn tests failed to produce as much marketable corn as did open-pollinated varieties in spite of no killing frost until October 18.

Dual-Purpose Cattle Project

Twenty-one females completed lactation periods during the year with an average of 4,277 pounds of milk and 158 pounds of butterfat in 234 days. This is the lowest average production and number of days in milk since the herd was established in 1935. Records of first calf heifers account for much of the drop. The seven heifers milked an average of 202 days, producing 3,037 pounds of milk and 111 pounds of butterfat. The top heifer produced 211.2 pounds of butterfat and the lowest one 32.4 pounds. Only five cows in the herd made a record above 200 pounds, with 312.9 pounds of butterfat as top. Seventy-five per cent of the herd tested below four per cent as determined from a night and morning sample taken the first of each month.

The feed requirement exclusive of pasture for producing one pound of butterfat was 9.4 pounds of grain, 26.2 pounds of hay and 25.1 pounds of silage.

Supplements to Prairie Hay for Range Calves

A three-year trial was completed on feeding soybean oil meal in various amounts with and without the addition of steamed bone meal. Results of the three experiments are summarized in the following table:

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<th>Ration with Hay Ad lib</th>
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<th>Summer Gain</th>
<th>Total Gain</th>
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<tr>
<td>Soybean Oil meal 0.5 lbs.</td>
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<td>182</td>
<td>282</td>
</tr>
<tr>
<td>Soybean Oil meal 0.5 lbs. Steamed bone meal 0.08 lbs.</td>
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<td>168</td>
<td>308</td>
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<tr>
<td>Soybean Oil meal 0.75 lbs.</td>
<td>125</td>
<td>170</td>
<td>295</td>
</tr>
<tr>
<td>Soybean Oil meal 0.75 lbs. Steamed bone meal 0.06 lbs.</td>
<td>149</td>
<td>156</td>
<td>305</td>
</tr>
<tr>
<td>Soybean Oil meal 1.0 lb.</td>
<td>148</td>
<td>160</td>
<td>308</td>
</tr>
<tr>
<td>Soybean Oil meal 1.0 lb. Steamed bone meal 0.04 lb.</td>
<td>165</td>
<td>145</td>
<td>310</td>
</tr>
</tbody>
</table>
Box Butte Experiment Farm

Weather conditions were generally favorable for crop production in 1946. Wind movement and evaporation were less than long time means for Alliance, and temperatures were lower than average throughout the summer. Rainfall for the crop season (October 1 to September 30) was 2.02 inches below average.

Yields were good in 1946 in the various fields and plots: potatoes 50-275, generally 180 bushels per acre; winter wheat 10 to 50, generally about 35 bushels per acre; barley 20 to 65, generally about 45 bushels per acre; corn 20 to 40 bushels per acre. The quality of all crops was good.

Dry land crop rotations. The crop rotation experiment includes: continuous cropping of winter wheat, corn, and potatoes; various three and five-year rotations with potatoes; and several rotations involving use of summer fallow.

Potato and winter wheat yields were again significantly higher following summer fallow. Barley grown following corn yielded 19.8 bushels per acre as compared to 50.7 bushels per acre following potatoes.

Protein content of wheat grown after summer fallow was found to be much higher than wheat grown following any other crop.

Serious losses in total soil nitrogen have occurred during the 17 years since these plots were established. A large block of crested wheat grass planted in 1945 will be incorporated into long rotations to study the effect of grass on this problem.

The departments of Agronomy, Horticulture, and Plant Pathology cooperate with Box Butte Farm personnel in conducting these plots.

Seed increase. Six acres of Mida spring wheat were grown. It is a new variety developed by the North Dakota Experiment Station, for which the Box Butte Farm has the only seed supply in Nebraska. Several acres of Velvon 11 barley and foundation Triumph seed potatoes were produced. Bulk seed was grown for two superior new potato varieties soon to be introduced.

Experimental Work

Brief summaries of experimental work conducted by department specialists are given here. More detailed reports appear elsewhere in this bulletin.

Potatoes. (H. O. Werner). Hundreds of new seedling potato selections were tested in an effort to produce superior new varieties. Seed production for further study or introduction of all promising lines is carried out at the Box Butte Farm. Replicated variety trials were planted on three dates to determine yielding ability, grade, and cooking quality of best new selections as compared with standard varieties of this area.

Cultural experiments included study of rate of tuber production with Triumph and Kasota as determined by harvesting at intervals; size of seed piece and distance of planting with relation to grade and yield; and the effect of cutting and healing seed pieces at intervals from March 25 until planting time on seed piece decay, stand, and yield.

Much progress is being made in working out effective economical methods of holding seed potatoes in good condition until needed in June
by means of a shell-cooled bin, controlled by a thermostatically operated fan. This year further improvements were made with this type of bin.

**Grass** (E. C. CONARD, J. R. McHENRY). A series of plots was established for study of the adaptation and yield of the most promising perennial grasses under dry-land conditions, and for study of the subsequent effects of the different sods on certain physical and chemical properties of the soil.

**Small grains** (K. S. QUISENBERRY, O. J. WEBSTER). The small grain work included replicated variety trials of winter wheat, spring wheat, oats, and barley. These trials included locally adapted varieties together with new untested selections. Special emphasis was placed on winter hardiness in the winter wheat selections. Selection of desirable spring wheats for this area from the breeding nursery received considerable attention.

**Sorghum trials** (O. J. WEBSTER). The sorghum project included yield tests of nine grain and five forage varieties. Good yields of grain and forage were recorded. The nursery included 24 lines planted in single rows for observation, and numerous early generation hybrid lines. Several selections were made of types thought promising for this area.

**Corn investigations** (JOHN LONNQUIST). Testing of local varieties and available early hybrids from other states was continued. Dawes No. 2 continues to be the highest yielding strain on the basis of long-time averages. Several new hybrids which are as early or earlier than Dawes No. 2, however, appeared very promising in 1946. Observation plantings were made of new top crosses and S₂ lines from western Nebraska varieties.

