59th Annual Report of the Agricultural Experiment Station June 1946

W.W. Burr

University of Nebraska at Lincoln

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Cover picture—Potato Field and Scotts Bluff. Photograph provided through courtesy of C.B.&Q. Railroad Co.

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59th Annual Report

Agricultural Experiment Station

The University of Nebraska College of Agriculture

Introduction

As Nebraska farmers relinquish some of the burdens imposed by the wartime demand for agricultural products, they can take pride in the contributions they have made to both military and civilian subsistence. These contributions were vital factors in the successful conclusion of the world conflict. During the war years Nebraska agriculture surpassed a number of its former production records. Meanwhile the sons of many Nebraska farmers who normally bear a large measure of the farm labor and management load were absent from the state and carrying their share of the active military burden in the scattered theaters of war. With the return of veterans with farm experience the problem of labor shortage should, in some degree at least, be alleviated. Careful planning and the usual vigorous farmer enterprise will shortly return agricultural production in Nebraska to normal provided, of course, that national conditions become stabilized at an early date and a satisfactory amount of farm machinery and other equipment can be obtained.

Increased production has been the necessary goal of our wartime agricultural economy. In attaining that goal it has sometimes been necessary to do things not in keeping with the best interests of our agricultural resources. One of the first objectives of the years ahead must be a renewed interest in conserving and improving our land resources. In 1945 a reappraisal of our agricultural problems was made and some programs for the future were suggested in a bulletin published by this station.

The primary role of the Experiment Station during 1945 continued to be that of a pilot laboratory for the farming industry of Nebraska. Studying the problems that Nebraska farmers face, the Station continued its research in farm science and economy, insofar as somewhat curtailed resources, equipment and staff would permit. Progress has been made in the development of Nebraska-adapted varieties of cereal and forage crops, in the study of native grasses, in the nutrition of animals, in the control of costly disease and insect pests, and in numerous other fields where research is needed, in terms of dollars and cents, by Nebraska agriculture. Naturally some projects have been suspended for lack of manpower or equipment. Yet during the year noteworthy advances have been made in understanding and applying the new insecticides, in obtaining the farmers' acceptance of several new small grain varieties developed at this station, in the knowledge of new drugs, such as penicillin and the sulpha derivatives, and in their effect on the diseases of livestock. During the year there has continued the heavy demand upon the staff from action
agencies, particularly those concerned with the need for more food. But this report will show that even under these conditions the research program has not been materially slighted. Moisture conditions, a topic of perennial concern in a Plains region state, varied rather widely during the year and from one area of the state to another. Because of the record rainfall of 1944, the cropping year of 1945 began with the subsoil well saturated in most regions of the state. In both eastern and western Nebraska, moreover, there was an ample supply of moisture during the months of April, May and June, but a deficiency in many sections of the state was recorded for the remainder of the year. Cold, wet weather enforced operational delays in most of the state at the time of spring seeding of small grains and the planting of corn. As in 1944, because of late planting there was considerable soft corn. Nevertheless, small grains came through the season exceptionally well and the corn yield was above the ten-year average.

This fifty-ninth annual report summarizes the research projects completed or advanced during 1945 at the Station and the related research at the substations. The services of staff members were drawn upon for wartime needs just as in previous years; the demands continuing even after the close of hostilities. No doubt the year ahead will see the end of these tasks and the return to the Station of many staff members who have been engaged in military service.

Cooperative work with farmers over the state was continued in 1945, county agents and staff members assisting in these projects. Cooperation in a number of projects has continued with several federal bureaus, the agricultural extension service and the chemurgy division of the University. A number of industrial organizations have also contributed substantially to the support of several research projects and activities that touch at one point or another items of profit and interest to them.

Research progress here reported is for the calendar year of 1945. Financial reports are, as in the past, for the fiscal year beginning July 1, 1944 and closing June 30, 1945.

Letter of Transmittal

The University of Nebraska—Agricultural Experiment Station

To His Excellency, Dwight Griswold, Governor of Nebraska:

Sm: 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 Fifty-Ninth Annual Report of the Agricultural Experiment Station of Nebraska.

W. W. Burr, Director

February 1, 1946

Governor’s Certificate

State of Nebraska, Executive Department

Mr. W. W. Burr, Director, Nebraska Agricultural Experiment Station:

Sm: I hereby acknowledge receipt of the Fifty-Ninth Annual Report of the Agricultural Experiment Station of Nebraska.

Dwight Griswold, Governor

February 1, 1946
Erosion Control and Moisture Conservation

The experimental work on erosion control and moisture conservation that is being conducted cooperatively with the U. S. Department of Agriculture, Soil Conservation Service Office of Research, continues to be centered around the problems of crop residues and the practice of subsurface tillage.

The 1945 season was one of extremes that put the use of residues on the surface to an unusual test. The cropping year began with the subsoil completely filled with moisture, regardless of prior treatments, to depths beyond six feet. April, May, June, and the fore part of July were exceedingly wet and the remainder of the year, except at winter wheat seeding time, was extremely dry. Inadequacies of soil fertility and delays in operations due to weather rather than moisture shortages were controlling elements in production.

Oats and wheat grew slowly and generally showed nitrogen deficiency, but not any more adversely on subtilled than on plowed or disked land. In rotation plots where certain residue treatments have been followed consistently for six seasons the yields were as follows:

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield Per Acre—1945</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oats Bushels Grain</td>
</tr>
<tr>
<td></td>
<td>Wheat Bushels Grain</td>
</tr>
<tr>
<td>Subsurface tillage, all crops, all residues returned</td>
<td>50.2</td>
</tr>
<tr>
<td>Disking for oats, plowing for wheat and corn, all residues removed</td>
<td>50.7</td>
</tr>
<tr>
<td>Plowing, all crops, all residues returned</td>
<td>49.8</td>
</tr>
</tbody>
</table>

Corn seedbeds were delayed by wet weather, and more aggravatingly so where subsurface tillage was being used than where land was being plowed. In the end, however, equally satisfying seedbeds were obtained and at equal expenditures of labor. The main disadvantage of subsurface tillage for corn in 1945 arose through the more profuse germination of weeds where it was used than on plowed land where seed had been deeply buried, and the difficulty of killing these weeds promptly under the wet conditions that prevailed. As an average for seven different tests, corn on subsurface tillage yielded 53.1 bushels per acre compared with 57.5 bushels per acre on plowed land in the same tests. In five tests plowing was significantly superior, in one test subsurface tillage was significantly superior, and in one other test the two methods were practically equal.

The season of 1945 was the third in which soybeans have been grown by subsurface tillage methods. Each year the tests have been on slope land (4-8 per cent) and the erosion control resulting from the use of residues has been outstanding. The following is a summary of yields obtained:

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield—Bushels Soybeans Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface tillage</td>
<td>1942</td>
</tr>
<tr>
<td>Plowing</td>
<td>1942</td>
</tr>
</tbody>
</table>

1 Following wheat stubble.  
2 Following corn stalks.  
3 Mean of four tests.
A. Winter wheat on clean summer fallow in western Nebraska. A heavy rain shortly after seeding badly washed and gullied the field. This land had been plowed and the residues buried. B. One mile away another summer-fallow field on similar slope with abundant protective residues between the rows suffered no damage during the same rain. This field had been handled by proved practices of subsurface tillage and all residues had been kept on the surface. C and D. Two practices diametrically opposed to all good philosophy of soil conservation. (C) Wheat straw, regarded as a waste and nuisance on the land, has been harvested and baled for shipping to another state for use in industry. (D) Wheat stubble was burned in place to facilitate seedbed preparation and planting. Such land is subject to soil blowing, and on rolling land to excessive erosion.
Studies begun several years ago to show the possibilities and limitations of residues on the surface for evaporation control have been continued during 1945. In tests conducted from January 15 to May 5 the comparative, total evaporation losses from residue-covered and bare soil were 2.78 and 5.98 inches. Total savings due to residues as reflected in subsoil storage amounted to 2.96 inches. The rainfall of the period was 8.40 inches. Its efficiency from the standpoint of storage was more than doubled through the use of residues. In general, however, evaporation control through residues on the surface has been great during cool seasons rather than hot; following large rains rather than small, or during periods of persistent wetness; and it has been great at any time only in proportion to the thoroughness with which the soil is covered and shaded. Quantities of residues that only incompletely cover the soil are much more effective relatively at runoff reduction and erosion control than at evaporation control.

The use of legumes of various kinds in connection with maintaining adequate available nitrogen supplies is being tested on land where crop residues are used for erosion control. Biennial and annual sweet clover, lespedeza (19604), vetch and partridge peas are showing much promise. The ability of these crops to volunteer in small grain after the land has produced one or two crops of corn is being tested. In some cases it has been partially successful, but must be tested further. In Webster county good stands of both annual and biennial sweet clover have been obtained on badly eroded areas. This has provided a good supply of organic residue for protecting the soil as well as added nitrogenous material for use of the next crop.

Seedings of grass have been made on land protected with sweet clover residues and good stands obtained.

Runoff and soil erosion measurements during 1945 on corn, oats, wheat rotation plots and comparisons with the mean of four preceding seasons.

<table>
<thead>
<tr>
<th></th>
<th>1945 Season</th>
<th>Mean of Four Previous Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inches or Tons</td>
<td>Inches or Tons</td>
</tr>
<tr>
<td>Residues Substituted</td>
<td>No Residues Plowed or Disked</td>
<td>Residues Substituted</td>
</tr>
<tr>
<td>Runoff—inches</td>
<td>0.75</td>
<td>1.89</td>
</tr>
<tr>
<td>Soil loss—tons per acre</td>
<td>1.67</td>
<td>8.11</td>
</tr>
<tr>
<td>Runoff—inches</td>
<td>0.35</td>
<td>2.42</td>
</tr>
<tr>
<td>Soil loss—tons per acre</td>
<td>0.47</td>
<td>7.86</td>
</tr>
<tr>
<td>Runoff—inches</td>
<td>0.11</td>
<td>0.31</td>
</tr>
<tr>
<td>Soil loss—tons per acre</td>
<td>0.08</td>
<td>0.13</td>
</tr>
</tbody>
</table>

* Nine runoff-producing rains amounting in total to 8.68 inches, all coming during April, May and June. The corresponding mean for four preceding seasons has been 12.59 inches.

F. L. Duley, J. C. Russe, T. H. Goodding.
Soil Microbiology and Crop Residue Management

Soil temperature and stubble mulching. For a period of three to four months after an application of a straw mulch at the rate of two to three tons per acre, soil temperatures were reduced 3° to 6°C. at the one-inch depth and 2° to 4°C. at the four-inch depth. After six to nine months of decay, soil temperatures were not reduced appreciably below those of plowed land. The effect of this small temperature variation on biological activity is not known definitely, but it has seemed to have only a slight effect on the production of nitrates in the soil.

Fungi decomposing plant residues. Members of the genera Penicillium and Aspergillus were most commonly found in the soil. Chaetomium was frequently found in large numbers on straw and corn stalks during intermediate states of decomposition. Other genera encountered were: Alternaria, Rhizopus, Hormodendrum, Trichoderma and Fusarium. The fungi varied considerably in the rate and type of decomposition produced.

Loss of carbon dioxide and ammonia from a residue mulch. Carbon was lost at the same rate from wheat-straw or corn-stalk residues mixed into the soil as when left on the surface under laboratory conditions. Drying and rewetting of the soil was stimulative to microbial activity. Freezing and thawing had no effect. Corn cobs decayed slower than wheat straw, corn stalks or sorghum. There was little ammonia nitrogen lost from straw or corn stalks left on the surface under constant moisture and temperature conditions in the laboratory. From these results it appears that wheat-straw or corn-stalk residues can be used on the surface of the soil for increasing water intake and controlling water and...
Mixed and mulched
Mixed
Mulched
Check

The rate of carbon dioxide production per day with different placement of wheat straw. Where straw was mixed with soil, it was confined to about two inches depth.

wind erosion of the soil without loss of nitrogen as ammonia from the decay of the residue mulch.

Factors influencing water percolation. Compacting, puddling, reducing aggregate or lump size, and sprinkling all decreased the percolation rate. The organic matter present in the surface soil increased the percolation rate over Peorian loess without organic matter under most experimental conditions. However, when some of the aggregates of the surface soil were broken down by puddling, the presence of organic matter in the soil did not increase the percolation rate.

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

Fertilizers for Corn

Nitrogen fertilizers increased the yield of corn significantly in six of eight tests on irrigated land and in three of eight tests on non-irrigated land. In general the results from the application of nitrogen fertilizers were not as outstanding as those obtained in 1944. Three rates of nitrogen application were studied—20, 40 and 80 pounds per acre. The 20-pound rate increased the yield of corn significantly but was decidedly less effective than the higher rates. In most tests the 40-pound rate was as effective as the 80-pound rate and in all tests the 40-pound rate was more profitable. In tests where ammonium sulfate was plowed under and uramon applied at the time of planting and at the last cultivation, there was no significant difference in yield from the method or the time of
Ammonium nitrate was found to give more efficient results when applied as a side-dressing at the last cultivation than when applied at the time of planting.

In the tests on non-irrigated land, thickness and uniformity of stand greatly influenced the results obtained from applications of commercial fertilizers. In general, increases in yield from the use of fertilizers were obtained only where the plants were spaced on an average of 20 inches or less in rows 40 inches apart. In fields where the stands were thinner than this, there apparently was not sufficient competition between plants to make optimum use of the fertilizer applied. In some of the fields where no increases were obtained from the use of fertilizer, it was apparent that the fields had the correct spacing of corn plants for the amount of fertility and moisture present in the soil.

In one test in the irrigated area of central Nebraska comparisons were made of the effect upon corn yields of second year sweet clover plowed under when 12 inches tall, an application of 10 tons of barnyard manure per acre, and applications of two rates of ammonium nitrate as a side-dressing at the last cultivation. All treatments increased the yields significantly over the untreated plots. The largest increases (from 38 bushels per acre for the untreated to 91 bushels per acre for the treated) were obtained on the sweet clover ground and from an application of 80 pounds of nitrogen, the next largest increase in yield was obtained on the plots receiving 40 pounds of nitrogen, and the smallest increase was obtained where manure was applied.

Phosphorus and potassium fertilizers did not increase the yields of corn significantly in any of the tests. In two of the tests, however, where the corn had been planted late it was slightly more mature and of a better quality where a combination of nitrogen, phosphorus and potash was used.

Fertilizers for Small Grains

Seven fertilizer trials were conducted on winter wheat in eastern Nebraska. The treatments included applications of nitrogen and phosphorus alone and in combination with each other, and applications of potash in combination with nitrogen and phosphorus. All fertilizer materials were applied in the fall at the time of seeding except one treatment where ammonium nitrate was applied as a top-dressing in April after the wheat had resumed growth. The results indicated nitrogen was the most important limiting factor in yield as far as fertility was concerned. A spring application of nitrogen was much more effective than a fall application. An application of 20 pounds of nitrogen per acre gave significant increases in yield, but it seemed likely that the amount of nitrogen applied was insufficient to give maximum benefits.

A fertilizer and seed treatment test on barley was conducted on a sandy terrace soil in Merrick county. This test was conducted in cooperation with the county agricultural agent and the Plant Pathology Department. The fertilizer treatments included nitrogen and phosphorus alone and in combination. The same fertilizer treatments were applied to plots in which the seed was treated with New Improved Ceresan. No increase in yield was obtained from either the seed treatment alone or the application of superphosphate alone. Nitrogen fertilizer alone gave a small increase in yield but a fertilizer containing both nitrogen and phosphorus gave a markedly larger increase. The largest response was obtained where both seed treatment and a fertilizer containing nitrogen and phosphorus were used.

Fertilizers for Grasses and Legumes

Two experiments were conducted on the fertilization of wet hay meadows on sandy soils in northern Nebraska. The treatments consisted of nitrogen, phosphorus, and potash applied singly and in all possible combinations. Nitrogen fertilizer was most effective in increasing the yield and protein content of the hay, although phosphorus and potash were effective also when applied in addition to the nitrogen. Neither phosphorus nor potash were effective when applied alone. The increases in yield and protein content were not sufficiently large to be profitable on any of the treatments.

Three fertilizer tests were conducted on bromegrass fields in southeastern Nebraska in which yields were taken of the hay rather than of the seed. Only nitrogen and phosphorus fertilizers applied alone and in combination were used in these tests. In one test an application of 80 pounds of nitrogen in the form of ammonium nitrate increased the yield of forage 1.15 tons per acre and increased the protein content 1.50 per cent. An addition of 30 pounds of phosphorus ($P_2O_5$) with 80 pounds of nitrogen increased the yield slightly more than did the application of 80 pounds of nitrogen alone. In the other two tests only nitrogen was effective in increasing plant growth. In one field an application of nitrogen fertilizer in the spring increased both the carotene and protein contents of bromegrass. The fall application of nitrogen had no effect on the protein or carotene contents. Superphosphate did not materially change either the protein or carotene contents.

Nitrogen in the form of ammonium nitrate was applied to plots of bromegrass, western wheatgrass, big bluestem and blue grama at the North Platte Experiment Station. Yields of hay were increased approximately one-half ton per acre on all except bromegrass, the latter being increased about three-fourths ton per acre. Twenty pounds of nitrogen per acre was the optimum rate for big bluestem and blue grama but 40 to 60 pounds was optimum for western wheatgrass and bromegrass.

The fertilizer experiments on alfalfa were conducted in southeastern Nebraska in cooperation with the Soil Conservation Service. In one field it was possible to study different rates of phosphate on the yields of both a newly seeded and an old stand of alfalfa. In addition, lime was used on the new seeding. Phosphate applications were equally beneficial on the new seeding and the old stand. Superphosphate (45% $P_2O_5$) at rates of 100 to 150 pounds per acre were most profitable for the single season. Lime plus phosphate gave the largest increase in yield of the newly seeded alfalfa. Lime alone increased the yield somewhat, although the increase was much less than was obtained from the application of phosphate alone. On plots where the superphosphate had been applied the previous fall, marked increases in yields of hay were obtained at the first cutting. On plots where the superphosphate was applied in the early spring there was a small increase in hay yields at the first cutting, with larger increases at later cuttings.


Effects of Different Grasses on the Soil

A series of grass plots, established at Lincoln to study the adaptation of grasses under different intensities of harvesting, was studied over a six-year period. In this experiment marked differences were shown among the grasses in adaptation, season of growth, total yield, and response to
clipping treatments. At the conclusion of the experiment in 1944, it was thought that the grass plots would show relatively different effects upon the physical and chemical properties of the soil. Accordingly, soil samples were taken by 0-6 inch and 6-12 inch depths from replicated plots of each of twelve different grass sods for the determination of organic matter and nitrogen. Special samples were taken from depths of 1-3 inches and 5-7 inches to determine aggregate stability and porosity.

Significant differences in nitrogen and carbon contents were obtained in the surface six inches of soil from the twelve different grass sods. It is of interest to note that the nitrogen and organic matter contents of all the grass plots were substantially higher than in an adjoining continuously cultivated field. No significant differences were observed in the second six inches.

It was found that stability of the soil aggregates in the 1-3 inch depth of soil was favorably affected by the grass cover, some grass sods having significantly more stable aggregates than others. This differential was also apparent at the 5-7 inch depth, although the differences were small. Side-oats grama, blue grama and bromegrass sods had the greatest amounts of stable aggregates, buffalo grass and western wheatgrass sods the least. Soils from the grass plots contained considerably more stable aggregates than the soil from an adjacent cultivated field. The different grasses had no measurable effect upon the porosity.

Results obtained emphasize importance of grasses in maintenance of organic matter and in development of desirable soil structure. The length of time that the grasses are effective in maintaining a desirable soil structure after the sods have been plowed needs to be determined.


Nitrate Production in Soil Following Different Grasses

Soil samples were taken by 0-6 inch depths in August, 1944, from a series of grass plots at Lincoln for the purpose of studying nitrate production in the laboratory under controlled conditions. Four cool-season grasses including western wheatgrass, crested wheatgrass, bromegrass and Kentucky bluegrass and four warm-season grasses including buffalo grass, side-oats grama, blue grama and big bluestem were involved in the study. Following the sampling, the plots were plowed and during the latter part of September they were planted to winter wheat. Samples were taken again in April, 1945, to determine the changes in nitrate production resulting from the influence of environmental factors following the plowing of the sods.

Laboratory results from the initial sampling indicate a greater nitrate content and a more rapid nitrate production in the sods of the cool-season grasses than in the sods of the warm-season grasses. This was to be expected, since the warm-season grasses were making their maximum growth at the time of sampling, thus using all the available nitrogen in producing root material, presumably of a high carbon-nitrogen ratio. On the other hand, the maximum growth of the cool-season grasses had occurred about two months prior to the sampling so that sufficient time had elapsed for decomposition of some of the root material produced during the active growing period. The fall growth of winter wheat on these plots appeared to follow closely the trend of nitrate production as measured in the laboratory. For example, a marked nitrogen deficiency was noted in the wheat growing on the plots previously in big bluestem, blue grama and side-oats grama, and the nitrate production was ex-
tremely low in the soils from these plots. The growth of bromegrass and winter wheat seedlings in the greenhouse on bulk soil samples taken in August was also in agreement with the nitrate production as measured in the laboratory.

Laboratory results from the samples taken in the spring indicate that by April, 1945, changes in the capacity to produce nitrates had occurred in soils from certain of the plots. From August to April, there were practically no changes in the relatively high nitrification rates of the sods of crested wheatgrass and western wheatgrass. However, there were marked increases in the nitrification rates of sods of bromegrass and Kentucky bluegrass and of all of the previously low nitrate-producing sods of the warm-season grasses. As measured by these laboratory tests, there were practically no differences between the nitrate production of the several sods by this date. These results indicate the importance of taking into consideration the kind of grass, whether cool-season or warm-season in growth habit, in making plans for the rotation and for plowing the grass sod considerably in advance of planting the subsequent crop.

H. F. RHODES, L. C. NEWELL.

Infiltration of Irrigation Water

Studies were conducted in Dawson and Phelps counties relative to the rate and depth of penetration of irrigation water. Soil moisture changes subsequent to the application of water were studied by determining electrical resistance in buried plaster-of-Paris blocks by means of a moisture bridge developed by Bouyoucos. Studies were conducted in three corn fields in Phelps county and in one corn field in Dawson county. Results were also obtained from an alfalfa plot and a bromegrass plot in Phelps county.

Differences in topography were a major cause in differential rate of infiltration and depth of water movement. The greatest depth of water penetration was on level areas or on long uniform slopes that did not exceed 0.5 per cent. Moisture penetration was noticeably less on the slopes exceeding 0.5 per cent than on the more level areas. On a micro-relief scale, small sharp changes in elevation greatly influenced the rate of infiltration. The rate and depth of water penetration were much greater in the alfalfa and bromegrass fields than in the adjacent corn fields.

In these studies, greater penetration of moisture was obtained in the soil of Dawson county than in the soils of Phelps county. These differences appear to be due in part to differences in texture of the subsoils and in part to past cropping practices. The field studied in Dawson county has had a good cropping system which included alfalfa, whereas the fields studied in Phelps county have been growing corn and small grains without legumes or grasses. Thus it appears that the years of cultivation without growing grasses or legumes have adversely affected stability of the soil in Phelps county, so that irrigation results in a slaking of soil granules and the sealing over of the soil until moisture intake is markedly reduced.

In a comparison of relative rates of moisture penetration in the corn tests, the infiltration was slightly faster and somewhat deeper in the furrow than in the ridge. With successive irrigations during the growing season, increasingly lower values for the rate and depth of moisture penetration were obtained. Apparently each irrigation resulted in more silting or sealing over of the surface soil in the furrow with a resultant decrease in moisture penetration.

J. R. McHENRY, J. W. FITTS.
Alkali Studies

FIELD AND LABORATORY studies were conducted in two alkali soil areas in Platte county and one in Lincoln county. In Platte county it was desired to determine the feasibility of irrigating the alkali soils and to make recommendations concerning their management. In Lincoln county it was desired to study the alkali conditions brought about by a rising water table and to make recommendations concerning management of the land after the water table has been lowered by establishment of drainage. Soil profile samples were taken from each area and the following determinations were made in the laboratory; cation exchange capacity; soluble salt content; soluble plus exchangeable calcium, magnesium, sodium and potassium; and mechanical analyses by a modified Bouyoucos hydrometer method using different dispersion techniques.

In one of the areas in Platte county, alkali soils are interspersed with soils that do not show any indication of alkali. There is a moderate concentration of soluble salts with appreciable quantities of soluble and exchangeable sodium in the alkali spots. In this area it will be necessary to drain the alkali soils and it would be desirable to treat them with gypsum. Some difficulty may be experienced in establishing adequate drainage since the soils are moderately fine-textured. In the other area in Platte county, a few severe alkali spots containing moderate quantities of soluble salts and large amounts of soluble and exchangeable sodium from the surface downward are interspersed with soils that show no harmful concentrations of soluble salts or sodium in the surface depths, but which contain moderate quantities of salts and large quantities of sodium in the lower depths. It is essential that adequate drainage be established throughout the entire area, and the soil texture is favorable for such drainage. Treatment with gypsum would be desirable in the most severe alkali spots. The establishment of adequate drainage should correct the problem in Lincoln county except in the more severe alkali spots. In such spots it may be desirable to treat with gypsum, although the concentration of sodium is not as great as that obtained in the Platte county alkali areas.

A laboratory technique was adopted for measuring variations in the degree of dispersion of the soils studied. The degree of dispersion measured by that technique was closely correlated with the ratio of soluble plus exchangeable sodium and potassium to soluble plus exchangeable calcium and magnesium. A similar close relationship was obtained between degree of dispersion and the ratio of exchangeable and soluble sodium to cation exchange capacity. The results suggest the possibility of using the degree of dispersion as a partial substitute for the more laborious methods of determining exchangeable and soluble cations in making quick tests for estimating alkali conditions in soils.

Field Crops Research
Department of Agronomy

The Comeback of Nebraska Crops

The Great Drought which started in 1934 is broken in Nebraska after eight years. Crop yields have returned to a normal level and have exceeded it in many areas. Although it is a fair conclusion that no permanent unfavorable change occurred in the state's climate, wise planning will anticipate that the weather, other production hazards and yields will continue to fluctuate from season to season and will prepare for an occasional lean year.

Annual crop yields at the Experiment Station Farm at Lincoln are summarized in the following table to illustrate crop performance during and after the drought as compared with the pre-drought period and the long-time average, 1909-1945. As far as possible, yields of the same standard varieties have been used throughout the 37-year period so that variations might reflect primarily the seasonal environmental differences. Had the superior varieties now available been used throughout the 37 years, yields would have been increased by the following percentages: hybrid corn 20, Pawnee wheat 32, Spartan barley 15, Cedar oats 39, and Lincoln soybeans 15. Throughout the period the soil has been maintained by applications of 10 tons of manure each 10 years.

Grain yields of standard grain crops on the Experiment Station Farm at Lincoln during eight years of drought, compared with pre-drought and post-drought periods, 1909-1945.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Corn (Reid)</td>
<td>35</td>
<td>42</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Soybeans (Aksarben)</td>
<td>15</td>
<td>17</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Grain sorghum (Kalo)</td>
<td>...</td>
<td>...</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Winter wheat (Turkey)</td>
<td>29</td>
<td>32</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Oats (Kherson)</td>
<td>43</td>
<td>47</td>
<td>21</td>
<td>37</td>
</tr>
<tr>
<td>Barley (Trebi)</td>
<td>...</td>
<td>...</td>
<td>12</td>
<td>23</td>
</tr>
</tbody>
</table>

Yields of the various crops for the last four years have averaged two to 16 times more than during the first four drought years, and two to seven times more than for the eight-year drought period. They have also more than equaled the 25-year pre-drought averages and have materially surpassed the 37-year long-time average. T. A. Kieselbach, W. E. Lyness.

Crop Rotation Experiments

The favorable response, observed in eastern Nebraska, of corn and small grain crops to the growing of legumes in the rotation, and to fertilization with barnyard manure, has been substantiated by results on the Agronomy Farm at Lincoln. Even more gain in yield would be expected on farms where soil fertility is lower.

Seven rotations, all including corn, wheat, oats and barley, and either with or without a legume, were started in 1932 on Marshall silty clay
loam soil (heavy subsoil phase). The land had been given a uniform application of 12 tons barnyard manure per acre four years previously. Six of these required six years and one nine years to complete the rotation. The legumes were either sweet clover, red clover, or alfalfa. Clovers were started with oats sown at half the normal rate as a companion crop and retained for either one or two seasons, while the alfalfa was sown alone in the fall and grown for two years. Each crop of a rotation was represented every year, and all rotations were in triplicate. The legume was always followed by corn. Since the effects of a rotation cannot be measured before it has completed at least one cycle, results of only the last four years, 1942-45, are here summarized:

Grain yields in various crop rotations on the Agronomy Farm at Lincoln, four-year average, 1942-45.

<table>
<thead>
<tr>
<th>Length of Rotation</th>
<th>Number of Rotations Avgd.</th>
<th>Kind of Legume Harvested for Hay</th>
<th>Manure Per Acre Before Winter Wheat</th>
<th>Yield of Grain Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Corn* Oats Winter Wheat Barley</td>
</tr>
<tr>
<td>6</td>
<td>1 or 2</td>
<td></td>
<td></td>
<td>13.6</td>
</tr>
<tr>
<td>6</td>
<td>1 or 2</td>
<td></td>
<td></td>
<td>14.3</td>
</tr>
<tr>
<td>6</td>
<td>1 or 2</td>
<td></td>
<td></td>
<td>15.1</td>
</tr>
<tr>
<td>6 or 9</td>
<td>3</td>
<td>Sweet clover, red clover, alfalfa</td>
<td></td>
<td>16.2</td>
</tr>
</tbody>
</table>

* All rotations had two years of corn except three years each in the alfalfa and one-year sweet clover rotations.
† Sweet clover plowed under for corn at a height of six inches in spring of second year.
‡ One rotation had two years sweet clover, one had two years red clover, and one had two years alfalfa in a nine-year rotation.

The six-year rotation, including two years of sweet clover and an application of 12 tons manure per acre, proved decidedly the most productive. In it the corn yielded 13 bushels higher, the winter wheat 10.1 bushels higher, the oats 6.9 bushels more, and the barley 5.9 bushels more per acre than on the non-legume rotation without manure. Such rotation management would be feasible on livestock farms in eastern Nebraska.

A 12-ton manure application increased the crop yields more than did two years of legume forage in the rotation. In these tests, sweet clover plowed under in the early spring of the second year proved inadequate. The low oats yield is attributed to its use as a companion crop sown at only half the normal rate (one bushel per acre).

The three rotations, including two years of either red clover, sweet clover or alfalfa, averaged higher for all grain crops than did the non-legume rotations. It should be pointed out that the forage legumes made relatively little growth during the drought years of the 1930's, and therefore had far less soil effect than would be expected following years of heavy growth. In building up non-irrigated soils with manure or legume rotations, care should be taken to avoid excessive fertility. It leads to over-stimulation of vegetative growth, exaggerating the drought hazard and the likelihood of small-grain lodging.

T. A. KIESSELBACH, W. E. LYNES.
Improvement of Small Grains

The past year was very favorable for small grains in yields and information obtained. Varietal reactions to diseases such as leaf rust and Septoria were unusually distinct. Oats made some record yields. Cool, damp weather during the late spring delayed maturity, and heavy rains just before harvest caused some lodging and twisting. This late maturity favored rust development so that valuable notes could be obtained on resistant lines.

At Alliance, winter wheat came through the winter with no killing and a good crop was harvested. The color of grain, glumes and stems was so well developed that varietal differences were very sharp. Spring wheat, barley and oats had outstanding grain quality, and some of the highest yields on record at the Box Butte Experimental Farm.

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

**Winter wheat.** Pawnee, the new winter wheat, continued to give good yields over a rapidly increasing acreage. As an average for nine years in Experiment Station tests at Lincoln, it has surpassed the yield of the standard Turkey by 32 per cent. Because of high yield, earliness, resistance to Hessian fly in the hard red winter wheat region, high resistance to loose smut, and some resistance to leaf and stem rust and to bunt, the variety is popular in southeastern Nebraska. Developed cooperatively by the Nebraska and Kansas Experiment Stations and the U. S. Department of Agriculture, it is recommended in this state for the area south of the Platte river and east of Highway U. S. 81. In 1945 about 8,000 acres were certified and it was estimated that 22,000 acres of the variety were not certified. They produced enough seed to plant from 600,000 to 800,000 acres for the 1946 crop.

Strains having stiff straw and rust resistance were the most outstanding. Selections from hybrid combinations such as Nebraska No. 60 x Mediterranean-Hope, Turkey x Cheyenne, Hope-Turkey x Cheyenne, and Marquillo x Oro gave the best yields at Lincoln in 1945.

At Alliance, Tenmarq yielded 41.4 bushels per acre, compared with 40.3 for Cheyenne, 38.9 for Kharkof, 37.4 for Nebred, and 36.9 for Pawnee. A new selection Cheyenne x Turkey 1062 (C. I. 12142) had a yield of 41.6 bushels per acre. This strain is best described as being a bunt-resistant Cheyenne. For a long period at this station Cheyenne has had the highest average yield, closely followed by Nebred and Nebraska No. 60. Tested for five years, Pawnee has averaged 27.4 bushels per acre, compared to 30.0 bushels for Cheyenne. Their performance is reversed in eastern Nebraska.

**Spring wheat.** The spring wheat variety test at Lincoln yielded from 16.5 to 4.4 bushels per acre. Leaf rust was heavy on all but the most resistant varieties. Kearney, Henry, Mida, Ceres, Rival, Pilot and Thatcher yielded in the order listed. Kearney continues to have the highest yield over a period of years, although Thatcher, Pilot and Rival have also performed relatively well. Lincoln is not in the spring wheat territory and yields are usually low.

At Alliance, Merit x Pilot (C. I. 12316) ranked first with an average yield of 34.9 bushels per acre. Other high-yielding varieties were Rival, Henry, Mida and Pilot, all of which ranked above Thatcher and Ceres. For a period of years Rival has made a good average yield as have Pilot
and Thatcher. Mida, a new variety from North Dakota, has performed very well during the two years it has been included in the test.

**Barley.** Velvon 11 (C. I. 7086), a new barley developed by the Utah Agricultural Experiment Station in cooperation with the U. S. Department of Agriculture, was added to the list of certified varieties in 1945. It is medium early, has smooth awns, white grain, and some resistance to loose and covered smuts. Because of its field performance, it is recommended primarily for the northeastern and northwestern counties of the state. A 12-acre increase field at the Box Butte Experimental Station produced 750 bushels of high quality seed. At Lincoln 250 bushels were produced. This supply was sold a few days after the variety was released for distribution.

Although weather conditions during the spring and summer were favorable for spring small grains, chinch bugs were a limiting factor in barley production at Lincoln. The most outstanding varieties in the nursery were a new Bulk selection (C. I. 7152) from Idaho, Velvon 11, and Peatland x Vaughn selection (S. D. 252). The Peatland x Vaughn selection is resistant to stem rust and has a good record at Lincoln and North Platte. Of the varieties tested which are suitable for malting, Wisconsin selection (C. I. 7143) and Minnesota selection (C. I. 7141) gave the highest yields and seem best adapted to Lincoln conditions.

