1945

58th Annual Report of the Agricultural Experiment Station 1945

W.W. Burr

University of Nebraska at Lincoln

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Nebraska Agriculture 1944

58th Annual Report of the Agricultural Experiment Station

Agricultural Experiment Station
University of Nebraska, College of Agriculture
W. W. Burr, Director, Lincoln, Nebraska
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Letter of Transmittal

The University of Nebraska—Agricultural Experiment Station

To His Excellency, Dwight Griswold, Governor of Nebraska:
Sir: In accordance with the Act of Congress approved March 2, 1887, and the Act of the General Assembly of the State of Nebraska, approved March 31, 1887, establishing and regulating experiment stations, I have the honor herewith to submit the Fifty-Eighth Annual Report of the Agricultural Experiment Station of Nebraska.

W. W. Burr, Director
February 1, 1945.

Governor’s Certificate

State of Nebraska, Executive Department

Mr. W. W. Burr, Director, Nebraska Agricultural Experiment Station:
Sir: I hereby acknowledge receipt of the Fifty-Eighth Annual Report of the Agricultural Experiment Station of Nebraska.

Dwight Griswold, Governor
February 1, 1945.

INTRODUCTION

In 1944 as in former war years the Nebraska farmer and his family have been called upon for increased production of food and feedstuffs. This increased production was necessary despite the fact that there were less experienced labor and equipment available. The farmers put forth unlimited effort with quite satisfactory results considering weather conditions.
A state-wide view of the weather records for the year is interesting. The rainfall for the state as a whole was the greatest since 1923, ranging from a high of 40 inches at points in eastern Nebraska to less than 12 inches at some points in the western part of the state. There were no extreme temperatures or serious drought periods. Heavy precipitation in April over much of the state seriously delayed the planting of spring grains but built up a reserve of moisture in the soil. The late planting resulted in a low total yield of spring-sown grains and the reduced acre-age plus a serious rust epidemic reduced the yields of winter wheat. The corn crop was the largest on record.

A large part of the research work of the Experiment Station for the year was devoted to answering questions of immediate need in the wartime program. The widest possible dissemination of new information obtained was striven for. Through Agricultural Extension, the personal efforts of the staff, and our regular series of publications, data on the prevention of crop and animal diseases, the control of insect damage, better cultural practices, effective weed control, time and labor-saving machinery, not to mention the results of long-time experiments in crop improvement by means of better varieties and new tillage methods were brought to farmers in every part of the state. Because of the difficulty of the labor situation, some research projects have continued inactive. Those vitally related to increased production or those with long-time aspects have been maintained. On the whole satisfactory progress was made in the research program as can be observed by those who care to read the following report.

Postwar studies were continued during the year and a preliminary report on many phases of Nebraska agriculture has been completed. The call upon members of the staff for many kinds of services has taken an increasing amount of time. Most of these demands were necessary in meeting the wartime needs in our state. Not only station and extension workers but the college faculty contributed in this effort.

The fifty-eighth annual report covers the research program undertaken during 1944 as well as related programs carried at the North Platte, Mitchell, and Valentine substations, the experimental farm at Alliance and the fruit farm at Union. Work cooperative with farmers was conducted in many sections of the state with the assistance of county agents and staff members. Cooperation has been continued with a number of the federal bureaus and offices, with the agricultural extension service and with the chemurgy division of the University. Some of the research projects have received substantial support from industrial organizations.

This report on research progress is made for the calendar year of 1944. The financial report is on the basis of the fiscal year July 1, 1943, to June 30, 1944.
Virgin Nebraska soils were conserved and their fertility replenished by natural means—by dying vegetation, by grazing bison and other animals, by the absence of tillage. Under present day grazing and cropping practices and the continuous drain of nitrogen and other chemical resources from the soil, wise soil management depends on knowing and applying the findings of soils research.

Soils Research
Department of Agronomy

Erosion Control and Moisture Conservation

Experimental work on soil erosion control and moisture conservation is being conducted cooperatively with the U. S. Department of Agriculture, Soil Conservation Service—Office of Research. The work involves both the physical and biological phases of these problems.