**Oil crop investigations** (C. E. CLAASSEN). Safflower, flax, sunflowers, and various Brassica species were tested.

Cultural tests are being continued on safflower which is now produced on farms in western Nebraska on a limited scale. An extensive breeding program is conducted at the Experiment Farm with safflower to develop spineless strains which are high in oil and seed yields.
Scotts Bluff Substation

Climatic Conditions

Precipitation during the year totaled 13.96 inches, compared with the 37-year mean of 13.64 inches. During the growing season (April-September) it amounted to 10.55 inches, compared with the 37-year mean of 11.04 inches. Most of the growing-season precipitation (7.53 inches) fell during May and September. Cool temperatures accompanied the heavy precipitation during May, and on May 10 a heavy frost destroyed all fruit blossoms and sugar beet seedlings. The sugar beet crop was replanted after this date. The heavy precipitation during September moderately damaged the third cutting of alfalfa hay and the dry bean crop. On August 31, hail severely damaged sugar beet, corn, and bean crops in a small area in the vicinity of the station.

Temperatures were nine degrees above normal during April, four degrees below during May, and near normal during the remainder of the growing season. Wind movement was considerably below normal during April, and slightly below during the remainder of the growing season. No heavy wind storms occurred, and the movement of soil by wind was less than usual. Evaporation was low during May and September, the months of highest rainfall, and unusually high during April.

The last frost in the spring occurred on May 20 and the first in the fall on September 23, leaving a frost-free period of 126 days compared with the 36-year mean of 136 days. Because of the short season, only the earliest corn hybrids matured properly. Unusually cold weather during the first half of October caused potatoes to crack badly during harvest.

Experimental Work

Experimental work in this report was conducted in cooperation with several departments in the Agricultural Experiment Station of the University of Nebraska, and the U. S. Department of Agriculture.

Crop rotation. The crop rotation program includes studies of the value of farm manure, phosphate and nitrogen commercial fertilizers, alfalfa as a green manure, and sweet clover as a pasture and green manure crop. In addition to continuous plots, the experiments comprise rotations varying in length from two to six years. Several rotations have been designed specifically to study the development of scab on potatoes. Part of the rotations have been in operation since 1912, a period of 35 years. Those dealing with commercial fertilizers and potato scab were started in 1942.

During 1946 the untreated continuous plot of corn produced 28.0 bushels per acre compared with 49.1 bushels per acre from the continuous manured plot. The untreated, continuous plot of sugar beets produced 0.96 tons per acre, compared with 4.01 tons on the continuous plot treated with phosphate and nitrogen. Sugar beet diseases caused great loss on these plots during the season, reducing the stand from 90 per cent at thinning time to 27.3 per cent on the continuous untreated plot, and to 13.9 per cent on the plot treated with phosphate and nitrogen. The continuous untreated plot of barley produced 43.3 bushels per acre, compared with 66.7 bushels, 81.0 bushels, and 75.3 bushels per acre for similar plots treated respectively with manure, nitrogen, and both phosphate and nitrogen. The continuous plot of beans produced 14.4 bushels per acre compared with 21.7 bushels on the continuous manured plot. Farm
manure, nitrogen, and phosphate and nitrogen together, increased the total yield of potatoes on continuous plots, but failed to influence to a great degree the yield of No. 1 potatoes because of the abundance of scab on potatoes from all of these plots.

Highest yields of sugar beets were obtained from alfalfa rotations treated with farm manure where the mean yield amounted to 15.14 tons per acre. Lowest yields (4.68 tons per acre) were harvested from the short untreated rotations. Manured rotations without alfalfa produced 12.56 tons per acre, compared with 12.26 tons per acre for commercial fertilizer in similar rotations. Alfalfa alone produced 11.25 tons per acre of beets; alfalfa plus manure, 15.14 tons; alfalfa plus phosphate and nitrogen, 13.54 tons. A pastured sweet clover rotation produced 11.45 tons per acre compared with 12.42 tons per acre for a similar rotation treated with phosphate and nitrogen.

Manured rotations produced 33.0 bushels of beans per acre, compared with 26.5 bushels per acre for phosphate and nitrogen. In an alfalfa rotation treated with phosphate and nitrogen, beans yielded 39.4 bushels per acre compared with 39.1 bushels per acre in a comparable rotation treated with farm manure.

The yield of barley in manured rotations was 41.9 bushels per acre, compared with 36.6 bushels per acre in comparable rotations treated with phosphate and nitrogen. Alfalfa alone produced 54.7 bushels of barley per acre; alfalfa plus farm manure, 67.2 bushels per acre; and alfalfa plus phosphate and nitrogen, 58.5 bushels per acre. Sweet clover as a green manure produced 33.8 bushels of barley per acre, and farm manure added to a comparable rotation returned a yield of 59.2 bushels per acre.

The mean yield of potatoes from alfalfa rotations treated with phosphate and nitrogen was 317 bushels per acre, compared with 276 bushels per acre from similar rotations treated with farm manure, and 294 bushels per acre from untreated, alfalfa rotations. A pastured sweet clover rotation produced 348 bushels of potatoes per acre, compared with 296 bushels per acre in a comparable rotation treated with phosphate and nitrogen. Sweet clover as green manure produced 242 bushels per acre, and farm manure added to a comparable rotation returned a yield of 323 bushels per acre. Farm manure and commercial fertilizers as separate treatments in short rotations without alfalfa increased the total yield of potatoes over untreated plots, but the prevalence of scab held the yield of No. 1 potatoes at a very low level. For example, of a total yield of 365 bushels per acre from a three-year rotation treated with phosphate and nitrogen, 175 bushels per acre graded scabby, and only 55 bushels per acre passed as No. 1.

Highest yields of No. 1 potatoes came from alfalfa and sweet clover rotations four to six years in length. The yield of No. 1 potatoes was low and the yield of scabby potatoes high in all rotations three years or less in length, regardless of treatment.

**Lamb feeding.** Lamb feeding experiments during 1946 included studies of cull beans as a replacement feed for grain in corn silage rations, and a continuation of death loss studies from beet top silage and corn silage rations.

The ration used as a check to study cull beans as a replacement feed for grain consisted of grain mixture (equal parts corn, barley, and dry pulp), soybean meal, bone meal, corn silage, and alfalfa hay. This ration was fed to Lot 1. During a period of 108 days, the mean daily gain per lamb was 0.29 pound. Of the 45 lambs starting the test, three (6.6 per
cent) died, probably from listerellosis, a disease of the brain and nervous system caused by Listerella monocytogenes. During previous work, this particular ration has produced excellent gains (0.38 pound daily) and no death loss.