Nearly all winter barley varieties came through with a good survival. The highest yielding ones were Purdue selection (28154A3-1-1-6-2), Tennessee Winter, and Michigan Winter. Reno is grown quite extensively in the southwestern counties of the state and is probably the best variety available for that area.

In the barley variety test at Alliance, all varieties with the exception of Spartan yielded over 50 bushels per acre. The highest yields were made by Velvon, Velvon 11 and Lico. Ezond and Velvon have the best long-time records. Velvon 11, Lion x Minia (C. I. 6980), and Titan yielded over 70 bushels per acre in the nursery.

**Oats.** Cedar oats continued to be popular in 1945. The first distribution for farm use was made by the Nebraska Station in 1943, and in 1945 8,000 acres yielding 225,000 bushels were certified. It is estimated that 12,000 additional acres were grown.

In the oat variety test at Lincoln, stem and crown rusts reduced the yields and caused lodging of susceptible varieties. Brunker, Kanota, Fulton and Kherson were low in yield and test weight and lodged badly. Clinton ranked highest with a yield of 71.4 bushels per acre, compared with 34.6 bushels for Kherson. Some other yields were 65.7 bushels per acre for Tama, 62.9 for Osage, 62.7 for Cedar, and 53.5 for Otoe. Clinton is a new variety being distributed by the Iowa station. It is a selection from a D69 x Bond hybrid, has at least as much rust and smut resistance as Cedar, and a heavier test weight per bushel. In 1944 it did not yield quite as high as Cedar and no recommendation can be made at present. The highest yielding varieties that have been grown for more than three years are Cedar, Tama, Boone and Marion of the disease-resistant types, Brunker and Otoe among the early types.

Results in the nursery at Lincoln were much the same as in the field plot test, in that Clinton and other D69 x Bond types gave the highest yields. It must be remembered that the season was very favorable for the later-maturing types.

Clinton, with a yield of 93.6 bushels per acre, and Fulton with 91.7 bushels ranked highest in the 1945 variety test at Alliance. Kanota,
Neosho, Brunker, Otoe, Cedar and Trojan ranked in the order listed. All varieties in the test yielded 75 bushels or more per acre, and no test weights were lower than 32 pounds per bushel. Of the varieties grown for several years Kanota, Fulton, Trojan, Brunker and Cedar have given highest average yields.

K. S. QUISENBERRY, O. J. WEBSTER, T. A. KIESSELBACH.

**Varietal response to time of planting oats and barley.** Four Nebraska-grown varieties of oats and two of barley have been tested during the last three years at early, medium and late planting dates, approximating April 1, April 10 and April 20. Average yields may be tabulated as follows:

### Comparative yields of oats and barley when planted at early, medium and late dates.

**Three-year averages, Lincoln, 1943-1945.**

<table>
<thead>
<tr>
<th align="left">Crop and Variety</th>
<th>Actual Yields Per Acre</th>
<th>Relative Yields</th>
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<tbody>
<tr>
<td align="left"></td>
<td>April 1</td>
<td>April 10</td>
</tr>
<tr>
<td align="left">Oats</td>
<td></td>
<td></td>
</tr>
<tr>
<td align="left">Cedar</td>
<td>72</td>
<td>66</td>
</tr>
<tr>
<td align="left">Otoe</td>
<td>52</td>
<td>49</td>
</tr>
<tr>
<td align="left">Trojan</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td align="left">Fulghum</td>
<td>44</td>
<td>36</td>
</tr>
<tr>
<td align="left">Average</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td align="left">Barley</td>
<td></td>
<td></td>
</tr>
<tr>
<td align="left">Ezond</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td align="left">Spartan</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td align="left">Average</td>
<td>26</td>
<td>22</td>
</tr>
</tbody>
</table>

All varieties reduced in yield with delayed planting. Relatively, Fulghum reduced the most and Otoe the least. The response of Otoe and Trojan were almost identical. Cedar surpassed the average yield of the other three varieties by 44 per cent when planted on April 1, 47 per cent on April 10, and 46 per cent on April 20. The lowest yield of Cedar at the latest date was equal to the best yield of any other variety at the earliest date.

The two barley varieties averaged only about half as many bushels per acre as the average of the four oat varieties, and approximately one-third the yield of Cedar oats at each date. Considering that the percentage of hull approximates 30 per cent in oats and 15 per cent in barley, the yield of feed units per acre is distinctly greater for oats. In fifteen years this relationship has been reversed because, in part at least, of greater progress in the breeding of oats than of barley. The greater susceptibility of barley to chinch bugs has also been a factor. For these reasons, barley acreage has been decreasing in proportion to that of oats.

The response of spring grains to early planting is great. Where these crops follow corn, the seedbed should be prepared by disking if it will speed up the work preparatory to planting.

T. A. KIESSELBACH, W. E. LYNES.

**Sorghum Improvement**

Weather conditions during the 1945 season were not particularly favorable for sorghum production over most of the state. A wet, cold spring
was followed by one of the coolest Junes on record. Although most of
the crop was planted during the last week of May, little growth had been
made by early July. Heading was a few days later than average but at
Lincoln all varieties were matured by the end of September. Chinch
bugs were again a limiting factor in southeastern Nebraska. They killed
almost 100 per cent on a few plots of susceptible varieties at Lincoln.
Good control was effected in the Sudan grass yield test by two dustings
with DDT and Sabadilla.

Breeding. As a result of the war, a special demand has been created
for starch from sorghum grain which has the waxy type of endosperm.
Cody, developed by the Ft. Hays (Kansas) Experimental Station, is the
only "waxy" variety now being grown commercially. The starch from
this grain is used to make a food substitute for tapioca. Because of the
value of this type of starch not only for human food but also for adhe­
sives, paper sizings, etc., financial grants have been made by industry
through the Midwest Research Institute of Kansas City, to the Agricul­
tural Experiment Stations of Nebraska, Kansas and Oklahoma to aid in
breeding better adapted waxy varieties. Numerous crosses have been
made at Lincoln, most promising of which is a group of selections from
back crosses between Western Blackhull x Day (Nebr. No. 45) and Cody.
These are moderately early, combine types having waxy seed.

Grain varieties. The testing of commercial and experimental varieties
was continued. Highest yield in all tests was 90.4 bushels per acre made
by Kalo selection (H. C. 613). As is usual at Lincoln, the highest yields
were made by full-season varieties tolerant to chinch bugs. In the main
test, yields ranged from 82 bushels per acre for Western Blackhull x Day
(Nebr. No. 44) to 29.5 bushels for Day; ten of the 33 varieties gave average
yields above that of corn. The principal commercial varieties gave the
following yields per acre: Club 79.1, Western Blackhull 72.1, Bonita 70.9,
Pink kafir 70.9, Coes 65.9, Early Kalo 62.3, Midland 55.1, and Martin 48.9
bushels. Of these, Midland and Martin are recommended as combine
varieties for the grain sorghum area of the state—the south-central
counties.

Forage varieties. Grain yields of the ten forage varieties tested ranged
from 65.4 bu. per acre for Norkan to 43.4 bu. for Leoti x Atlas (H. C. 42-27).
In the production of forage figured on a 15 per cent moisture basis, yields
ranged from 6.2 tons per acre for the early Atlas selection (Conable No. 1)
to 4.4 tons for Fremont. On a 70 per cent moisture basis which corre­
sponds with that of ensilage, these yields range from 17.5 tons per acre
to 12.4 tons. The later varieties, Atlas and Kansas Orange, did not make
their usual high yields because of a shortage of soil moisture late in
the season.

Sudan Grass. Interest is being shown in Nebraska for the new Sudan
grass variety, Texas Sweet, recently released by the Experimental Sta­
tion at Lubbock, Texas. It has a lower average yield for the past two
years at Lincoln than Wheeler, the Nebraska certified strain. In 1945,
however, it was superior to Wheeler in forage yield, which may be ex­
pected most years because it is relatively tolerant to chinch bugs and is
later maturing. Its forage is of better quality and it provides more
palatable pasture. For the past two years at Lincoln, Texas Sweet has
been high in prussic acid and caution is advised if it is used for pasture
in this state. Its seed yield was higher this year than that of any other
strain tested.
Seed increases and distribution. Some 40 farmers in the northern and western counties of the state were each furnished with 30 pounds of Fremont seed for increase and testing. This is an early maturing, forage variety well adapted in the counties where it was distributed. Several growers have reported a good crop of high quality forage.

Numerous Leoti selections have been tested at Lincoln during the past four years. A few of the best were planted in an isolation block, the seed harvested was bulked, and ten bushels of it will be available for distribution in 1946.

The sorghum yield tests at Alliance included nine grain and six forage varieties planted in replicated plots. All grain varieties were immature at the time of frost the middle of September. The sorghum nursery included 30 varieties in single rows for observation, 71 rows of hybrid material, and six plots of F₂ material. O. J. Webster, T. A. KiesSELbach.

Corn Improvement

The Nebraska acreage of hybrid corn took another jump in 1945, the preliminary estimate being 85 per cent of all corn planted in the state. Its slow acceptance in dry-land areas of western Nebraska is due to lack of adapted, superior, early maturing types that can be recommended.

In the Experiment Station corn-breeding program, hybrid combinations were tested at 19 locations within the state in 50 different experiments, as follows: 13 top-cross tests of new lines, 11 single-cross tests, and 26 tests involving double-cross hybrids.

Selection and testing of new lines for use in hybrids. The method now in use for the isolation of new inbred segregates is to top cross all new material rather early in the selfing program to suitable testers. These top crosses are then grown in the region of the state believed to be suited. Only the best segregates as judged by their top cross performance are chosen for further inbreeding and selection. The second heavy elimination of new lines is done on the basis of single-cross performance data. All possible single-cross combinations among a given set of lines are made up for this purpose, and are tested extensively in yield trials for final evaluation as to combining ability and general agronomic characteristics of the lines.

In addition to using single-cross performance as a measure of line value in crosses, the data provide a means for predicting suitable double-cross combinations that can be made for further testing. The plan now in use is to test single crosses over a two-year period, then to make and test the most promising predicted double crosses. The two-year predicted data are taken as the equivalent of an equal amount of testing of the doubles themselves; thus if a superior three-year average performance is indicated for a new combination, it is assumed worthy of consideration for commercial production. No new combinations are released for farm use unless they show improvement over those hybrids now in production. This helps avoid further confusion for the farmer who is obliged to choose from among a great many comparable hybrids that are offered for sale.

Seed of more than 100 locally adapted open-pollinated varieties was collected from farmers in the western half of the state in the spring of 1945. These varieties were entered in tests located in their general area of adaptation, so that those showing superior characteristics could be utilized for future inbreeding and hybridization for western Nebraska areas.
The dent corn breeding nursery contained 3,854 progeny rows distributed as follows: 1,486 of segregating populations; 201 for line increase; 1,384 for single-cross production; 432 for double-cross production; and 251 for miscellaneous research. About 25,000 hand pollinations were made.

A breeding nursery was planted at the North Platte Station for the first time in 1945, to assist in the isolation of early ripening lines from native varieties suitable for use in western Nebraska hybrids.

**Popcorn hybrids.** The use of popcorn as a confection has greatly increased in recent years. Popcorn hybrids were again tested in three locations in the state. A continued superiority over the varieties both in yield and popping expansion was noted. There is still considerable room for improvement, particularly as regards standability.

**Waxy corn breeding and testing.** In breeding work to develop productive hybrids of waxy corn, whose starch has a special industrial value as a replacement for tapioca, the more promising of 1,500 waxy lines were advanced another generation by inbreeding or backcrossing. Twenty-six top crosses of waxy lines on the open-pollinated variety, Nebraska Waxy, were tested for performance, preliminary to making single crosses. The new Iowa waxy hybrid, Iowax 2, was included in the yield test at Lincoln for the first time. The following acre-yields were obtained on the agronomy farm as averages for four replications: Iowax 1, 50.6; Iowax 2, 56.9; Nebraska Yellow Waxy 1 (open pollinated), 56.9; Nebraska White Waxy (open pollinated), 50.1; the highest yielding top cross, 57.8 bushels. In comparison the standard non-waxy hybrids yielded as follows: Iowa 939, 56; Iowa 306, 61.2; and U. S. 13, 64.8 bushels.

**Full-season hybrids most productive.** In comparative tests of Nebraska certified hybrids, maximum yields are to be expected in eastern Nebraska from hybrids that ripen fully but utilize practically the entire growing season. The lower yield capability of good hybrids that ripen a week or more earlier than so-called full-season corn cannot be sufficiently compensated by closer spacing of the plants. For example, during the last two years at Lincoln, U. S. 13 has averaged about 15 per cent higher grain yield than Iowa 939 on an equal moisture basis.

**Detasseling as a hazard in hybrid seed corn production.** Detasseling, a necessary practice with the production of hybrid seed in crossing fields, does not materially affect grain yields unless accompanied by loss of leaves or followed by a heavy infection with smut that is induced by the stalk injury. Pulling the upper one, two or three leaves with the tassel reduced the grain yield two, four, and 12 per cent. Such losses can be understood when it is realized that the pulling of all leaves at the time of tasseling causes a complete failure of grain development.

Pulling tassels may bring about a heavy smut epidemic by infection at the point of stalk injury. The development of large smut galls on 60 per cent of the plants was found to reduce grain yields of the infected plants by 46 per cent in one crossing field.


**Pollination Habits of Grasses**

The procedures of improvement by selection and breeding vary for different groups of forage grasses according to whether they normally produce seed by self-fertilization or cross-fertilization. Most species of importance as pasture grasses in Nebraska are normally cross-fertilized.
During the past two years, studies were made of the specific pollination habits and distances of pollen dispersal of numerous cross-pollinated grasses. Approximately 7,500 vaseline-coated glass microscope slides were exposed for definite periods during the two seasons to measure the amounts of grass pollen in the air.

Sixteen cool-season and 13 warm-season grasses growing in isolated fields were studied to determine the time of day and the number of days of blooming and pollen shedding. In the cool-season group the daily period of pollination was found to occur in the morning for rye, timothy and Kentucky bluegrass, while for the remaining grasses of this group, including bromegrass, crested wheatgrass, intermediate wheatgrass, western wheatgrass, Russian wild rye and tall fescue, it occurred in the afternoon. In all of the warm-season grasses studied, including buffalograss, blue grama, side-oats grama, switchgrass and the bluestems, the daily period of pollination was found to begin in the forenoon. With most of these grasses the period of pollen dispersal by an individual inflorescence extended over seven or eight days, with four and twelve days being the extremes.

Dispersal of pollen was studied at distances of five, 15, 25, 40, and 60 rods from isolated fields of seven grasses. The larger amounts of pollen were caught to the north of these fields, opposite the direction of the prevailing wind. As compared with large amounts of pollen in the air at the source, the pollen load decreased rapidly as the distance from the field was increased. Results show that chances of maintaining genetic identity are greater when seed is produced at 60 rods as compared to 40 or 25 rods. Even at 60 rods the pollen caught, representing several thousand pollen grains per square foot, is sufficient to be considered as a possible source of contamination in the field production of pure seed stocks.

MELVIN D. JONES, L. C. NEWELL.

Grass Seed Production in Cultivated Rows

GRASS SEED PRODUCTION in cultivated rows has been found feasible, especially for certain cool-season grasses, under dry-land conditions in central Nebraska. This conclusion has been reached from studies conducted jointly since 1937 by the nursery section of the Soil Conservation Service, the Nebraska Experiment Station, and the North Platte Substation. Tests were made with cool-season grasses (crested wheatgrass, Russian wild rye, western wheatgrass) and warm-season grasses (big bluestem, switchgrass, side-oats grama, blue grama) when close drilled as compared with cultivated rows spaced 18, 30 and 42 inches apart.

Warm-season grasses. Of the warm-season grasses, side-oats grama appears most promising for seed production in cultivated rows on dry land. Although the yields were not high, in years of average or greater than average rainfall they were only slightly less than those obtained under irrigation. Blue grama yielded about as much seed and forage in solid stands as in the 30 and 42-inch rows. The 18-inch rows showed a slight advantage in yield over the other spacings.

Big bluestem and switchgrass produced up to two and one-half tons of hay (12 per cent moisture) per acre in the 30 and 42-inch rows, but only in one year out of the eight were seed yields sufficient to be profitable. The solid-drilled stands of big bluestem, switchgrass and side-oats grama were killed by drought and weed competition during the summer of 1940.
All of the grasses made good growth in cultivated rows of all widths every year but considerable hand labor was required to keep the rows free of weeds during the first three summers following spring seeding. Thereafter, one or two cultivations each spring were sufficient. In four years out of eight the warm-season grasses failed to produce any seed. Only during years of high rainfall was sufficient seed produced to warrant harvest.

Intermediate wheatgrass, left, and crested wheatgrass, right, for seed production in 40-inch double rows on dry land at North Platte. The grasses were planted on summer-fallow ground September 23, 1944. Photographed May 22, 1945. Some residue of the oats, planted in 40-inch double rows August 27, to control soil blowing during the winter, still remains on the soil surface between the rows of grass. The lower picture shows the same field two months later, July 21, 1945, when the grasses were in bloom. Intermediate wheatgrass, left, and crested wheatgrass, right, planted September 23, 1944, produced 205 and 175 pounds of seed (90% pure) per acre, respectively, in 1945. (Pictures were taken by Soil Conservation Service.)
Cool-season grasses. Most of the cool-season grasses are well adapted for seed production in cultivated rows. Their early and vigorous growth during the cool weather of spring results in control of the annual weeds within the rows and in early maturity of the seed before the hot, dry weather of summer. Accordingly this group of grasses offers the most promise for economical seed production under dry-land conditions. Yields of seed of crested wheatgrass and Russian wild rye during the 1941-1945 period were as follows:

<table>
<thead>
<tr>
<th>Manner of Planting</th>
<th>1941</th>
<th>1942</th>
<th>1943</th>
<th>1944</th>
<th>1945</th>
<th>Av.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled</td>
<td>19</td>
<td>53</td>
<td>none</td>
<td>123</td>
<td>57</td>
<td>50</td>
</tr>
<tr>
<td>18-in. rows</td>
<td>180</td>
<td>338</td>
<td>none</td>
<td>122</td>
<td>51</td>
<td>137</td>
</tr>
<tr>
<td>30-in. rows</td>
<td>236</td>
<td>458</td>
<td>none</td>
<td>194</td>
<td>179</td>
<td>212</td>
</tr>
<tr>
<td>42-in. rows</td>
<td>315</td>
<td>440</td>
<td>none</td>
<td>136</td>
<td>163</td>
<td>209</td>
</tr>
<tr>
<td>Diff. req. for sig., 5% level</td>
<td>104</td>
<td>114</td>
<td>......</td>
<td>14</td>
<td>24</td>
<td>......</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kind of Grass</th>
<th>Pounds of Seed Per Acre (Purity of 90%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1944</td>
<td>1945</td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>390</td>
</tr>
<tr>
<td>Lincoln bromegrass</td>
<td>370</td>
</tr>
<tr>
<td>Russian wild rye</td>
<td>325</td>
</tr>
<tr>
<td>Feather bunchgrass</td>
<td>155</td>
</tr>
</tbody>
</table>

Western wheatgrass blooms and matures its seed two to four weeks later than other cool-season grasses, hence the yield of seed is more likely to be reduced by heat and drought during early summer. Seed yields of 80 per cent purity obtained from rows spaced 30 and 42 inches were 131 and 116 pounds per acre, respectively, in 1941 and 104 and 101 pounds per acre in 1942. Yields obtained from other spacings and during the other years were too low to be profitable. No seed was produced in three of six years, 1938 to 1943.

That seed of cool-season grasses can be produced profitably on dry land has been demonstrated further by plantings on a field scale at the North Platte Substation. Approximately 4.6 acres of crested wheatgrass, 5.1 acres of Lincoln bromegrass, 9.3 acres of Russian wild rye, and 3.6 acres of feather bunchgrass were planted on the contour in 40-inch rows on summer-fallowed land September 8-10, 1942. A light crop of seed of crested wheatgrass, bromegrass and feather bunchgrass was produced in 1943, but was lost due to hail on June 12. The yields of seed obtained in 1944 and 1945 were as follows:

<table>
<thead>
<tr>
<th>Kind of Grass</th>
<th>Pounds Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1944</td>
<td>1945</td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>390</td>
</tr>
<tr>
<td>Lincoln bromegrass</td>
<td>370</td>
</tr>
<tr>
<td>Russian wild rye</td>
<td>325</td>
</tr>
<tr>
<td>Feather bunchgrass</td>
<td>155</td>
</tr>
</tbody>
</table>

A similar planting of 4.4 acres of crested wheatgrass and 6.9 acres of intermediate wheatgrass was made on summer-fallowed land September 23, 1944. Crested wheatgrass produced 175 pounds and intermediate wheatgrass 205 pounds of seed (90 per cent pure) per acre in 1945.

E. C. Conard.
Time of Cutting Prairie Hay

SIX HUNDRED FORTY acres of virgin prairie land four miles south of Virginia, in Gage county, has been granted to the University of Nebraska Foundation by Dwight Dalby, Beatrice, as a memorial to his wife, Hannah Virginia Lewis Dalby, and her father, Ford Lewis. The gift was made with the stipulation that, except for such experimental purposes as the University wishes, the land shall be preserved in its natural condition. For many years approximately one-half of the land has been pastured and the other half has been cut for hay.

The grant makes possible additional research with native hay and pasture under southeastern Nebraska conditions. Management of the land has been assigned to the Agronomy Department and research work has been started in cooperation with the Animal Husbandry Department.

A study to determine the effects of time of cutting on the yield and quality of native grass hay and on the vigor and density of the many plant species in the meadow was initiated in 1945. Twenty-five plots, 4.18 to 6.77 acres in size, were laid out in five series. Plots in each series are of the same size and are located so as to be similar in topography and vegetative composition. Cutting treatments begun in 1945 to be continued over a period of years are: early cutting each year; mid-season cutting each year; early cutting and mid-season cutting in alternate years; and late cutting each year. The aftermath growth produced on the early-cut plots in favorable years will be harvested toward the end of the season.

Harvesting of the hay for yield determinations in 1945 was carried out under the supervision of M. L. Baker of the Animal Husbandry Department. The yields calculated on the basis of 12 per cent moisture are as follows:

<table>
<thead>
<tr>
<th>Cutting Method</th>
<th>Yield ( tons per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early cutting (July 6-12)</td>
<td>1.12</td>
</tr>
<tr>
<td>Aftermath cutting (Sept. 16-19)</td>
<td>.44</td>
</tr>
<tr>
<td><strong>Total for two cuttings</strong></td>
<td><strong>1.56</strong></td>
</tr>
<tr>
<td>Mid-season cutting (Aug. 6-15)</td>
<td>1.43</td>
</tr>
<tr>
<td>Late cutting (Sept. 10-15)</td>
<td>1.51</td>
</tr>
</tbody>
</table>

Chemical analyses of samples of the hay from each cutting will be made and comparative palatability, digestibility and nutritive value will be determined through feeding trials.

Permanent transects have been established in each plot and initial surveys of the desirable legumes and undesirable weeds have been made, preparatory to studying the effect of time of cutting on these species. Permanent quadrats will be located and mapped during the spring of 1946 to provide the initial data needed to study the effect of time of cutting on the vegetation of the different soil types and slopes.

E. C. CONARD, L. C. NEWELL.

Selection and Improvement of New Forage Legumes

IT IS RECOGNIZED that perennial grasses make a better growth and furnish better pasture when grown with a legume in the mixture. The only perennial legume commonly seeded with grasses in Nebraska is alfalfa which, in combination with bromegrass for pasture and hay, has been widely recommended for eastern counties and for irrigated sections of the state. Since the drouth years, the seeding of white clover in pastures has been nearly discontinued. The biennial legumes, sweet clover and red clover, are sometimes grown with bromegrass.
Birdsfoot trefoil. This European legume, *Lotus corniculatus*, has been tested at the Experiment Station since 1940 in mixtures with various cool-season and warm-season grasses. Although slow in becoming established, it produces good yields on soils of high fertility and also appears relatively well adapted to dry slopes and to clay soils of low fertility. The mat-like character of vegetation makes it an ideal legume for use with grasses in erosion control. Growth begins early in the spring and continues well throughout the season under favorable conditions. It produces a mass of yellow bloom early in the summer and may continue to flower and set seed throughout much of the season. Yields and stands have been reduced, but partial stands in experimental grass pastures have been maintained over a five-year period under severe grazing by sheep. The crop is susceptible to the root disease known as charcoal rot. Lack of information on the best methods of stand establishment and the high price of seed have been limiting factors to recommending this legume for planting except on a small scale. Early spring seeding has given the best stands. The seed is very small and a seeding rate of two to five pounds per acre is sufficient in grass mixtures. The prostrate habit of growth when grown alone or in sparse stands of grass has made the harvest of seed a difficult problem. Of the several commercial strains, the New York Broadleaf is most suitable for Nebraska. Judging from the progeny performance of individual plant selections made from seed of New York and European origin, birdsfoot trefoil offers much promise of improvement. Twenty-five selections, which differ widely in vegetative characters and have remained healthy over a period of four years, are being used in the development of new strains by hybridization.

Two new vetches. A recently introduced species, *Astragalus cicer*, referred to as milk vetch, is of particular interest because of its manner of spreading over the ground and its ability to compete with weed growth. It has large, coarse, succulent stems and a heavy growth of compound leaves. It spreads by means of long underground stems or rhizomes from one to four inches beneath the surface of the ground. Although it roots deeply, numerous roots also occur in the surface soil and are effective during much of the growing season in controlling the growth of shallow-rooted annuals. These characteristics suggest that it would be a desirable plant to use with grasses for erosion and gully control. It has been determined experimentally to be easily killed by plowing, since the rhizomes are so near the ground surface. Seed supplies of this legume are being increased for further tests. Distribution for farm use will be withheld until more is known about its nutritive value and its ability to grow in combination with grasses. Another legume of interest is crown vetch, *Coronilla varia*. This plant may prove to be of value for gully control as it makes a profuse growth. Its bitter taste, however, is indicative of low value as a forage plant.

A warm-season forage legume. Korean lespedeza, *Lespedeza stipulacea*, is a low-growing summer annual peculiarly adapted to the heavy upland and sloping soils of southeastern Nebraska. Its chief value is for pasture and soil building on rather thin and eroded soils. The roots of lespedeza are fibrous and branching, and do not leave the soil in as loose and erodible condition as do legumes with large tap roots. The area of Nebraska to which lespedeza is adapted is somewhat limited in that frost often catches the plants before the seed has fully matured. Selections of Korean lespedeza show marked differences in dates
of maturity. A strain known as Korean 19604 was compared with ordinary Korean at Lincoln and not only was it two weeks earlier in maturity but it gave an average seed yield of 8.4 bushels per acre, as compared with 2.8 bushels for the common Korean. Unfortunately the Korean selection 19604 is susceptible to wilt disease. From preliminary tests it appears that some of the newer selections resulting from breeding programs offer promise of combining earliness and wilt resistance with satisfactory yield under these Nebraska conditions.


Sweet Clover

Breeding. Attention continued on the improvement of sweet clover with respect to yield, fineness of stem, lateness of maturity, seed production and coumarin content.

Seed increase plots were established for two newly developed varieties. One is a fine-stemmed, very leafy, white-flowered variety which may have possibilities as a hay-type sweet clover. The other is a late-maturing, yellow-flowered variety tentatively called Rasmussen Late Yellow. It is the latest maturing sweet clover known. The plants continue to grow until late fall of the second year. It is, however, a poor seed producer due to the indeterminate nature of flowering and the many seeds that fail to mature before fall frosts. Determination of its full potentialities must await thorough testing in different parts of the country.

Work on increasing the palatability of sweet clover has centered largely around efforts to reduce the content of coumarin, responsible for bitterness and the toxicity of spoiled hay. Partial success has been attained by isolation of plants quite low in coumarin but the non-toxic level has not been reached.

For the intelligent pursuance of the assay program, information is necessary on the causes of variation of coumarin in sweet clover. During the first year of growth the coumarin content increases from the seedling stage until the peak is reached in mid-summer. Thereafter it decreases rapidly until late fall when very little coumarin remains in the above-ground portions of the plant. Bio-assays with rabbits fed experimentally spoiled hay were conducted to determine whether spoiled hay is non-toxic when harvested in late fall. These studies showed that the toxicity is greatly reduced but that the danger of the bleeding disease is not entirely eliminated, especially if the spoiled hay is fed over a long period of time. Pioneer, a non-bitter variety, found to contain coumarin in a bound form, proved as toxic as the commonly grown bitter varieties.

Sweet clover seed production. Studies were continued to determine the best methods of planting, field treatment, harvesting and threshing sweet clover for seed.

The smaller growing sweet clover varieties, as Common Yellow and Madrid, may under average field conditions be harvested with a grain binder without great difficulty, and threshed with a combine or grain separator. On the other hand, the height attained by the tall, coarse varieties may become so great without special reduction treatment that the harvesting and threshing of a seed crop cannot be economically accomplished. The tall, late types in 1945 reached a height of five to seven feet under favorable moisture conditions on fertile soil. While the five-foot growth could be cut with a grain binder with some difficulty, it was necessary to cut the seven-foot crop with a corn binder at relatively high cost in time and labor. To determine a practical method for vegetative
An excellent volunteer stand of fall-germinated Evergreen sweet clover, from which a seed yield exceeding six bushels to the acre was harvested in 1945 following a seed yield of seven bushels in 1944. Sweet clover fields will produce seed crops two or more years in succession, when moisture conditions following harvest are good and volunteer stands are well established before winter.

To control, two tall, coarse-growing varieties have been subjected since 1943 to four different clipping treatments in the spring of the second year of growth.

Clipping once in early spring when 15 inches tall and leaving a 10-inch stubble reduced the average mature height of the Spanish variety from 50 to 37 inches, and of Evergreen from 57 to 46 inches. Clipping once when 24 to 30 inches tall reduced the height of Spanish to 31 inches and Evergreen to 43 inches, while clipping two different times when 15 inches tall reduced Spanish to 28 inches and Evergreen to 38 inches. Delay in clipping until the initial bud stage resulted in excessively short and weedy growth and small seed yields. Best yields were obtained by clipping once when plants were 15 inches tall to simulate early spring grazing. Vegetative growth was sufficiently reduced to permit economical harvest with a grain binder and threshing with a pick-up combine or a grain separator. Although the seed yield of Spanish was reduced 33 per cent by this treatment, Evergreen was not reduced significantly. More severe clipping treatments gave much greater reduction in seed yield. It was indicated that fields subjected to grazing in early spring should be clipped after the removal of livestock and before the height of ungrazed areas exceeds 20 inches. This second-year clipping should never be closer than 10 inches above ground.

Harvests of Evergreen sweet clover seed at different stages of maturity in 1945 verified results of the preceding year. The best seed yields were obtained by harvesting when 30 to 60 per cent of the seed pods had turned brown. Above 60 per cent, seed shattering of the 1944 and 1945 standing crops increased rapidly.
Sweet clover fields will produce seed crops two or more years in succession under these conditions when rainfall is sufficient following seed harvest to produce well established volunteer stands before winter. At Lincoln in 1944, as an example, the volunteer stand of Evergreen established in that fall produced a 1945 seed yield exceeding six bushels to the acre.

These sweet clover studies are cooperative with the division of forage crops and diseases of the U. S. Department of Agriculture.


Alfalfa Investigations in 1945

The season of 1945, although not outstanding for alfalfa seed production, was much more favorable than 1944. Throughout the state the average yield of seed per acre was only slightly more than in 1944 but almost twice the acreage was harvested, resulting in a production of nearly twice that of 1944 and a fourth more than the 10-year average. At Lincoln the season was favorable for establishment of natural crossing blocks for experimental production of hybrid seed. Warm, sunny weather during late July was favorable for beneficial insect activity and a satisfactory seed set was obtained. The long, dry fall was ideal for harvesting seed of high quality and in most cases sufficient seed was obtained from natural crossing blocks to provide for the cooperative testing of experimental combinations throughout the United States. As in 1944, forage production in most parts of the state was considerably above the 10-year average.

Selection and performance of clonal lines. In recent years the alfalfa improvement work has centered around selection and evaluation of clonal lines. Easily propagated vegetatively, an individual alfalfa plant serving as a source of cutting material can be increased to any desired number of plants, all identical in their genetic make-up. Such a group of rooted cuttings having a single plant as their common origin is known as a clonal line. Two or three hundred lines are selected each year from six or seven thousand plants in a breeding nursery established with individual plants which have survived a severe inoculation with the organism causing bacterial wilt. Three to six years are required to evaluate these lines.

A clonal line, after selection as an outstanding plant in a breeding nursery, is advanced to a clonal observation nursery where critical observations eliminate inferior lines. The best ones are thereafter included in a clonal polycross nursery, each line replicated several times. The entries are evaluated for production of both seed and forage, self-fertility, foliage color, vigor, resistance to leaf hoppers and other insects, and general desirability. The few lines proving superior by these as well as progeny tests are included in natural crossing blocks where all possible single-cross combinations are made. Evaluation of these single-cross progenies makes possible the prediction of those hybrid and synthetic combinations most likely to be superior. All clonal lines of possible value are maintained in a permanent nursery to serve as a source of cutting material for further testing of desirable combinations. In addition to the evaluation of clonal lines under field conditions the more promising lines are also evaluated for their resistance to bacterial wilt and cold under controlled conditions.

In the clonal nurseries for 1945, seed production varied from less than one to over 11 grams per plant while cured forage production varied from five to over 100 grams on the same basis. Ranger averaged 3.4 grams of seed and 48.5 grams of forage per plant. A variation of equal magnitude was observed for other characteristics.
The hybrid progeny performance of clonal lines. The open-pollinated or hybrid seed produced on clonal lines is evaluated for resistance to cold, bacterial wilt, insects, and for forage and seed production. A controlled cold test is conducted each fall. Seedlings started in greenhouse flats in late August are allowed to harden under natural fall conditions and are frozen in a controlled freezing chamber at \(-14\) to \(-20^\circ C\). during October and November. Although other factors are involved in winter hardiness the test permits the elimination of much susceptible material. In the 1945 test 67 entries were included. Twenty-nine proved equal to or better than Ranger with 38 inferior. The data listed below for varieties known to differ in winter hardiness illustrate the value of a controlled cold test as an index of winter hardiness under proper conditions of hardening and freezing.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Relative % Survival</th>
<th>Cold Resistance Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranger</td>
<td>43</td>
<td>100</td>
</tr>
<tr>
<td>Buffalo</td>
<td>32</td>
<td>74</td>
</tr>
<tr>
<td>Kansas Common</td>
<td>14</td>
<td>33</td>
</tr>
<tr>
<td>Arizona Chilean</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

Most devastating and widespread of alfalfa diseases is bacterial wilt. Wherever fertility and especially soil moisture conditions are favorable for the maximum growth of alfalfa, bacterial wilt is prevalent and makes its appearance during the second or third year. Fortunately the technic for determining whether a variety or strain is resistant to the disease is well worked out and susceptible strains can be eliminated in a controlled test within two or three months from the time of planting. Two tests of this type are conducted each year, one in the field and one in the greenhouse, with excellent results. Over 200 entries are included in these tests with Grimm and Hardistan as susceptible and resistant checks, respectively. Grimm usually shows from one to three per cent healthy plants with Hardistan ranging from 15 to 35 per cent, depending upon the severity of the test. Hardistan is generally considered to be sufficiently resistant for field conditions. Hybrid progenies included in these tests range from equally susceptible to Grimm to several times more resistant than Hardistan.