During the year 1944 the total rainfall has been above normal, but because of the gentle nature of most of the rains the amounts of runoff and erosion have been less than usual as regards plowed land. A comparison of the runoff and erosion on corn land for two years of rainfall shows the interesting fact that although the total rainfall was less in 1942 the runoff and erosion were greater in that year than in 1944. The two years may be compared as follows:

<table>
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<th>Treatment for corn</th>
<th>1942 Runoff (inches)</th>
<th>1942 Erosion (tons per acre)</th>
<th>1944 Runoff (inches)</th>
<th>1944 Erosion (tons per acre)</th>
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<tr>
<td>Residues—subtilled</td>
<td>1.00</td>
<td>6.12</td>
<td>0.86</td>
<td>1.82</td>
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<tr>
<td>No residues—plowed</td>
<td>2.69</td>
<td>18.61</td>
<td>1.90</td>
<td>16.70</td>
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The amount of water entering the soil during 1944 has been high, and some soils of the state have been wet down to greater depths than for many years. Large amounts of precipitation of low intensity during late winter and spring, together with low evaporation at that time, accounted for the greater depth of moisture penetration.

Average results over a 2-yr. period showed that compared with plowed land with no residues, use of crop residues on the surface of the soil reduced erosion by 72% on corn, 80% on oats, and 70% on wheat land. The amount of runoff was also reduced 57% by the use of residue left on the surface.

High precipitation during April, June and August kept the soil adequately supplied with water so that corn did not suffer seriously at any time from lack of moisture. These periods of excessive moisture, however, did wash some of the soluble nitrate to depths below the root zone. The corn crop showed some symptoms of nitrate deficiency on land where the cropping system was such that there was not a good supply.
1. A wheat field in western Nebraska where the stubble has been left on the surface by proper setting of the on-way disk. No wind erosion will take place here.
2. Preparing combine wheat stubble land with the subsurface tillers and treders pulled in tandem. The land is to be seeded to bromegrass.
3. A good fall growth of wheat in southwestern Nebraska on land fallowed with the old stubble left on the surface for protecting soil.
4. A “treader” used for supplementing various types of subtilage tools which leave the residues on the surface.
5. Seeding bromegrass with a lime spreader. Alfalfa seed for mixture is being seeded with attachment on treader. The treader is then covering both types of seed.

In the lower right picture a two-row cultivator is shown using sweeps for cultivating corn land protected with crop residues.
of nitrifiable material in the soil. On land that had been in sweetclover
the previous year, corn appeared to be well supplied with available
nitrogen.

Progress was made during the year in adjusting equipment to do a
satisfactory type of tillage and to give proper distribution and mainte­
nance of residues on the surface. Much of this progress has been due
to the helpful cooperation of the United States Tillage Laboratory at
Auburn, Alabama; several machinery companies have done considerable
testing of their different types of equipment.

Further attention has also been given to the matter of eradication of
weeds or volunteer grain both on land where the seedbed is being pre­
pared and also on land in cultivated row crops. After six years of work
it appears that weeds can be controlled under Nebraska conditions about
as effectively through a system of stubble mulching with subsurface
tillage as where land is plowed. However, when weeds are to be con­
trolled by a system of undercutting instead of by plowing them under,
several fundamental points should be observed and certain practices
carefully followed—such as preventing weeds from maturing seed; sub­
tilling weeds on hot and dry days; running the tiller as shallow as pos­
sible; and using a treader when necessary to break up clods. The use
of two treads pulled askew is also effective in eradicating weeds or
volunteer small grain.

Fall subtillage of land to be used for spring small grain or for corn
has been found advantageous. Soil so treated will absorb more water
from melting snow. The residue may be flattened enough to reduce
erosion but not so much that snow will not be held on the field. Fall
subtilled land usually can be worked a few days earlier in spring than
land that has had no tillage.

Publications.—F. L. Duley and J. C. Russel: The use of treaders with
subsurface tillers. (Lithographed) U. S. Department of Agriculture, Soil
Conservation Service, Region V. 5 pp. April 1944. F. L. Duley and C. E.