Lots 2 and 3 were fed the same as Lot 1 except that cull beans replaced one-half of the grain mixture in Lot 2, and two-thirds of the grain mixture in Lot 3. The daily gain in Lot 2 amounted to 0.26 pound. In Lot 2, three lambs died from listerellosis. During the first 64 days the lambs in Lot 3 gained only 0.20 pound daily, and three died from listerellosis. After 64 days the cull beans and corn silage were replaced with grain mixture and alfalfa hay. On this ration the daily gains amounted to 0.37 pound and three additional lambs died from the same disease. Lot 4 received the same ration as Lot 1 except that the protein supplement was omitted. During the first 64 days, the lambs gained only 0.12 pound daily. Five lambs died from listerellosis. After 64 days protein supplement was added to this ration and cull beans and corn silage removed. The daily gain during the next 44 days amounted to 0.44 pound and no lambs died. During the first 64 days the lambs in Lot 5 made practically no gain (0.08 pound per lamb daily) on a ration of dry pulp and cull beans equal parts by weight, bone meal, corn silage, and alfalfa hay. Six lambs died from listerellosis. After 64 days corn replaced cull beans, protein supplement was added, and corn silage removed. During the second period of 44 days, the daily gains amounted to 0.49 pound. Three additional lambs died as the result of the same disease. During the first 64 days the lambs in Lot 6, on a ration of equal parts of corn and cull beans, bone meal, corn silage and alfalfa hay, gained only 0.12 pound per head per day. Three lambs died of listerellosis. During the next 44 days, corn silage and cull beans were removed and protein supplement added. No death loss occurred during this period, and daily gains amounted to 0.46 pound per lamb.

Five additional lots of lambs received beet top silage, with various grains and protein supplements, and one lot received field-cured beet tops in comparison with beet top silage. The cured beet tops compared favorably with the beet top silage. All lots fed the beet top silage or field-cured tops produced good daily gains, ranging from 0.31 pound for
a ration of corn, cottonseed meal, and beet top silage, to 0.38 pound for a ration of grain mixture, soybean meal, bone meal, beet top silage, and alfalfa hay.

All but a few lambs fed during 1946 were ewe lambs, and very little urinary calculi occurred in any of the lots. None of the lambs fed beet top silage or field-cured beet tops died from listerellosis.

**Mechanical thinning test with sugar beets.** This work was carried on in cooperation with the Beet Sugar Development Foundation of Fort Collins, Colorado. Various methods of thinning beets mechanically, by cross cultivation with knives, duck-feet, bull-tongues, and down the row cultivation with the Dixie and Paul Milton machines, were compared with the long-handle hoe, and the old style method of hand blocking and thinning. The treatments were applied on two dates involving early, or on time, and delayed thinning. The reductions in yields on the mechanically thinned plots, as compared with hand work, ranged from 13 to 21 per cent for early thinning, and 13 to 25 per cent for delayed thinning.

An additional test involved a low rate of seeding with no hand or mechanical thinning of any kind, compared with a heavier rate of seeding and long-handle hoe thinning. The yield on the unthinned plot was 2.5 tons or 17 per cent less than on the thinned plot.

**Moisture, fertility, and spacing for potatoes.** An experiment was begun this year to study the effects of different soil moisture treatments, different plant spacings, and different fertility treatments, and the interactions of these variables upon the yield and quality of potatoes. Included in the test were three moisture variables obtained by irrigating specified plots when prescribed soil moisture stresses were reached. The number of irrigations per plot required under this procedure varied from one to six. Three different spacings between plants were used: 8, 12, and 18 inches. A constant row spacing of 36 inches was used. Two fertility treatments included an application of 100 pounds of superphosphate (45 per cent P₂O₅) alone and a similar application of superphosphate plus 80 pounds of nitrogen as ammonium nitrate.

Potato yields ranged from 83 to 369 bushels per acre. There was a large increase in yield, both total and U. S. No. 1 potatoes, with an increase in amount of moisture supplied. Yields increased with an increase in plant population in the plots receiving the highest moisture levels, but plant population had no effect upon yield in the plots with the two lower moisture levels. A small increase in total yield with a somewhat larger increase in yield of No. 1 potatoes was obtained for the application of a nitrogen fertilizer. It appears likely that greater differences in yield due to fertility level and spacing would have been obtained with higher moisture levels than were used in this experiment.

There was less scab on the potatoes from the plots receiving a combination of nitrogen and phosphorus fertilizers than on the potatoes from the plots receiving only a phosphorus fertilizer. This was reflected in a somewhat higher yield of No. 1 potatoes on the plots receiving both phosphorus and nitrogen fertilizers even though there were more harvest cracks in the tubers from these plots. The percentage of tubers with scab was highest in the plots with the highest moisture level. There was a high correlation between the amount of flea beetle damage and the amount of moisture present in the soil, damage being greatest in the plots with the highest moisture level.
Dry-Land Crop Rotations

Notwithstanding a short growing season and a short moisture supply during July and August, weather conditions were generally favorable in 1946. Crop yields for the third consecutive year were well above long-time averages. There was no winter killing in fall-seeded wheat. High temperatures in early spring induced heavy vegetative growth of wheat on fallow. Later in the season, there was not sufficient moisture to fully develop the crop, and grain yields were low in proportion to straw.

On cropped land there was much less early growth and the proportion of grain to straw was high. These conditions narrowed the expected differences in yield. After fallow, yields ranged from 20.3 to 50.0 bushels and averaged 37.1 bushels per acre. On cropped land the range was from 3.3 to 46.3 bushels and the average 19.1 bushels. The influence of previous cropping on winter wheat is shown by acre yields of 37.2, 17.2, 15.5, and 11.4 bushels following potatoes, corn, small grain, and early kalo. Winter wheat after potatoes was affected more than usual by preparations for the potatoes. Following potatoes after fallow, corn, and winter wheat, the wheat yields were 43.8, 34.6, and 28.2 bushels per acre in comparison with 10-year averages of 16.8, 17.2, and 15.3 bushels. Yields of winter wheat after corn grown in 40, 80, and 120-inch rows were 22.1, 33.5, and 38.5 bushels per acre in comparison with 10-year averages of 13.9, 16.3, and 17.1 bushels. In the series of four-year rotations with green manures and fallow preceding winter wheat, the yield of winter wheat was 43.4 bushels after rye for green manure, 42.2 bushels after field peas for green manure, 39.5 bushels after clean fallow, and 29.3 bushels after sweet clover for green manure. For the 10-year period yields average 25.3 bushels after fallow, 22.9 bushels after rye, 21.2 bushels after field peas, and 17.6 bushels after sweet clover.