Several yield tests are planted each year, most of which are conducted on a biennial basis, since it has been found that with uniform stands the yield the first two years is closely correlated with the yield of subsequent years. The controlled tests for resistance to cold and wilt are relied upon to provide an estimate of stand longevity.

During the past year 16 hybrids yielded significantly more forage than Grimm. A few of the more interesting are given below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Tons Per Acre [(12% Moisture)]</th>
<th>Per Cent of Grimm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cross 33-1015 x 1019</td>
<td>6.78</td>
<td>121</td>
</tr>
<tr>
<td>Single cross 33-1019 x 1124</td>
<td>6.71</td>
<td>120</td>
</tr>
<tr>
<td>Polycross 39-1019</td>
<td>6.84</td>
<td>122</td>
</tr>
<tr>
<td>Polycross 39-1268</td>
<td>7.01</td>
<td>125</td>
</tr>
<tr>
<td>Polycross 39-1269</td>
<td>7.14</td>
<td>127</td>
</tr>
<tr>
<td>Synthetic variety, Ranger</td>
<td>5.87</td>
<td>105</td>
</tr>
<tr>
<td>Standard variety, Grimm</td>
<td>5.58</td>
<td>100</td>
</tr>
</tbody>
</table>
In other tests the value of the polycross (comparable with a top cross in corn) in predicting general combining ability has been clearly demonstrated, a fact which greatly simplifies the evaluation of clonal lines.

**Breeding alfalfa for large seed and easily tripped flowers.** An easy tripping clone obtained from the Colorado Agricultural Experiment Station was grown for the first time in 1945. This clone was observed to have 35 per cent of its flowers tripped whereas surrounding clones averaged less than 10 per cent. Few wild bees were present and most of the tripping was believed done by honey bees which were plentiful in the nursery at that time. In other respects this clone has little value and a back-crossing program is being inaugurated in an attempt to transfer the easy tripping character to more desirable clones. The successful transfer of this character to a superior variety or hybrid, making it possible to obtain satisfactory pollination with honey bees, would remove one of the greatest hazards involved in alfalfa seed production.

Another clone having large seed and showing considerable resistance to leafhoppers, a serious alfalfa pest east of Nebraska, has been obtained from Wisconsin. This line is also relatively undesirable in other respects and an attempt is being made to transfer its desirable characters to more useful clones.

Unlike most crops, alfalfa does not lend itself to the development of numerous regional strains. As a result, the improvement program has become cooperative on a nation-wide scale. The principal objective of the National Alfalfa Improvement program, in which Nebraska plays an important part, is the development of a superior hybrid or synthetic variety adapted to the entire northern section of the United States.

**Soybean Improvement**

The climatic conditions prevailing in Nebraska during 1945 had an adverse effect on the yield of late maturing soybean varieties. The cool, moist spring and early summer, followed by a dry late summer and fall favored the early varieties of northern adaptation. Soybean yields, as a rule, were somewhat lower in 1945 but the plants were remarkably free of injury by insects and diseases.

The performance of certain new selections suggests that within a few years farmers may have more productive varieties than those now in use. The increase and distribution of these new varieties, however, must be delayed until further testing confirms their superiority. One such experimental strain tested at Wayne, Nebraska, is the A3-108 which yielded 27.8 bushels as compared with 24.8 bushels for Richland, the highest yielder among commonly grown varieties.

In a yield test of later maturing varieties at Lincoln, the experimental strain A3-176 yielded 24.2 bushels as compared with 22.8 bushels for the Lincoln variety and 21.9 for Dunfield. In the same test the two very late varieties, Chief and Patoka, gave relatively low yields of 17.8 and 16.5 bushels per acre, respectively.

A performance test was made of 125 hybrid lines of the sixth generation; a number were sufficiently superior to warrant further testing.

The attractive war-time prices of Mung beans have prompted inquiries regarding possibilities of growing the crop in this state. Mung beans have been grown in performance tests along with edible soybeans for the past three years at the agronomy farm near Lincoln. The better
varieties have averaged around five bushels per acre during this period. Because of a vine-like and prostrate growth, their production cost is greater than that for soybeans. The limited demand, as well as the prospects for resumption of imports from the Orient, should discourage extensive plantings of this legume.

Studies were continued to determine the effect of seed inoculation with commercial cultures on the yield of soybeans. In the 1945 test the inoculated soybeans yielded 20 bushels per acre compared with 17.3 bushels for those without inoculation.

J. M. Slatensek.

Crops of Chemurgic Interest

Introduction and Testing new crops of industrial promise is being continued in cooperation with the University of Nebraska chemurgy project. This year perilla and chia were added to the list of those under investigation. Weather conditions, particularly during the spring and late summer, were not favorable for the production of oil-seed crops in Nebraska. Most of these were two to three weeks late in maturing which adversely affected not only yield but seed quality. However, the unfavorable conditions were somewhat of an advantage because selections or varieties which were able to make normal growth were easily recognized.

Safflower. High humidity associated with frequent showers during July and August was detrimental to safflower in 1945. Average yields at Alliance, Hay Springs, Scottsbluff and Sidney for all varieties were 1,025, 492, 314, and 317 pounds per acre, respectively.

Two years' results from comparing flax with safflower in western Nebraska have shown that unless weeds are a limiting factor there are no significant differences in yields for either of these crops, when grown in 6-inch non-weeded and 24 and 42-inch cultivated rows. When weeds are a limiting factor in the production of either crop, higher yields are obtained in cultivated rows than in solid drilling. Safflower produced significantly higher seed yields than flax in three of the four tests made. However, because of higher oil content in the flax, the oil yield and gross income per acre from present varieties of the two crops were approximately the same. Under drouthy conditions the margin of safflower over flax was found to be considerably less than when both crops were grown under favorable moisture conditions.

The breeding program started in 1942 to isolate and purify superior strains from mixed varieties has been continued. Incidence of natural crossing in safflower has been found to be similar to that of alfalfa, ranging from five to 100 per cent, their being various degrees of self-incompatibility. Insects are responsible for 98 to 100 per cent of the natural crossing in this crop.

Castor beans. The object of the castor bean breeding program is to develop as soon as possible high-yielding, non-shattering strains containing 50 per cent or more of oil. This year the work was considerably expanded. The breeding nurseries at Lincoln contained 230 individual selections which were selfed and otherwise tested. Duplicate observation nurseries and yield test plots were located at Lincoln on dry land and at Holdrege under irrigation. At Holdrege it was noted that some varieties were considerably more immature than the same varieties at Lincoln although there were but a few days' difference in planting time. The plants were also taller, more variable in height, and had more spikes. In addition to irrigation at Holdrege, the plots also received ammonium...
nitrate as a side-dressing, which may have been a partial cause of difference in growth habits.

One of the interesting differences among castor bean plants is their ability to hold their burrs once these are ripe. This year a number of non-shattering plants were found which had other desirable characteristics as well. These selections will be studied further.

**Sesame.** It was necessary this year because of the late spring to delay the planting of sesame in southeastern Nebraska. This caused a serious reduction in yield of seed, particularly of the two small commercial plantings at David City and at Brownville. Six selections were tested at Lincoln in replicated yield plots and a number of others grown in observation rows. Yields varied from 425 to 744 pounds of seed per acre when sections were cut from the plots before the first hard frost. The yields of the same selections cut following the frost were with one exception considerably less because of shattering. An investigation was also made of the effect of different spacings on yield when sesame was grown in 10 1/2, 21 and 42-inch rows.

Within the next two or three years it should be possible to obtain as pure lines white, brown and black-seeded varieties. This year the seed from individual plants was selected for this purpose. Data obtained from a study begun in 1944 showed that for the two varieties tested, cross-pollination took place to the extent of five and 5.9 per cent, respectively.

**Other Chemurgic crops.** Preliminary results with perilla obtained originally from Illinois were encouraging. The average acre yield computed from five 16-foot sections taken from a single plot was 370 pounds of seed. Experimental work was also continued with sunflowers, flax, rape, mustard, pyrethrum, fennel and hemp.

C. E. Claassen, E. V. Staker.
2,4-D—A New Chemical for Weed Control

In the early months of 1945 a new organic chemical became available for testing as a herbicide. Referred to as 2,4-D, its full name is 2,4-dichlorophenoxyacetic acid. Much publicity was given to its merits on the basis of a few preliminary tests mainly by the companies producing it. A strong testing program was initiated by many of the experiment stations, including Nebraska.

Under guidance of the North Central States Weed Control Conference, a uniform plan of experimentation with 2,4-D was set up. Nebraska experiments were conducted cooperatively between the Department of Agronomy of the University of Nebraska, the Noxious Weed Division of the State Department of Agriculture, several county extension agents, and several of the noxious weed districts at the following locations and on the weeds indicated:

<table>
<thead>
<tr>
<th>County</th>
<th>Town</th>
<th>Weed Treated</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Nebraska</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boone</td>
<td>Petersburg</td>
<td>tanweed</td>
<td>Cullinane Ranch</td>
</tr>
<tr>
<td>Butler</td>
<td>Brainard</td>
<td>bindweed</td>
<td>Kavar farm</td>
</tr>
<tr>
<td>Dixon</td>
<td>Emerson</td>
<td>bindweed</td>
<td>Dahms farm</td>
</tr>
<tr>
<td>Johnson</td>
<td>Tecumseh</td>
<td>bindweed</td>
<td>Roberts farm</td>
</tr>
<tr>
<td>Lancaster</td>
<td>Lincoln</td>
<td>bindweed, lawn weeds, hoary cress,</td>
<td>Experiment Farm</td>
</tr>
<tr>
<td>Saunders</td>
<td>Wahoo</td>
<td>tanweed, and Canada thistle</td>
<td>Bern farm</td>
</tr>
<tr>
<td>Saunders</td>
<td>Touhy</td>
<td>Russian knapweed</td>
<td>Hennessey farm</td>
</tr>
<tr>
<td>Central Nebraska</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phelps</td>
<td>Holdrege</td>
<td>bindweed, whiteweed</td>
<td>Tri-county Farm</td>
</tr>
<tr>
<td>Phelps</td>
<td>Holdrege</td>
<td>bindweed</td>
<td>Lyon farm</td>
</tr>
<tr>
<td>Western Nebraska</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box Butte</td>
<td>Alliance</td>
<td>bindweed</td>
<td>Gebhart farm</td>
</tr>
<tr>
<td>Morrill</td>
<td>Broadwater</td>
<td>bindweed</td>
<td>Peono farm</td>
</tr>
<tr>
<td>Perkins</td>
<td>Grant</td>
<td>bindweed</td>
<td>Epler farm</td>
</tr>
<tr>
<td>Scottsbluff</td>
<td>Gering</td>
<td>bindweed</td>
<td>Simmerman farm</td>
</tr>
</tbody>
</table>

A number of the county extension agents also put out small test plots and a few observation plots were established by the noxious weed division of the State Department of Agriculture and Inspection.

Duplicate square-rod plots were treated and the results determined by checking the resultant stand against the original stand on check plots. Treatments were made on bindweed when the plants were in the following stages of growth: pre-emergence, full emergence, pre-bud, full bloom, and well developed growth after summer dormancy. The other weeds were treated during some one of these stages of growth. The spray solutions of 500, 1,000 and 1,500 parts per million were applied at ¾, 1⅛ and 2¾ gallons per square rod. Conditions of weather, plants and soil were noted at treatment to check their effects on the results. In most cases the treated areas were observed several times during the growing season after treatment and stand counts were taken in the fall to determine the effects. The results in general were as follows:

**Bindweed.** Experiments with 2,4-D on bindweed were conducted at four locations in eastern Nebraska, two in central, and four in western Nebraska. Time-of-treatment experiments at Lincoln indicated that best results are obtained when the plants are treated in the pre-bud to full-bloom stages of growth. Results varied from 88.5 to 99.5 per cent reduction of top growth at Tecumseh in Johnson county to zero per cent reduction on all plots treated at Broadwater in Morrill county. Reason for
the difference was not apparent. In general all products containing 2,4-D were nearly equal in effectiveness at most locations; concentrations of 1,000 and 1,500 ppm were more effective than 500, and all rates of ¾, 1½ and 2¼ gallons per square rod were about equal. The destruction of roots by 2,4-D was not equal to top-growth kill. While vertical roots were found to be killed as deeply as 24 inches in a few cases, vertical roots and horizontal roots remained alive, though stunted, in all plots treated. No seed of bindweed was produced on any of the areas treated and the visible plants were markedly reduced.

**Hoary cress.** Experiments with hoary cress were conducted at Wahoo, Nebraska. Three 2,4-D-containing products were used and these were applied at 1,000 ppm concentration and at the rates of ¾, 1½ and 2¼ gallons per square rod. Treatments were made when the plants were in the full-bloom stage. Conditions of weather and soil appeared to be optimum. Average reductions in top growth from the three products at ¾ gallon per square rod were 51, 77.5 and 71.5 per cent; at 1½ gallons per square rod 77, 82 and 91.5 per cent; and at 2¼ gallons per square rod 90, 95 and 98.5 per cent, respectively. Sodium chlorate applied at the same time at the rate of four pounds per square rod reduced the stand by 12 per cent.

**Russian knapweed.** These experiments were at Touhy, Nebraska, on plants in the full-bloom stage with three 2,4-D-containing products at 1,000 ppm concentration and at ¾, 1½ and 2¼ gallons per square rod. Percentage reduction of top growth varied from zero to 36, indicating that Russian knapweed is tolerant to 2,4-D. Sodium chlorate at four pounds per square rod resulted in 88 per cent kill of plants.

Dandelion plants on the left were treated with 2,4-D. Although generally slow in action, the chemical has in seven days caused leaves to dry and necrosis of the central portion of the root.
Canada thistle. The experiments on Canada thistle were near Wahoo, Nebraska. Two 2,4-D products were applied at the full-bloom stage at 1,000 ppm and $\frac{3}{4}, 1\frac{1}{2}$ and $2\frac{1}{4}$ gallons per square rod. The per cent reduction in top growth from the two products was 72 and 64 for $\frac{3}{4}$ gallon, 59 and 69 for $1\frac{1}{2}$ gallons, and 71 and 83 for $2\frac{1}{4}$ gallons per square rod, respectively. The indication is that Canada thistle is moderately resistant to 2,4-D.

Whiteweed. The experiment with whiteweed was at Holdrege, Nebraska. Results from three products of 2,4-D applied at 1,000 ppm and $\frac{3}{4}$, $1\frac{1}{2}$ and $2\frac{1}{4}$ gallons per square rod, when the plants were in full bloom, varied from zero to 60 per cent reduction in top growth. The indication is that this weed is at least moderately resistant to 2,4-D.

Tanweed. Experiments with tanweed were near Petersburg in Boone county. Results from two products applied at 1,000 ppm at $\frac{3}{4}, 1\frac{1}{2}$ and $2\frac{1}{4}$ gallons per square rod varied from zero to 37.5 per cent reduction of top growth indicating that this weed is quite resistant to 2,4-D.

Lawn weeds. Experiments with lawn weeds at various times during the year indicated that dandelions, Rugel’s plantain, chickweed, yellow trefoil, henbit, and several other broad-leaved weeds can be largely eliminated by the use of 2,4-D. Grassy weeds such as crabgrass, yellow and green foxtail, barnyard grass, and nimblewill are not affected.

Annual and biennial weeds. Some additional weeds, mostly common annual and biennial types, are listed below as to their relative susceptibility to 2,4-D.

Generally Susceptible
- Prickly lettuce, lamb's quarters, kochia, annual sunflower, curled dock, prostrate knotweed, rough pigweed, wild hemp, giant ragweed, annual peppergrass, evening primrose and shepherd’s purse.

Intermediately Susceptible
- Pennsylvania smartweed and common ragweed.

Resistant
- Wild ground cherry, barnyard grass, prostrate vervain, lady's sorrel, stinkgrass, green foxtail, Russian thistle, wild buckwheat, low mallow, buffalo bur, sandbur and nodding wild rye.

Cultural experiments in the weed project at Lincoln were continued cooperatively with the Department of Agricultural Engineering. Further information will be found in the report from that department.

N. S. Hanson, C. W. Smith, F. D. Keim.

Outstate Testing

Numerous crop variety tests, fertilizer tests, and other agronomic studies are conducted annually on farms in areas of the state not fully represented by the experiment stations. The work is carried out cooperatively by staff members of the Experiment Station and Extension Service.

Crop variety tests. A total of 48 variety tests of all important crops were planted and 37 materialized for yield determination. The locations of these tests and names of cooperators are given in the accompanying table. Data from these tests, along with those from the experiment stations, are considered in releasing new varieties and making recommendations to growers in all parts of the state.

The corn tests included privately controlled commercial hybrids as well as state certified and experimental hybrids. Entries of privately
controlled hybrids were selected from nominations submitted by approxi-
mately 200 growers. Yields in general were lower than in 1944. It may be
concluded from the tests that there are suitable hybrids for most
localities, but that the superiority of hybrids is far less clearly defined
for the dry-land areas of the western and north-central counties than
elsewhere. Types better adapted and more productive for the sections
of short-growing season and low rainfall need development and demon-
stration. Duplication of many hybrids under various names is apparent.

Pawnee wheat was again outstanding in all districts, especially in the
southeast. Rust-resistant varieties of oats such as Cedar, Tama, Clinton,
Osage and others were definitely superior to the disease susceptible ones.
Velvon 11, a reselected strain from Velvon, was the highest yielding
variety of barley in all tests except one.

Twelve grain sorghum varieties and seven forage sorghum varieties
were compared in Phelps and Thayer counties. Martin, one of the newer
combine-type grain sorghums, yielded 25.4 bushels per acre compared
with 24.4 bushels for Early Kalo.

List of Outstate Crop Variety Tests, 1945

<table>
<thead>
<tr>
<th>District and County</th>
<th>Cooperator</th>
<th>Address</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pawnee</td>
<td>Arthur Hildebrand</td>
<td>Pawnee City</td>
<td>oats, lespedeza †</td>
</tr>
<tr>
<td>Pawnee</td>
<td>Andy Halek</td>
<td>Pawnee City</td>
<td>wheat</td>
</tr>
<tr>
<td>Otoe</td>
<td>Arnold Rinne</td>
<td>Dunbar</td>
<td>wheat</td>
</tr>
<tr>
<td>Thayer</td>
<td>Glenn Schoenholz</td>
<td>Bruning</td>
<td>wheat, † barley, † oats, † sorghums</td>
</tr>
<tr>
<td>East Central</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>W. A. Steavenson</td>
<td>Fontanelle</td>
<td>corn, wheat, barley, oats</td>
</tr>
<tr>
<td>Platte</td>
<td>Henry Eden</td>
<td>Humphrey</td>
<td>corn, barley, oats</td>
</tr>
<tr>
<td>Merrick</td>
<td>Oscar Blevins</td>
<td>Chapman</td>
<td>wheat</td>
</tr>
<tr>
<td>Sarpy</td>
<td>William Lorenz</td>
<td>Gretna</td>
<td>wheat</td>
</tr>
<tr>
<td>Douglas</td>
<td>John Bull</td>
<td>Elkhorn</td>
<td>oats</td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wayne</td>
<td>Arthur Perry</td>
<td>Wayne</td>
<td>corn, soybeans</td>
</tr>
<tr>
<td>Wayne</td>
<td>Eddie Gathje</td>
<td>Wayne</td>
<td>corn, † barley, † oats</td>
</tr>
<tr>
<td>South Central</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phelps (Ir.)</td>
<td>Tri-County Farm</td>
<td>Holdrege</td>
<td>corn</td>
</tr>
<tr>
<td>Phelps (Dry)</td>
<td>Roy Waller</td>
<td>Holdrege</td>
<td>corn, sorghums, wheat †</td>
</tr>
<tr>
<td>Furnas</td>
<td>George B. Kasson</td>
<td>Cambridge</td>
<td>wheat</td>
</tr>
<tr>
<td>Harlan</td>
<td>William Vincents</td>
<td>Stamford</td>
<td>corn</td>
</tr>
<tr>
<td>Central</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valley (Ir.)</td>
<td>H. G. Bobst</td>
<td>Ord</td>
<td>corn, popcorn, barley, † oats †</td>
</tr>
<tr>
<td>Valley (Dry)</td>
<td>E. O. Schudel</td>
<td>North Loup</td>
<td>corn, popcorn, † barley, † oats †</td>
</tr>
<tr>
<td>North Central</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holt</td>
<td>Clarence Ernst</td>
<td>O'Neill</td>
<td>corn, wheat, † rye, barley, oats</td>
</tr>
<tr>
<td>Cherry</td>
<td>Kenneth Hall</td>
<td>Valentine</td>
<td>corn</td>
</tr>
<tr>
<td>Southwest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chase</td>
<td>Oscar Siefkan</td>
<td>Imperial</td>
<td>wheat, winter barley</td>
</tr>
<tr>
<td>Keith</td>
<td>Clyde Suddarth</td>
<td>Brulé</td>
<td>corn</td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheyenne</td>
<td>Fred Kettler</td>
<td>Sidney</td>
<td>wheat, † winter barley</td>
</tr>
</tbody>
</table>

† Single-row observation plots.
* Not harvested because of poor stand, lodging, etc.

Soil studies. Studies on the use of commercial fertilizers and moisture
penetration during irrigation were in cooperation with other soil projects.
Results are given earlier in this report under the titles: Fertilizer for corn,
Fertilizers for grasses and legumes, Fertilizers for small grains, and Infil-
tration of irrigation water. G. T. WEBSTER, J. W. FITTS.
Horticultural Crops
Department of Horticulture

Storage Structures for Seed Potatoes

Studies were continued toward improving structures for storing seed potatoes until late spring or early summer.

Shell-cooled bin. Approximately 374 cwt. of Triumph potatoes were stored in a shell bin that was cooled with air circulating from a thermostatically controlled fan. From October 10, 1944 to June 5, 1945 (238 days) the net shrinkage of these potatoes was only 7.3 per cent. When taken out of the bin the weight of the sound potatoes was 89.4 per cent, the sprouts 1.84, rots 1.22, and dirt 0.22 per cent of the original weight.

On June 4 and 5 these potatoes varied from a mere beginning of sprouts in the lower foot to four-inch sprouts in the top six inches. Sprout growth along the walls, outside of which air circulated, was one-fifth to one-half as great as at the same level in the center of the bin. Ten days earlier the largest sprouts in the top were less than 1 1/2 inches.

Because cooling commenced immediately after this bin was filled, temperatures along the floor and walls were too low for wound healing and the percentage of rotting tubers was greater there than in the warmer parts of the bin. Among the potatoes in slatted crates buried in the bottom of the bin, rotting tubers weighed 4.74 per cent and the sprouts 0.26 per cent of the original weight, in contrast to rot weight of 1.46 per cent and sprout weight of 8.32 per cent for potatoes in the crate in the top center. The net result was sound tubers in the bottom center crate weighing 89.4 per cent and those in the top center 86.1 per cent of the original weight.

In this fan-cooled bin the desired temperature of 40°F. or lower could be maintained from November 13 to April 6 in the top center and from October 24 to April 21 in the bottom center. A comparable bin of potatoes with spaces for gravity air circulation along the end and rear wall, but having a solid dirt floor, was available for comparison. In this bin the desired winter temperature of 40°F. was attained in the center at the floor only by December 29 and at the five-foot level (near top) by December 17. By installing a flue in the floor from the driveway to the rear wall, the temperature was generally lower by two to 5°F. along the floor and one to 2°F. at a height of five feet when compared with the portions of the bin midway between the flues.

Periodic readings showed that the ground temperature under the shell bin was 40°F. or lower at a depth of three inches from October 30 to May 17, but at 27 inches it was lower only from February 6 to April 23.

Much of the value of a shell-cooled bin comes from the circulating air carrying away ground heat during the fall and spring. The fan that circulated air in the space around the bin of potatoes operated whenever the outdoor air was colder than that above the potatoes about two feet from the outside wall. As the temperature at that place was several degrees higher than that of the potatoes in the bottom of the bin, the fan was bringing in air that was warmer than the coolest potatoes for some time at the beginning and toward the end of a nightly run, generally during about half of the hours it was operating. The fan was in operation approximately 15 hours per day in mid-October, three hours in late
December, zero to 1.5 hours in January and February, four to five hours in early April, eight hours in early May, and 10 to 11 hours in late May. In 1944-45 the functioning of this bin was improved by installing a double center partition with circulating air space. This resulted in a great reduction in temperature and sprout growth in the upper central part of the bin. As a consequence, a portion of the bin is being operated in 1945-46 with circulating air space partitions 3½ feet apart in one-half of the bin.

**Pre-cooled pit.** An earth-covered pit 6 x 6 feet square, dug to 9.5 feet below the surface of the ground (with openings left open all winter until it was filled with crates of potatoes on March 30), was found to be an excellent place to store seed potatoes until June. A small flue brought cold air to the bottom of the storage pit. This year a layer of baled straw over the top of the potatoes provided insulation against heat coming through the roof from outdoors, and an outlet ventilator through the roof carried away much of the heat.

At the bottom of the center of this pit the temperature on any date from April 1 to June 5 was generally one to 4°F. lower than in the bottom of the shell bin, and in the top center of the pile in the pit it was generally three to 4°F. lower than in the top center of the shell bin. Consequently, the average weight of sprouts on the potatoes in the pit was a trifle over one per cent in contrast with almost two per cent in the shell-cooled bin.

During the year a series of plans of modern type farm potato storage was prepared by A. D. Edgar of the U.S.D.A. in conjunction with the project leader. The plans are available through the agricultural engineering plan service. Storages with a total capacity of more than 225,000 bushels were built along modern approved lines by virtue of these publications and efforts of the project leader through meetings and conferences.

H. O. Werner.

**Potato Cultural Experiments on Dry Land**

**Date of harvesting dry-land Triumph potatoes.** Total yield of Triumph and Kasota potatoes planted in mid-January and harvested at bi-weekly intervals increased to the greatest extent throughout late August and the first half of September, after which the daily increase was much less and changed to a loss in weight after October 16. Practically all of this yield increase was due to tubers increasing in size. The percentage of No. 1 potatoes increased as the season advanced—more so with Kasota than with Triumph. With the latter variety, the steady increase in scab as harvesting was delayed offset the gain from increase in size.

Triumph potatoes harvested on different dates in western Nebraska, and some produced by planting on different dates, were again planted in south Texas in late December and in south Alabama in late January to determine desirability for seed. The more mature tubers emerged most rapidly but yield differences were slight, largely because of destruction of vines by late blight.

**Summer fallowing methods and plowing.** With favorable spring moisture conditions, differences in yield due to preceding summer tillage methods were very small, with subsurface tillage being best, followed in order by basin listing and plowing plus rod weeding. Plowing just before planting resulted in a small increase in yield over planting on fallowed land without plowing.
Date of planting. Potatoes planted on May 26, June 8, and June 22 produced practically the same total yield, but the yield dropped about 40 per cent when planting was delayed until July 6. With both varieties the percentage of No. 1 grade tubers increased slightly with each succeeding date until June 22, because of a decrease in the percentage of rough potatoes, but then decreased with July 6 planting because of the much greater percentage of small potatoes. Total yields of Kasota tubers were approximately 20 per cent greater than those of Triumph except with July 6 harvest when they were the same. The percentage of U.S. No. 1 potatoes was approximately 10 per cent greater with Kasota than with Triumph from each planting date except July 6 when there was little difference.

Planting rate and distance. In the moist spring and summer of 1945, tuber size and yields were practically the same regardless of planting distance or seed piece size.

Advance cutting of seed potatoes. A test was conducted to determine the feasibility of cutting Triumph seed potatoes several weeks or months in advance of planting time. Seed potatoes cut at intervals from February 20 until planting time on June 19 were held in tight wooden boxes at conditions of temperature and humidity favorable for wound healing for one week, then placed in a humid cellar until planting time. When managed this way, seed pieces showing some decay at planting time amounted to 1.3 per cent of the original number when cut as early as May 14 (five weeks before planting) compared with 4.7 per cent for April 17, six per cent for March 19, and 14 per cent for February 20 cutting. Stands of plants from seed cut April 17 or earlier were not as good as desired, but those cut later were satisfactory and equal to those with fresh cut seed. Yields were practically the same.

Potato Breeding

A large number of phenotypes with the desired red skins have been selected and several dozen are being increased for more extensive testing on a field scale. With some of these lines the tubers are of excellent type and the specific gravity is high, indicating good cooking quality.

The customary program of producing seed in the greenhouse during the winter by crossing and selfing has been carried on, as well as the growing of 10,000 seedling plants and the testing of about 300 selections in small plats and some 50 lines in larger plats at Scottsbluff or Alliance. Replicated yield tests of 13 varieties were conducted at the two places. Some lines were also tested in the early potato region of Gibbon, Nebraska. The cooking quality of most of these 300 lines has been determined by the brine specific gravity test.

Cooking tests were conducted in conjunction with the Home Economics Department to determine culinary merits of seven of the most promising lines in comparison with five standard varieties as grown at Alliance on dry land and at Scottsbluff with irrigation. At least two lines revealed relatively high culinary merit.

Three white and two red skin varieties are being increased for initial commercial field tests in 1946 and 1947. The Nebraska Certified Potato Growers Non-Stock Cooperative is cooperating with this phase of the project. Maintenance of virus-disease-free seed stocks for this program involves indexing from 6,000 to 12,000 tubers each year in the greenhouse at Lincoln.

This work was done with cooperation from the Department of Plant Pathology.

H. O. WERNER, M. W. FELTON.
Ascorbic Acid Content of Nebraska Tomatoes and Potatoes

This study was cooperative with the Department of Home Economics.

Tomatoes under shade. Red Cloud tomatoes grown at Lincoln under cloth shade, to prevent sun damage to exposed fruits, had appreciably lower ascorbic acid content than fruits from plants grown in full sunlight. (Ascorbic acid as used in this report refers to the reduced form of ascorbic acid.) It was also less when plants and fruits were coated with Bordeaux spray as a protection against leaf spot diseases than when not sprayed. Loss due to spraying was very much greater with shaded than with unshaded plants. The range of values for ascorbic acid content of the tomatoes grown at Lincoln in 1945 was from 16.03 to 27.88 milligrams per 100 grams of fresh fruit.

H. O. Werner, Ruth Leverton.

Home-canned tomatoes. In tests with four home-canning methods for Nebraska-produced Sioux tomatoes, the canned tomatoes contained significantly less reduced ascorbic acid than did the fresh fruit. The decrease occurred as a result of three manipulations in the canning procedures: blanching; processing, whether before or after the fruit was placed in the jar; and storage. Of the total loss in ascorbic acid content from the raw to the canned product, storage accounts for the largest amount, blanching for the next largest, and processing for the least.

Although many phases of the problem remain to be studied, it seems that loss of ascorbic acid during canning and subsequent storage is great. However, it appears that in home canning of tomatoes the loss can be kept to a minimum by using as short a blanching period as possible and by storing the product in quart rather than pint jars. The method used for canning, whether open-kettle, hot-pack, or cold-pack, makes no significant difference in retention of ascorbic acid. This does not mean that method will not influence the content of a serving of canned tomatoes. In the open-kettle method at least 10 per cent more evaporation of moisture takes place than in the hot or cold-pack methods. Therefore, a 100-gram serving of tomatoes canned by the open-kettle method will contain a greater original weight of fruit and will furnish more ascorbic acid than a 100-gram serving of fruit of the same initial value but canned by the Other methods.

Ruth Leverton, Doretta Schlaphoff.

Matilda Peters, H. O. Werner.

Sampling procedure. The problem of what constitutes an adequate sample of tomatoes for ascorbic acid determination has been studied in an effort to determine how many fruits should be analyzed, and if the whole fruit needs to be analyzed to give a reliable mean value.

An evaluation of different sampling practices showed that: Analysis of 20 fruits gave a mean ascorbic acid content which was representative of the true mean (on the basis of 80 fruits). Analysis of either the whole fruit, or a quarter cut as a radial sector or as a horizontal slice from the center of the tomato, resulted in a reliable mean value. Variation in the ascorbic acid content of individual tomatoes of the same sample is great enough to imply the necessity for always reporting the range, together with the mean value and the standard deviation.

Doretta Schlaphoff, Ruth Leverton, H. O. Werner.

Potatoes. Ascorbic acid content of tubers was found to increase until about the time the plants attained their maximum vegetative growth, and as plant senility advanced, ascorbic acid content diminished. Potatoes from plantings at Alliance and Scottsbluff on three dates from May 25
to June 22 had much the same ascorbic acid content, but those planted as late as July 6 had a much lower content when harvested in early October. The loss of ascorbic acid in storage was more rapid with these immature potatoes from late plantings than from the more mature tubers.

Ascorbic acid was lost very rapidly at a storage temperature of 40°F. As the temperature was increased from 40 to 42.5, 45, 47.5 and 50°F, losses of ascorbic acid diminished. With temperatures of 60, 75, and 80°F, the loss was about the same or possibly a trifle higher than at 50°F.

When potatoes with low ascorbic acid content, because of low storage temperature, were moved to room temperature (72-75°F.) for six weeks there was no indication of any recovering or increase in content.

Tubers of different varieties differed consistently in ascorbic acid content. However, it is sometimes difficult to determine how much is due to variety and how much to maturity.

Dehydroascorbic acid, which is considered just as available physiologically as reduced ascorbic acid, has been found present to the extent of five to eight milligrams per 100 grams of fresh tuber weight. There was no marked change in the actual amount throughout the storage period. However, by late winter and later, the amount of dehydro-ascorbic acid was generally slightly greater than that of the reduced form. Consequently, during midwinter and later, potatoes are a better source of ascorbic acid than the relatively low figures now available would indicate. The total ascorbic acid content (dehydro plus reduced ascorbic) of Nebraska potatoes in late winter and spring has been found to be from eight to 12 milligrams per 100 grams fresh weight.

H. O. Werner, Ruth Leverton.

Metabolic Efficiency and Water Economy of the Potato Plant

Effect of heat treatment on the tissues. In the routine testing of potato plants of breeding lines to determine their heat resistance (126°F., 4½ hours in a heat machine), preliminary observations were made on the internal changes. Low resistance to heat was associated with the premature formation of pith cavities in the upper stem. Frequently these cavities were lined with pith cells high in starch. Small cavities developed in the pith of petioles and in the cortical parenchyma of petioles and stems. In moderately resistant lines the starch disappeared from the inner pith cells before the latter collapsed to form a pith cavity. Many heat-resistant lines had thick, succulent leaves but some had thin leaves.

Cracking of tubers in the fall. Studies on the cracking of Triumph potato tubers at harvest time gave the following results: Cutting roots one week before harvest reduced tuber cracking 36 per cent. Exposing freshly dug tubers on a sunny day for three hours reduced cracking 52 per cent, and for four hours 82 per cent. Four hours exposure on a cloudy day reduced cracking 42 per cent. Tubers toughened by exposure to sunshine did not become more susceptible to cracking after one day of storage in wet soil. The damage to tubers was progressively accelerated as the temperature was lowered from 64°F to 48°F.