Soil Microbiology and Crop Residue Management

Determining soil structure stability.—Since a rain is made up of water
drops, a method was devised to test the effect of individual water drops
on soil structure. By dropping water from a burette upon small soil clods
the relative stability of different soils or soils with different treatments
could be determined. Under the impact of the water drops, samples of
Peorian loess, devoid of organic matter, seemed to melt away like sand.
Peorian loess has little binding power to hold it together. Samples of
Marshall silty clay loam broke up into small units or aggregates that
eventually gave way under the continued impact of the water drops.

Basically, the procedure involved the application of a unit of energy or hitting
force to a small lump of soil. Certain organic liquids such as benzene or toluene
do not cause the soil to swell and may be dropped on the soil almost indefinitely
without destroying the structure. Some organic liquids, on the contrary, greatly
change the size of structure particles. (See figure.) One-half gm. of water drops was
required to destroy a moist lump of soil, whereas 1000 gms. of force were required
to crush a dry lump. The action of the falling water drop on soil structure was
largely effected through wetting and swelling, which softened the lump so that a
drop would disintegrate it.
The influence of two organic substances on the granulation of Peorian loess; Left, Peorian loess treated with glacial acetic acid and subsequently treated with water; Right, Peorian loess treated with benzene and then slaked in water.

Influence of decay and organic substances on structure stability.—Wheat straw or sweetclover residues returned to the soil increased for an appreciable period the stability of the soil to water drops. Surface soils with an accumulation of organic matter were two to six times as stable under the impact of water drops as soil material without the organic matter. Many organic substances were tested for their effect on soil structure stability. Dextrose, sucrose, starch, peptone, cellulose and gum arabic did not increase the stability of soil structure but did furnish energy material for soil microorganisms which produced substances that did stabilize the soil. Lignins, proteins, oils, fats, waxes, and resin increased stability of the soil structure directly. Substances of this nature have been extracted from the soil organic matter, and it appears that compounds of this nature give organic matter its property of increasing the stability of soil structure.


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

Fertilizers for corn, sugar beets, and oats

Nitrogen fertilizers increased the yield of corn significantly (19 to 52 bu. per acre) in eight tests on irrigated land in central Nebraska, the untreated fields yielding 26 to 68 bu. per acre. In all cases tests were conducted on fields thought to be deficient in nitrogen, as judged by the cropping history. Ammonium sulfate, ammonium nitrate, and uramon were equally effective as nitrogen carriers. An application of 40 lbs. of nitrogen was almost as effective as 80 lbs. Phosphorus and potassium fertilizers did not increase the yields of corn in these tests. No significant increases in yields of corn as a result of fertilizer applications were ob-
tained in two tests on nonirrigated land in southeastern Nebraska. Variations in stands in the latter tests appeared to explain yield more than did use of commercial fertilizer.

Two fertilizer tests on irrigated sugar beets were conducted in the Platte Valley. The sugar beets in one field showed characteristic symptoms of nitrogen deficiency and a significant increase in yield was obtained from an application of 80 lbs. of nitrogen. In the other field untreated sugar beets yielded 26 tons per acre and no significant increases were obtained as a result of fertilizer applications.

Six fertilizer tests on oats and barley were established on nonirrigated land. Only two tests on oats were harvested since it was necessary to abandon four of the tests because of poor stands. One test (Pawnee County) showed a significant increase in yield due to an application of superphosphate (30 lbs. P₂O₅ per acre) whereas the other test (Holt County) showed a significant increase in yield due to an application of ammonium sulfate (20 and 40 lbs. nitrogen per acre). Potassium fertilizer had no significant effect on the yields.


Methods for applying nitrogen fertilizer for irrigated corn

Four methods of applying nitrogen fertilizers for irrigated corn in central Nebraska were studied. The methods included placing the fertilizer in bands at the bottom of the plow furrow, placing the fertilizer in bands about two inches from the seed at planting time, applying the fertilizer as a side-dressing at the last cultivation, and applying the fertilizer in the irrigation water.