Spring grain yields were generally above long-time averages and in several rotations the highest in 10 years on the present location. Average acre yields of all treatments were 18.7 for spring wheat, 25.0 bushels for barley, and 42.5 bushels for oats. After fallow, yields of 32.9 bushels for spring wheat, 52.4 for barley, and 63.7 for oats represent increases over cropped land of 100, 146, and 71 per cent. The 10-year average increases are only 60, 79, and 50 per cent.

Light rainfall in July and August limited corn yields. Damage would have been heavy except for favorable soil moisture storage and moderate temperatures. The average yield of all plats was 23.7 bushels per acre. There were imperfectly pollinated ears scattered through all plats because of pruning of silks by corn root worm beetles and grasshoppers. This damage however was minor in comparison with that caused by root worm larva working on roots in plats where corn followed corn. This was the first time corn root worm caused severe damage in dry-land corn at the station. Injury was indicated by a high percentage of leaning and lodged stalks, and by poor color and stunted growth. In field C, 14 plots in corn for the second year averaged 14.5 bushels. In adjacent plats where the previous crop was wheat, yields averaged 24.6 bushels. In previous years the yield difference between these sequences has not exceeded five bushels. For the five-year period, 1941-45, the average yield of corn after corn was 24.4 bushels and after wheat 26.1 bushels. As in previous
years, corn after fallow made a poor record. The single plat of corn after fallow yielded 19.0 bushels or 4.7 less than the general average.

Early kalo stands were poor and somewhat irregular. In alternation with winter wheat, the yield was 31.4 bushels per acre. In a four-year rotation of wheat and kalo with fallow preceding each crop, the kalo yield was 35.7 bushels. In previous years kalo in the four-year system has doubled that yield immediately after wheat. Continuously cropped, the yield of kalo was 23.7 bushels on spring plowing and 21.7 bushels on fall plowing. The low yield of 20.0 bushels was on alternate fallow and kalo.

Potato yields were somewhat below those of the previous two years but well above long time averages. Total yields after fallow, corn, and winter wheat were 169.2, 119.3, and 152.9 bushels per acre and of No. 1 grade 146.6, 101.7, and 127.4 bushels per acre. The highest yield after fallow and lowest yield after corn agrees with results of previous years.

L. L. Zook.

Small Grain Varieties

Winter wheat. Fifteen varieties ranged from 45.2 to 28.2 bushels per acre. Two varieties of hybrid origin and not yet available for distribution, Cheyenne x Early Blackhull and Cheyenne x Tenmarq, ranked uppermost in yield. Local Turkey and Cheyenne occupied third and fourth place with yields above 40 bushels. The early varieties, Pawnee, Wichita, Blackhull, and Triumph, suffered some injury by the freeze of May 11. The yield of Pawnee was 39.5 bushels.

In spite of the poor crops caused by winter killing in 1940-41, the eight-year average yield of Pawnee after fallow is 33.5 bushels in comparison with 32.5 bushels for Cheyenne. Nebred suffered more than most other varieties from limited moisture and high temperatures during the second week of June, and occupied fourteenth place in the test with a yield of 32.8 bushels. For the eight-year period its yield is nearly the same as that of Cheyenne. Wichita, which had made excellent yields the previous two years, dropped to tenth place with 36.7 bushels. On account of low milling quality, this variety is not recommended for the state.

Spring wheat was grown in nursery plats. Of 18 varieties, the highest yield was produced by Mida with 33.1 bushels per acre. This variety, grown for only three years, ranks first in yield for that period. Second place, both for 1946 and the three-year period is held by Ceres x Hope (C I 12263) with yields only slightly below Mida. Of five varieties grown for 13 years, highest places are held by Kearney and Ceres with yields of 13.7 and 13.6 bushels per acre. Of varieties grown for seven years or more, Pilot and Rival rank highest, with yields of 15.3 and 14.9 bushels.

Barley yields of 12 varieties ranged from 38.1 bushels for Club Mariot to 24.4 bushels for Mars. Yields of 36.5 and 34.2 bushels were made by Velvon and Velvon 11. Of varieties grown for eight years or more, highest yields were made by Ezond and Trebi with averages of 33.7 and 32.8 bushels per acre. Based on the yields of Club Mariot for the years grown, first place is held by Ezond with 118 per cent, followed by Velvon 11 with 113.5 per cent, and Velvon with 113 per cent.

Winter barley yields in nursery plantings ranged from 76.4 bushels for Ward to 11.8 for Michigan Winter. Survival ranged from 7 to 97 per cent, and was above 50 per cent for all but three varieties. Maturity of winter varieties was 16 to 20 days earlier than that of spring varieties.
Oats yields of 14 varieties ranged from 58.9 for Ventura to 36.7 for Cedar. Brunker was in sixth place with a yield of 53.9 bushels. Of varieties grown for seven years or more, Brunker is in first place with an average yield of 33.8 bushels, followed by Kanota with 33.1 and Trojan with 32.2. In nursery plantings on fallow, promising records have been made by new selections originating from crosses. Of nine of these grown for three years, best records were made by Fulton x Victoria-Richland (Ks. 1994), and two Richland x Fulghum selections (Ks. 321781 and Ab. 6947) with yield averages of 82.3, 77.1, and 76.1 bushels per acre in comparison with 57.2 bushels for Brunker and 49.5 for Kanota under the same conditions.

L. L. ZOOK, K. S. QUISENBERRY, O. J. WEBSTER.

Corn tests were continued in cooperation with the Department of Agronomy on dry land and under irrigation. Most of the hybrids under trial were experimental and not yet released. Under irrigation, 58 hybrids ranged in yield from 124.7 to 72.5 bushels and averaged 101.3 bushels. Yields of 35 hybrids exceeded 100 bushels in comparison with 86.2 and 85.9 bushels per acre for two open pollinated varieties. All hybrids except four outyielded the open pollinated varieties, and exceeded them by an average of 15.3 bushels or 17.8 per cent. Five hybrids producing over 100 bushels per acre in the order named were U. S. 35, Cornhusker 148, DeKalb 680, Ohio 92, and Nebr. 601 (1001).