R. H. Moore, H. O. Werner.

Tomato Breeding

Plants in the extensive breeding trials planted at Lincoln in 1945 were practically ruined by several types of virus diseases (mostly mosaic), apparently carried by aphids which invaded the field in great numbers shortly after transplanting time. Because of this, selection of breeding
types was not feasible. However, this epidemic of virus disease resulted in discovery of at least two lines of tomatoes that appear to possess resistance. The plants of the variety Pearl Harbor—introduced by the University of Hawaii (Dr. W. A. Frazier)—and a Nebraska selection produced very good crops of tomatoes. Pearl Harbor was selected from a cross between Bounty and a California Experiment Station line designated B. C. 10, and was selected for resistance to spotted wilt virus. The Nebraska segregate was from a cross of Bounty and Porter. Both of these lines have "determinate" vines with red fruit that ripens early.

Plant Pathology Department cooperated in these trials.

H. O. WERNER, M. W. FELTON.

Vegetable Crops

Sweet potatoes. In an experiment on growing sweet potatoes "flat"—without ridging—the yield of Porto Rico sweet potatoes was greatest with a 12-inch ridge, 20 per cent less with a six-inch ridge, and 40 per cent less with flat culture. The percentage of No. 1 grade roots was 45, 41 and 17 per cent respectively for high and low ridges and flat culture. Varying planting distance from 12 to 18 inches did not cause an appreciable difference in yield and grade of roots. In 1945, relatively cool and unfavorable for sweet potatoes, the best producing of a dozen varieties tested, in order of their production of No. 1 roots, were Maryland Golden, Porto Rico, Red Bermuda and Florida White. All of these except Red Bermuda were quite superior in market quality.

Lima Beans. A test of eight varieties of bush lima beans, including some new lines from the USDA, was conducted at Lincoln. The three most productive varieties were Fordhook 242, US 243 and Early Market. Early Market produced good quality beans throughout the longest picking period but the beans of US 243 seemed superior in quality to the others. The Henderson was the least desirable variety in the test. The season of 1945 was exceptionally favorable for lima beans.  H. O. WERNER.

Crop Rotations on Dry Land Near Alliance

BEING THE 16TH SEASON for these rotations, 1945 marked the completion of the third cycle for differential cropping in the five-year and the fifth cycle in the three-year rotations. As a result of heavy spring rainfall, the soil moisture content was up to field-carrying capacity in the top five feet of all plats of all rotations by the beginning of summer. Supplemented by timely rains throughout the summer, this resulted in exceptionally high yields of all crops.

Yields of barley, which generally followed potatoes, ranged from 58 to 82.4 bushels per acre. Winter wheat yields after barley ranged from 25.9 to 37.8 bushels, after winter wheat from 17.5 to 46.7, after corn from 37.5 to 48.1, and after summer fallow from 49.7 to 59.2 bushels per acre. Corn yields ranged from 17.5 to 38.2 bushels with most plats, including those continually in corn, yielding more than 25 bushels per acre.

The plats continuously in winter wheat were plowed in early July to prevent ripening of the seed in the thick stand of downy brome grass which had practically choked out the winter wheat. Wheat yields in prospect were less than one bushel per acre when the plats were plowed.

During recent years it has seemed that superior yields of potatoes and winter wheat after summer fallow could not be attributed entirely to greater soil moisture content. In 1944 and again in 1945 it seemed evident that they were largely the result of the accumulation of nitrates in the
summer fallow plats and depletion in the cropped plats. At the time potato plants emerged—July 5—nitrate nitrogen content in the top foot of soil in plats following fallow, wheat and corn was quite similar—between 5.6 and 6.7 p.p.m. However, in each of the four feet below the top foot the nitrate content following wheat was between 1.8 and 3.3 p.p.m., whereas following summer fallow it ranged from 4.5 to 15.6 p.p.m., and following corn from 4.8 to 14.4 p.p.m. Evidence of nitrogen deficit was the shorter straw growth of wheat and the smaller, paler and earlier maturing vines of potatoes.

Plant Pathology and Agronomy cooperated in these experiments.

H. O. Werner, M. W. Felton, H. F. Rhoades,
Karl Quisenberry, Kerwin Jantz.

Supplemental Water for Orchards in Eastern Nebraska

Because of heavy rainfall, at no time during the 1945 growing season should the trees have been short of water. From February through September the monthly average was nearly five inches with July showing 1.33 inches. Total rainfall January 1 to November 30 was 40.38 inches with the total for January, October and November being only 2.08 inches.

Soil moisture determinations made early in the season and again in late September indicated no withdrawal of reserve subsoil moisture in the experimental block; in fact, in a few instances there seems to have been some storage of soil moisture. These thickly planted three-year old Delicious trees probably maintained themselves on annual rainfall during 1945.

Considerable pumping was done during the 1945 season, especially in the fall months, to make even more favorable soil moisture conditions in the bearing parts of the older apple planting for development of the large number of fruit buds. The 1945 crop was insignificant because this was the "off" year and there was considerable damage from low temperatures in the spring.

Continuing cooperation was received on this project from the Department of Agricultural Engineering. C. C. Wiggans, E. E. Brackett.

Fruit Breeding

Several apple varieties were set in 1945 and also some specimens of a new bramble, the Rossberry, from a Texas nursery. The 1945 cherry planting at Union showed greatest transplanting loss occurring in the Michigan Montmorency strains.

Some detailed observations were made on the black walnut varieties now in production, most of which did not fully mature. Many shells had little or no kernel in them. Among the sorts showing good maturity were Edras, Rohwer, Hepler and Beck, with Thomas and Stabler both showing much immaturity. Cracking percentage was highest in Edras, Creitz, Wintle, Stabler, Hepler and Beck, lowest in Thomas, Stambaugh, Booth and Fosterite. Quality of meat was most pleasing in Ten Eyck with Edras nuts having a rather peculiar flavor.

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

Fruit Stocks Investigation

Two-year-old trees of Virginia Crab and Hibernal, transplanted to new mangum terraces at the Union Fruit Farm in 1943, were budded to five standard scion varieties in July, 1945. Scion measurements taken in November show that all varieties had grown better on Virginia Crab than
on Hibernal. The greater mean length of scions on Virginia Crab amounted to 207, 96, 62, 38, and 38 per cent for Golden Delicious, Delicious, Winesap, Jonathan and Grimes Golden, respectively. North-south diameters, measured one foot above the soil line, averaged 9.2 per cent greater for Hibernal than Virginia Crab.

A number of Pyrus ioensis seedlings secured from the North Platte Experiment Station were planted at Lincoln in 1945 to be used as stock plants for standard apple varieties. Quite variable growth has been observed and some of the seedlings may dwarf the scion variety.

Topbudding the Virginia Crab and Hibernal trees at Lincoln to various named varieties is now practically complete. A few of the trees showed a limited number of blooms in 1945 and others gave evidence of approaching the production stage.

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

Orchard Spraying

Delayed-action sprays, which retard the opening of buds in the spring, were applied to two varieties each of apples and cherries, one variety of apricots, and seedling peach trees. Since no effective concentration has been reported for "2,4-D," this growth substance was used at 10, 50, 150 and 300 p.p.m. Alpha-naphthaleneacetic acid was applied at the recommended concentration of 800 p.p.m. Water and a 0.5 per cent solution of Carbowax 1500 in water were used as carriers. The sprays were applied in mid-summer.

Within three weeks the spray concentrations of 2,4-D higher than 10 p.p.m. had produced visible effects. At 50 p.p.m. 2,4-D twisted petioles and yellowed leaves. The higher concentrations of both chemicals killed some leaves and green stems. In late December, buds were frequently smaller on branches that had received a concentration of 50 p.p.m. or more. Carbowax and higher concentrations of growth substances usually intensified the effects. The Wealthy apple was only mildly affected even by highest concentrations. In the order of increasing damage sustained, other varieties ranked as follows: Virginia Crab, Early Richmond, Montmorency, Ningut apricot, and seedling peach trees.

Bean Diseases

Spray tests for control of halo blight. To check the preliminary results given in the last annual report, a similar experiment to that of 1944 was conducted. Bordeaux mixture, 4-4-50, applied four times, again resulted in slightly decreased infection and increased yields over the unsprayed beans, whereas Hyamine 1622 at 1 to 500 and Dithane D-14 plus ZnSO₄ and lime gave no evidence of control.


Cereal Diseases

Seed treatments. Two samples of Otoe oats, one with a germination percentage of 98 and one of 77, were treated with New Improved Ceresan, DuBay 1452-F, U.S. 604, Arasan, and Spergon and planted on March 27 and April 19. New Improved Ceresan improved the stand of both samples of oats when planted on April 19 but not when planted on March 27. DuBay 1452-F improved the stand from the poor germinating sample of oats when planted on April 19 only. No other treatment gave a significant increase in stand.

In a similar test made with winter wheat no significant stand increases were obtained.

Seed treatment tests with sorghum seed have been conducted since 1942 and the results recently published. All except one of the treatments satisfactorily controlled smut when applied according to directions. The volatile mercury dusts, however, gave somewhat better smut control with varieties having persistent glumes.

Improvement in sorghum stands resulted, in most cases, when seed treatments were applied. This depended somewhat on the variety and on environmental conditions at planting time. All of the commonly used materials gave significant stand increases under most conditions and with most varieties. Sulphur, which was recommended in some states as a substitute for smut control during the war years, seldom increased the stand and occasionally gave a significant reduction.

Storage of treated sorghum seed, except with certain volatile mercury compounds, caused no serious loss of vitality, provided the seed was of good quality, of low moisture content, and free from injury. The volatile mercury compounds injured seed of certain varieties; however, in most instances the improvement in stand, which was due to the protective effect secured by the use of these materials, outweighed any injury.

Barley fertilizer and seed treatment tests. Uramon and superphosphate were applied singly and together at planting time on barley in Merrick county. Half of the seed was treated with New Improved Ceresan before planting and half left untreated. The plots containing both Uramon and superphosphate gave a higher yield than when either was used alone.

Seed treatment with New Improved Ceresan produced a very significant increase in yield when used in connection with the soil treatment of Uramon plus superphosphate. There was also an increase in stems per plant and height of plants but not in the number of plants. In no other treatment did New Improved Ceresan effect any improvement in stand or yield.
Cereal smut studies. A series of experiments was started to identify the parasitic strains of covered kernel smut of sorghum and stinking smut and loose smut of wheat. Fifteen collections of sorghum smut from as many counties were used to inoculate six differential hosts. Three parasitic strains of the smut were positively identified.

Twenty collections of bunt from 12 counties were tested on five differential wheat varieties, and five parasitic strains were identified.

Ten collections of loose smut of wheat were tested on 12 differential hosts and four parasitic strains were identified.

Leaf rust of wheat. Leaf rust readings were made in the wheat yield test at the Agronomy farm. Wichita and an unnamed selection were quite resistant throughout their growth. Pawnee was fairly resistant with very little infection until the plants were heading. Clarkan showed the least leaf rust at the last observation but showed the most infection when the first observation was made.

Charcoal rot of corn and sorghum. Charcoal rot causes an annual loss of from five to 15 per cent of the total corn crop. The loss in sorghum varieties varies greatly, being extremely serious in some years and insignificant in others. Experimental results showed that the disease develops only with high temperatures and low soil moisture, and either low mean soil temperature or high mean soil moisture will prevent serious losses. In the field charcoal rot has been most serious in areas of Nebraska having an average daily air temperature above 22°C. during July, August and September, and a total rainfall below 10 inches during the same period.

In two comparative greenhouse tests Western Blackhull was affected least of the commercial varieties grown in Nebraska.

Short crop rotations do not show much promise as a means of control. The use of irrigation gives very good control.

Ear corn storage. A considerable portion of Nebraska's large crop of corn in 1944 was piled on the ground or placed in unventilated cribs. Approximately 25 per cent of this corn contained 30 per cent or more moisture at the time of cribbing. During the winter many reports of molding in the crib were received and on March 7 to 14 a survey revealed that there had been very little change in the moisture content of the corn after it was cribbed. Corn with less than 21 per cent moisture when cribbed was keeping satisfactorily, whereas corn with 27 per cent moisture or more was being seriously damaged by molds. Eleven per cent of the cribs contained corn with a moisture content between 27 and 30 per cent and 16.3 per cent moldy kernels. Almost seven per cent of the cribs contained corn with a moisture content above 30 per cent with 51 per cent moldy kernels. Average percentage of moldy kernels in all cribs was 9.49. The type of crib in which the corn was stored was of minor importance compared to the condition of the corn at the time it was cribbed.

Corn stalk rots. Stalk rot records taken in Washington, Harlan, Phelps, Red Willow and Lancaster counties, in the variety tests of the Outstate Testing Program, showed considerable variation in the amount of stalk rot in the various hybrids in different counties. There was also some variation from the results obtained in 1944. Thirty hybrids were grown in each test.

Of the new single crosses being tested in the corn breeding program only one line consistently gave a low percentage of stalk rot in 1945. Several other inbred lines gave a low percentage of stalk rot in one or two single cross combinations.

J. E. LIVINGSTON.
Ornamental Diseases

Phloem necrosis of elms. Phloem necrosis, a new disease of American elms in Nebraska, was observed in Richardson county. This disease has been very destructive in Missouri, Illinois, Indiana, Ohio and Kentucky, especially in city plantings. The disease appears to spread from tree to tree, but as yet no insect vector has been identified. There is a possibility that Nebraska may be about the northern limit for this disease, judged by the distribution east of Nebraska. The Chinese elm, which has been widely planted in recent years, is not affected by phloem necrosis.

Pine twig blight. The comparative value of Bordeaux mixture (8-8-100) and Fermate at the concentrations of 1% pounds and three pounds per 100 gallons of water was tested on twig-blight infected Austrian pines in Elmwood Park at Omaha. Bordeaux mixture (8-8-100) and Fermate at the concentration of 1½ pounds per 100 gallons of water produced only slight improvement in growth over the unsprayed trees. The three-pound concentration of Fermate appreciably reduced the number of dead needles per twig and appeared promising as a control spray. This concentration of Fermate, however, seems to retard the rate of shoot growth, particularly early in the season.

Potato Diseases

Diseases in central Nebraska. Seedpiece rot seriously reduced stands throughout the early potato area in central Nebraska. Although some seedpiece damage was observed in all varieties, Red Warba proved exceptionally susceptible. Unusually cold, wet soils immediately following planting apparently predisposed freshly cut seed to rots. Whole seed suffered much less damage. The early symptoms consisted of a reddish-brown corky rot which extended in from the cut surfaces. Affected tissues remained crisp and firm. Specimens from various fields displayed marked similarity. An unidentified Fusarium was isolated. With the advent of higher soil temperatures, the affected seedpieces broke down rapidly with soft rot. Losses were more severe where facilities for proper handling of seed had been lacking. The construction of heated sheds or warehouses should be encouraged in this area to permit the warming up of cold or dormant seed before planting.

Black-leg, following after seedpiece rot, was found in most fields, varying in amounts up to 15 per cent of the plants infected. Plant symptoms were of an unusually severe type, the black, water-soaked rot often extending six or eight inches above the ground. Quite frequently the rot extended through the stolons into the tubers where the symptoms varied from slight vascular discoloration to complete destruction of the central pith, with a brown layer of cork cells delineating the diseased tissue. Infected tubers were not readily detected on the washers and many found their way into the pack, only to break down in transit. It was this tuber phase of the black-leg problem which proved most troublesome and a constant threat to the market.

Late blight was well distributed in the Platte Valley early-potato area by the last week of June but failed to develop appreciably until mid-July when several days of rain, fog, and low temperature provided optimum conditions. The foliage in some fields was entirely killed 10 days to two weeks early and losses in yields up to 30 per cent were estimated. Fortunately, tuber infection was quite rare and then restricted to low, water-logged spots in the fields. Satisfactory control of late blight was obtained with four applications of Bordeaux mixture spray.
Virus diseases were negligible except in several fields where uncertified seed was used.

An unidentified rosette disease affecting up to 10 per cent of the plants in some fields was observed. This disease appears similar to a condition first noticed in 1940 but was found in more fields and over a wider area this year. Tubers from affected plants show a roughened surface, abnormal eyes which fail to sprout, and internal necrosis.

**Diseases in western Nebraska.** Rot or “breakdown” is a problem where seed potatoes are being held for late spring planting. Examination of cellars where damage of this sort occurred indicated three possible sources of trouble: first, the development of soft rot following turning or treating of badly sprouted lots; second, rot and fungus breakdown in lots with 10 per cent or more dry rot; and third, pink rot. Rising temperature and respiration rate and the accumulation of moisture added to the breaking down of injured sprouts or rotting tubers, and complicated by periodic turning (to delay sprouting), soon resulted in conditions favorable to soft rot and unfavorable to the defense or “corking off” mechanism of the tuber. Once the stage commonly known as “heating” is reached, the potatoes rot very rapidly. Extra precautions should be taken to provide ample aeration when badly sprouted or dry-rot damaged potatoes are handled. Pink rot, held quiescent by the low temperatures and relatively dry winter storage conditions, becomes active with rising temperatures. When damp or cut tubers are turned in late spring, optimum conditions for spread and development are provided and infection builds up rapidly. When a trace or more of pink rot exists, potatoes must be kept as cool and dry as possible and not turned or sorted when the surface of the tubers is wet.

Following harvest an unusual amount of rot appeared in potato storages in the North Platte Valley, in some cases necessitating immediate disposal of large lots. Washed potatoes from this area frequently developed soft rot in transit, in extreme cases 20 per cent of the tubers being infected at destination. Two distinct diseases occurred singly or together in these damaged lots. The firm, reddish-brown, cortical rot is the tuber-rot phase of late blight found in this area for the first time. Although late blight foliage infection was not particularly conspicuous during the growing season, the heavy rains and occasional over-irrigation at the end of the season provided favorable conditions for tuber infection. Low-lying, poorly drained fields or spots where drainage was inadequate suffered the most damage.

As long as infected tubers were kept cool and dry, a soft rot breakdown did not occur. However, where temperatures were high or where infected tubers were washed, rapid breakdown followed.

Pink rot, recently discovered in this area, is favored by similar conditions, over-irrigation or water logging. The disease spreads and forms “pockets” of rotting tubers in the bin. Low temperatures and dry storages tend to reduce or allay the damage from both late blight and pink rot.

**Pink rot.** Experiments were conducted under controlled conditions in the greenhouse to determine the effect of environmental factors on the occurrence of this disease. Extremely high soil moisture was favorable for infection of plants grown in inoculated soil. Fifty-three per cent of the plants and 23 per cent of the tubers were infected as contrasted with six and three per cent, respectively, at optimum soil moisture and no infection at low soil moisture. It was found in laboratory experiments
that the disease could spread rapidly from infected tubers to healthy tubers by contact when the potatoes were stored at high humidity at warm temperature. Wounds were not necessary for such infection and one infected tuber missed in grading could result in spotted sacks after shipping under warm conditions, such as often occur with the early crop.

**Potato scab resistance.** A few of the more promising selections obtained through the potato breeding project (cooperative with Horticulture) were tested. These were planted in a commercial field and five of them showed promising quality and scab resistance in comparison with Triumph.

**Seed potatoes.** During the past two years an interest in producing certified Red Warba seed potatoes has developed in north-central Nebraska. This seed was planted in Buffalo county in 1945 in a comparison test with certified Red Warbas from states west and north of Nebraska. The certified Red Warbas from Custer county, Nebraska, yielded practically the same as seed from the North and better than seed from the West. Seed produced in Custer and Valley counties appears to be as good as seed from northern and western states when planted in the early commercial area of Nebraska.

Bacterial ring rot has occasionally caused serious losses from tubers rotting in the field in central Nebraska and in transit. This disease is brought into the area in the seed. In a test of 13 samples of imported seed one contained ring rot with nine per cent of the plants in the field diseased.

M. W. Felton, R. W. Goss, J. E. Livingston.

**Diseases of Tomatoes and Related Crops**

**Weather conditions** in eastern Nebraska were again favorable to defoliating diseases. For the first time in recent years early blight caused severe defoliation and extensive fruit damage in commercial areas. However, the loss from Septoria leaf spot was probably greater. Toward the development of a leaf-spot resistant variety suitable to Nebraska climatic conditions, 86 F., plants from crosses between several selections of determinate habit and a leaf-spot resistant selection of indeterminate habit have been increased.

Bacterial speck was again the most prevalent tomato disease in western Nebraska. The fruits roughened by bacterial speck infection, although not deeply damaged, are definitely undesirable for wrapping or fancy packing. Temperatures favoring optimum symptom expression have been found to be much lower for bacterial speck than for bacterial spot. As with bacterial spot, the small fruits develop resistance to infection as they increase in size.

Pepper plantings in the Omaha area were again badly damaged by bacterial spot. A comparison of various isolates of the bacterial spot organism from both pepper and tomato indicated that while cross infection occurred readily, there were certain characteristics distinguishing the two groups. In further investigations of bacterial spot of tomato it was found that the length of time that the young fruits remained susceptible was determined by the rate of development rather than calendar age. For instance, fruits in an unfavorable terminal position in a large cluster developed more slowly and remained susceptible over a correspondingly longer period.
Chemical Studies with Plant Materials

Department of Agricultural Chemistry

Studies on the Amylases

Research was continued during the past year on three related phases: the amylases of cereals; the amylase inhibiting substances present in certain cereals; and the amylases produced by bacteria and fungi. Research done on the microbial amylases was cooperative with Dr. George L. Peltier of the Department of Bacteriology.

Cereal amylases. In cooperation with 18 other laboratories in the United States and Canada considerable effort has been devoted to the standardization of methods for malt amylase evaluation. This has given a better appreciation of the utility of the “Nebraska methods” which are rapidly becoming standard for the industry. Further, as the culmination of several years’ research, investigations concerning the preparation of highly refined enzymes have resulted in commercial production of a purified beta-amylase of proved utility for research and control work.

As explained in published articles, the amylase activity of germinated hard red winter wheat is dependent on variety and environment, similar to the relations established for barley. The indication is that wheats from locations conducive to the production of grain with high protein content will produce malts with superior alpha and beta-amylase activities. Among those grown at any one location, a further selection could be based on variety.

“Applications of the amylases in milling and baking technology,” by Eric Kneen and R. M. Sandstedt, is a chapter of “Enzymes in the Milling and Baking Industry” edited by J. A. Anderson. This chapter discusses in detail the amylases of wheat, flour, and germinated wheat, the degradation of starches by amylases, amylase activity during breadmaking, amylase supplements, and the significance of determinations of amylase activities in flour and supplements.

Amylase inhibitors. Research was continued on the substance in wheat which inhibits the action of salivary, pancreatic, and certain bacterial amylases. Of primary significance is the fact that the inhibitor was found in all mature wheats and wheat flours investigated. It was not destroyed by the bread-baking procedure; its presence in bread would be considered as a serious factor in nutrition were it not that it is destroyed by the action of the proteolytic enzyme pepsin. Removal of the inhibiting substance by pepsin insures digestion of the starch of wheat by the subsequent action of the pancreatic enzymes. Therefore, although the action of salivary amylase on the starch of wheat products cannot be efficient, only in the instance of impaired stomach proteolysis would interference with metabolism be anticipated.

A somewhat different inhibitor found in Leoti and Schrock sorghums also was investigated. This inhibitor affects all known amylases except those produced by fungi, even its own amylase system. Like the wheat inhibitor it has a high degree of thermostability, but unlike the wheat inhibitor it disappears during germination of the grain. So far, the
sorghum inhibitor has not been found in varieties other than Leoti and Schrock.

**Microbial amylases.** The investigation of the production and properties of bacterial amylases was completed and attention directed to the amylase produced by the growth of fungi. Many fungal isolations were made by the Bacteriology Department. Of these some 500 were grown in pure culture on wheat bran in sufficient quantity to test for the quantity and quality of amylase produced. Many different types were found, some of which appear to have definite industrial possibilities. The most promising were tested in the production of industrial alcohol from corn, and yields of alcohol obtained were above normal.

Production of a starch saccharifying amylase system by an isolate classified as *Bacillus subtilis* was described in a publication. The necessary details for commercial adaptation of the method were given and many of the properties of the amylase produced were outlined. The amylase has different properties from those of the bacterial products commercially available and appears to be particularly adapted to the pre-cook liquefaction of corn mashes.

Another article outlined details relative to the production of the saccharifying type of bacterial amylase in a liquid medium. Efficient amylase production was obtained in shallow layers of liquid, in deeper liquids with subsurface stirring, or by trickling the liquid over wood chips on which the bacteria were growing. Thin stillage, an industrial "waste" available in large quantity, was found to be an excellent source of growth nutrients.

Methods used in isolating amylase-producing bacteria and results of testing some 1,000 bacterial isolates were outlined in a paper. Of this number 37 isolates appeared to have possible industrial application.

Results found by culturing 53 bacterial isolates in a liquid medium were described in an article for publication. Amylase production varied in quantity from very high levels to those below economic adaptation. Qualitatively the bacteria could be separated into four types on the basis of the starch degrading properties of their amylases: *Bacillus subtilis*, isolated from ropy bread, which produces a high-liquifying and dextrinizing amylase comparable to those produced commercially. *Bacillus subtilis*, isolated from other sources than ropy bread, which produces an amylase system with high starch saccharifying power relative to liquefaction. *Bacillus polymyxa* which produces an amylase system of very high saccharifying power, comparable in many ways to the mixture of amylases present in barley malt. *Bacillus macerans* which produces a unique amylase system that first converts the starch to crystalline "Sbardinger" dextrins, then degrades these dextrins to fermentable sugars.

**Baking Properties of Flour**

In further studies using dehydroascorbic acid as an oxidizing agent in flour extracts and flour suspensions, it was found that the acid does not oxidize the sulphhydryl groups of denatured protein. Since dehydroascorbic acid is a specific oxidizing agent for sulphhydryl groups in the presence of certain enzymes this makes it specific for the simpler sulphhydryl containing compounds. Based on these observations a method has been developed for the determination of glutathione in flour (glutathione is the substance found in wheat germ which is responsible for most of its deleterious effect when it is added to doughs). B. D. Hites, R. M. Sandstedt.
Soybeans have been found to contain a substance which inhibits the action of trypsin (trypsin is the protein-digesting enzyme of the small intestine). It is known that raw soybean meal in a diet causes a lowered growth rate. Accordingly, it seemed quite probable that the decreased growth rate was the result of tryptic inhibition with a consequent incomplete digestion of the protein. Feeding trials with chicks showed this to be the case. Addition to the ration of the partially purified inhibitor prepared from soybeans had a retarding effect on growth and markedly affected the efficiency of gain. The inhibitor had a greater effect on growth when fed with a ration supplemented with soybean protein than when fed with a diet supplemented with a more complete protein of animal origin.

R. M. Sandstedt, W. E. Ham.
Tuber flea beetles. The cool, wet spring of 1945 retarded emergence of over-wintered beetles and early seasonal development of the tuber flea beetle in western Nebraska. These weather conditions likewise practically precluded the planting of potatoes until about mid-June. Late planting, along with more widespread use of recommended sprays and dusts during the growing season, probably was largely responsible for the relatively light flea beetle injury noted on tubers at harvest time.

A field experiment designed to compare effectiveness of 2.5 per cent DDT dusts (mechanically mixed with both sulfur and pyrophyllite and fused with sulfur) and the standard cryolite-sulfur mixture (1-3) was conducted at the Scotts Bluff Substation. The flea beetle infestation was light and results obtained with the four dusts were not significantly different. However, all were effective and statistically better than the untreated checks.

In another test a dust of three per cent DDT in pyrophyllite and a one per cent DDT-fused sulfur dust gave almost 100 per cent kill as measured by sweeping the plots 24 hours following the applications. However, the one per cent DDT-fused sulfur dust remained significantly more effective over a period of several days and continued to kill many newly developed beetles as they emerged from the soil. A dust containing one per cent DDT in pyrophyllite gave unsatisfactory control.

In a third test at the Scotts Bluff Station DDT-pyrophyllite dust mixtures were applied by hand to the soil one to two inches above the seed piece at the time of planting. Dusts of three, six and ten per cent DDT were used at the uniform rate of 300 pounds of the mixed dust per acre so that the amount of DDT actually applied was nine, 18 and 30 pounds per acre. All three treatments significantly reduced the amount of larval damage to the tubers. Potatoes from plots receiving 30 pounds of DDT to the acre were of slightly better quality than those harvested from plots where nine pounds had been used. The degree of freedom from flea beetle damage was so low in all plots that the results cannot be considered conclusive. However, they were indicative and it is possible that different DDT formulations and better methods of application might produce results of value. No injury to potato plants was observed.

Potato psyllid. The psyllid population remained at a very low level throughout the entire 1945 season. Apparently prevailing weather conditions were unfavorable for this species.

Aphids. Sweep-net records showed aphid populations to range from nine to 47 in plots treated with DDT dusts as compared with 126 where cryolite-sulfur dust was used and 186 in the untreated checks. This evidence of control along with similar data obtained in 1944 is important to growers who are interested in the production of seed potatoes. It indicates that this new material may be used without building up the population as is generally the case where zinc arsenite is used. In fact, the evidence suggests that DDT has definite aphicidal properties when used against *Myzus persicae* on potatoes in western Nebraska.
Airplanes for applying dusts and sprays. During the 1945 season airplanes were first used for the application of insecticides to Nebraska potato fields. At the Scotts Bluff Substation a preliminary test compared the effectiveness of DDT dusts applied by airplane and ground machinery. The plane was a Navy N-3-N biplane, formerly used for flight training. Both methods of application resulted in almost a 100 per cent kill of tuber flea beetles as measured by sweep-net collections 24 to 30 hours after dusting. However, dusts applied with ground machinery gave somewhat better control of secondary pests such as the false flea hopper and certain species of leafhoppers.

Observations in several commercial fields which had been dusted with the plane also revealed that this method of applying a three per cent DDT-pyrophyllite dust was giving good results against the tuber flea beetle. Because of the low psyllid infestation no information was obtained regarding the effectiveness of dust applied by airplane for controlling this insect.

Another preliminary test near Gering involving application of a DDT-spray concentrate by plane was unsuccessful. Mechanical improvement of the dispersing equipment must be made before liquid sprays can be effectively applied to potatoes by plane.

Large field tests with DDT. Four neighboring commercial potato growers near Scotts Bluff cooperated with this department in a large scale test with DDT. All potato fields on the four farms (approximately 150 acres) were treated four or five times with a three per cent DDT-pyrophyllite dust. Insect collections were made at regular intervals throughout the summer in each of the treated fields and also from nearby plantings which had been treated with the standard cryolite-sulfur dust. Although the collections have not been completely analyzed, it was demonstrated
that DDT may be used effectively and safely by commercial potato growers under Nebraska conditions. There was no evidence that this material caused any excessive disturbance in the so-called biological balance. Fields treated with DDT were noticeably “free” of insects as compared to those treated with cryolite-sulfur dusts.

Approximately 107,000 pounds of three per cent DDT dust and 1,400 pounds of 25 to 50 per cent wettable DDT powder were used in large scale field tests and demonstrations on potatoes in Nebraska in 1945. About 400 acres were treated in central Nebraska one or two times and about 700 acres in western Nebraska three to five times. The material was distributed by local insecticide dealers and used under the general supervision of the Department of Entomology.

General observations were made as to effectiveness on potato insects and also on various crops in the vicinity to determine if outbreaks or increases of other species occurred as a result of the destruction of predatory and parasitic insects. In addition to potatoes the crops checked included alfalfa, corn, sugar beets and garden crops. Insofar as could be determined, no significant increases of harmful insects occurred. Although some predators and parasites were killed in treated fields this did not appear to have any appreciable effect on the insect problem as a whole.

**Central Nebraska field test.** A field test involving several insecticidal and fungicidal combinations was conducted near Kearney in cooperation with the Department of Plant Pathology. The following combinations were used: zinc arsenite-bordeaux mixture spray; DDT-tribasic copper sulfate spray; DDT-tribasic copper sulfate-sulfur dust; DDT-sulfur dust; DDT-basic copper arsenate-sulfur dust; DDT-pyrophyllite dust; and cryolite-sulfur dust. The cool, wet weather was unsuited for potato insect development in central Nebraska and hence the insect population was exceptionally low in the experimental plots. Consequently the value of the results obtained in this test was greatly restricted. The best control of the Colorado potato beetle, potato leafhoppers, and Lygus bugs was given by the DDT combinations.

**Chinch Bugs**

A prolonged, wet spring accompanied by an outbreak of the chinch bug fungus in June and early July (1945) reduced one of the most serious chinch bug threats on record in Nebraska to one of minor consequence. Barriers were needed in only a few cases, although there was a potential need for 1,500,000 gallons of creosote for barrier construction early in the season. Weather conditions were more favorable for second generation bugs and as a result light damage to corn occurred in some sections in late August and in September. A moderate to heavy population of bugs went into hibernation in a few counties, particularly in Lancaster and Gage and in portions of surrounding counties.

Weather conditions in 1945 were unfavorable for field tests on control. However, some information was obtained on the effectiveness of certain insecticides when applied directly to chinch bugs on small grain and corn.

Replicated plots of barley heavily infested with bugs were dusted with one, two and four per cent dinitro-o-cresol, two per cent dinitro-o-cyclohexylphenol, one per cent ammonium dinitro-o-cresol, ten per cent DDT dust, and five and ten per cent sabadilla. Plots ranged in size from 1/20 of an acre, treated with a rotary hand duster, to ½ of an acre on which a 4-row, three nozzles per row, power duster was used. Thirty-five to 40 pounds of dust per acre were applied.
The various concentrations of dinitro dusts killed a large proportion of the bugs (estimated at over 90 per cent) in exposed places within one to two hours. Results with DDT were less conclusive and apparently it was less effective. Sabadilla powder at the ten per cent or even five per cent concentration was superior to all other treatments. Many of the bugs survived as the result of being in protected places behind leaf sheaths, under clods and in cracks in the soil.

In early September ½-acre plots of Sudan grass and corn heavily infested with both nymphal and adult bugs were treated as follows: a spray containing two pounds of sabadilla powder per 100 gallons; and two pounds of DDT per 100 gallons. Applications were made with a power sprayer. All bugs wet with the sabadilla spray were dead at the end of about one hour. Considerable numbers in leaf sheaths survived.

Results with DDT were less conclusive and apparently less satisfactory. The bugs were irritated by the spray to such an extent that they quickly left the stalks and moved in all directions. What happened to the bugs is uncertain, but indications were that only small numbers were killed and the survivors established themselves on other plants.

To summarize, sabadilla was superior to either dinitro dusts or DDT sprays and dusts for direct application to the bugs on growing plants. It is only partially effective in that large numbers of the bugs are not killed under field conditions. However, where large numbers are present on plants the bugs can be reduced to such an extent as to save the plants.

H. DOUGLAS TATE, DORIS B. GATES.

Hessian Fly

Many wheat fields in the southeastern quarter of Nebraska were moderately to heavily infested by Hessian fly in the fall of 1944, but the succeeding winter was so mild that little winter killing of the infested plants occurred. The cool, wet spring also aided recovery by infested plants and was unfavorable for development of the spring brood of Hessian fly. Consequently spring and summer damage by this pest was unusually light.

Favorable moisture conditions in July and August resulted in an early emergence of the main fall brood, and little wheat was available for egg deposition when the adult flies appeared. This caused the “fly safe” sowing date throughout the infested area to come approximately ten days earlier than normal and very little planted wheat became infested. Infestation in December of 1945 was much lower than the year before, and little trouble from Hessian fly was anticipated for the spring of 1946.

The Hessian Fly Uniform Nursery Plantings were continued at Lincoln in cooperation with the Agronomy Department and the U. S. Bureau of Entomology. Spring and fall plantings were made but in neither was the Hessian fly infestation heavy enough to give a critical test. O. S. BARE.

Grasshoppers

Grasshopper injury in 1945 was confined largely to the Panhandle section of the state. Here it was more or less spotted and principally in the form of marginal damage to such crops as corn, alfalfa and fall wheat.

Weather conditions unfavorable for grasshopper development were of first importance in preventing damage. A prolonged cool, wet period in June delayed development and destroyed many young nymphs, resulting in an estimated 50 per cent reduction in the grasshopper population. Parasites, predators and diseases destroyed large numbers of grasshoppers in some areas, although no general, widespread outbreak was encoun-
tered. Sarcophogid fly parasites were very abundant locally in some of the more western counties.

Cooperative grasshopper control work was carried on in 20 counties. Of these 12 issued significant quantities of bait. A federally financed baiting program was conducted in parts of four Panhandle counties. Generally speaking, local interest in grasshopper control reached the lowest peak of recent years.

The 1945 adult and fall egg survey indicated little change in the grasshopper potential for 1946. Threatening populations are confined to the Panhandle counties and little trouble, except for the possibility of migrations, is indicated in other sections of the state.

H. Douglas Tate, Harold A. Hauke.

Corn Rootworms

Corn rootworms continued to increase in 1945. Growing corn on the same soil for several years in succession, a common practice in some sections of the state, is especially favorable for rootworms, and an increasing amount of irrigation in the Platte River valley and other parts of central Nebraska is providing more favorable conditions for them.

Two species are largely responsible for the damage; the Colorado corn rootworm in the central and southwestern part of the state and the northern rootworm in the eastern third. The southern corn rootworm also causes some damage in southeastern counties, but it is generally much less important than either of the other species.

Left: Normal root system. Center and right: Root system destroyed by northern corn rootworms.
In August, 1945, records were obtained on 38 fields that had been in corn for periods of one to twenty-five years and the amount of damage evident at that time was estimated. All of these fields were in the vicinities of Lexington, Kearney, Gibbon and Wood River where the Colorado species is predominant. Results were as follows: no damage occurred in one-year corn; moderate to heavy damage in second-year corn; and moderate to very heavy in third-year corn. With increasing numbers of years continuously in corn the incidence of damage increased, but there was not always an increase in severity in a field after the first few years.

Severe damage to second-year corn was found only in heavily infested areas, and then only where there were adjoining or nearby fields in which rootworms had been present in large numbers the previous year.

The only known fully effective method of controlling the Colorado and northern corn rootworms is to avoid planting corn in old corn fields where damage occurred the previous year. In irrigated regions of the central part of the state where heavy rootworm populations have been allowed to build up, growing corn two years in succession on the same soil may result in serious injury in some cases. Under less critical conditions corn may be successfully grown three or even four years in succession, especially in soils having good moisture and fertility. Timely irrigation and maintenance of good fertility are especially valuable in reducing losses.

H. Douglas Tate, O. S. Bare.

Corn Borers

European corn borer. The rapid westward spread of the European corn borer in the last three or four years has again focused attention on this pest. The first infestation in Iowa was recorded along the Mississippi River in 1942. In 1944 it extended its known range all the way across Iowa and a single infested stalk was found near Lincoln, Nebraska.

A survey of eastern Nebraska counties was made in 1945 but no specimens of borer were found. It is not yet present in appreciable numbers in this state or in Iowa counties immediately adjoining the Missouri River.

Southwestern corn borer. The southwestern corn borer is generally regarded as a corn pest of first importance in areas where climatic conditions are favorable for its development. A few specimens were found in south-central Nebraska in 1943. This area was surveyed in 1944 and again in 1945. No evidence of any increase was found. It has been reported also that there has been no increase in Kansas counties immediately adjoining Nebraska. Further south in that state serious damage continued in 1945.

It appears that climatic conditions in Nebraska are unfavorable for the development of significant numbers of this pest. Perhaps it should be kept in mind that in time it might extend its present range through adaptation.

H. Douglas Tate, O. S. Bare.

Onion Thrips

Onion thrips are pests of major importance in Nebraska, particularly in the eastern part of the state. In past years insecticidal sprays generally have proved ineffective for controlling this pest on onions. Since there are also important plant disease problems associated with onion production, the departments of Plant Pathology and Entomology started in 1945, in a preliminary way, a cooperative project to test under Nebraska conditions those varieties of onions which have shown promise from the standpoint of disease and insect resistance. Twenty-seven varieties and
strains were grown in Lincoln and data obtained on relative susceptibility to onion thrips, along with records on various other factors.

Wide variation in thrip susceptibility occurred. Certain varieties of the sweet Spanish type which were developed by the U. S. Bureau of Plant Industry had a thrips population when the records were taken on July 7 of from 12 to 25 per plant, whereas some of the commonly grown varieties averaged more than 100 per plant; for example, Ebenezer 138 and South Port Yellow Globe 186. Some of the more thrips-resistant varieties also showed promise from the standpoint of quality and yield.

DORIS B. GATES.

Pine Tipmoth

Experiments were conducted in cooperation with the Plumfield Nursery of Fremont on the control of the pine tipmoth by means of sprays and dusts. Materials used were: a three per cent DDT-pyrophyllite dust; a spray containing two pounds of 50 per cent DDT wettable powder per 100 gallons of water; and three pounds of lead arsenate, plus a light oil, per 100 gallons of water. Applications were made in May for the first generation and again in July for the second generation.

Despite extremely unfavorable weather conditions at the time of treatments in May, the lead arsenate-oil combination gave a significant reduction in tipmoth damage. On Scotch pine, check plots showed 39 per cent of the buds destroyed while 17 per cent of the buds were destroyed on the plots sprayed with lead arsenate and oil. On Tanyosa pine 22 per cent damage occurred on check plots and seven per cent on those sprayed with lead arsenate and oil. DDT dusts were relatively ineffective. DDT sprays showed some value but were inferior to lead arsenate and oil. This may have been because no sticker or spreader was used with the DDT sprays.

Damage by second generation tip moth was higher than that of the first generation. Infestation on check plots was 78 per cent; on lead arsenate-oil sprayed plots 30 per cent; on DDT sprayed plots 44 per cent; and on plots dusted with a three per cent DDT dust 65 per cent.

O. S. BARE.

DDT and Fly Control

On June 17, 70 head of cattle on pasture near Sprague were sprayed with a 0.2 per cent DDT water suspension. Horn flies were present at the rate of 100 to about 500 per animal and stable flies were also numerous. Approximately one pint of spray was used per animal which was enough to thoroughly wet the back and head and run down on the sides a little.

Two applications were made at 14-day intervals. The second day following treatment no horn flies could be found on the animals and significant numbers were not observed until about the 14th day following treatment. The stable flies were not effectively controlled which may have been partly because legs and undersides of animals were not sprayed.

On June 19, a herd of 18 dairy cows and the housing facilities for handling them were sprayed with 0.25 per cent DDT water suspension and then re-treated two to three times at intervals following this. The lactating cows were brought into the barn twice daily whereas the other animals were kept continuously in small pastures. At the time of the first treatment 75 to 300 horn flies and stable flies were present on most animals and on a few especially susceptible cows the population was estimated to be approximately 500. Favorite resting places in the barns and milk sheds carried an estimated fly population of 12 per square foot.
The DDT spray residue in milk rooms and other protected sites continued to kill flies fairly effectively for three or four weeks and for a shorter time in more exposed places. Horn flies were quickly eliminated on all of the treated animals. However, stable fly control under the conditions was not satisfactory even when legs were sprayed at two or three-day intervals. Weather conditions were very favorable for stable-fly development and numerous places suitable for stable-fly breeding were present in the immediate vicinity.

Dairy and beef cattle barns at the Agricultural College, a total of more than 50,000 square feet in inside barn surface, were sprayed on July 16 and 17. The beef cattle barn, about one-fifth of the total area, was sprayed with a five per cent DDT water suspension and the dairy barns with a three per cent suspension. Several hundred animals were kept in these barns but most of them were allowed to run outside in small pastures a part of each day. Some were kept in open sheds with adjoining lots. None of the animals was treated.

Heavy fly populations were present at the time of treatment. In favorite resting places the population was estimated at about 12 per square foot and in some sheds there were “swarms” of flies. Some animals, especially large bulls kept in close quarters, were carrying several hundred flies. It is estimated that 50 to 60 per cent of the fly population were stable flies and the remainder house flies and horn flies along with a small number of other related species.

The day following treatment the fly population in favorite resting places had been reduced to less than one per square foot, and only an occasional live fly could be found in the dairy barns, including open sheds. When the milk cows were brought in from pasture in the evening, large numbers of stable flies came in with them, but by the next morning all of these had been killed.

At the end of about six weeks the rate at which the flies were being killed was somewhat reduced, but satisfactory control was still being obtained at the end of the fly season in late September (about 2½ months). The results indicate that stable flies, house flies and barn flies can be very successfully controlled in and around dairy barns by simply applying a residual spray to the barn, particularly favorite resting places for the flies within these buildings.

Under the conditions of these tests no appreciable difference could be detected between the five and three per cent sprays. The five per cent suspension was somewhat difficult to apply because of the high percentage of solid materials present in the liquid. Some records were taken to determine the approximate rate of application of DDT in this test. With the three per cent suspension 300 milligrams or more of DDT per square foot were applied to the walls, which is more than that indicated by some workers as being necessary for maximum kill.

At the time the treatments were being made in the barns it was not believed that roaches were present in significant numbers. However, the day following treatment large numbers of Oriental Roaches (or water bugs) were dead or dying in the open. The DDT caused irritation, forcing them out of their hiding places. Adult mealworms were killed in large numbers and they were still being killed at the end of 2½ months.

On July 7 two dairy barns in Douglas county having a 15 to 20 animal capacity were sprayed with DDT. One of these was sprayed with a three per cent DDT water suspension and the other with a five per cent DDT emulsion. A moderate to heavy fly population was present, 50 per cent
or more of which were stable flies and the remainder house flies and horn flies.

Satisfactory fly control was still being obtained with the three per cent DDT suspension at the end of the fly season in late September (about 2½ months). Although satisfactory control was obtained with the five per cent emulsion, it appeared somewhat less effective than the suspension.

On September 7, 37 brood sow sheds and runways were sprayed with a three per cent DDT water suspension. The premises were very heavily infested with flies: 75 to 100 per square foot in favorite spots around feeding troughs. Sixty to 75 per cent were estimated to be house flies and most of the remainder stable flies along with a few blow flies.

Within a few hours after treatment the fly population had been reduced to an insignificant level and a careful examination about 10 days after treatment showed that practically no flies were present. The foreman and workers at the hog barns reported very effective control during the remainder of the season.

On August 10 the outside entrances, walls and screens of a creamery were sprayed with a five per cent DDT-kerosene solution. Walls consisted of both concrete and glazed plaster and the floors were concrete. Flies were fairly numerous at this time and the manager reported that they were always a serious nuisance throughout the fly season. Frequent observations were made between August 10 and August 29. It was concluded that the treatment was ineffective. On August 29 the same surfaces were treated with a three per cent DDT water suspension. Within a few hours the fly population was reduced to a low level and remained there during the remainder of the fly season. Under the conditions of the test the suspension was more effective than the solution.

H. Douglas Tate, Martin H. Muma.

DDT and Bedbug Control

Two poultry houses at Valley, Nebraska, were sprayed with a five per cent DDT emulsion on July 7 to control bedbugs. Both houses were heavily infested—60 to 75 bedbugs per linear foot in cracks—and the owner reported that this particular infestation had persisted for more than ten years in spite of various treatments.

The poultry houses were examined three times during the summer following treatment and no live bedbugs could be found. The owner reported that he had been unable to locate a single live bedbug after the houses were sprayed.

H. Douglas Tate, Martin H. Muma.

Chicken Mite Control

Five chemicals were tested against the chicken mite under laboratory conditions and the most promising of these was tested to a limited extent in the field. These materials were ammonium dinitro-o-cresol, dinitro-o-secondary butylphenol, dinitro-o-cresylate, a five per cent DDT dust, and dusting sulfur.

Dinitro-o-secondary butylphenol proved to be slightly more toxic than the other dinitro compounds; DDT killed a high percentage of mites but was less effective; and sulfur gave very low kills.

Although a very high mortality (over 99 per cent) was obtained under laboratory conditions with dinitro-o-secondary butylphenol dust, it did not prove especially promising when used in poultry houses, probably because of inadequate penetration of cracks and crevices.

Doris B. Gates.


Miscellaneous Greenhouse Tests

Greenhouse plantings of young chrysanthemum plants heavily infested with thrips (thrips tabaci) were treated with a three per cent DDT-pyrophyllite dust. No live thrips could be found on the plants after approximately 24 hours and reinestation of sufficient importance to cause trouble did not occur again during the winter growth period. At the same time check plants were severely damaged. Chrysanthemum aphids, Macrosiphum sanborni and Rhopalosiphum rufomaculatum, were also effectively controlled by the same treatment. However, it was necessary to repeat treatment at ten-day to two-week intervals, probably because aphids survived in small numbers in the terminal buds of the plants.

The onion thrips, Thrips tabaci, were effectively controlled on Cineraria with a three per cent DDT-pyrophyllite dust but it was only partially effective against a species of aphids (undetermined) on this plant. No damage to any of the above plants by the DDT was observed.

Tests were conducted to obtain information on the toxicity of DDT to growing corn plants. Series of plantings were treated with DDT, one with three per cent DDT-pyrophyllite and the other with ten per cent, by applying small quantities around the seed at the time of planting. Two other series were treated when the plants were three or four inches tall and again one week later. Plants were kept under observation for approximately two months. None of the treatments caused any visible damage except that one plant, in the series where the seed was treated with ten per cent dust, showed slight burning when three to four inches tall. The plant recovered and developed normally. This may have had some cause other than DDT toxicity.

Satisfactory control of red spiders on carnations was obtained by treating with a dinitro-o-cyclohexylphenol-sulfur dust. Eighteen days following application only a small number of mites could be found on the plants and these were not causing any serious damage. The check plants, particularly flowers and buds, were practically a total loss.

Rodent and Predatory Animal Control

Rodent and predator control work in 1945 consisted mainly of control demonstrations, organized control programs and related educational activities. The work was carried on cooperatively with the Agricultural Extension Service and the U. S. Fish and Wildlife Service. Control of rats received special attention and control programs were organized in ten towns and cities. A limited amount of prairie dog and pocket gopher eradication work was carried on in the western half of the state.

Among predators, coyotes comprised the outstanding problem, and loss of livestock and poultry from their depredations has been increasing. According to reports, they are responsible for the curtailment of chicken, turkey and sheep production on many farms and ranches in the state. Livestock and poultry losses have been estimated at $1,046,697 annually. Three additional county cooperative predator control associations, making a total of five, were organized in Panhandle counties and professional hunters employed. Expenses of these associations and salaries of the hunters were paid from U. S. Fish and Wildlife Service funds, and funds raised by voluntary assessment on livestock belonging to members of the associations. Marked reduction of losses from coyotes was noted in these areas.

O. S. Bare.
Feeding Hogs, Cattle and Sheep

Department of Animal Husbandry

Hog Feeding Investigations

Substitutes for alfalfa meal for pigs in dry lot. Preliminary results indicate that bromegrass cut at an immature stage and field-cured can be used successfully to replace alfalfa in dry lot rations for growing pigs. They indicate also that distillers' solubles may be used to replace alfalfa and part of the tankage in the dry lot ration, under some conditions.

Four lots of 12 pigs each were fed in this experiment. They were purchased from the Range Livestock Experiment Station at Miles City, Montana. Developed from a Danish Landrace-Hampshire foundation, they were a thrifty, active group.

The pigs were started on the test rations eight days after arrival, at an average weight of about 60 pounds. Two lots were self-fed a ration of ground yellow corn and a protein supplement, free choice. The supplement fed to Lot 1 consisted of equal parts tankage, soybean meal and ground alfalfa hay (4th cutting). Supplement for Lot 2 consisted of tankage, soybean meal and ground bromegrass hay.

Two lots of pigs were fed mixed rations containing the same level of crude protein. Lot 3 was fed a mixture of ground yellow corn, tankage, soybean meal and ground alfalfa hay (4th cutting). For the pigs in Lot 4 all of the alfalfa and part of the tankage were replaced by distillers' solubles. A level of 18 per cent crude protein was fed until the pigs in each lot reached an average weight of 125 pounds. For the remainder of the experiment the level of protein was reduced to 13 per cent by decreasing the amount of tankage and soybean meal and increasing the proportion of corn. Seven per cent of alfalfa and of distillers' solubles were fed to the pigs in Lots 3 and 4, respectively, throughout the trial.

This table shows the carotene and protein content of the forages used and the protein content of the solubles used:

<table>
<thead>
<tr>
<th></th>
<th>Moisture %</th>
<th>Crude Protein %</th>
<th>Carotene Content in mgs. Per 100 Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa, 4th cutting</td>
<td>12.2</td>
<td>18.1</td>
<td>Nov. 15, 1944 21.7 May 8, 1945 4.7</td>
</tr>
<tr>
<td>Bromegrass, No. 1</td>
<td>10.1</td>
<td>13.5</td>
<td>Nov. 15, 1944 34.5 May 8, 1945 4.7</td>
</tr>
<tr>
<td>Bromegrass, No. 2</td>
<td>10.0</td>
<td>9.8</td>
<td>Nov. 15, 1944 22.1 May 8, 1945 4.7</td>
</tr>
<tr>
<td>Distillers' solubles</td>
<td>3.2</td>
<td>34.1</td>
<td>Nov. 15, 1944   May 8, 1945</td>
</tr>
</tbody>
</table>

The bromegrass was second cutting, cut at a height of about 10 inches, in July, 1944. Very fine-stemmed, it dried quickly, being stored in the barn the day after it was mowed.

The pigs fed bromegrass (Lot 2) consumed more feed and made more rapid gains than the pigs fed alfalfa (Lot 1), between the weights of 60-125 pounds, and also from 125 pounds to market weight. Feed requirement per pound of gain was practically the same for both lots. For the entire feeding period the results were as follows:

Average daily gain, Lot 1—1.41 lbs.; Lot 2—1.55 lbs.
Average ration, Lot 1—5.7 lbs.; Lot 2—6.4 lbs.
Feed consumed per pound of gain, Lot 1—4.0 lbs.; Lot 2—4.1 lbs.
The pigs fed the mixed ration containing alfalfa (Lot 3) gained at a more rapid rate, 1.55 pounds as compared with 1.32 pounds, than the pigs fed distillers' solubles (Lot 4), between the weights of 60-125 pounds. However, from a weight of 125 pounds to market weight the gains made by both lots were nearly identical, 1.68 and 1.67 pounds per pig daily. The alfalfa-fed pigs consumed more feed daily during both periods, 5.2 pounds and 7.8 pounds in the first and second periods respectively, as compared with 4.7 pounds and 7.1 pounds consumed by the pigs fed distillers' solubles. Those fed alfalfa required less feed per pound of gain during the first period and more feed per pound of gain during the second period. For the entire feeding period the results were as follows:

Average daily gain, Lot 3—1.63 lbs.; Lot 4—1.51 lbs.  
Average ration, Lot 3—6.8 lbs.; Lot 4—6.0 lbs.  
Feed required per pound of gain, Lot 3—4.2 lbs.; Lot 4—4.0 lbs.

**Protein requirements of weanling pigs in dry lot.** Three feeding experiments completed during the past year support the conclusion that a level of 20 to 24 per cent crude protein in a mixed ration self-fed to weanling pigs is preferable to a protein level of 27 per cent, or to free-choice feeding of corn and the protein supplement.

Thirty-seven pigs were used in each treatment and were placed on test at approximately nine weeks of age. The average initial weight was 37 pounds, and the average final weight was 65 pounds for the pigs fed free choice, and approximately 75 pounds for each of the other groups.

The control groups were self-fed finely ground yellow corn and a protein supplement free choice. Three other groups were fed mixed rations of the same ingredients adjusted to provide mixtures containing 20 per cent, 24 per cent and 27 per cent crude protein respectively. The protein supplement fed to the control pigs was composed of 15 pounds tankage, 15 pounds fish meal, 15 pounds soybean meal, 15 pounds linseed meal, and 20 pounds of ground, fourth-cutting alfalfa. The mixed rations fed contained five per cent ground alfalfa and sufficient mixed supplement (equal parts by weight of tankage, fish meal, soybean meal and linseed meal) to obtain the desired protein levels.

Each group of pigs was self-fed a simple mineral mixture. Only a very small amount of mineral was consumed.

In the first experiment, fall-farrowed pigs of excellent quality were used. The control pigs in this test consumed enough protein supplement so that the protein level of their self-chosen diet was 17.8 per cent. They gained at the average rate of one pound daily per pig and consumed 2.6 pounds of feed per pound of gain. Comparable figures for the three groups were:

- 20% protein, 1.06 lbs. gain—2.6 lbs. feed per pound of gain.  
- 24% protein, 1.10 lbs. gain—2.1 lbs. feed per pound of gain.  
- 27% protein, 1.2 lbs. gain—2.2 lbs. feed per pound of gain.

The pigs used in the second experiment were spring farrowed and of lower quality. For some reason the control pigs consumed an abnormally small amount of supplement, and the protein level of their self-chosen diet was only 12.4 per cent. This was reflected in their gain of only 0.37 pound daily per pig. The other three groups made average gains of 0.76, 0.78 and 0.77 pound daily. Likewise the control pigs made very inefficient gains, requiring 5.3 pounds feed per pound. The feed requirement was 3.4, 3.7 and 3.8 pounds per pound of gain, for the 20, 24 and 27 per cent groups respectively.
In the third experiment, spring-farrowed pigs of good quality were used. Here the control pigs consumed enough supplement so that their self-chosen diet contained 14.8 per cent protein. Average daily gains and amounts of feed required per pound of gain were as follows:

- Free choice, 0.76 lb.—3.6 lbs.
- 20%, 1.07 lbs.—2.9 lbs.
- 24%, 1.12 lbs.—2.9 lbs.
- 27%, 1.00 lb.—3.2 lbs.

The mean results of the three experiments are summarized in the following table:

<table>
<thead>
<tr>
<th>Ration</th>
<th>Free Choice 15.3% Protein</th>
<th>20% Protein</th>
<th>24% Protein</th>
<th>27% Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain, lbs.</td>
<td>0.70</td>
<td>0.95</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Average daily feed, lbs.</td>
<td>2.4</td>
<td>2.7</td>
<td>2.8</td>
<td>2.9</td>
</tr>
<tr>
<td>Feed required per pound gain, lbs.</td>
<td>3.4</td>
<td>2.8</td>
<td>2.8</td>
<td>2.9</td>
</tr>
</tbody>
</table>

From the data obtained in these experiments and from one experiment reported last year, it is apparent that pigs which are very thrifty and which are of good size at weaning will respond better to the free-choice method of feeding than those not so thrifty or light in weight at weaning. Under the conditions of these experiments, however, the forced feeding of additional protein supplement (by feeding mixed rations) improves the performance of pigs in the feed lot. The pigs fed the 20 and 24 per cent protein mixtures grew faster, in part at least, because they consumed more feed daily than the pigs fed free choice. Those fed the 27 per cent mixture consumed more feed daily than any of the other groups, but it was not reflected by gains greater than were made by the pigs fed the lower protein mixed rations. The 27 per cent mixture also tended to scour the pigs somewhat.

**Distillers’ solubles in dry lot rations for fattening pigs.** Results of this experiment indicate that distillers’ solubles should be added to the list of protein supplements suitable for swine feeding. They show also that distillers’ solubles are more valuable in the ration if they are added to a simple protein supplement mixture than when substituted for the tankage, soybean meal or alfalfa meal in that mixture.

Five lots of 12 pigs each (average initial weight 49 pounds) 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 (4th cutting). For Lots 2, 3 and 4, distillers’ solubles were substituted for the alfalfa, soybean meal and tankage in the mixture respectively. For Lot 5, the supplement consisted of equal parts of tankage, soybean meal, ground alfalfa and distillers’ solubles.

The distillers’ solubles used in this experiment were produced from 90 per cent mixed grain (corn, wheat, rye, etc.), and 10 per cent barley malt, plus a slight fraction of wheat bran, according to the manufacturer (Farm Crops Processing Corporation, Omaha). They had a protein content of 32.5 per cent, with 8.3 per cent moisture.

The results are presented in the following table:
### Cattle Feeding Investigations

**Relation of grain and forage sorghums to lithiasis, anasarca and pathological liver condition.** Seventeen steer calves with an average initial weight of 320 pounds were started on feed December 15, 1944. They were fed ground Early Kalo, ground alfalfa hay, which was practically devoid of carotene, and soybean oil meal. They also had access to salt and water. Grain was increased steadily and hay decreased until the calves were eating approximately 4.7 pounds of alfalfa per head daily. For the first 33 weeks they consumed an average of 2.8, 7.0, 9.3, 10.3, 11.3, 11.8, 12.6 and 12.0 pounds of ground Early Kalo per head daily by four-week periods. During the 33rd week the average daily grain consumption per head dropped to 10.2 pounds. They were fed approximately .47 pound of soybean oil meal per head daily during this 33-week period.

During the same 33-week period the average daily gain per head by 4-week periods was 1.22, 2.02, 2.49, 2.07, 1.94, 2.02, 1.54 and 1.24 pounds for the first 32 weeks. The calves lost 0.80 pound per head daily during the 33rd week.

At the close of this period the calves exhibited symptoms characteristic of avitaminosis although generally not as marked as symptoms shown by calves fed rations deficient in carotene the preceding year. One apparent exception to this was that the calves in 1945 more generally showed evidence of impaired vision.

At the close of the 33-week period the calves were divided into four lots. The eight head (Lot 4) which seemed least affected as a result of the low-carotene ration were fed as before except that alfalfa hay containing an average of 26.6 micrograms carotene per gram of hay was substituted for the low-carotene hay previously fed. This same ration was fed to three calves designated as Lot 2 while Lot 1, consisting of three calves, was continued on the ration fed prior to allotment. Lot 3, another three calves, was continued on the ration fed prior to allotment, with the addition of one ounce of fish oil with a vitamin A potency of 1,000 USP units per gram per head daily.

Differences in response to the different treatments generally were not as pronounced as in the preceding year. Although the calves placed in Lot 4 showed less noticeable symptoms of avitaminosis than the other calves at the time of allotment, they reacted similarly to the calves in Lot 2, also fed alfalfa hay with a carotene content of 26.6 micrograms per gram of hay, for the first 13 weeks after allotment. At that time four calves from Lot 4 showed unmistakable evidence of having developed urinary calculi and the lot was sold for slaughter. Three weeks later one calf from Lot 2 was slaughtered because of urinary calculi. The

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lot No. 1 Controls</th>
<th>Lot No. 2 Solubles Replaced Alfalfa</th>
<th>Lot No. 3 Solubles Replaced Soybean Meal</th>
<th>Lot No. 4 Solubles Replaced Tankage</th>
<th>Lot No. 5 Control Supplement Plus Solubles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain, lbs.</td>
<td>1.15</td>
<td>1.15</td>
<td>1.23</td>
<td>1.20</td>
<td>1.34</td>
</tr>
<tr>
<td>Average ration, lbs.</td>
<td>4.5</td>
<td>4.0</td>
<td>4.7</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Feed required per 100 lbs. gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>328</td>
<td>291</td>
<td>308</td>
<td>291</td>
<td>285</td>
</tr>
<tr>
<td>Supplement</td>
<td>65</td>
<td>57</td>
<td>73</td>
<td>78</td>
<td>68</td>
</tr>
<tr>
<td>Mineral</td>
<td>0.4</td>
<td>0.4</td>
<td>1.0</td>
<td>2.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

L. E. Hanson.
carcass from this calf was condemned because of a ruptured bladder and the presence of urine in the abdominal cavity. Gains in live weight made by Lot 2 were intermediate between those made by Lots 1 and 3. In the 20 weeks following allotment the calves in Lot 1 made an average gain of 191 pounds; Lot 2, 251 pounds; and Lot 3, 313 pounds.

General appearance of the calves in Lot 3 was much better than in Lot 2 and the latter was in better condition than Lot 1. As in the preceding year, the calves given a more adequate level of vitamin A or carotene after the depletion period improved in general appearance and muscular coordination, increased in rate of gain, showed less evidence of nervousness or excitability and gained more rapidly than before. The calves continued on the low-carotene ration either failed to show improvement or deteriorated in these respects.

This was the first trial in which a considerable proportion of the calves had to be removed because of urinary calculi.

**Marvel L. Baker, W. J. Loeffel, L. E. Hanson.**

**Distillers’ dried grains for wintering steer calves.** Two trials in which soybean oil meal and distillers’ dried grains were compared as protein supplements for wintering steer calves were conducted during the 133-day period from December 15, 1944 to April 27, 1945. The distillers’ dried grains used were a by-product of the manufacture of alcohol, largely from sorghum grain with a crude protein content of 28.8 per cent.

Two lots of eleven 385-pound steer calves were used in the first trial. Both lots were full-fed corn silage and an average of 2.80 pounds of ground corn per head daily. Lot 5, which consumed an average of 27.17 pounds of silage, also was fed 0.99 pound of soybean oil meal per head daily. Lot 6 was fed an average of 1.44 pounds of distillers’ dried grains and consumed 24.87 pounds of silage per head daily.

The calves in Lot 5 made an average daily gain of 1.68 pounds per head and consumed an average of 1,619 pounds of corn silage, 167 pounds of ground shelled corn, and 59 pounds of soybean oil meal per 100 pounds of gain. The calves in Lot 6 made an average daily gain of 1.53 pounds and consumed an average of 1,623 pounds of corn silage, 182 pounds of ground shelled corn, and 94 pounds of distillers’ dried grains per 100 pounds of gain.

Two lots of seventeen 380-pound steer calves were used in the second trial. Lot 7 consumed an average of 27.71 pounds of corn silage and 0.99 pound soybean oil meal per head daily, made an average daily gain of 1.29 pounds and required an average of 2,151 pounds of corn silage and 77 pounds of soybean oil meal per 100 pounds of gain. Lot 9 consumed an average of 27.07 pounds of corn silage and 1.46 pounds of distillers’ dried grains per head daily, made an average daily gain of 1.35 pounds, and required an average of 2,005 pounds of corn silage and 108 pounds of distillers’ dried grains per 100 pounds of gain.

Two lots of seventeen 380-pound steer calves were used in the second trial. Lot 7 consumed an average of 27.71 pounds of corn silage and 0.99 pound soybean oil meal per head daily, made an average daily gain of 1.29 pounds and required an average of 2,151 pounds of corn silage and 77 pounds of soybean oil meal per 100 pounds of gain. Lot 9 consumed an average of 27.07 pounds of corn silage and 1.46 pounds of distillers’ dried grains per head daily, made an average daily gain of 1.35 pounds, and required an average of 2,005 pounds of corn silage and 108 pounds of distillers’ dried grains per 100 pounds of gain.

**Marvel L. Baker.**

**Substitution of distillers’ dried grains and solubles for soybean oil meal for wintering steer calves.** In this trial two lots of seventeen 380-pound steer calves were fed for 133 days from December 15, 1944 to April 27, 1945.

Lot 7, fed an average of 27.71 pounds of corn silage and 0.99 pound soybean oil meal per head daily, made an average daily gain of 1.29 pounds, and required an average of 2,151 pounds of corn silage and 77 pounds of soybean oil meal per 100 pounds of gain. The calves in Lot 10
were fed an average of 26.98 pounds of corn silage and 1.40 pounds of the mixture of equal parts by weight of distillers' dried grains and distillers' solubles per head daily. They made an average daily gain of 1.37 pounds per head, and required an average of 1,969 pounds of silage and 102 pounds of the supplemental mixture per 100 pounds of gain. The mixture of distillers' dried grains and solubles was derived largely from sorghum grain and contained approximately 27.0 per cent crude protein.

**Safflower meal for wintering calves.** Safflower meal, with a crude protein content of approximately 42 per cent, was compared with soybean oil meal for wintering steer calves. Two lots of seventeen 450-pound calves were fed from February 9, 1945 to April 27, 1945, a period of 77 days.

The calves in one lot consumed an average of 28.92 pounds of corn silage and 1.0 pound of soybean oil meal per head daily, made an average daily gain of 1.33 pounds, and required an average of 2,173 pounds of silage and 75 pounds of soybean oil meal per 100 pounds of gain. The other lot consumed an average of 28.80 pounds of corn silage and 1.0 pound of safflower meal per head daily, made an average daily gain of 1.35 pounds and required an average of 2,136 pounds of silage and 74 pounds of safflower meal for 100 pounds of gain.

**Feeding distillers' dried grains to fattening steers.** Three trials were conducted in which soybean oil meal and distillers' dried grains were compared when fed with corn silage and ground shelled corn to fattening steers.

In the first trial two lots of 11 steer calves with an average initial weight of approximately 390 pounds were fed from December 15, 1944 to July 20, 1945, a period of 217 days. Distillers' dried grains used in this trial were derived largely from sorghum grain and contained 28.8 per cent crude protein.

The calves in Lot 3 consumed an average of 15.95 pounds of corn silage, 9.42 pounds of ground shelled corn, and 1.36 pounds of soybean oil meal, made an average daily gain of 1.99 pounds, and required an average of 801 pounds of corn silage, 473 pounds of ground shelled corn, and 68 pounds of soybean oil meal per 100 pounds of gain. The calves in Lot 4 consumed an average of 15.86 pounds of corn silage, 9.85 pounds of ground shelled corn, and 2.04 pounds of distillers' dried grains, made an average daily gain of 2.13 pounds per head daily, and required an average of 745 pounds of corn silage, 628 pounds of ground shelled corn, and 67 pounds of soybean oil meal per 100 pounds of gain.

At the conclusion of the trial the steers in Lot 3 fed soybean oil meal were considered slightly fatter than the steers in Lot 4. The two lots sold for $16.00 and $15.75 per hundredweight respectively.

In a second trial, two lots of fleshy yearling steers with an average initial weight of approximately 600 pounds were fed for 196 days, from April 27, 1945 to November 9, 1945. The distillers' dried grains used in this trial were derived largely from sorghum grain and averaged approximately 26 per cent crude protein.

The steers in Lot 5, fed 1.45 pounds of soybean oil meal per head daily, also consumed an average of 16.27 pounds of corn silage and 13.68 pounds of ground shelled corn per head daily; they made an average daily gain of 2.18 pounds, and required an average of 747 pounds of corn silage, 628 pounds of ground shelled corn and 67 pounds of soybean oil meal per 100 pounds of gain. The steers in Lot 6, fed 2.00 pounds of distillers'
dried grains per head daily, also consumed an average of 15.87 pounds of corn silage and 13.52 pounds of ground shelled corn per head daily, made an average daily gain of 2.22 pounds, and required an average of 715 pounds of corn silage, 609 pounds of ground shelled corn, and 90 pounds of distillers' dried grains per 100 pounds of gain.