On dry land, yields of 34 hybrids ranged from 31.5 to 24.6 bushels. The only open pollinated variety included was Substation White. Its yield of 25.4 bushels was exceeded by 11 hybrids which averaged 28.8 bushels. Of certified and commercial hybrids, the four hybrids yielding over 25 bushels ranked in the following order: Nebr. 601 (1001), Iowa 4316, Cornhusker 148, Ohio C92.

JOHN LONNUST, L. L. ZOOK.

Grain sorghum. Yields of 17 varieties grown after fallow ranged from 41.5 to 72.5 bushels per acre. Highest production was made by selections No. 66-3-1 and No. 20-5 from Weskin x Greeley, with yields of 72.5 and 72.4 bushels per acre. The three-year average yield of No. 20-5 is 59.9 bushels, 107 per cent of Early Kalo for the same years. These selections are too tall to become popular for combine harvesting but are promising for bundle feed or grain production where the crop is handled by binding and threshing. Other varieties with good records for the present year are Early Hegari, Bonita, and Martin with yields of 65.9, 64.8, and 63.2 bushels per acre. Early Kalo which usually attains high yields occupied twelfth place with 50.5 bushels.

Forage sorghum. The average yield of ten varieties was 4.45 tons cured forage per acre which is the record yield for a seven-year period. Waxy Atlas with 5.13 tons produced the highest yield and is highest for three years 1944-46 with 3.94 tons. Atlas No. 17 with 4.67 tons for 1946 and a 3-year average of 3.89 tons is second high for the three-year period. Rox Orange and Black Amber have 1946 yields of 4.97 and 4.94 tons, and identical yields of 3.77 tons for the 3-year period. For a 7-year period the six varieties Atlas 17, Early Sumac, Norkan, Black Amber, Leoti and Fremont rank in the order named with yields from 3.48 to 3.05 tons per acre.

L. L. ZOOK, O. J. WEBSTER.
Irrigation

Light rainfall in April, July, and August created a heavy demand for irrigation water. The electric pump was operated 490 hours—25 in April, 96 in June, 201 in July, and 168 in August. Electric energy of 8,190 kwhr was used to pump 1,212 acre-inches of water at an average cost of 2.117 cents per kwhr. Water to the amount of 443.4 acre-inches was applied in four applications on 23 acres of brome and alfalfa pasture; 205.6 acre-inches were used in three applications on 8.6 acres of new brome and alfalfa seeding; 443.4 acre-inches were applied in two applications on 24 acres of corn, and 90.2 acre-inches were used to water three acres of potatoes, sweet corn, and beans. All measurements were taken at the pump and include losses from laterals, evaporation, and other causes. Cost per acre-inch of water pumped was 14.3 cents for power and 20.25 cents for labor at 50 cents per hour. Fixed costs per acre inch were 24.77 cents.

The motor-driven unit on the Ryan lease was operated 481.8 hours, pumping 971.1 acre-inches of water, and using 1,340 gallons of tractor fuel, eight gallons of gasoline and 10 gallons of oil at a cost of $145.96 or 15.03 cents per acre-inch for power. Water amounting to 333.22 acre-inches was used on 34 acres of corn, 12 acres of which were watered three times and the remainder twice. Another 637.9 acre-inches were used by the Soil Conservation Service on 80 acres of grass nursery.

Horticulture

Strawberries. Forty varieties of strawberries from the Cheyenne Horticultural Field Station were planted in the spring of 1945, and fruited for the first time in 1946. Two selections, Cheyenne 1215 and 1221, were outstanding in the trial and have been increased for state-wide testing in 1947.

Chrysanthemums. Five selections of hardy 'mums, bred at the Station and under test for the past three years, have proved well adapted to western Nebraska conditions and are being increased for naming and introduction. Leo Anderson of North Platte is cooperating with the Substation in 'mum breeding work.

Cooperative field trials. A cooperative testing program has been set up with cooperators well distributed over the western two-thirds of the state. Trials with two strawberries, three tomatoes, and four chrysanthemums were made in 1946.

Herbicides. Tests of 2,4-D and Dinitro compounds were continued through a second growing season.

Insecticides. Piperonyl Cyclohexenone as a control of grasshoppers was tested on a limited scale. Results of cage and field trials were very promising. Kills of hoppers of all ages averaging 95 to 100 per cent were secured under varied conditions. In addition to being very toxic to grasshoppers, the compound appears to be effective on the squash bug and cucumber beetle.

Vegetable storage. Storage tests of potatoes and onions, using commercial compounds containing a-napthaleneacetic acid and 2,4-D, are under way. Preliminary tests in 1945 indicate that sprouting is inhibited, and longer storage is possible than is the case with untreated materials.

James C. Adams.

Glenn Viehmeyer.
Strawberry variety test plots at North Platte Substation. Forty varieties are being tested for winter hardiness and yield in western Nebraska conditions.

Cooperative potato trials. In cooperation with the Department of Horticulture, 11 varieties and selections of Irish (white) potatoes were planted and observations made on season of maturity, yield, and general adaptability to Substation conditions. Two randomized plantings of eight replications each were made, one on dry land, and the other on irrigated land.

In the irrigated tests, one seedling (SND48-2) that produces smooth, uniform, white tubers relatively early yielded 490 bushels per acre of No. 1 tubers in comparison with a yield of 434 by Irish Cobbler. On dry land the yields were 181 and 153 bushels respectively. Table quality of this selection is on a par with Irish Cobbler.

The 1946 growing season was favorable for potato production and yields on both dry and irrigated land were above the 10-year average. DDT was used as an insecticide on observational plots of Irish Cobbler potatoes and gave a yield increase of 23 per cent over the untreated check plots.

Sweet potatoes. Five varieties of sweet potatoes: Florida White, Maryland Golden, N. C. 1, Nancy Hall, and Porto Rico were tested for yield and adaptability to North Platte conditions. Maryland Golden was the most desirable. It yielded 12,310 pounds per acre. The tubers were uniform, of medium size, with high color and quality. Either because of low yields or poor quality, the other three varieties in the test appeared poorly adapted.