At the close of the trial, there was no apparent difference in the market desirability of the two lots of steers and they sold at the same price, $17.25 per hundredweight.

In a third comparison between soybean oil meal and distillers' dried grains for fattening steers, two lots of ten 565-pound yearlings were fed from April 27, 1945, to November 23, 1945, a period of 210 days. The distillers' dried grains used in this trial contained approximately 26 percent crude protein and were derived largely from sorghum grain.

The steers in Lot 7 were fed 1.5 pounds of soybean oil meal and an average of 16.20 pounds of corn silage and 14.24 pounds of ground shelled corn per head daily, made an average daily gain of 2.38 pounds per head, and required an average of 681 pounds of corn silage, 598 pounds of ground corn, and 63 pounds of soybean oil meal per 100 pounds of gain. The steers in Lot 9 were fed 2.20 pounds of distillers' dried grains, and an average of 15.57 pounds of corn silage and 13.56 pounds of ground shelled corn per head daily, made an average daily gain of 2.29 pounds per head, and required an average of 679 pounds corn silage, 591 pounds ground shelled corn, and 96 pounds distillers' dried grains per 100 pounds of gain.

At the conclusion of the trial, there was no apparent difference in the market desirability of the two lots and they sold at the same price, $17.65 per hundredweight.
Safflower meal for fattening yearling steers. Safflower meal with a crude protein content of 42 per cent was compared with soybean oil meal for fattening steers in one trial.

Two lots of ten 565-pound yearling steers were fed for 168 days, from April 27, 1945 to October 12, 1945. The steers in one lot, fed 1.5 pounds of soybean oil meal, also were fed an average of 17.28 pounds of corn silage and 13.88 pounds of ground shelled corn per head daily, made an average daily gain of 2.42 pounds, and required an average of 713 pounds of corn silage, 573 pounds of ground shelled corn, and 62 pounds of soybean oil meal per 100 pounds of gain. Steers in the other lot, fed 1.5 pounds safflower meal, also were fed an average of 17.06 pounds of corn silage, and 14.18 pounds of ground shelled corn; made an average daily gain of 2.57 pounds per head; and required an average of 665 pounds of corn silage, 553 pounds of ground shelled corn, and 58 pounds of safflower meal per 100 pounds of gain.

At the close of the trial there was no apparent difference in the market desirability of the two lots of cattle.

Use of pasture in producing finished cattle. Three lots of twelve yearling heifers with an average initial weight of 493 pounds were grazed on pasture beginning April 27, 1945. The three lots were grazed together on a 20-acre bromegrass pasture until May 25. On that date Lot 3 was moved to an adjoining 10-acre bromegrass pasture which had been grazed at approximately the same rate. The other two lots were continued on the original bromegrass pasture until June 16 when Lot 2 was moved to a 10-acre pasture largely of grama. All three lots were continued on these pastures until September 5, 1945. Lots 1 and 2 were fed no grain throughout the summer. From June 16 to September 5, the heifers in Lot 3 were fed an average of 3.95 pounds of ground shelled corn per head daily with a maximum of 6.00 pounds per head.

The average gains per head by periods were as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 27-May 25, 28 days</td>
<td>86</td>
<td>83</td>
<td>81</td>
</tr>
<tr>
<td>May 25-June 16, 22 days</td>
<td>25</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>June 16-July 21, 35 days</td>
<td>46</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>July 21-August 18, 28 days</td>
<td>24</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>August 18-September 5, 18 days</td>
<td>20</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
<td>188</td>
<td>241</td>
</tr>
</tbody>
</table>

The 20-acre bromegrass pasture provided 2,508 animal days of grazing and produced a total of 4,728 pounds of gain in live weight. The 10 acres of grama grass provided 972 animal days of grazing and produced 912 pounds of gain. As it was utilized in 1945, the bromegrass pasture thus provided approximately 125 animal days of grazing and produced 236 pounds of live weight gain per acre; the grama grass provided 97 animal days of grazing and produced 91 pounds of live weight gain per acre. In 1944 the bromegrass pasture provided 135 animal days of grazing and produced 130 pounds gain per acre and the grama-grass pasture provided 86 animal days of grazing and produced 110 pounds gain per acre. Variations in growing conditions, in the condition of the pasture, and in the number of animals used in relation to the available forage, all affect the gain per head and the gain per acre. Feeding a limited amount of grain to the heifers in Lot 3 apparently resulted in some increase in the gain per head during the pasture season and in fatter heifers at its close.
All three lots of heifers were placed on feed in dry lot on September 5, 1945 and were fed for 100 days, or until December 14, 1945 on corn silage, ground shelled corn, and an average of 1.43 pounds of soybean oil meal per head daily. It was necessary to feed Lots 1 and 2 together. In addition to soybean oil meal the heifers in these two lots consumed an average of 19.63 pounds of corn silage and 12.55 pounds of ground shelled corn per head daily, made an average daily gain of 2.36 pounds, and required an average of 832 pounds of corn silage, 532 pounds of ground shelled corn, and 60 pounds of soybean oil meal per 100 pounds of gain.

The heifers in Lot 3 went on feed more rapidly than the heifers in Lots 1 and 2 and consumed an average of 15.24 pounds of corn silage and 14.33 pounds of ground shelled corn per head daily. They made an average daily gain of 2.34 pounds per head and required an average of 652 pounds of silage, 648 pounds of ground shelled corn, and 61 pounds of soybean oil meal per 100 pounds of gain.

At the close of the feeding period, the heifers in Lot 3 unquestionably were fatter than the other heifers. However, the three lots sold at the same price, $17.00 per hundredweight.

Progeny Testing of Rams

First year's work was completed on progeny testing 10 purebred Corriedale rams. The average birth weight of the lambs sired by each ram ranged from 9.26 pounds to 10.8 pounds. Average gain of the lambs from birth to the close of the summer grazing August 18, 1944, by sires, ranged from 37.57 pounds to 42.35 pounds. Average live weight January 14, 1945, by sires, ranged from 79.88 to 91.85 pounds. Shorn January 14, 1945, the lambs produced fleeces with an average weight by sires from 4.66 to 6.31 pounds. Both the live weights and fleece weights were probably affected by a prolonged sickness that ran through the group of lambs. Several lambs slipped their wool.

There was no outstanding sire in both live weight and fleece weight of offspring. Some of the rams that ranked high as sires of lambs with heavy final weights or gains showed a large variance within their offspring. One of the rams, No. 8, ranked second in siring lambs with a large gain and ranked first in siring lambs with a small variance of gain. The same ram ranked first in siring lambs with a heavy fleece but rated eighth in variance of fleece weight produced by his offspring. This ram is being used on the group of ewes called the tested flock at the North Platte Experiment Station.

The second group of 10 purebred Corriedale rams for testing was started November 1, 1944. In April, 1945, the lambing record showed a range in average birth weights, by sires, from 10.58 to 11.32 pounds, less than half the range in the 1944 lamb crop by a different group of rams but out of the same group of ewes.

Range in average live weight of lambs when taken off summer grass September 24, 1944, by sires, was from 57.4 to 64.2 pounds. This difference is about one-half greater than the range for 1944. M. A. Alexander.
Factors Affecting Reproduction in a Dairy Herd

Information was gathered as to the normal interval between estrus periods, the regularity from one period to another, and the number of cows that exhibit estrus at unexpected times. The answer to these questions would be of great help in normal herd management and perhaps more especially in artificial insemination. Quoting from a summary of the study: “The breeding efficiency from artificial insemination over an eight-year period in the University of Nebraska dairy herd was analyzed. The summer and late summer months required more services per conception than did the months during the other seasons of the year. August was high with 2.24 services per conception.

“Results indicated that it was not possible to predict from the breeding efficiency of the previous year the number of services required for subsequent conceptions. The services required for conception in virgin heifers did not give any indication as to the number of services required for the following conception, for the average number of services required per conception throughout the lifetime of the individual, and no indication as to the number of services required for first conception in her daughters. An analysis of the breeding histories for the cows sold as sterile showed that their previous breeding records gave no indication that sterility would follow.

“Daughter-dam comparisons made for the average number of services required for all conceptions throughout the lifetime of the individual indicated that it is not possible to predict the breeding efficiency of daughters from the breeding records of their dams. However, when the services required per conception were tabulated by cow families, it was found that among twenty families there was one with very low fertility and two with extremely high fertility. Analysis of the breeding records for the daughters of 19 bulls revealed one with daughters that required a highly significant number of services per conception and another sire that very closely approached that level.” H. P. Davis, A. B. Schultze.

Artificial insemination with dairy cattle. Relatively little is known about the breeding efficiency of bulls used regularly in a bull stud. The department has 20 bulls in service, of varying ages and representing four breeds: Holstein, Guernsey, Jersey, and Milking Shorthorn. Thus there is opportunity to study the behavior of bulls when used artificially. Since artificial insemination is becoming more widespread, all possible information bearing upon the practice is needed.

Tabulations for the calendar year 1944 for each individual bull showed the number of cows inseminated for the first, second, third, and subsequent times. All tabulations were made after March 1, 1945 so that at least 60 days had elapsed from inseminations in late December 1944 and a much longer period for previous ones. Where the records of the breeding association did not show return inseminations, the cow was considered pregnant. On this basis the tabulations were made by individual bulls, by breeds, and by months of the year. There were some significant month-to-month variations between bulls; but not enough data were available for conclusions. For 2,154 inseminations, the conception rate was 59.47 per cent. H. P. Davis, A. B. Schultze, R. G. Fossland.
Protein Supplements in a Dry Calf Starter

This is the third feeding trial using very young Holstein heifer calves in trying to determine the effectiveness of various protein supplements in dry calf starters, which followed a trial to determine the maximum of milk that was needed for successful calf development.

The summary of this trial follows: "Fifty-five grade, Holstein heifer calves which had received whole milk for approximately three weeks before the start of the experiment were fed to six months of age in six groups. It was planned that each calf was to be allowed 50 pounds of skim milk after which it was expected to obtain its nutrients from the protein supplement (provided in liquid form until the calf reached 52 days of age), a dry calf starter (later a grain mixture), and alfalfa hay (U.S. No. 1). The basal grain mixture used throughout the experiment but modified during the calf-starter period was composed as follows: 150 pounds of ground yellow corn, 150 pounds of ground oats, 100 pounds of wheat bran, 100 pounds of soybean meal (expeller process), 12 pounds of steamed bone meal, and six pounds of iodized salt. During the first 15 weeks various protein supplements were added to this basal mixture to make up six calf starters; namely, a control group and five experimental groups. Each calf starter was adjusted to the same calculated protein content. To the basal mixture 50 pounds of soybean meal were added for Group 1; 37.5 pounds of soybean meal plus 13.8 pounds of non-fat dry milk solids (powdered skim milk) were added for Group 2; 200 pounds of distillers' grain solubles were added for Group 3; 25 pounds of soybean meal plus 26.6 pounds of non-fat dry milk solids for Group 4; 55 pounds of non-fat dry milk solids for Group 5 (control group); and 200 pounds of distillers' grain insolubles were added for Group 6. Group 2 had approximately one-fourth and Group 4 approximately one-half of the non-fat dry milk solids of Group 5 (control). Vitamins were supplied by an A and D concentrate first fed as liquid, later as part of the calf starter.

"The calves in Group 1 did not make consistent gains in weight until after the fifth week of the experiment and it was necessary to feed three of the group of eight calves additional whole and skim milk. In Group 2 the calves made consistent but small gains during the early part of the experiment and it was necessary to feed additional whole and skim milk to two of the nine calves. The calves of Group 3 did not make consistent gains during the first five weeks of the experiment and it was necessary to feed two calves additional whole and skim milk. The calves of Group 4 made consistent but small gains throughout the experiment and it was only necessary to feed additional skim milk to one calf of the ten. In Group 5, ten calves made gains every week, though these were not always uniform and the group made the largest total gain of any group in the experiment. No additional milk beyond the specified 50 pounds was fed to any calf. Group 6, which received the same liquid feed as Group 5 for the first 30 days, had one calf of nine which received additional whole and skim milk. This group made consistent but somewhat irregular gains throughout the experiment.

"The diagonal measurement and height at withers showed no significant difference at the various stages of the experiment for the several groups. The heart girth at two months of age did seem to show slight differences between the several groups but these were not believed to be significant. Of the measurements used, the greatest inequalities during the early stages of the experiment occurred in weight. There appeared to be no significant inequalities between the calves so far as skeletal measurements.
could reveal them. The differences in weight represented largely a condition of fatness and these were mostly eliminated by the time the animals reached six months of age.

"In feeding Holstein heifer calves from three to 19 weeks of age the following ration—50 pounds of skim milk, alfalfa hay ad libitum, and a dry calf starter (16 per cent digestible protein) with soybean meal as the principal high protein supplement—it was found that the results as measured in gains and growth were not satisfactory. This response confirmed previous experiments. Non-fat dry milk solids had an ameliorating effect even in small quantities when substituted for soybean meal. A dry calf starter containing ten per cent of non-fat dry milk solids produced normal gains with young calves. After the calves reached 18 weeks of age, a grain mixture containing soybean meal as the principal high protein supplement yielded satisfactory growth and gains.

"Distillers' dried grains, both solubles and insolubles, used as one of the principal high protein supplements in a dry calf starter (after two months of age) gave good results under the conditions of the experiment.

"The results emphasize that up to the time calves eat grain and hay freely, non-fat dry milk solids are particularly useful in getting calves started."

H. P. Davis, George W. Trimberger.

**Carotene Content of Native Nebraska Grasses**

Studies of the carotene content of 24 native grasses of Nebraska were made during three seasons, eight grasses per year. The carotene determinations were made colorimetrically by standard procedures either by means of a colorimeter or spectrophotometer. Climatological data were obtained to correlate with the result. The grasses studied were: side-oats grama, blue grama, Indian grass, big bluestem, switchgrass, western wheatgrass, buffalo grass, sand dropseed, sandhill bluegrass, sloughgrass, sand reedgrass, needlegrass, tall dropseed, hairy grama, little bluestem, western needlegrass, wild rye, saltgrass, prairie dropseed, northern reedgrass, Junegrass, bluejoint, alkali dropseed and lovegrass. Samples were taken from pure stands maintained by the Department of Agronomy at Lincoln. The plants were cut from one to two inches above the ground and no attempt was made to obtain only green material.

The summary of the bulletin is as follows: "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 the grasses contained enough carotene to supply the needs of range cattle until late November. However, only 18 of the grasses still 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 ranged from 60.7 p.p.m. (Junegrass) to 1.6 p.p.m. (little bluestem) during periods of lowest concentration."

The results indicate that pastures composed of native Nebraska grasses would not furnish sufficient carotene to meet the needs of livestock throughout the year. Some additional source of Vitamin A would be
necessary if the animal’s body storage of vitamin A was to be maintained and if a decrease in the vitamin A content of the milk produced was to be prevented. If experiments show the grasses were equal in feeding value, it might be advisable to encourage those grasses with a higher carotene content.

I. L. HATHAWAY, H. P. DAVIS, F. D. KEIM.

Cheese, Butter and Ice Cream

**Studies of Nebraska cheese.** There were indications that the procedure followed in the manufacture of cheese had a greater effect upon the body than upon the flavor, although the overproduction of acid did affect the flavor. Too rapid development of acid resulted in a cheese that ripened too early for export, while too slow aging appeared more likely to develop a poorer flavor in stored cheese. In the various steps of manufacture it was found that:

Recontamination of milk after pasteurization may result in a low quality of cheese.

The coli-count was a valuable aid in measuring such contamination.

Time, temperature, and acidity relationships determine the moisture content of the finished cheese when proper draining has been provided.

The bacterial content of the curd is higher than that of the whey.

Production of acid during manufacture is a bacterial function controlled in the usual way. As a result of the small laboratory batches, the importance of the methods of handling starter and its control was verified. A limited study of the pH on samples of cheese graded for the government indicated that the lower pH was associated with lower grade cheese.

Observations made during the grading and regrading of cheese for the War Food Administration indicated considerable variation in the speed of ripening. Efforts were made to determine the accuracy of the initial grading upon the final quality of the cheese after storage. Twelve lots were held in storage more than 425 days. Tabulations of 87 gradings of 15 lots of cheese, all but three of which were held more than 425 days, indicated that grading of fresh cheese gave reliable results. Four lots improved one grade over the initial grading which was made at approximately 15 days after manufacture, and this improvement was due to a change in body texture, especially the disappearance of small mechanical openings and of a small amount of sweet gas. Two lots lost one grade (Fancy to No.1) due to the development of unpleasant flavors. One batch showed a marked change in flavor (No.1 to No.2). The No.2 (3 grade) cheese usually showed up as “overactive” which indicated too rapid breakdown of the curd and other undesirable characteristics as the cheese aged.

P. A. DOWNS.

**Vitamins in cheese.** Studies have been carried on for several years of riboflavin (vitamin G) content of cheese by biological analysis. To quote from the summary of the research bulletin: “The riboflavin concentration of 27 kinds of cheese and cheese spreads was 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 spread). The samples of goat, Velvetta, Mel-O-Pure and Liederkranz had the highest concentration of riboflavin while samples of cream and pimento cream had lowest.”

The cheeses studied included of the hard cheese: cheddar (both New York and Wisconsin type), Edam, goat, Gold-N-Rich, Kau Kauna Klub
(both smoked and unsmoked), and Tiny Tulip. The semi-hard cheeses studied were: Husker, May Bud and Mel-O-Pure. Soft cheeses in the study included: limburger, Liederkranz, Roquefort, cottage (both plain and vegetable), cream and pimento cream. The group of processed cheeses used in the experiment included: American Kraft, Meadow Gold Process, Robert's Pasteurized, brick, Munstett, Pabstett, Swiss Kraft, Velveeta and Vera Sharp.

The studies indicate that, compared with other foods, various kinds of cheese are very good sources of riboflavin. L. H. Hathaway, H. P. Davis.

**Vitamin content of commercial butter.** Butter samples have been obtained monthly from 14 sampling centers scattered over the state as part of a National Research Council nation-wide study on vitamin content. A considerable number of samples have been analyzed for vitamin A, carotene, moisture and fat.

Results so far as reported indicate that Nebraska winter-produced butter averages 11,287 international units of Vitamin A. Summer butter made in Nebraska averaged 20,667 international units. The annual average potency of Nebraska butter is listed as 17,030 international units of Vitamin A per pound.

L. L. Hathaway.

**Ice cream stabilizers.** Preliminary trials were conducted with ice cream mixes containing whole eggs, both fresh and frozen, added prior to pasteurization. Whole egg additions were varied to constitute one, two, six and ten per cent of the mix weight. At the ten per cent level both whole eggs and the yolk equivalent were used. At the six and ten per cent levels of whole eggs, the milk fat was reduced in an amount equivalent to the fat content of the added eggs and the serum solids reduced to 80 per cent of the milk fat. The basic mixes contained 10.5 per cent milk fat, 8.4 per cent serum solids, 15 per cent sugar (nine per cent sucrose, three per cent corn sugar, and three per cent Frodex), and 0.4 per cent gelatin. Mixes were pasteurized at 175°F. for five minutes and homogenized at 3,000 and 5,000 pounds. They were aged 24 hours and frozen in a 40-quart direct-expansion batch freezer. The conclusions from these trials are:

The use of whole eggs improved the whipping and body of the ice cream at all levels.

There was a progressive increase in body improvement with the increased percentage of whole eggs or equivalent, with ten per cent of eggs producing the best body.

The use of eggs in the quantities mentioned did not produce undesirable egg flavors in ice cream.

Frozen whole eggs were as satisfactory as fresh whole eggs.

When whole egg solids were used to replace milk solids, the resulting ice cream had body characteristics similar to an ice cream containing no eggs.

Condensed cheddar cheese whey (32.5 per cent total solids) was used in sherbet mixes with success in quantities varying from eight to ten per cent. Under such conditions the overrun was satisfactory and the body of the sherbet was improved. When the condensed whey constituted 20 to 30 per cent, by weight, of the sherbet mix the overrun was excessive and not controllable. Condensed whey was held frozen from 90 to 120 days and remained satisfactory for use provided it was heated to a sufficiently high temperature to redissolve the milk sugar and the milk salts.

L. K. Crowe.
When Should Turkeys Be Marketed?

It is recognized that turkeys are efficient meat producers during the early stages of growth. For the latter part of the growth period there is, of course, an improvement in quality as well as an increase in the weight. How long turkeys of a given breed and strain can be fed profitably should be determined experimentally, and some observations were made during the past season.

On October 19, 1945, a number of turkey toms were selected. These consisted of 76 Bronze toms in one pen, 45 small Beltsville White toms in a second pen, and 39 cross-bred birds, which were intermediate in size between the broad-breasted toms and the small Beltsville Whites. These birds were not sufficiently matured at 26 weeks to justify marketing, and so they were retained for feed-converting efficiency studies during two additional two-week periods.

At 30 weeks of age, the average weights were: Beltsville White—18.84 pounds; cross-breds (½ White x ½ Bronze)—24.15 pounds; cross-breds (¾ Bronze x ¼ Whites)—24.59 pounds; broad-breasted Bronze—27.15 pounds.

All birds were fully feathered and well finished at 30 weeks. Quality of feathering and maturity were slightly in favor of the cross-bred stock. A few of the Beltsville Whites and cross-breds would have been classified as slightly staggy at 30 weeks of age.

More observation should be made to determine when the point of marginal returns is reached with respect to the profitable feeding period. These data show that, with the strains under observation, profitable meat production can still be obtained up to an age of 30 weeks for the males. It should also be emphasized that the improvement in quality obtained, as the feeding period was extended, is important when Turkey marketing is done on a graded basis. The advantage here is definitely for the longer feeding period.

J. H. Claybaugh, F. E. Mussehl.

Estrogens for Fattening Cockerels

Some recent research at the University of California suggested the possibility of improving quality and reducing the cost of producing market poultry through the use of synthetic estrogens.

The first product used was diethylstilbestrol, administered orally in 5 mg. capsules each week per bird. Leghorn cockerels, averaging about 7.40 gms. each, were used for the experimental lot and the controls.

There was no apparent physiological effect from the oral administration of the diethylstilbestrol at the 5 mg. per week level. Both lots of cockerels made good gains, and there was no apparent effect on sexual development, growth rate, or fattening quality.

A second synthetic estrogen, dianisyl-hexene, had a definite physiological effect. This product also was administered orally by adding the material dissolved in oil directly to the ration. The ration contained dianisyl-hexene at a level of one quart in 10,000 of complete ration.

Effect of the compound on comb color was evident within 48 hours. After four weeks on the experimental diet, a distinct effect on feathering
and comb development was noted. The neck and saddle feathers of the birds which received dianisyl-hexene were more round and characteristically "hen feathered."

Weight of the control cockerels at termination of the experiment, however, was still about 15 per cent above that of the group receiving the dianisyl-hexene. Blood studies demonstrated distinct differences in blood quality, which may be summarized in the following characteristics of the lot receiving the synthetic estrogen: The bleeding and clotting time was much prolonged; the blood presented a milky red appearance, instead of the bright clear red of the control group; it dried slowly on the smears, and presented an oily appearance when dry; erythrocyte, leucocyte and thrombocyte levels of the birds on the estrogen diet were lower than those of the controls.

Although certain definite physiological effects can be ascribed to the inclusion of dianisyl-hexene in the diet at a level of one part in 10,000, the economy of its use is not apparent. Effect of residual material in the tissue of the birds should be investigated. At the present time, use of synthetic estrogens for fattening poultry is very properly being limited to research laboratories.

F. E. Mussehl, Esther Wolla Copeman.

Protein Utilization by Chicks and Poults

An important management problem in poultry production is how best to supplement natural feedstuffs with essential proteins, vitamins and minerals. There is evidence of adaptation to rather wide extremes in tolerance for these supplements, but naturally the search could continue for the optimum combinations.

This problem should also be approached with proper respect for economic principles. Supply influences price, and ingredients should be combined in such a way as to utilize best the concentrate resources. (See the graph on the next page.)

Four combinations of concentrates were studied with relatively large numbers of chicks and poults. They included varying amounts of soybean meal, alfalfa meal, meat scraps, fish meal, dried buttermilk, dried fermentation solubles, and a salt mix. The concentrates were combined with the same cereal base to provide a protein level of 20.9 per cent for all lots, with 165 S. C. White Leghorn chicks per lot.

All four combinations of concentrates produced excellent growth in Leghorn chicks when used with the specific cereal base TCX. There was no evidence of either protein, vitamin or mineral deficiencies in any of the lots.

Experiments indicate that poults require more protein than do chicks for optimum growth. Combinations of concentrates, cereal base and Vitamin D carrier were fed to four lots of 80 poults each. The experiment was then repeated with 110 poults in each of four lots. Some losses in one lot which remain unexplained limit the conclusions.

Seventeen days after the experiment started this lot experienced unusual losses, apparently due to poisoning. Removal of the suspected feed and replacement with another sample made in accordance with the same formula prevented further loss. Since the variable in this ration was the fermentation by-product, attention was naturally directed to this ingredient. The combinations of concentrates, as listed, are well utilized by growing poults, but further research work is required on the end products which result from certain fermentation processes. A third experiment indicated again the possibility of organic poisoning from the use of certain samples of fermentation by-product dried solubles.
These solubles contain some of the proteins from the cereals fermented, plus yeast cells and by-products of yeast activity. Theoretically this product should be an excellent source of vitamin B complex factors. Whether rations made up of natural feedstuffs are likely to be marginal for these factors was the object of another experiment.

For the variable portion of the rations, blends of soybean meal, fermentation by-product solubles, and yellow cornmeal were made to provide the same protein level for each ration. The vitamin B complex level of the rations was increased as the amount of fermentation dried solubles was increased.

When basic cereal ingredients, as used in our experiments, are supplemented with five per cent good quality alfalfa meal, three per cent meat scraps, three per cent sardine meal, and 24 per cent soybean meal, there is no evidence that additional amounts of the B-complex factors are needed. Proteins of fermentation dried solubles (corn base) can be rated as having a biological value for chicks the equivalent of soybean protein.

F. E. Mussehl.

Sterilamp Irradiation for Chicks

LAMPS HAVE BEEN developed which produce energy of known germicidal value. Whether or not the irradiation of the environment in which chicks are brooded with such energy would affect the growth rate brings up a logical question.
The vitamin D contributions of Sterilamp irradiation were not a consideration in this experiment, since the antirachitic effect of germicidal lamp energy is admitted to be very slight. The ration, therefore, included adequate levels of vitamin D provided by activated animal sterol (454 A.O.A.C. units D per pound of ration).

Summarizing the growth rate and mortality experience with two lots of 192 chicks each, it was concluded that when healthy pullorum-free chicks are brooded in a clean environment there appears to be no advantage in irradiation from germicidal lamps.

F. E. Mussehl.
Examinations of Specimens

The bacteriologic, serologic, and pathologic examination of specimens submitted by private citizens and others has continued. During the year 1945, a total of 7,598 specimens were subjected to examination and the results reported to the persons interested. F. R. Woodring.

Swine Erysipelas

Three phases of the problems connected with swine erysipelas were given attention:

1. The validity of the culture-vaccines used in the prevention and control of the disease in this state. As in preceding years this work was continued at the request of and in cooperation with the Nebraska Bureau of Animal Industry which collected and provided the samples needed for analysis.

The results obtained during 1945 can be recorded as follows:

<table>
<thead>
<tr>
<th>Producer</th>
<th>No. of Cultures Acceptable</th>
<th>No. of Cultures Not Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>G</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>51 (72.85%)</td>
<td>19 (27.14%)</td>
</tr>
</tbody>
</table>

It appears that, as in previous years, some concerns produce valid vaccination materials, whereas others more or less constantly fail to do so.

2. Experiments inaugurated some years before, in an effort to discover certain influences which may impair culture-vaccines, were continued and concluded. The data will be analyzed and presented for publication. However, a clear-cut conclusion may not be possible; it may be that the causes of culture failure can be solved only at the producing laboratories.

3. (Sub-experiment.) Owing to its possible importance to the management of swine erysipelas, advantage was taken of an opportunity to study the effect of penicillin on *E. Rhusiopathiae*.

Conclusions from this study were:

*Erysipelothrix Rhusiopathiae* was found sensitive to penicillin. When dosage was adequately adjusted, the drug caused pigeons to survive inoculations of the virulent cultures.

The injection of 1,200 Oxford units of penicillin was not sufficient to protect a majority of the pigeons against the culture inoculations. It became apparent that in penicillin experiments with pigeons the protective dosages range between 2,400 and 3,600 Oxford units.

A significant number of the pigeons injected with 2,400 Oxford units of penicillin succumbed to the culture inoculations when they were less than 12 hours advanced in their incubation period at time of treatment.

When the penicillin treatment was delayed for 48 hours after the culture inoculations a high mortality was observed among the pigeons. In
the type of experiments here considered, it is preferable to inject culture and penicillin simultaneously. The interval between the two injections should not exceed 12 hours.

Even under the adverse influence of a more or less delayed penicillin treatment, there is a conspicuous difference in the number of surviving pigeons between the groups which received one or two penicillin doses and those which were injected three or more times, with a decided advantage in favor of the latter.

The results of the injections with culture-penicillin mixtures did not greatly differ in two groups of pigeons. In each group only four pigeons succumbed to the inoculations. Twenty-six birds in each group were adequately protected in the primary experiments. In the immunity tests of a total of 52 pigeons only one showed to be resistant, the remainder failing to acquire any immunity.

When the resistance of pigeons which survived after the primary inoculations with culture was challenged by one or two subsequent culture inoculations, it was found that a significant number of such birds had acquired a manifest immunity.

As there is no reason to believe that in the immunity test a penicillin influence persisted, there probably is no ground for an attempt to determine the relative value of the two penicillin salts (sodium and calcium). The experimental data submitted in the text tend to show that any difference between them could not have been a very conspicuous one.

Treatment by the administration of penicillin may be indicated in the earliest stages of swine erysipelas. The repeated penicillin injections that seem necessary for best results constitute a considerable limitation on its employment in veterinary practice. Its use, however, may receive consideration in the treatment of erysipeloid in persons sensitized to horse anti-swine erysipelas serum. L. Van Es, J. F. Olney, I. C. Blore.

Mortality in Turkey Flocks and Its Prophylaxis

Experiments during 1945 pertained to three phases of the problem:

1. A census of the apparent causes of death among poults and turkeys submitted by flock owners revealed that in 1945 a total of 163 turkeys and poults were subjected to examination.

The following conditions or disorders were encountered and their comparative incidence expressed as percentages:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Per Cent</th>
<th>Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackhead</td>
<td>11.27</td>
<td>Fowl pox, injury, malnutrition, peritonitis, pneumonia, rickets, sinusitis, swine erysipelas</td>
</tr>
<tr>
<td>Pullorum disease</td>
<td>11.27</td>
<td></td>
</tr>
<tr>
<td>Paratyphus</td>
<td>10.42</td>
<td></td>
</tr>
<tr>
<td>Coccidiosis</td>
<td>9.20</td>
<td></td>
</tr>
<tr>
<td>Trichomoniasis</td>
<td>6.75</td>
<td>Ascitis, avitaminosis, bronchitis, edema, enteritis, hexamitiasis, perosis, pyocyanosis, salmonellosis</td>
</tr>
<tr>
<td>Fowl cholera</td>
<td>5.32</td>
<td></td>
</tr>
<tr>
<td>Fowl typhus</td>
<td>4.90</td>
<td></td>
</tr>
<tr>
<td>Air sack infection</td>
<td>1.84</td>
<td></td>
</tr>
<tr>
<td>Colibacillosis</td>
<td>1.84</td>
<td></td>
</tr>
</tbody>
</table>

This census disclosed the high morbidity of such diseases as blackhead, coccidiosis, fowl cholera, fowl typhus, paratyphus, pullorum disease and trichomoniasis, many of which are filth-borne disorders, amenable only to sanitary measures.

In a conspicuous number of the birds examined (19.63 per cent of the total), the death cause could not be determined by routine bacteriological examinations. It is possible in some of these cases that an ultra-microscopic virus may have to be considered as an etiologic factor.
2. A study of the possible influence of the addition of certain sulfa drugs to the feed as a protection against paratyphus was made. In these experiments sulfadiazine and sulfamerizine were used. The following results could be recorded:

The addition of two per cent sulfadiazine to the feed apparently had a toxic effect on the poults used in these experiments. These birds lost their appetite and half of them succumbed without revealing the presence of \( S. \) \textit{typhimurium}. Four poults died of paratyphus to which they were exposed and a similar number survived.

When the amount of sulfadiazine in the feed was reduced to one per cent the drug failed to protect the poults so fed and all died of paratyphus to which they had been exposed.

The addition of 0.5 per cent of sulfamerizine to the feed apparently exercised an inhibitory influence on the development of \( S. \) \textit{typhimurium} infection in the poults maintained on such a ration, but not to a degree to warrant the use of this drug in practice.

An effort was made to determine whether or not the use of the sulfa drugs in these experiments had any influence on the persistence of positive reaction titers after agglutination tests with paratyphus (\( S. \) \textit{typhimurium} antigen). For this purpose all the poults which survived in all the experimental series were periodically subjected to the tests mentioned.

At the conclusion of this season's work all the positively reacting poults were subjected to final agglutination tests. It was found that the previous agglutination titers had failed to persist but owing to the fact that this was also the case in the control poults included in the series (not fed with sulfa drugs) it could not be concluded that the negative final tests could be attributed to sulfa drug influences.

3. In order to ascertain whether or not treatment with penicillin may have a place in the control of paratyphus (\( S. \) \textit{typhimurium}) two experiments were undertaken.

In the first experiment three groups of eight poults each having an average weight of 250 gm. each were used.

In Group A the eight poults were each injected with 2,500 Oxford Units of penicillin-sodium on the morning and evening of one day. The first injection was immediately followed by the inoculation of 0.25 cc. of a 24-hour broth culture of \( S. \) \textit{typhimurium}.

In Group B the penicillin injections were made on the morning and evening of three successive days, the poults being inoculated with the above-mentioned culture immediately after the first penicillin injection.

In Group C another eight poults were inoculated with culture only in order to serve as culture controls. All of the poults of the three groups failed to be protected by the penicillin and succumbed to the culture inoculations after a brief incubation period.

In the second experiment, undertaken approximately two months after the first, a similar number of poults, also divided into three groups, was injected with penicillin and culture as outlined in the preceding experiment. However, there was this difference—the average weight of the poults was then 1,145 G. and the penicillin doses used in Groups A and B were 10,000 Oxford units. Results are recorded in the following table:

<table>
<thead>
<tr>
<th>Groups</th>
<th>No. of Poults</th>
<th>No. of Poults Which Survived</th>
<th>No. of Poults Which Died of Paratyphus</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (2 penicillin doses)</td>
<td>8</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>B (6 penicillin doses)</td>
<td>8</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>C (Controls)</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
It appears that in the second experiment poults of an average weight of 1,145 G. showed a greater basic resistance to the culture inoculations than the ones used in the first experiment in which the birds had an average weight of 250 G. each.

The relatively larger number of control poults which survived indicates that the influence of age or of a greater body weight may have been more or less dominant factors.

When the results among the control birds are compared with those obtained in poults which received two or six penicillin doses, it becomes apparent that \textit{S. typhimurium} is not very sensitive to penicillin, and that the use of penicillin cannot be used with confidence in the control of paratyphus among turkeys.

A total of 14 poults survived in the second experiment and these were subjected to a second inoculation with \textit{S. typhimurium}, in order to determine whether or not these birds had acquired any resistance. Only two of these poults developed paratyphus. The resistance of the 12 birds which withstood the second inoculation must be attributed to the culture injections in the primary experiment rather than to a penicillin influence.

\textbf{L. Van Es, J. F. Olney, I. C. Blore.}

\textbf{Comments.} There can be no doubt that in large flocks, often composed of thousands of turkeys, disease constitutes a conspicuous hazard. With such filth-borne diseases as blackhead, coccidiosis, fowl typhus, paratyphus and probably some others, the solution of the morbidity problem depends entirely on the prevention of contamination of feed and water by the body wastes of poults actually involved in such diseases or of apparently normal infection carriers.

It is a hazard particularly to be considered in flocks maintained on rather circumscribed areas. Flock morbidity is likely to increase in proportion as the areas upon which body wastes are deposited become more restricted.

In the prevention of disorders of the type mentioned, only sanitary measures adequately applied can be depended upon. Until more refined methods of prophylaxis may find application, a beginning may be made by dividing turkey flocks in as many smaller units as circumstances permit. When disease declares itself in a flock of 5,000 turkeys, the introduction of infection is apt to expose the entire lot, whereas when the flock is divided the risk may pertain to a more restricted number of birds.

The results of certain experiments reported in Nebraska Research Bulletin 118 (1940) showed that losses from such diseases as blackhead, coccidiosis and fowl typhus can be prevented by certain prophylactic measures especially designed for the purpose. Such methods may in time also be made applicable in relatively large flocks.

However, before any specific recommendations can be made in this connection, such details as production costs, mortality costs, etc., should be carefully studied because, after all, the disease problem \textit{per se} is not entirely one of sanitation. The financing of flock management constitutes part of the problem to be solved.

On the whole, it seems doubtful that the administration of medicinal agents can be relied upon for desirable results. Even if certain chemicals may have an inhibitory effect on the spread of disease in turkey flocks, the addition of drugs to the feed would require a more or less continuous administration, the results of which cannot as yet be predicted.

\textit{L. Van Es.}
Heating Drinking Water for Livestock

The need for keeping the temperature of drinking water for livestock above the freezing point is evident. For this purpose, and with the further aim of studying the effect of different levels of temperature on the drinking habits of livestock, a low cost immersion-type thermostat was devised. For the past four seasons it has been under test on a farm near Lincoln.

A small-volume watering trough made of two-inch redwood and heated by means of soil-heating cable has been in use on a small dairy farm for one season. The trough holds 20 gallons of water which is held at constant level by a float valve. Water temperature is maintained at approximately 40°F. by an immersion-type thermostat. The trough supplies drinking water for two horses and 14 head of milk cows, heifers and calves. Electric energy consumption for the period November 13, 1944 to March 7, 1945 amounted to 61 kilowatt-hours.

Increasing the temperature of the drinking water to approximately 60°F. for a period of five days in February, 1945, definitely increased the energy consumption but had no apparent effect on the drinking habits of the cows or upon milk production. E. E. Brackett, F. D. Yung.

Eradication and Control of Noxious Weeds

In this cooperative project with the Agronomy Department, the Agricultural Engineering Department has concerned itself with devising a method of planting and cultivating which will effectively eliminate bindweed and other noxious weeds. The method, briefly described, consists of planting one row and skipping two, and planting at double the rate normally used in the planted row. This rate gives two-thirds as many hills of corn on the area as where corn is planted at the normal rate.

The late, cold spring delayed work on this project as well as others and the corn was not planted until June 21. However, the stand obtained was the best for the three seasons. More power was required to cultivate than during previous years, and the wet season made it necessary to cultivate at times before the soil was as dry as it should be. Furthermore, the abundance of moisture in the soil and its heavy, putty characteristics caused it to pack and resist cultivation. The corn did well, considering the lateness of planting, and 147 bushels were harvested from this field.

A few bindweed plants survived in two portions of the field where erosion during the first and second seasons had hindered the effectiveness of cultivation. C. W. Smith.

A General-Purpose Farm Refrigerator

Interest in farm refrigerator units has markedly increased in recent years. The three-zone side-opening farm refrigerator has been retained in the laboratory for continued study of performance and, as may be required, modification in details of design. One change has been effected. Vertical cold plates were replaced by horizontal plates having approximately the same surface area. Advantages gained by this change were:

1. Increased storage space by elimination of unused space between the vertical plates and the walls of the freezing and zero-storage compartments.
2. Convenience in the use of the horizontal plates as shelves.

3. Availability of the horizontal plate surfaces for plate freezing.

Insulation around the freezing and zero-storage compartments was increased from six inches to eight inches. The insulation was added internally, leaving the external refrigerator dimensions unchanged. Resulting reduction in operating cost was offset in some degree by loss of space, the freezing compartment being smaller by about two cubic feet, and the zero-storage space by approximately four cubic feet.

The first compressor used with the refrigerator was a one horsepower water-cooled unit, larger than needed but used because of its availability. This unit has been replaced by an air-cooled three-fourths horsepower refrigerating machine which has ample capacity. An air-cooled is less efficient than a water-cooled machine but many Nebraska farms lack a continuous water supply under pressure.

Energy consumption for the three-zone refrigerator, which now consists of a 12-cubic foot freezing compartment, a 24-cubic foot zero-storage space, and an above-freezing section of 38 cubic feet, ranges from less than 10 kilowatt-hours per day, when the temperature of the surrounding air is 65°F., to about 20 kilowatt-hours per day when air temperature is 90°F.

A top-opening farm freezer having approximately 20 cubic feet of freezing and storage capacity has been constructed and is now in the laboratory. The evaporator consists of a 6' x 2' x 2', round-end, galvanized-iron stock tank around which is wrapped about 200 feet of half-inch copper tubing. The tubing is soldered to the walls of the tank which then become cold plates in effect. Eight inches of a fill-type insulation is provided around the entire tank and two doors in the top furnish access to the interior. This construction was undertaken in an effort to learn about the possibilities of building a portable freezer on the farm out of materials readily available. A one-third horsepower refrigerating machine, air-cooled, is connected to the copper tubing through a thermo-expansion valve. Temperature regulation within the freezer is by means of the low pressure control on the compressor. This freezer is just entering the laboratory trial stage.

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

**Insulated Electric Brooders**

The extension of service lines in Nebraska has brought the electric brooder and its possibilities for developing the farm poultry enterprise to the attention of more and more Nebraska farmers and poultrymen. Proper attention paid to brooding requirements will pay dividends during the egg production period of a chicken's life. The Nebraska Standard Brooder, developed at this Station in 1935, has been studied with respect to insulation, heating elements, and various conveniences—all with the aim of improving the Standard Brooder. Results of these studies may be found in a Station circular published during 1945.

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

**Inexpensive Thermostats for Potato Storage**

Differential thermostats of both the wafer-type and the bimetal type have been developed for control of ventilating equipment in potato storage structures. The differential thermostat enables the storage operator to take full advantage of the cold autumn night air for cooling potatoes after harvest. It starts the ventilating fans whenever the temperature of the outdoor air falls below that of the air within the storage, and it
also shuts down the fans when the outdoor air is as warm as or warmer than the storage interior.

The wafer-type thermostat proved to be very sensitive over part of the seasonal range of temperatures required but was unreliable during unusually warm or extremely cold weather. The bimetal-type which uses thermostatic bimetal for the heat sensitive elements is not quite as sensitive as the wafer-type, but is consistent in its performance throughout the required temperature range of 32° to 100°F.

A bimetal-type differential thermostat is in its third year of operation at the Alliance Experimental Farm. Its performance has been satisfactory, and its use for experimental purposes is being continued.

E. E. BRACKETT, F. D. YUNG.

Emergency Methods of Cooling Milk and Cream

The cream receiving cabinet, developed for use in small cream stations, has been installed for trial and observation in the Omaha laboratories of one of the major creamery companies.

A "self-serve" cream receiving cabinet, intended for use without an attendant, is under construction. The cabinet is designed to be housed in a store or other commercial center. It will receive cans or other containers of cream from the producer and hold them under favorable temperature conditions until removed for transportation to the creamery. Conveyor-type rollers in the bottom of the cabinet will facilitate the movement of cans which will be inserted and removed through doors in one end. The roller bottom is to be pivoted in the center so that it can be tilted by means of a lever to slope toward the far end of the cabinet when cans are being received and to slope toward the doors for the removal of cans. The cooling equipment will consist of a one-third horsepower refrigerating machine and a forced-draft evaporator.

F. D. YUNG, P. A. DOWNS.

Power, Labor and Machinery

The season of 1945 was the sixth in which attention has been focused on machinery for seed-bed preparation for corn and the requirements for cultivation attending seed-bed preparations.

The spring was wet and cold. More preliminary field work was done than in any other season to attempt to kill weeds before planting. Although a duck-foot cultivator was used for this work, weeds undercut by it did not die because an abundance of moisture saved them. A tandem disk would doubtless have been more effective. Cornstalks from the previous season were heavy and were used for residue on the surface of some plots on which corn was planted beneath the residue. The rotary hoe was very helpful in cultivating the first time over. Disk furrow-openers were used on the planter for both the plowed and the disked plots. This treatment made possible a more effective cultivation the first time over on those plots and accounted in no small part for the weed control being best on the plowed plots. Corn rootworm took a heavy toll. This was the third season for this project on this field, and some portions had been in corn one or more years prior to their use for this experiment.

During the seasons 1944 and 1945 a study was made of the adaptability of several corn hybrids to mechanical husking. Observations have been made on the amount of corn left in the field: because of the date of picking, and because of the speed at which the tractor was driven.

C. W. SMITH.
**Corn Drying Studies**

During the "wet corn" emergency of early 1945, the use of forced air for drying ear corn in an outdoor crib was studied under farm conditions in a trial installation in York county. A round pile of about 1,000 bushels of yellow mixed hybrid corn was selected for experimental drying. On March 1 this corn tested 28 to 30 per cent moisture.

At the end of the first week in March this corn was moved by means of a portable elevator from the pile on the ground to a round wire crib which had been erected beside it. The crib was provided with a raised wood floor, a shelling trench, and a vertical central ventilator having a cross section two feet square. The crib was 16 1/2 feet in diameter and averaged 11 feet high. The average moisture content of the corn after cribbing was 26 per cent.

On March 16 a 24-inch double-inlet forward-curved multivane blower, driven by a five horsepower electric motor, was connected to one end of the shelling trench. The opposite end of the trench was blocked as was also the top of the central vertical ventilator. The blower was operated throughout the remainder of the month during the middle of the day when the weather was favorable. After 50 1/2 hours of operation of the blower without supplemental heat the average moisture content of the corn had been reduced to about 20 per cent. Electric energy used amounted to 175 kilowatt-hours.

Continued operation of the blower for a total of 37 hours, 12 1/2 of which were with supplemental heat, lowered the average moisture content to about 16 per cent. The heat supplied raised the temperature of the air entering the crib to about 25°F. above that of the outdoor air. Electricity used for the additional 37 hours was 120 kilowatt-hours.

Since it seems desirable at times to use auxiliary heat in forced-air drying of corn for market, some preliminary tests have been made to study the effects on the marketability of corn of temperatures above those considered safe for drying seed corn. Samples of yellow hybrid ear corn containing about 35 per cent moisture were dried with hot air at temperatures ranging from 190 to 200°F. for a period of eight hours to the 15 per cent moisture level. Another sample of the same corn was dried at about 200°F. to 10 per cent moisture in 22 hours. These samples of ear corn showed no visible evidence of physical change that might affect the market grade. However, when the corn was shelled there was found a definite shrinkage of the germ to the extent that the milling quality was impaired. The germ end of the kernels was brittle and discolored.

Samples of ear corn were also dried from 25 to 27 per cent moisture to the 15 per cent level in two hours at 300°F. These ears of corn were visibly discolored and on shelling numerous heat-damaged discolored kernels were found which would adversely affect market value.

E. E. Brackett, F. D. Yung.
Cost of Producing Farm Crops

Records were secured from 140 farmers on the cost of growing wheat and from 175 farmers on the cost of growing corn. Information was also secured upon the flow of water from irrigation wells and the cost of pump irrigation.

Production costs were noticeably higher in 1945 than in preceding years as a result of increased wage rates and some increase in other costs. Yield per acre was the most important single factor influencing per bushel costs for both corn and wheat.

Farm Organization and Costs

Account books from 115 farmers who cooperated in the project showed a growing trend toward increasing the size of the farm unit. Those who had a well-balanced business with labor fairly well distributed through the year had a financial advantage over the man whose business was not well balanced. Good farm management paid dividends. In general, the farmers who accomplished the most work units per man had the best net returns.

Poultry gave the largest returns per $100 worth of feed. Conversely, poultry required more labor in proportion to returns than any other type of livestock.

The grain farmers who kept records in 1944 secured larger net incomes than the livestock farmers. Dairy farming and livestock feeding require more labor than merely producing and selling grain. Apparently the prices of dairy products, hogs and cattle were not high enough to pay the cost of the additional labor required.

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

Land Use Planning

The volume of agricultural production in Nebraska has been at a high level during the war period. In 1944 the farmers of the state harvested a record corn crop of 329,855,000 bushels from 8,915,000 acres. In 1945 a record wheat crop of 86,366,000 bushels was produced on 3,772,000 acres. Yields of other crops have been above average in most areas of the state. Because of the effort for maximum production, customary crop rotations have not been followed. The result has been a heavy drain upon soil fertility. Deficiencies in plant nutrients, particularly in nitrogen, have become evident in many areas. Material adjustment in land use is needed.

Scientists in the Soil Conservation Service have classified the land in the state according to the intensity of soil conserving practices required to protect it from serious decline in productivity when under cultivation or in perennial meadow and pasture. They have made definite recommendations for a complete soil and moisture conserving program on each land class. The results of their investigations show that there are in the state approximately 21,000,000 acres which are physically suitable for tilled crop production. Only 5,745,000 acres are sufficiently level and free from wind erosion hazards to be suitable for continuous cultivation without employing special tillage measures. The remaining 15,204,000 acres of cultivated land require one or more practices such as contour
Grass can be planted to conserve Nebraska soil and moisture.

planting, subsurface tillage, strip cropping, terracing and long-time rotations in perennial grasses and legumes with occasional grain crops, in order to conserve moisture and control erosion.

If a complete conservation program were adopted on all of the land in the state which is physically suitable for cultivation, the area planted to intertilled crops probably would not average more than 7,000,000 acres. Wheat, oats, barley and rye would occupy about 7,987,000 acres. About 1,042,000 acres would be summer tilled for moisture conservation in preparation for planting other crops, and the remaining tillable acreage (approximately 4,970,000 acres) would be in grasses and legumes.

Under this plan of land use, additional numbers of cattle and sheep would be needed in the state and the proportion of farm income received from livestock undoubtedly would rise above the present average of 70 to 75 per cent.

Additional investigations are needed to determine the effects of these changes upon farm organization and the type of market facilities that will be needed in the areas where the present production pattern will be changed most by adopting soil-conserving methods of farming.

Frank Miller.

Land Tenure Problems

Land prices have risen materially in nearly all parts of the United States since the bottom of the depression. In the majority of the states the low level was reached in 1933, but as a result of the long drought in the northern Great Plains, prices continued to fall in Nebraska and the Dakotas until 1941. Although land prices have changed at a much slower rate than have the prices of industrial stocks and farm products, the rise has been sufficiently rapid to cause many persons to fear that a speculative land boom is under way.

Land prices rose to a high level in Nebraska and most other states during and following World War I. They started to decline almost as soon as the prices of farm products started to drop in 1920 and the fall continued during the nineteen-twenties. In Nebraska the decline was
Three-fourths of the state's cultivated land requires special tillage measures.

greater than for the country as a whole. The state index fell from 179 in 1920 (prices in 1912-1914 = 100) to 69 in 1933 and to 55 on March 1, 1941. On the average, land which sold for $100 per acre in 1912-14 and $179 per acre in 1920 would have sold for only $55 per acre in 1941 at the end of the long period of drouth and depression.

Nebraska land prices have risen steadily since 1941, but are not yet as high as in the years preceding World War I. On March 1 the price index was 86. While prices have increased about 56 per cent in less than five years, the actual dollar increase per acre has not been large because the value was low at the beginning of the rise in prices.

The more important forces which tend to increase the demand for land and thus increase land values include increased prices of farm products, good yields, increased efficiency of producing crops and livestock, low interest rates, accumulation of investment funds, and fear of further inflation. Some of the forces that tend to decrease land prices are government control of the price of farm products, increased cost of production, higher taxes, production control, and the recollection of the price declines following World War I and earlier wars.

There was apparently little speculative buying of land in 1943-1945. The majority of the buyers were actual farmers, and re-sales of land purchased during these years have not been numerous. Relatively few purchasers have had to place a heavy mortgage on their land. Many buyers have paid cash in full for their purchases and others have paid two-thirds or more of the purchase price in cash.

Of the landowners who lost their farms because of financial reverses between 1920 and 1941, a considerable number owed the major part of the purchase price of the land at the beginning of the depression. A similar statement can be made concerning losses from land ownership in earlier periods of depression. A debt that can be carried easily during a period of rising prices becomes an intolerable burden when the price level declines. The owner of land, or stocks, or any other commodity or security, who has paid only 40 per cent of the original cost loses his entire equity when the price declines 40 per cent. The man who has paid in full for his purchase suffers an inventory loss when the price declines which is counterbalanced by an inventory gain when the price rises to its original level. Buying land on credit when prices are high is a speculative venture.

H. C. Filley, Frank Miller.
Credit

Farmers of Nebraska use credit for the following three purposes:

1. To provide funds which can be used with savings for the purchase of land, livestock or equipment.

2. To pay current family and farm operating expenses until crops and livestock are ready for market.

3. To take care of unusual expenses such as may arise from accident, illness or death in the family.

The Federal Land Bank, insurance companies, individuals, the Federal Farm Mortgage Corporation, and commercial banks supply most of the farm mortgage credit in the six southeastern Nebraska counties where detailed investigations have been made. Principal sources of short-term credit on farms of various size are shown in the table.

<table>
<thead>
<tr>
<th>Lenders</th>
<th>Size of Farm</th>
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<tbody>
<tr>
<td></td>
<td>Below 170 Acres</td>
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<tr>
<td>Banks</td>
<td>36.2</td>
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<tr>
<td>Grain elevators</td>
<td>.2</td>
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<tr>
<td>Implement companies</td>
<td>15.7</td>
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<tr>
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<td>Lumber yards</td>
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</tr>
<tr>
<td>Oil companies</td>
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</tr>
<tr>
<td>Production Credit Associations</td>
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<tr>
<td>Retail stores</td>
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<tr>
<td>Farm Security Administration</td>
<td>13.8</td>
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<tr>
<td>Other lenders</td>
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</tr>
<tr>
<td>Total</td>
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</tbody>
</table>

Banks, farm machinery companies, and individuals are the heaviest lenders in this field. Further analysis of the data by tenure groups shows that owner and part-owner operators obtain most of their short-term credit from banks, while tenants borrow rather heavily from implement companies and other lenders.

During the depression years tenants on small and medium-sized farms obtained a considerable part of the credit they needed from government agencies, primarily the Farm Security Administration. Approximately one-third of the renters on small farms and about one-fourth of those on farms between 170 and 250 acres apparently did not have enough capital to be considered good credit risks by private agencies.

Examination of farm records from six southeastern Nebraska counties shows that a few of the farmers could have paid four per cent interest on a mortgage equal to 65 per cent of the inventory value of land and buildings, and six per cent interest on a debt equal to one-half of the value of the non-real estate capital, after deducting the usual cash expenditures for family living from net farm income in each of the years from 1930 to 1944. All of the operators who submitted complete records of income and expenditures for analysis could have met these payments in the years from 1942 to 1944.

Frank Miller.
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 for several years in preparing annual reports dealing with Nebraska's capacity to produce farm commodities. The 1945 report indicated, as nearly as can be determined, the quantities of products that can be expected in the state in 1946 under the price, labor and equipment conditions that are expected to prevail. Similar reports were submitted from other states.

The United States Department of Agriculture also assembles information concerning the needs for all types of agricultural commodities both at home and abroad. This information is used with the production capacity reports to determine acreages of crops, numbers of livestock, and quantities of livestock products that will be needed in each state.

In the course of these studies the following problems have been examined critically and suggestions have been made for dealing with them:

- Development and conservation of Nebraska resources.
- Adjustments that will be needed in the production of crops and livestock.
- Marketing agricultural products.
- Opportunities for settlement on the land after the war through water development.
- Land tenure problems.
- Farm credit in the postwar period.
- Social security.
- Rural health service and facilities in Nebraska.
- Postwar housing and equipment needs.
- The present situation and needs in nutrition.
- Rural education.
- Agricultural research.

Frank Miller.

Marketing

The Nebraska Station has continued to cooperate with the experiment stations of 13 other corn belt states and the Bureau of Agricultural Economics in collecting information upon livestock marketing. For the past year, work has been concerned chiefly with securing data on hog prices. These data have been secured from records of actual sales of hogs for 1937 to 1941 at two interior markets in Nebraska and from the published market reports for the Omaha market for 1931 to 1941.

Records based upon the annual audits of cooperative elevators were secured for 1943 and 1944.

L. B. Snyder.

Farm Work Simplification

The Departments of Rural Economics and Agricultural Engineering and the Agricultural Extension Service cooperated on this project to promote efficient and economic use of labor on the farm. Financial assistance was obtained from the General Education Board of the Rockefeller Foundation.

Two moving picture films, "Easier Methods of Handling Wild Hay" and "Easier Methods of Handling Alfalfa," have been developed and made available for circulation. These films show various methods used by Nebraska farmers.

A. W. Epp.
FIFTY-FIVE HEALTHY college girls served as blood donors for a continuation of the study of blood regeneration. Throughout the year they lived on their self-chosen diets. For six weeks following the first blood donation they were given a daily supplement which provided 40 grams of protein from meat, milk and egg, and following the second donation no supplement was given.

The protein supplement increased the donors' protein intake to 90 grams and their blood regeneration, as judged by the return of the hemoglobin value to its pre-donation level, was better than during the second period when self-chosen diets were not supplemented and their protein intake averaged only 50 grams. Regeneration on the 90 gm. protein level was better than it had been the previous year on a 75 gm. intake. Feeding a high protein diet for only five days immediately preceding or for seven days following a blood donation did not increase the rate of regeneration over that observed when the girls were continuously on their self-chosen diets.

RUTH LEVERTON.

Farm lighting with kerosene and gasoline lamps. Considerable illumination data have been secured for the various types of lamps being studied. Thus far all the readings have been taken in a laboratory where as many factors as possible could be controlled. Results indicate that, used individually, only the pressure gasoline lamps provide enough light for minimum adequate illumination. Although used extensively in many homes, intensity of illumination from the ordinary kerosene lamp, as would be expected, is very low. Hence, in further investigations of this study, only pressure gasoline and mantle kerosene lamps will be used.

Coal and wood ranges. A new laboratory has been equipped for the study of coal and wood ranges. Gathering of experimental data is still in the preliminary stage.

ARNOLD E. BARAGAR.

Two hundred high school and college girls and 154 members of their families have been given a test designed to throw light on the following aspects of personality development: masculinity-femininity (psychological), leadership, and social participation. The girls have been grouped according to age, college year, and residence in a farm, village, or city home. Norms for Nebraska girls between the ages of 16 and 25 are in process of construction. Analysis is being made of differences between urban and rural families and the inter-relationships among the three aspects of personality in the same family. Plans are being formulated on the basis of this preliminary analysis for the collection of other samples on rural families.

Validation study of leadership. A validation study of the leadership key of the personality test used in the study outlined above is being carried on with the collaboration of a group of college girls enrolled in a
professional course. Using a carefully constructed rating scale, three ratings are being obtained for each of 80 campus leaders. The leaders and their families will also take the personality test. Results will be compared with those for a control group of college girls, of the same ages, college year, and residence in a farm, village, or city home, who have shown no evidence of leadership in college. Results on families of the two groups will also be compared.

**Intelligence testing of Nebraska children.** Children, aged six to sixteen, in grades one through nine of the public schools of Nebraska are being given an intelligence test. The object of the study is to determine the causes of differences in test performance between urban and rural children. In the past, rural children have tested lower than urban children and the reasons for this difference have not been clear. In previous studies insufficient attention to obtaining samples that are truly representative of the children in each environment has been an important factor that tended to obscure results. If the differences reported are real, and are found to be related to limited opportunities for rural children, measures to relieve this handicap should be taken.

Special attention is being given to sampling procedures in this study. The number of children in rural, village and city schools has been made proportional to the total number of children in each of these groups for each of the counties used. Twelve counties, geographically distributed, have been selected to represent the state. Size of city has also been controlled and the children selected from cities have been matched with the census data for father's occupation. Background data has been obtained on each urban and rural child on the following items: residence, whether or not parents are foreign born, the use of a language other than English in the home, race, years of schooling of parents, occupation of father, size of home, presence of modern conveniences in the home, ownership of a car, and sex, age, and years of schooling of siblings. Children belonging to Negro, Indian, Mexican, Chinese, or Japanese groups, considered to have distinct cultural backgrounds, have been excluded from the study.

Sex differences, differences related to residence, changes in test results with age, and the inter-relationships between the background features mentioned above and the test scores will be analyzed. An item-analysis of the completed tests will be made to determine specifically where the differences between rural and urban results lie. This will lead to improvement of the tests and give basic information to teachers and parents concerning environmental lacks found in either urban or rural groups.

Thus far approximately 2,000 children have been tested and their tests scored. Reports are being sent to their schools. Katharine M. Maurer.
Valentine Substation

Climatic Conditions and Crops

Rainfall for 1945 was 2.72 inches below normal. Most of this deficit accumulated after mid-July and was not reflected in the crop yield. The spring was wet and cold but produced a small grain yield considerably above the average, especially oats.

Ranchers were delayed two weeks in starting their haying because of so much water on the meadows. The water level in subirrigated meadows has raised sufficiently to make seeding of clover and tame grasses profitable again over a considerable acreage of land. The water level is up to the pre-drought stage.

A Nebraska regional corn variety test was conducted on the table-land north of the Substation. Twenty-five hybrids and five local open-pollinated varieties were planted in five replications of 20 hills each. Field observation at husking time showed no significant advantage in yield of the hybrids over the best open-pollinated varieties. Not over one-third of the hybrids were as good as the local varieties. The late spring and cool summer retarded corn development and resulted in a high percentage of soft corn, although the first killing frost was September 29, only a few days earlier than normal.

Supplements to Prairie Hay for Wintering Range Calves

Facilities for conducting wintering tests were enlarged to include three additional lots. This was done so that data might be obtained as to the value of distillers' dried grain and dried soluble for wintering calves. The average protein content of the half-and-half mixture was 27 per cent. Results from feeding soybean oil meal at three rates with and without steamed bone meal were about the same as in previous trials, except that adding bone meal to one pound of soybean oil meal showed a little more gain than in previous tests. This year completed the third trial comparing soybean oil meal, cottonseed meal, linseed oil meal, and a mixture of the three when fed at the rate of one pound per day. The respective winter gains were: 148, 169, 144 and 145. Total gain for the winter and grazing period was: 321, 321, 315 and 319 respectively.

Comparing the three rates of feeding soybean oil meal with and without bone meal, it is significant that as the amount of soy is increased the benefit from adding bone meal decreases.

Dual-Purpose Cattle Project

The milking Shorthorn herd has increased to the maximum handling capacity of the Substation. All females are kept until their first lactation and culling follows the merits of production and type. This year the herd was culled in numbers equivalent to the number of females born. A few of the bull calves were sold for breeding purposes and the others fed out as steers by the Department of Animal Husbandry.

Twenty-eight females completed a lactation period this year with an average of 4,575.2 pounds of milk and 175.2 pounds of fat. The milk from all but nine head tested below four per cent.

Nine cows produced over 200 pounds, averaging 259.9. Five of these are foundation cows from eight to 13 years old. Only two daughters have equalled the production of their dams. Five herd sires have four or more daughters with production records. The average production of the dams
of the herd sires is above that of the foundation cows. It is quite probable that records of the sires' dams were made under more favorable conditions than those which exist at the Substation where alfalfa hay is seldom available and the pasture is Sandhill range. Sorgo silage and concentrates are being fed with prairie hay. The feed requirement, exclusive of pasture, for producing a pound of butterfat was 8.2 pounds of grain, 24 pounds of silage, and 24.7 pounds of hay.

E. M. Brouse.

**Box Butte Experiment Farm**

Seasonal conditions were unusually favorable for crop production in 1945. Well-distributed rainfall resulted in very high yields of all crops. In the various fields and plats, yields were as follows: potatoes 100 to 300, generally about 200 bushels per acre; winter wheat 17.5 to 59.2, but generally 40 to 45 bushels per acre; barley 58 to 82, generally 65 bushels per acre; oats 65 bushels per acre; and corn 17.5 to 38.2 bushels. The quality of these crops was above average except the corn which was quite immature when frosted in mid-September.

Along lines of experimental work, the long-time crop rotation project was continued cooperatively between the farm and several departments. The following is a brief report of lines of experimental work conducted on the farm by departmental specialists. More detailed results are published elsewhere in this bulletin.

Work of the farm was managed by Acting Supervisor Kerwin Jantz. This report is by H. O. Werner for the Box Butte Experiment Farm Committee.

**Potatoes** (H. O. Werner). Breeding to produce superior varieties of potato involved testing hundreds of new seedling selections on a small scale, a smaller number of promising selections on a large scale and producing foundation seed stock of the latter for test elsewhere and for release to certified seed potato growers. Variety trials were made to determine yielding ability, grade, cooking quality, etc., of best new selections in comparison with the standard varieties best suited to the area. Foundation Triumph seed potatoes were produced for seed plots of certified seed potato growers in cooperation with the Certified Seed Potato Inspection Service.

Cultural experiments included: study of rate of tuber production and initiation of grade defects as determined by time of harvesting; relation of time of planting to yield, grade and cooking quality of Triumph and Kasota tubers; effect of method of summer fallowing and plowing prior to planting on yield and quality of the crop; size of seed piece and distance of planting on dry land; and effect of cutting seed potatoes at intervals from mid-February until planting time on seed piece decay, stand and yield.

Potato storage experiments designed to develop more effective structures for holding seed potatoes until early summer included: construction and operation of a shell-cooled bin, and study of effectiveness of a deep pre-cooled pit.

**Grass** (E. C. Conard). A large block of land has been seeded to crested wheatgrass for the purpose of studying the influence of grass upon soil structure and yields of crops that follow, as well as to determine the feasibility of including grass in a long crop-rotation sequence.
Triplicate plots of Lincoln bromegrass, standard crested wheatgrass, and intermediate wheatgrass (*Agropyron intermedium*), a recent introduction from Russia, were planted on summer fallow September 5, 1945. Seed and forage production and general adaptation of the three grasses will be compared.

**Small grains** (K. S. Quisenberry, O. J. Webster). The small grain work at Alliance included varietal trials of winter wheat, spring wheat, oats and barley. Material thought to have value for the area was included for all crops. There was also a small amount of selection work.

The following amounts of pure seed were produced: Cheyenne winter wheat certified—800 bushels on 20 acres. Velvon 11 barley (foundation seed)—750 bushels on 12 acres. Trojan oats—780 bushels on 12 acres.

**Corn investigations** (J. H. Lonnquist). Available early corn hybrids from other states were compared with a number of open-pollinated varieties obtained locally. Top crosses of Dawes No. 2 (a superior western Nebraska open-pollinated variety) were made with early lines from this and other states. S₁ lines from western Nebraska varieties were top-crossed to Dawes No. 2.

**Sorghum trials** (O. J. Webster). The sorghum project included yield tests of nine grain and six forage varieties. All grain varieties were still immature when growth was stopped by a killing frost the middle of September. The nursery included 30 varieties planted in single rows for observation, 71 rows of early generation hybrids, and six plots of F₂ materials. Forage yields were taken and maturity notes were recorded on all varieties.

**Safflower investigations** (Carl E. Claassen). Tests were conducted with safflower, a new crop that seems well suited to western dry-land culture. It is attracting much attention as a possible source of oil for commercial purposes and as a concentrated feed. Surface and lister planting in rows that are cultivated was compared with drilling, and different rates of seeding were tried. Yield tests were made for oil in comparison with flax. Tests were made of date of planting combined with two different spacings.

In addition to these cultural tests an extensive breeding project is being carried on to develop varieties with higher oil content and fewer thorns.
Scotts Bluff Substation

This review of experimental work includes general results of crop rotation and lamb feeding experiments, and an outline of projects conducted in cooperation with several departments in the Agricultural Experiment Station of the University of Nebraska, and with the Office of Sugar Plants in the U. S. Department of Agriculture.

Climatic Conditions

During the season of 1945 the climate at the Scotts Bluff Substation was characterized by low temperatures, low evaporation, low wind movement, and high precipitation. The latter totalled 16.25 inches, compared with the 36-year mean, 1910 to 1945, of 13.63 inches. Precipitation during the growing season (April to September) amounted to 13.37 inches, which was 2.31 inches above the 36-year mean. During June 5.15 inches of rain fell, an amount 2.77 inches above average. Hail storms occurred at the station on June 8 and June 27, the first causing slight damage to crops, the second resulting in severe damage to small grain, safflower, tomatoes, corn and sugar beets. The first cutting of alfalfa was damaged moderately. Corn and sugar beets recovered, but small grain, safflower and tomatoes were entirely destroyed. High precipitation favored the development of rust and blight on beans.

Temperatures were below normal during all months of the growing season, and above normal during the rest of the year, except December. Temperatures were five degrees below normal in April, and seven degrees below in June. In general, low temperatures during the growing season retarded crop growth, causing lower than normal yields in some instances. Cool weather proved favorable for the barley crop in areas where hail storms did not destroy it.

Evaporation during the growing season of 1945 amounted to 28.45 inches, or 7.55 inches below the 36-year mean, and was below normal during all months of the growing season. Wind movement also was below normal during the year. No heavy wind storms were recorded, and the movement of soil by wind was less than usual.

The last frost in the spring occurred on May 3, and the first in the fall on September 19, leaving a frost-free period of 139 days, which is a few days longer than normal. However, the September frost prevented the corn crop from reaching maturity. This frost also reduced yields of potatoes and beans.

Crop Rotation Experiments

The crop rotation program includes studies of the value of farm manure; commercial fertilizers, chiefly phosphate and nitrogen; 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. They were started in 1942 and have been designed to study yields and quality of crops. Several rotations have been designed specifically to study the development of scab on potatoes.

During 1945 the untreated, continuous plot of corn produced 12 bushels per acre, compared with 38.9 from the continuous, manured plot. Owing to the cool season and early fall frost, the corn on both of these plots was soft and of high moisture content at harvest time. The untreated, continuous plot of sugar beets produced 2.33 tons per acre, compared with 2.9 tons from the continuous plot treated with phosphate and nitrogen.
Sugar beet diseases caused a great reduction in stand and yield on the continuous plot treated with phosphate and nitrogen. The stand was reduced from 90 per cent at thinning time to 11 per cent at harvest. The continuous, untreated plot of beans produced 22.8 bushels per acre, compared with 24 bushels from the continuous, manured plot. Manure increased the total yield of potatoes on continuous plots, but failed to increase the yield of No. 1 potatoes to a significant degree, in view of the high percentage of scab on tubers from these plots.