L. L. Zook, Glenn Viehmeyer, H. O. Werner.
Experimental Work with Cattle

Relation of winter feeding to growth and reproduction. Five lots of 20 grade Hereford heifers, described in the 57th and subsequent annual reports, were continued on trial, with the number per lot reduced by the disposal of cows which failed to raise calves. The number of cows per lot with the average weight per head on November 27, 1945, when they were moved from pasture to winter lots, was by lots: (1) 19 cows, 900 pounds; (2) 16 cows, 986 pounds; (3) 16 cows, 993 pounds; (4) 16 cows, 946 pounds; and (5) 17 cows, 936 pounds. Winter rations were similar to those fed in previous years. Lot 1 was fed prairie hay, Lot 2 prairie hay and 1.0 pound soybean pellets. Lots 3, 4, and 5 were fed six pounds of alfalfa hay and 25 pounds of corn silage per head daily. In addition they were given prairie hay ad lib.

During the 156-day wintering period, Lot 1 lost .77 pounds per head. Lots 2 to 5 gained an average of 15, 122, 48 and 47 pounds per head respectively. The number and average birth weight of calves by lots were 17, 68 pounds; 15, 70 pounds; 15, 74 pounds; 15, 74 pounds; and 18 (one cow dropped twins), 74 pounds. The cows which did not produce calves were marketed.

The cows and calves were turned on pasture May 4, 1946. At that time the cows weighed an average of 823, 1001, 1115, 1004, and 1010 pounds, and the calves 94, 106, 119, 105, and 110 pounds per head.

The average weaning weights of the calves by lots at approximately 194 days were 381, 405, 396, 398, and 410 pounds. The cows weighed 926, 994, 1047, 1013, and 1003 pounds when the calves were weaned. Lots 1, 2, and 4 were kept to calve in 1947. Lots 3 and 5 were dropped from the experiment.

Deferred feeding of heifer calves. This was a continuation of former work. Four lots of heifer calves with an average initial weight of approximately 400 pounds were fed ground shelled corn at two different levels. Lots 1 and 2 were fed an average of 6.0 pounds of corn per day for 151 days and 11.8 pounds for an additional 54 days. Lots 3 and 4 were placed on full feed as quickly as practicable. They consumed an average of approximately 10 pounds of corn daily for a 180-day period. Lots 1 and 3 were fed silage and 1.0 pound of soybean oil meal per head daily; whereas Lots 2 and 4 consumed approximately 8.0 pounds of cut alfalfa per head daily. Salt and a mineral mixture were provided for the calves. At the conclusion of the two feeding periods, all of them sold at the same price.

Beet tops for wintering heifer calves. Six lots of 12 heifer calves with an average initial weight of approximately 400 pounds were fed for 151 days. Lot 1 consumed an average of 4.0 pounds cut alfalfa hay, 5.5 pounds prairie hay, and 4.0 pounds ground shelled yellow corn, and Lot 2 an average of 6.5 pounds beet tops, 5.0 pounds prairie hay, and 4.0 pounds ground shelled yellow corn per head daily. Lots 3 to 6 inclusive were given a full feed of corn silage. In addition, they were fed respectively 3.25 pounds beet tops and 2.0 pounds cut alfalfa hay; 3.25 pounds beet tops and 0.5 pound soybean oil meal; 6.5 pounds beet tops; and 4.0 pounds cut alfalfa hay. The average gain per head for the six lots respectively in the 151-day period was 194, 181, 191, 215, 157, and 180 pounds.

GUY N. BAKER, MARVEL L. BAKER.
Pasture for producing finished cattle. On May 7, 96 yearling heifers were divided into eight experimental lots. Lots 1 to 4 inclusive averaged approximately 650 pounds per head and were fed for 140 days. For the first 84 days or until July 30 they were fed an average of 8.5 pounds of grain per head daily. Lot 1 was fed ground shelled yellow corn and Lots 2 to 4 an average of 8.3 pounds of a combination of 80 per cent dried beet pulp and 20 per cent corn. Lots 1 and 2 were fed corn silage and 1.5 pounds of soybean oil meal per head daily in dry lot; Lot 3 was grazed on native grass pasture and Lot 4 on alfalfa pasture. For the last 56 days all four lots were fed in dry lot on a mixture of equal parts, by weight, of ground shelled yellow corn, ground barley, and dried beet pulp. They also were fed corn silage and 1.5 pounds of soybean oil meal for 44 days. Alfalfa hay replaced the silage and supplement for the last 12 days of the trial. The four lots made an average gain per head of 275, 284, 268, and 292 pounds for the 140-day period.

Lots 5 to 8 inclusive averaged approximately 540 pounds at the beginning of the grazing period. They were grazed on native grass pasture for 84 days or until July 30 when they weighed approximately 650 pounds. They were then placed on feed in dry lot. They were fed corn silage and 1.5 pounds of soybean oil meal for the first 44 days and alfalfa hay for an additional 57 days. Concentrate mixtures fed Lots 5 to 8 during the 101-day dry lot feeding period were respectively equal parts, by weight, of ground shelled yellow corn; ground barley and dried beet pulp; 25 per cent each of ground shelled yellow corn and barley and 50 per cent of dried beet pulp; equal parts by weight of ground barley and dried beet pulp; and two parts of ground barley and one part of dried beet pulp by weight. The four lots made average gains per head of 327, 315, 340, and 319 pounds.

Use of DDT. The herd of cows and calves at the Substation was divided into four lots for pasture, and DDT was applied by a commercial sprayer at intervals of different lengths. Lot 1 was an isolated check. Lot 2 was not sprayed but pastured alongside Lot 3 and watered at the same tank with Lots 3 and 4. Lot 3 was sprayed over the backs and sides with the nozzle. Lot 4 was driven through a chute having six nozzles on either side.

No effort was made to determine the amount of spray used per head. The chute method of spraying seemed fastest and most economical in use of material. Cows in the sprayed lots were obviously more comfortable throughout the fly season and gained an average of 17 pounds more than cows in the unsprayed lots. The calves in the treated lots gained 14 pounds more per head than those in the unsprayed lots.

Dairy cows. The dairy herd was continued in Advanced Registry test. During the past 11 months, 21 cows have completed 365-day butterfat records that average 543 pounds on twice-a-day milking. Two of these, Nos. 852 and 1027, the former an 11-year-old cow, produced above 700 pounds of fat. Nos. 852, 888, 889, 925, and 940 have passed the 100,000 pound total milk production.

Pasture trials in the use of alfalfa and tame grasses were continued through the summer months.

Use of DDT in fly control in the dairy herd obtained encouraging results and this work will be continued.
Dairy steer calves put on nutrition tests at North Platte Substation in fall of 1946. They were on milk substitutes during winter, put on pasture during summer of 1947 and will be put in feedlot in fall of 1947.

On October 25, 20 head of grade Holstein bull calves, from three days to a week old, were purchased. They were placed on trial to determine the possibilities of raising such calves on a limited amount of milk for the first few days, then substituting other forms of animal protein for the milk in their total ration made up mainly of home grown feeds. These calves will be fed to weaning age. They will be grazed on pasture during the summer of 1947, then fed for slaughter.

A. R. SHARRAH.

Poultry flock. The White Rock flock was discontinued, and the Substation flock is now made up entirely of White Leghorns. It was continued in the Nebraska cost account project conducted by the Poultry Department. With an average flock of 840 hens, the production per hen from October 1, 1945 through September 30, 1946, was 219.4 eggs as compared to 211.5 for the preceding year. The flock has averaged above 200 eggs for the past nine years. Improvement has also been noted in the size and livability of the pullets moved into the laying houses in the fall of 1945.

E. A. WOLFE, B. E. LEAVITT.

Apiculture. Brewer's yeast and dried milk as pollen substitutes were compared during the summer months. Twenty three-pound packages of bees were used in this test. The bees received identical treatment with the exception of the two pollen substitutes fed to them. Those receiving yeast produced an average surplus crop of 116 pounds of honey as compared to 43 pounds for those receiving dried milk. At the end of two years of testing, package bees receiving dried milk have had over 50 per cent supersedure of queens as compared to six per cent for those receiving brewer's yeast.

E. A. WOLFE.
Experiment Station Publications

Annual Report

Fifty-ninth Annual Report, presented to the Governor February 1, 1946. 1,500 copies.

Bulletins

381. Corn Rootworms (12 pages). H. Douglas Tate and O. S. Bare. 7,000 copies.
383. The Farm Business in Southeastern Nebraska (16 pages). W. L. Ruden. 5,000 copies.

Research Bulletins

143. Influence of Food Plants on Fecundity, Larval Development and Abundance of the Tuber Flea Beetle in Nebraska (16 pages). Roscoe E. Hill. 3,000 copies.
147. Pig Typhus (Salmonedosis suis) (28 pages). L. Van Es. 5,000 copies.

Circulars

82. Nebraska Egg Cooler (4 pages). Irven L. Williams and F. E. Mussehl. 5,000 copies.

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

Marion A. Shaw, David City
Charles Y. Thompson, West Point
Robert W. Devoe, Lincoln, President
Vincent C. Hascall, Omaha *
Stanley D. Long, Grand Island
Frank M. Johnson, Lexington
R. G. Gustavson, Ph.D., Chancellor of the University
John K. Selleck,¹ Comptroller of the University

The Station Officers

W. W. Burr, B.Sc., Director
W. H. Brokaw, Director of Agricultural Extension
W. W. Marshall, Executive Clerk
Ralph L. Reeder, A.B., Agricultural Editor

The Technical Staff

G. E. Abbenhuis, B.Sc., Assistant in Rural Economics
C. W. Ackerson, Ph.D., Agricultural Chemist (Acting Chairman)
James C. Adams, B.Sc., Superintendent, Experiment Substation, North Platte
M. A. Alexander, M.Sc., Associate Animal Husbandman
Vincent Arthaud, B.Sc., Assistant in Animal Husbandry
Guy N. Baker, B.Sc., Animal Husbandman, North Platte Substation
Marvel L. Baker, M.Sc., Animal Husbandman
Arnold E. Baragar, M.Sc., Associate Home Economist
Orlando S. Bare, M.Sc., Associate Entomologist
Cecil T. Blunn, Ph.D., Assistant Animal Husbandman
Raymond L. Borchers, Ph.D., Assistant Chemist
E. E. Brackett, B.Sc., E.E., Agricultural Engineer (Chairman)
E. M. Brouse, B.Sc., Superintendent, Valentine Substation
M. P. Brunig, A.M., Assistant Agricultural Engineer
H. W. Chapman, B.Sc., Supervisor, Box Butte Experimental Farm, Alliance
Carl E. Claassen, M.Sc., Assistant in Agronomy
E. C. Conard, M.Sc., Associate Agronomist
Bliss H. Crandall,² M.Sc., Associate Agronomist
L. K. Crowe, M.Sc., Associate Dairy Husbandman
H. P. Davis, M.Sc., Dairy Husbandman (Chairman)
Darrell Deane, Ph.D., Assistant Dairy Husbandman
P. A. Downs, Ph.D., Dairy Husbandman
F. L. Duley,² Ph.D., Senior Soil Conservationist
Abram Epp, M.A., Assistant Rural Economist
Margaret Fedde, M.A., Home Economist (Chairman)