Highest yields of sugar beets were obtained from alfalfa rotations treated with farm manure, where the mean yield amounted to 15.1 tons per acre. Lowest yield, 6.3 tons per acre, was obtained from untreated short rotations. Manured rotations without alfalfa produced 13.8 tons per acre, and similar rotations treated with phosphate and nitrogen produced 13.5 tons per acre. A sweet clover pastured rotation produced 8.8 tons of beets, compared with 13.8 tons from a similar rotation treated with phosphate and nitrogen. Alfalfa rotations treated with phosphate and nitrogen produced a mean yield of 13.9 tons per acre. A short rotation including sweet clover as a green manure produced 8.7 tons of beets per acre, compared with 12.1 tons from a similar rotation treated with manure.

Highest yield of beans, 27.7 bushels per acre, was harvested from an alfalfa rotation treated with manure. Yields from all plots were severely damaged by rust, blight and early frost.

The mean yield of potatoes from alfalfa rotations treated with phosphate and nitrogen amounted to 270.7 bushels per acre, compared with 268.3 from similar rotations treated with manure, and 265.6 from untreated, alfalfa rotations. Yield from untreated rotations without alfalfa was 144.7 bushels, compared with 224 bushels from similar manured rotations, and 252 bushels from similar rotations treated with phosphate and nitrogen. Highest percentage of No. 1 potatoes occurred in the untreated, alfalfa rotations, and lowest percentage in the untreated short rotations. Scab was the chief reason for the failure of potatoes to make the No. 1 grade.

Lamb Feeding Experiments

LAMB FEEDING EXPERIMENTS during 1945 included studies of dehydrated potatoes as a carbohydrate feed, safflower meal as a protein supplement, and a continuation of death loss studies from urinary calculi and other causes. Twelve lots each of 50 lambs each were studied.

**Dehydrated potatoes vs. grain mixture.** A grain mixture of equal parts by weight of yellow corn, whole barley, and molasses dried beet pulp was used as the concentrate to compare the value of dehydrated potatoes replacing respectively one-half and two-thirds of the mixture. The mean daily gain per lamb for the grain mixture was 0.37 pound, compared with 0.38 pound for one-half, and 0.40 pound for two-thirds dehydrated potatoes. Feed required to produce 100 pounds of gain amounted to 316 pounds of the grain mixture, 305 pounds of one-half potatoes, and 289 pounds of two-thirds dehydrated potatoes. In a similar manner less soybean meal, alfalfa hay, corn silage and bone meal were required for the production of 100 pounds gain on lambs receiving the dehydrated potatoes in place of the grain mixture. In this test dehydrated potatoes proved to be superior to the grain mixture as a feed for fattening lambs. No significant death loss occurred in the three lots.

**Soybean meal vs. safflower meal.** These two protein supplements were compared in a ration consisting of grain mixture, alfalfa, corn silage and bone meal, with one lot receiving soybean meal, and the other safflower
meal. The daily gains per lamb amounted to 0.37 pound and 0.38 pound, respectively. The lambs fed soybean meal consumed 316 pounds of grain mixture, 67.5 pounds of soybean meal, 152 pounds of alfalfa, 635 pounds of corn silage, and 7.6 pounds of bone meal for each 100 pounds of gain, compared with 308 pounds of grain mixture, 65.9 pounds of safflower meal, 143 pounds of alfalfa, 612 pounds of corn silage, and 7.4 pounds of bone meal. The safflower meal appeared to be a very satisfactory protein supplement in comparison with soybean meal. No death loss occurred in either lot.

**Soybean meal vs. cottonseed meal in beet top silage rations with grain mixture.** The basic ration in this comparison consisted of a grain mixture, equal parts by weight of corn, barley and molasses dried pulp; beet top silage; and bone meal. One lot received soybean meal and another lot received cottonseed meal as protein supplements. The lambs fed the soybean meal made slightly higher daily gains, and consumed slightly less feed per 100 pounds gain than the lambs fed cottonseed meal. No death loss occurred among the lambs fed the soybean meal. Five lambs died of urinary calculi on the cottonseed meal ration.

**Soybean meal vs. cottonseed meal in beet top silage rations with corn.** In this comparison the basic ration was corn, beet top silage and bone meal. Cottonseed meal was fed to one lot of lambs and soybean meal to another lot. The lambs fed cottonseed meal gained at the rate of 0.31 pound per lamb daily, compared with 0.36 pound for those fed soybean meal. Feed required per 100 pounds gain for the lambs fed cottonseed meal amounted to 333 pounds of corn, 1,878 pounds of beet top silage, and 9.2 pounds of bone meal, compared with 296 pounds of corn, 1,663 pounds of beet top silage, and 7.9 pounds of bone meal for the lambs fed soybean meal as a protein supplement. The lambs fed cottonseed meal consumed 80.6 pounds of this supplement per 100 pounds gain, compared with 70.2 pounds of soybean meal. On the cottonseed meal ration 20 lambs, 40 per cent, died as the result of urinary calculi, compared with a loss of 16 per cent in the lot fed soybean meal.

**Adding alfalfa hay to beet top silage rations.** Basic ration in this comparison was corn, cottonseed meal, beet top silage and bone meal. One lot received this ration and another lot received this ration plus alfalfa hay fed at the rate of one-half pound per lamb daily. The lambs fed the alfalfa hay consumed much less feed per 100 pounds gain, made faster daily gains, and suffered considerably less from urinary calculi than the lambs fed the ration without alfalfa. Where no alfalfa was fed, 20 lambs died as the result of urinary calculi, compared with five on the alfalfa ration. The ration consisting of corn, cottonseed meal, bone meal and beet top silage has consistently produced heavy death loss from urinary calculi in several years of lamb feeding experiments. Addition of a limited amount of alfalfa hay has consistently reduced, or entirely eliminated, death loss from this disease.

**Bone meal in a beet top silage ration.** The basic ration in this comparison consisted of corn, cottonseed meal, bone meal and beet top silage. One lot received this ration, and another lot received the same ration minus the meal. Lambs without the bone meal required much less feed per 100 pounds gain, produced much higher daily gains, and suffered considerably less from urinary calculi. On the ration including bone meal 20 lambs died of urinary calculi, compared with the loss of five lambs where no bone meal was fed.
Origin of lambs related to development of urinary calculi. This study involved the feeding of 12 lambs each from Montana, Wyoming, Colorado and New Mexico. They were placed in one pen and fed a ration of corn, cottonseed meal, bone meal and beet top silage, a ration which has consistently produced heavy death loss from urinary calculi in lambs obtained from the range area around Gillette, Wyoming. In this test, four of the Montana lambs, two of the Wyoming lambs, and one each of the Colorado and New Mexico lambs died from urinary calculi. The Montana lambs produced the fastest and cheapest gains, followed by those from Wyoming, Colorado and New Mexico in that order. Daily gains ranged from 0.29 pound for the New Mexico lambs to 0.37 pound for the Montana lambs. Considerable additional work should be performed before any conclusive statements are made regarding the influence of the origin of lambs on the development of urinary calculi.

Cooperative Investigations

These projects included hybrid corn tests, potato improvement work through the testing of a large number of seedlings, insect control studies, cultural experiments with sugar beets, breeding work with safflower, and irrigation investigations. They were carried on in cooperation with various departments at the University of Nebraska College of Agriculture, and with specialists connected with the U. S. Department of Agriculture.

Lionel Harris.

Sugar beets under irrigation in western Nebraska.
North Platte Substation

Dry-Land Crop Rotations

Moisture conditions during the growing season were unusually favorable. All months, April through September, were well above average, and the total for the six-month period was 59 and 63 per cent above average at the table and bench-land stations.

There was the greatest difference on record between yields of winter wheat on land cropped and land fallowed the previous year. Dry soil at seeding time on cropped land resulted in poor stands. Stored moisture made possible full stands on fallow. Average yields were 10.4 bushels on cropped land and 52.5 bushels on fallow.

Spring grain yields were somewhat above long-time averages and show favorable but not unusual response to fallow preparation. Average yields on cropped land and fallow were 15.3 and 29.4 for spring wheat, 33.4 and 69.1 for oats, 21.1 and 42.5 for barley.

Corn and grain sorghum were delayed by cool wet weather at planting time. All corn was replanted in early June. Adequate moisture during the growing season favored continuous growth and the crop reached fair maturity before frost. The average yield of 32.6 bushels for corn is well above average, but 2.7 bushels less per acre than that of the previous year and was of considerably poorer quality. Differences due to tillage practices and crop sequences were insignificant. Yields were reduced by wide-row spacing in about the ratio of reduction in stand. Yields from normal, double and triple-spaced rows with the same spacing between stalks in the row produced yields of 27.7, 17.8, and 12.5 bushels per acre. Early Kalo yields were 22.5 bushels on cropped land and 39.4 after fallow.

A nine-year cycle has been completed in the crop rotation field in which grass mixtures have been used. Determinations made in cooperation with the soils department at Lincoln and the U. S. Bureau of Plant Industry indicate that the rate of reduction of organic matter and nitrogen is definitely slower where grass is used in a crop rotation than where the cropping system is made up of annual grain and cultivated crops.

L. L. Zook, H. E. Weakley.

Small Grain Varieties

Winter wheat. Fifteen varieties of winter wheat were seeded after fallow and after corn. The crop after corn was a failure because of poor stands and soil blowing. Yields on fallow ranged from 58 to 70.3 bushels per acre. The highest yield was made by Local Turkey closely followed by Wichita and Cheyenne x Tenmarq with a yield of 69.7 bushels. Cheyenne and Nebred, recommended varieties for this region, produced yields of 66 and 63 bushels. Pawnee produced 64.3 bushels and lodged less than most other varieties. For two years, 1944-45, Wichita occupies highest yield rank. Of six varieties grown for 13 years, Cheyenne occupies highest rank.

Spring wheat. Yields of spring wheat in nursery rows after fallow ranged in yield from eight for Marquis to 22.2 bushels per acre for Mida. Rust resistance was again an important factor. Of 17 varieties under test, only six showed stem-rust infestation. These were Marquis with 25 per cent, Reward with 20 per cent, Ceres with eight per cent, Kearney...
with three per cent, and Mercury and Thatcher each with a trace. Leaf-rust infestation ranged from a trace on Mindum to 65 per cent on Thatcher. Mida and Henry carried but five per cent and Ceres x Pilot, Cadet and Pilot x Mida 10 per cent each. Mida occupies highest rank for the two years with a yield of 20.5 bushels, with Ceres x Pilot in second place with 20.4 bushels, and Merit x Pilot third with 17.7 bushels.

Oats. Early growth was slow because of cool wet weather. The amount of tillering was subnormal. Yields were the lowest for several years and ranged from 11.3 for Fulghum x Markton to 23.8 for Brunker. It is characteristic of Brunker to occupy high yield rank under adverse conditions and to drop below others under favorable conditions. Among eight varieties grown for six years, Fulton occupies highest yield rank with 37.7 bushels; Otoe second place with 37.1 bushels; Fulghum and Trojan third and fourth with 36.6 and 35.4 bushels; and Brunker sixth with 34.4 bushels.

Barley. Of 12 varieties compared in field plots, yields ranged from 14.6 to 29 bushels per acre. Highest yield was made by Trebi with Ezond, Velvon II and Velvon following with yields of 28.5, 26.4 and 23.1 bushels. Spartan and Beecher dropped to ninth and tenth places with yields of 17.8 and 15.6 bushels. Of eight varieties grown for seven years rank and yields are as follows: Ezond 33.8, Trebi 32.9, Velvon 31.5, Blackhull Sel. 30.9, Spartan 29.8, Lisco 29.7, Atlas 28.9, and Club Mariat 26.9.

Winter barley. Nine winter barley selections were grown in triplicated nursery rows and 21 in single rows on fallowed land. Survival ranged from 65 to 93 per cent and stands were sufficient to lend accuracy to yield comparisons. In the triplicate row test, the highest yield was that of Purdue 21 with 54 bushels per acre. Tennessee Winter, Missouri Early Beardless, Ward, Hyatter and Reno followed in order with yields of 51.8 to 48.5 bushels. The highest yield in 1944 was made by Reno.

K. S. Quisenberry, O. J. Webster, L. L. Zook, H. E. Weakley.

Corn Hybrids and Varieties.

Cool wet weather through May and June delayed growth of corn, and interfered with timely cultivation. Weeds were troublesome and soil in poor physical condition. As a result, corn yields under irrigation were very much less than those of 1944. The range in yield was not wide, being from 62.5 to 76.6 bushels with the mean yield 68.6 bushels. The single open-pollinated variety yielded 64.1 bushels, exceeded by all hybrids except one. Mean yield of all hybrids exceeds the open-pollinated variety by 4.5 per cent, that of the 10 highest yielding hybrids 13.8 per cent. Four hybrids included in the group of 10 with highest yields were also in the group of the 10 highest in 1944. These were Nebr. 717C, Nebr. 1001, Funk G 57 and DeKalb 639. In the dry-land test of 29 hybrids, and one open-pollinated variety, the mean yield was 38.8 bushels. Only six hybrids outyielded the open-pollinated variety. The mean yield of all hybrids was 5.4 per cent less, of the 10 highest yielding hybrids only 2.8 per cent above that of the open-pollinated variety. Superiority in stiffness of stalk of hybrids was evident at harvest time. Highest breakage of stalks of any hybrid was two per cent. For the open-pollinated variety, breakage was six per cent on dry land and 14 per cent under irrigation.

J. H. Lonnquist, L. L. Zook.
Sorghums

In a test of 15 grain sorghum varieties, Early Kalo ranked first with a yield of 65.9 bushels per acre. Early Hegari, Martin and Highland followed with yields of 61.1, 60.6 and 60.1 bushels. For the six-year period 1940-45, six grain sorghums have produced average yields as follows: Early Hegari 45.1, Early Kalo 44.4, Highland 40.5, Alliance 38.2, Day 38.1, Club 36.7 bushels. Several new grain sorghums selected from crosses are promising. Four of these: N 201, N 210, N 209 and N 80 outyielded Early Kalo by amounts ranging from one to three bushels. N 201 occupied first place in yield rank of 13 selections tested for two years.

Of 10 forage sorghums, Atlas occupied first rank with 4.17 tons of forage on the basis of 15 per cent moisture. For the seven-year period, six forage sorghums have produced average yields in tons as follows: Atlas 3.29, Leoti 3.25, Early Sumac 3.16, Norkan 3.15, Black Amber 3.03, Fremont 2.92.

Five strains of Sudan grass from different seed sources were grown for the first time. Yields of cured forage ranked from 2.09 to 2.54 tons per acre.

Horticulture

Progress has been made in developing a long range plan for horticultural work. Variety testing of fruit, vegetable and ornamental plants is a major Station research project. Over 250 varieties of fruit are now on test in the Station orchards, and additional varieties are being added as rapidly as possible. Vegetable trials are carried on each year. Native plums having superior fruit and very late blooming dates have been selected for use in fruit breeding in the hope that frost-escaping plums can be developed.

Breeding work with onions was started in 1945. A number of F1 crosses of tomato varieties were made during the summer. Seed of NP 1 and NP 5 tomatoes was increased for state-wide trial in 1946.

Increased cooperative work with public and private agencies and with selected individuals is in the program. The exchange of plant material with other agencies in the field is under way. Nebraska nurseries are furnishing ornamental and fruit plants for testing. Ground work for a fruit and vegetable testing program covering the west two-thirds of the state has been laid and some tests are in progress.

Vegetable seed production investigation in cooperation with the Cheyenne Horticultural Field Station has been carried on for the last three seasons. In 1945 onion and cabbage seed production was added.

Work with chrysanthemums is now in the second year and a number of selections are being increased for trial and possible introduction.

Forty selections of hybrid strawberries from the Cheyenne Station were put on trial.

Weed Control

The new herbicide 2,4-Dichlorophenoxyacetic acid was put on trial and tested throughout the entire growing season. Results indicate that near-perfect control of dandelion and other lawn weeds is possible if the chemical is properly used. Control of most broad-leaved annual weeds in irrigation ditches and fence rows seems practical. Use of the chemical with growing crops seems inadvisable until more is learned about its effect on crop plants.

Glen Viehmeyer.
Grass Seed Production

Grass in contoured rows on dry land seeded in 1942 declined sharply in seed production as compared with 1944. Per acre yields of clean seed for 1944 and 1945 respectively were 378 and 229 pounds of crested wheatgrass, 355 and 201 pounds of bromegrass, and 307 and 49 pounds of Russian wild rye.

E. C. Conard, L. L. Zook.

Cattle Feeding Experiments

Winter feeding of range cattle. Five lots of 20 grade Hereford heifers were continued through the third season. The average weights from pasture to wintering quarters on November 21, 1944 for Lots 1 to 5 were respectively: 870, 935, 951, 818 and 854 pounds per head. The rations of previous winters were continued with some variations. Lot 1 was fed native hay. Lot 2 native hay plus one pound of soybean pellets per head daily. Lots 3 and 4 were fed silage plus six pounds of cut alfalfa hay per head daily. Lot 5 was fed silage plus six pounds cut alfalfa hay and three pounds of ground shelled corn per head daily. Between January 4 and March 5, cut sorghum fodder was substituted for a part of the silage, and between March 5 and May 1, native hay was substituted for the cut sorghum fodder in Lots 3, 4 and 5.

The cows in Lots 1 to 5 inclusive dropped 20, 16, 19, 16 and 19 calves respectively. The number that survived were 20, 15, 16, 16 and 18.

One cow from Lot 5 died and the cows that did not raise calves were disposed of, leaving 20, 16, 16 and 16 respectively in each lot. During the 161-day wintering period, Lot 1 lost 146 pounds per head; Lot 2 gained 10 pounds; Lot 3 gained 81 pounds; Lot 4 gained 156 pounds; and Lot 5 gained 158 pounds. The birth weight and weaning weight of the calves were respectively: Lot 1—61 and 333; Lot 2—75 and 367; Lot 3—74 and 385; Lot 4—72 and 373; Lot 5—75 and 383 pounds.

Weight changes of the cows during the 210 days on pasture were: Lot 1 gained 176 pounds; Lot 2 gained four; Lot 3 lost 34; Lot 4 lost 28; and Lot 5 lost 76 pounds. Average weight of the cows on November 27, 1945 was: Lot 1—900 pounds; Lot 2—949 pounds; Lot 3—1,006 pounds; Lot 4—946 pounds; and Lot 5—964 pounds. M. L. Baker, Guy N. Baker.

Deferred feeding of heifer calves. Four lots of 12 head each of Hereford heifer calves were started on feed November 22, 1944. Lots 1 and 2 were fed four pounds of corn daily until March 21 when they were brought to a full feed of corn and continued until July 18. Lots 3 and 4 were fed corn throughout the period. Lot 1 was fed silage in addition to four pounds of alfalfa hay. Lot 2 was fed sugar beet tops based on the dry matter equivalent of the alfalfa. The first two weeks three calves were removed from Lot 2. Calves in Lot 1 made a daily gain of 1.21 pounds compared to .95 in Lot 2. Feed consumption per hundredweight gain of the two lots was respectively: Lot 1—silage 1,837, alfalfa 323 pounds; Lot 2—silage 2,163, sugar beet tops 876
pounds. Lot 1 showed more finish March 30 than did Lot 2, although Lot 2 was in a good thrifty condition.

**Restricted grain feeding on native grass and alfalfa pasture.** Four lots of 12 head each of Hereford yearling heifers were lotted April 25 and started on feed on pasture. Lots 1 and 2 were fed on native grass and 3 and 4 were fed on alfalfa pasture. Lots 1 and 3 were brought to a full feed of ground corn and carried there. Lots 2 and 4 were carried at seven pounds daily until July 25 and then brought to a full ration of corn. On August 23 the four lots were taken to the dry lots and alfalfa hay and one pound soybean added to their feed. They were fed to October 3.

Initial weights per head of the four lots were respectively 578, 583, 587 and 573. Average gain was 351, 344, 373 and 407. The cattle sold in Omaha for $16.50, 17.00, 17.25 and 17.25.  

**Swine Breeding**

The swine breeding project in cooperation with the Regional Swine Breeding Laboratory of the Bureau of Animal Industry, U.S. Department of Agriculture, was continued through 1945. Two North Platte lines were combined to start a new line, and a new line was started by introducing gilts from an outside herd and crossing them with two boars from unrelated herds. Pigs from eight lines as well as cross-line matings were included in the 1945 farrowings.  


**Corriedale Sheep**

The flock of Corriedale ewes consists of 78 ewes. This larger number provides for a more severe culling. One-half the flock is bred to two rams selected by testing at Lincoln on the grade flock. The other half is bred to rams selected on basis of visible or known merit.  

Guy N. Baker.

**Poultry**

The Substation poultry flocks of White Leghorns and White Rocks were continued as a commercial flock in the Nebraska cost account project. With an average flock of 830 hens, the number of eggs per hen was 211.5. Similar production of the 11 flocks compared in the project was 185.6 eggs. Net income per hen for the Substation flocks was $3.60 as compared to $2.90 for all flocks. This is the third consecutive year the average production has been above 200 eggs per hen, and makes the flock average above 200 for the past eight years.

White Rocks were discontinued during the year, and all houses filled with White Leghorns.  

E. A. Wolfe.

**Pump Irrigation**

The electric-powered pumping plant on the station was operated 78 hours during April. Water pumped during this period was used on 10 acres of brome and alfalfa pasture and 10 acres of alfalfa which was to be broken up and planted to corn. Because of the extreme dryness of the preceding fall and winter, the soil was in condition to absorb a heavy application of irrigation water. Following the first of May, precipitation was heavy enough to provide irrigation for crops until July 23 when it became necessary to start watering corn.

The pump was operated for a total of 318.75 hours to supply 767.27 acre-inches of irrigation water for use on a total of 50.5 acres of land.
Cost of current at 2.407 cents per kwhr. amounted to $126.72. Cost of current per acre-inch of water pumped was 17.4 cents. Labor costs of distribution at 50 cents per hour increased operating costs to 37.3 cents per acre-inch of water applied. On account of the limited amount of water used, fixed costs were relatively high. Assessed to 767.27 acre-inches, the cost per acre-inch was 65.2 cents. Total operating and fixed charges amounted to $1.02 per acre-inch.

Corn for ensilage on 22.5 acres received one irrigation of 9.5 inches. The ensilage yield was 16.2 tons per acre. The yield of corn on the mature basis would have been 82.2 bushels per acre. Operating costs per unit of yield amounted to 21.9 cents per ton of ensilage or 4.3 cents per bushel of corn. Inclusion of fixed charges raises these costs to 59.7 and 11.8 cents. With no irrigation, yields would have been about 10 tons of ensilage or 32 bushels of corn. Operating costs of the increased yields credited to irrigation amount to 57 cents per ton of ensilage or 7.1 cents per bushel of corn. Inclusion of fixed charges increases these amounts to $1.56 per ton of ensilage and 18.5 cents per bushel of corn.

A 10-acre field broken out of alfalfa and used for ensilage corn was irrigated before plowing and two irrigations were given to the growing crop. The three irrigations totaled 19.23 acre-inches. A late-maturing hybrid was used on seven acres of the field and its yield of ensilage was 29 tons per acre. An earlier hybrid on three acres produced 20 tons per acre. The average yield of ensilage was 26.4 tons and of corn 62.9 bushels per acre. Operating costs per unit of yield were 27.2 cents per ton of ensilage or 11.3 per bushel of corn. Inclusion of fixed charges brings these costs to 74.2 cents per ton of ensilage or 31.2 cents per bushel of corn. Without irrigation this field would have produced a limited amount of poor quality ensilage. Costs on the basis of increased yield would therefore not be greatly different from those given for total yield.

H. E. Weakley.
Experiment Station Publications During 1945

Annual Report

Fifty-eighth Annual Report, presented to the Governor February 1, 1945. 1,500 copies.

Bulletins

371. Wheat Fermentation By-Products in Poultry Rations (6 pages). F. E. Mussehl, R. M. Sandstedt, and Wendell Ham. 5,000 copies.
376. Experiments With Safflower in Western Nebraska (28 pages). C. E. Claassen and T. A. Kiesselbach. 4,000 copies.
379. Land Prices (36 pages). Frank Miller and H. C. Filley. 5,000 copies.
380. Nebraska Looks Ahead (116 pages) by Experiment Station Staff. 15,000 copies.

Research Bulletins

137. Studies on Riboflavin Content of Cheese (12 pages). I. L. Hathaway and H. P. Davis. 2,000 copies.
138. Effects of DDT and Other Insecticides on Several Species of Potato Insects (14 pages). Roscoe E. Hill. 2,000 copies.
140. Carotene Content of Native Nebraska Grasses (16 pages). I. L. Hathaway, H. P. Davis and F. D. Keim. 2,000 copies.

Circulars

79-1. Our Egg Marketing Job (4 pages). F. E. Mussehl and H. C. Filley. 2,000 copies.


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


1945 Experiment Station Administration and Staff

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ROBERT W. DEVOE, Lincoln  VINCENT C. HASCALL, Omaha
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The Station Officers

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ABRAM EPP, M.A., Assistant Rural Economist
MARGARET FEDDE, M.A., Home Economist (Chairman)

¹ By an act of the Legislature of the State of Nebraska approved and in effect February 15, 1899, the State Treasurer became ex officio custodian of the Experiment Station funds on and after July 1, 1899.
² On leave effective November 30, 1945, for military service.
³ On leave effective September 16, 1942, for military service.
⁴ Resigned December 1, 1945.
⁵ Resigned June 30, 1945.
⁶ On leave effective September 16, 1942, for military service.
⁷ Resigned June 30, 1945.
⁸ On leave effective September 16, 1942, for military service.
⁹ Resigned June 30, 1945.
¹⁰ On leave effective September 16, 1942, for military service.
¹¹ Resigned December 1, 1945.
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
Doris Gates, B.Sc., Assistant in Entomology
R. W. Goss, Ph.D., Plant Pathologist (Chairman)
Paige L. Hall, B.Sc., Assistant Agronomist
W. E. Ham, M.Sc., Assistant Agricultural Chemist
L. E. Hanson, Ph.D., Assistant Animal Husbandman
Noel Hanson, M.Sc., Assistant Agronomist
Lionel Harris, M.Sc., Associate Agronomist and Superintendent, Scottsbluff Substation, Mitchell
I. L. Hathaway, M.Sc., Associate Dairy Husbandman
Harold A. Hauke, M.Sc., Field Supervisor in Entomology
R. E. Hill, M.Sc., Assistant Entomologist
B. D. Hites, M.Sc., Assistant Agricultural Chemist
Orlando W. Howe, B.Sc., Assistant Agricultural Engineer
L. W. Hurlbut, M.Sc., A.E., Assistant Agricultural Engineer
V. J. Jeffers, B.Sc., Assistant in Dairy Husbandry
F. D. Keim, Ph.D., Agronomist (Chairman)
T. A. Kieselbach, Ph.D., Agronomist
G. C. Klingman, M.Sc., Assistant Agronomist
Eric Kneen, M.Sc., Associate Agricultural Chemist and Assistant Plant Pathologist
Ruth M. Levertont, Ph.D., Associate Home Economist
J. E. Livingston, Ph.D., Assistant Plant Pathologist
W. J. Loeffel, M.Sc., Animal Husbandman (Chairman)
John H. Lonnquist, M.Sc., Assistant Agronomist
W. E. Lyness, M.Sc., Associate Agronomist
T. M. McCalla, Ph.D., Associate Agronomist
R. A. Mapes, Manager, Union Fruit Farm
Howard J. Martley, Assistant Agent in Entomology
Frank Miller, M.A., Assistant Rural Economist
Rufus H. Moore, Ph.D., Assistant Horticulturist
R. F. Morgan, M.Sc., Assistant Dairy Husbandman
F. E. Musselhi, 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 after December 10, 1945)
K. S. Quisenberry, Ph.D., Agronomist
E. L. Reichart, M.Sc., Associate Dairy Husbandman
H. F. Rhoades, Ph.D., Associate Agronomist

1 Resigned September 22, 1945.
2 Resigned September 15, 1945.
3 Detailed from the U. S. Department of Agriculture, Washington, D.C.
4 On leave effective February 15, 1943, for military service.
5 On leave July 1, 1945 to February 1, 1946, for military service.
6 On leave effective February 1, 1943, for military service.
7 Resigned December 30, 1945.
8 Resigned September, 1943.
9 Resigned November 1, 1945.
RAYMOND ROBERTS, M.Sc., Associate Entomologist
WALTER RUDEN, M.Sc., Assistant in Rural Economics
MYRON G. A. RUMERY, B.Sc., Animal Husbandry Agent, North Platte Substation
J. C. RUSSEL, M.Sc., Agronomist
R. M. SANDSTEPT, M.Sc., Agricultural Chemist
DORETTA SCHLAPHOFF, M.Sc., Assistant in Home Economics
ANDREW B. SCHULTZE, Ph.D., Assistant Dairy Husbandman
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)
L. VAN ES, V.S., M.D., D.Sc., Animal Pathologist (Chairman to December 10, 1945)
GLEN 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)
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 and Superintendent, North Platte Substation

1 Resigned January 3, 1946.
2 Resigned, June 30, 1945.
3 Detailed from the U. S. Department of Agriculture, Washington, D. C.
4 On leave effective January 20, 1942 for military service.
Experiment Station Financial Report

Money Received from the United States Government

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, 1945, under act of Congress approved March 16, 1906. Total $15,000.00

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

Bankhead-Jones 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, 1945, under act of Congress approved June 29, 1935. Total $38,776.60

Salaries and Wages
Regular employees $24,498.14
Temporary employees 707.54
Total $25,205.68

Supplies
Office supplies $238.20
Laboratory supplies 1,114.80
Feedingstuffs 4,135.30
Agricultural supplies 361.40
Janitor and barn supplies 78.00
Educational supplies 92.94
Total $6,020.64

Expense
Postage $28.50
Freight, express and dray 12.40
Public printing, advertising and photo supplies 7.67
Traveling expense 841.63
Rentals 845.63
Special and temporary services 4,100.38
Telephone 11.89
Total $5,848.10

Repairs
Equipment $449.90
Total $449.90

Equipment
Furniture and fixtures $21.60
Apparatus, labor and equipment 360.52
Machinery 195.16
Livestock 675.00
Total $1,252.28

Grand Total $38,776.60

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, 1945, under act of Congress approved March 2, 1887. Total $15,000.00

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

Purnell 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, 1945, under act of Congress approved February 24, 1925. Total $60,000.00

Expenditures
For salaries and wages
Regular employees ................................................... $39,119.97
Temporary employees ................................................. 3,784.59
Total ....................................................................... $42,904.56

Supplies
Office supplies ............................................................ $150.34
Laboratory supplies .................................................... 2,618.46
Fuel (coal) ................................................................. 10.29
Foodstuffs ................................................................. 14.87
Educational and recreational supplies ......................... 729.64
Janitor and barn supplies ............................................ 231.08
Feedingstuffs ............................................................ 965.08
Agricultural supplies ................................................. 130.04
Total ....................................................................... $4,890.00

Expense
Postage .................................................................... $3.95
Telephone ................................................................. 9.10
Freight and drayage ................................................... 37.74
Water, heat, light and power ..................................... 61.06
Public printing, advertising and photo supplies .......... 374.96
Traveling expense .................................................... 815.63
Rentals ..................................................................... 119.20
Special and temporary services ................................. 7,057.94
Miscellaneous .......................................................... 69.76
Total ....................................................................... $8,541.44

Repairs
Buildings ................................................................. $27.83
Lands .................................................................... 1,088.26
Equipment ............................................................... 752.70
Total ....................................................................... $1,838.79

Equipment
Furniture and fixtures ............................................... $196.73
Apparatus, labor and equipment ................................. 1,135.43
Livestock .................................................................. 210.46
Machinery ............................................................... 253.23
Books, magazines and maps ..................................... 20.36
Total ....................................................................... $1,816.21

Fixed Charges
Refunds .................................................................... $9.00
Total ....................................................................... $9.00
Grand Total ............................................................ $60,000.00

Dated at Lincoln, Nebraska                         JOHN K. SELLECK, Comptroller.
# Station Financial Report

## Financial Statement Exclusive of Federal Funds

Statement of Expenditures for the Agricultural Experiment Station, University of Nebraska, for the year ended June 30, 1945, 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

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular employees</td>
<td>$72,534.26</td>
</tr>
<tr>
<td>Temporary employees</td>
<td>6,217.98</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$78,752.24</strong></td>
</tr>
</tbody>
</table>

### Supplies

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office supplies</td>
<td>$709.43</td>
</tr>
<tr>
<td>Laboratory supplies</td>
<td>6,365.84</td>
</tr>
<tr>
<td>Fuel (coal)</td>
<td>929.90</td>
</tr>
<tr>
<td>Foodstuffs</td>
<td>2,745.26</td>
</tr>
<tr>
<td>Educational and recreational supplies</td>
<td>477.27</td>
</tr>
<tr>
<td>Janitor and barn supplies</td>
<td>1,052.93</td>
</tr>
<tr>
<td>Feedingstuffs</td>
<td>60,397.96</td>
</tr>
<tr>
<td>Agricultural supplies</td>
<td>6,466.56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$79,145.15</strong></td>
</tr>
</tbody>
</table>

### Expense

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage</td>
<td>$668.69</td>
</tr>
<tr>
<td>Telephone and telegraph</td>
<td>1,200.61</td>
</tr>
<tr>
<td>Freight, express and drayage</td>
<td>1,929.36</td>
</tr>
<tr>
<td>Water, heat, light and power</td>
<td>5,705.94</td>
</tr>
<tr>
<td>Public printing, advertising and photo supplies</td>
<td>2,004.07</td>
</tr>
<tr>
<td>Traveling expense</td>
<td>5,613.98</td>
</tr>
<tr>
<td>Rentals</td>
<td>2,000.44</td>
</tr>
<tr>
<td>Special and temporary services</td>
<td>59,690.40</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4,000.80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$82,804.29</strong></td>
</tr>
</tbody>
</table>

### Repairs

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>$3,069.37</td>
</tr>
<tr>
<td>Lands</td>
<td>503.85</td>
</tr>
<tr>
<td>Equipment</td>
<td>8,886.27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$12,459.49</strong></td>
</tr>
</tbody>
</table>

### Equipment

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture and fixtures</td>
<td>$1,821.37</td>
</tr>
<tr>
<td>Apparatus, labor and equipment</td>
<td>4,363.14</td>
</tr>
<tr>
<td>Livestock</td>
<td>20,473.78</td>
</tr>
<tr>
<td>Machinery</td>
<td>6,573.32</td>
</tr>
<tr>
<td>Books</td>
<td>640.32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$33,871.93</strong></td>
</tr>
</tbody>
</table>

### Lands and Buildings

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land improvement</td>
<td>$310.69</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$310.69</strong></td>
</tr>
</tbody>
</table>

### Fixed Charges

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refunds</td>
<td>$515.70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$515.70</strong></td>
</tr>
</tbody>
</table>

**Grand Total**  $287,859.49

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.