¹ Deceased February 19, 1947.
² 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.
³ Detailed from the U. S. Department of Agriculture, Washington, D. C.
M. W. Felton, Ph.D., Assistant Plant Pathologist
H. C. Filley, Ph.D., Rural Economist (Chairman)
J. W. Fitts, M.Sc., Assistant Agronomist
Elvin F. Frolik, M.Sc., Associate Agronomist
Arnold W. Gadeken, B.Sc., Assistant in Rural Economics
R. W. Goss, Ph.D., Plant Pathologist (Chairman)
Paige L. Hall, B.Sc., Assistant Agronomist
L. E. Hanson, Ph.D., Assistant Animal Husbandman
Noel Hanson, M.Sc., Assistant Agronomist
Lionel Harris, M.Sc., Associate Agronomist and Superintendent, Scotts Bluff Substation, Mitchell
I. L. Hathaway, M.Sc., Associate Dairy Husbandman
Harold A. Hauke, M.Sc., Field Supervisor in Entomology
R. E. Hill, Ph.D., Assistant Entomologist
B. D. Hites, M.Sc., Assistant Agricultural Chemist
Ephriam Hixson, Ph.D., Entomologist (Chairman)
Orlando W. Howe, B.Sc., Assistant Agricultural Engineer, Scotts Bluff Substation, Mitchell
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F. D. Keim, Ph.D., Agronomist (Chairman)
T. A. Kieselbach, Ph.D., Agronomist
G. C. Klingman, M.Sc., Assistant in Agronomy
Ruth M. Levert, Ph.D., Associate Home Economist
J. E. Livingston, Ph.D., Associate Plant Pathologist
W. J. Loeffel, M.Sc., Animal Husbandman (Chairman)
John H. Lonquist, M.Sc., Assistant Agronomist
W. E. Lyness, M.Sc., Associate Agronomist
T. M. McCalla, Ph.D., Associate Agronomist
David P. McGill, B.Sc., Assistant in Agronomy
J. R. McHenry, Ph.D., Associate Agronomist
R. A. Mapes, Manager, Union Fruit Farm
Katherine M. Maurer, Ph.D., Associate Home Economist
Frank Miller, M.A., Assistant Rural Economist
Rufus H. Moore, Ph.D., Assistant Horticulturist
R. F. Morgan, M.Sc., Assistant Dairy Husbandman
F. E. Mussehl, B.Sc., Poultry Husbandman (Chairman)
L. C. Newell, Ph.D., Associate Agronomist
J. F. Olney, D.V.M., M.Sc., Associate Animal Pathologist
Carl Olson, Jr., D.V.M., Ph.D., Animal Pathologist (Chairman)
K. S. Quisenberry, Ph.D., Agronomist
H. F. Rhoades, Ph.D., Associate Agronomist
Myron G. A. Rumery, B.Sc., Animal Husbandry Agent, North Platte Substation
J. C. Russe, M.Sc., Agronomist
R. M. Sandstedt, M.Sc., Agricultural Chemist
Doretha Schlaphoff, M.Sc., Assistant in Home Economics
Andrew B. Schultze, Ph.D., Assistant Dairy Husbandman
Max L. Schuster, Ph.D., Assistant Plant Pathologist

8 Resigned May 31, 1946.
4 Resigned May 15, 1946.
9 Detailed from the U. S. Department of Agriculture, Washington, D. C.
6 Resigned, December 31, 1946.
7 Resigned, April 10, 1946.
8 Resigned August 1, 1946.
9 Detailed from U. S. Department of Agriculture, Washington, D. C.
ADMINISTRATION AND STAFF

ARDEN SHERF, B.Sc., Assistant Plant Pathologist
JOHN M. SLATENSEK, M.Sc., Assistant Agronomist
C. W. SMITH, M.Sc., M.E., Agricultural Engineer
L. B. SNYDER, Ph.D., Associate Rural Economist
E. V. STAKER, Ph.D., Assistant Agronomist
H. D. TATE, Ph.D., Entomologist (Chairman)
I. W. TERVET, Ph.D., Associate Plant Pathologist
L. VAN ES, V.S., M.D., D.Sc., Animal Pathologist
GLENN VIEHMeyer, Assistant in Horticulture, North Platte Substation
H. E. WEAKLEY, M.Sc., Assistant Agronomist, North Platte Substation
GILBERT WEBSTER, M.Sc., Associate Agronomist
O. J. WEBSTER, B.Sc., Assistant Agronomist
M. D. WeldON, Ph.D., Associate Agronomist
H. O. WERNER, Ph.D., Horticulturist
C. C. WIGGANS, Ph.D., Horticulturist (Chairman)
I. L. WILLIAMS, A.M., 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

10 Resigned February 28, 1946.
11 Resigned January 31, 1946.
12 Retired July 1, 1946.
# Agricultural Experiment Station
## Financial Report

### Money Received from the United States Government

**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, 1946, under act of Congress approved June 29, 1935. Total $41,505.16

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<th>Salaries and Wages</th>
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<td>Educational supplies</td>
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**Grand Total** $41,505.16

Dated at Lincoln, Nebraska

**John K. Selleck, Comptroller.**

### 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, 1946, under act of Congress approved February 24, 1925. Total $60,000.00

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<td>Water, heat, light and power</td>
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**Grand Total** $60,000.00

Dated at Lincoln, Nebraska

**John K. Selleck, Comptroller.**

102
FINANCIAL REPORT

Adams Fund

Receipts
Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1946, under act of Congress approved March 16, 1906. Total $15,000.00

Expenditures
For salaries $15,000.00

Dated at Lincoln, Nebraska

JOHN K. SELLECK, Comptroller.

Hatch Fund

Receipts
Received by the State Treasurer, who is also the Treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1946, under act of Congress approved March 2, 1887. Total $15,000.00

Expenditures
For salaries $15,000.00

Financial Statement Exclusive of Federal Funds

Expenditures for the Agricultural Experiment Station for the year ended June 30, 1946 (exclusive of Federal funds), including expenditures for central station at Lincoln and substations at North Platte, Scottsbluff, Valentine, Union, and Alliance, and for out-state testing.

Salaries and Wages
Regular employees $87,327.27
Temporary employees 4,386.58
Total $91,713.85

Supplies
Office supplies $2,464.50
Laboratory supplies 10,625.70
Fuel (Coal) 307.69
Foodstuffs 18,127.14
Educational and Recreational Supplies 10,754.00
Agricultural Supplies 27,376.50
Feedingstuffs 38,109.00
Miscellaneous 2,560.81
Total $110,098.34

Expense
Postage $715.24
Telephone and Telegraph 1,625.08
Freight, Express and Drayage 2,043.93
Water, heat, light and power 6,675.80
Public printing, advertising and photo supplies 2,489.47
Traveling 7,962.78
Rentals 1,149.00
Special and temporary service 64,560.64
Total $87,221.94

Repairs
Buildings $5,483.05
Lands 1,913.13
Equipment 11,186.36
Total $18,582.54

Equipment
Furniture and fixtures $4,717.09
Apparatus, labor and equipment 9,036.95
Livestock 18,572.79
Machinery 7,055.95
Books 322.61
Total $39,745.40

Lands and Buildings
Building improvement $172.50
Total $172.50

Fixed Charges
Insurance premiums, premium on bonds $256.44
Total $256.44
Grand Total $347,791.01

Dated at Lincoln, Nebraska

JOHN K. SELLECK, Comptroller.
Applying hexachlorocyclohexane (666) dusts with an orchard-type power duster for the control of grasshoppers. This was one of many important insect control experiments conducted by the department of entomology.