Larger increases in yields of corn were secured from applications of nitrogen fertilizer as a side-dressing at the last cultivation than from applications either in the bottom of the plow furrow or at planting time. These larger increases were attributed to a more favorable supply of nitrogen being available to the corn during the period when the nitrogen requirement of corn was greatest. In addition, the application of the fertilizer at the last cultivation appears to have an advantage over the other two methods in that it will allow the farmer to view the stand before the fertilizer is applied. The thicker the stand the greater the advantage that nitrogen fertilizer will give profitable returns. Where the stand is relatively thin, it is quite possible that the soil will be able to supply sufficient nitrogen for the crop.

Ammonium nitrate was the only fertilizer applied in the irrigation water. It was applied during the first irrigation in most of the tests. Increases in yield of corn by that method were almost as large as those attained by a side-dressing at the last cultivation. However, it was easier to apply the nitrogen as a side-dressing, and in addition, a more even distribution of the fertilizer was believed to result from the latter method. When nitrogen fertilizers are applied in the irrigation water, it is desirable to dissolve them first in water, using a barrel or other container provided with a suitable outlet for the purpose. The concentrated solution is then allowed to flow at a proper rate into a special mixing device placed in the lateral in order to facilitate mixing of the solution with the irrigation water. The solution should enter the lateral as near to the area to be fertilized as possible in order to prevent unnecessary loss of nitrogen in the lateral.

It is desirable to apply the nitrogen fertilizer during the last few minutes of the irrigation.

J. W. Fitts, J. R. McHenry, and H. F. Rhoades.

Moisture penetration during irrigation

A survey initiated in central Nebraska to determine the influence of soils, crops, and the present irrigation practices on the penetration of water during an irrigation shows that the depth of penetration of water is greatest near the irrigation lateral as long as the slope of the field is
uniform. However, where the percentage of slope is highest near the lateral, the depth of penetration of water may be greatest in a part of the field with less slope some distance from the lateral. The results also reveal that the distance water can be run during an irrigation without overwatering is greatly influenced by topography.


**J. W. Fitts and J. R. McHenry.**

**The nature and properties of soil clays**

Many agronomically important properties of soil are due to the nature of the fine soil particles commonly called clay. Studies of the properties of clays of various types are in progress, and determinations of the types of clay present in Nebraska soils are being made.

A study of the manner in which different clays hold plant nutrients has shown that clays of the montmorillonite type, common in Nebraska soils, hold calcium in a form that is less available to growing plants than where it is held by clays of the kaolinite type, common to soils of the southeastern United States. Acid treatment of clay also removes less calcium from the montmorillonite type of clay than from the kaolinite. Very close relationship between the amount of calcium taken from different kinds of clay by soybean seedlings and the amount removed from the clay by a mild acid treatment was shown. This supports the theory that the process of plant feeding is essentially an exchange of acid hydrogen ions from the plant for the nutrient cations from the soil.

Since the reaction in which calcium is removed from the clay by acid is fundamental to so many processes of plant nutrition and soil development, a study of this reaction in a number of pure clays, soil clays and soils is being made. Soils from Nebraska and other parts of the United States are included. Results to date indicate that calcium is not held as tightly by Nebraska soils or the clays from these soils as it is by pure minerals of the montmorillonite type.

The clay fraction of a number of Nebraska soils has been separated from the rest of the soil and will be subjected to detailed studies in order to establish its nature and properties. The clay is separated into coarse clay and fine clay by means of a supercentrifuge before the studies are made. Apparatus for detecting different types of clays in soils by measuring the temperatures at which the mineral crystals undergo changes has been constructed in the soils laboratories.

The purpose of these studies is threefold: (1) to gain basic information about the soils of the state to assist in classifying them more accurately; (2) to reveal the nature of the changes that have taken place during the development of Nebraska soils from the raw parent material; and (3) to understand more clearly the exact nature of reactions that govern plant nutrition as a fundamental basis for research on such practical matters as soil testing and alkali reclamation.

A paper, "The availability of calcium from different types of colloids as affected by the degree of calcium saturation," has been accepted by and will appear in an early issue of Soil Sci.

W. H. Allaway and H. F. Rhoades.

**Nature of phosphorus in Nebraska soils**

A survey to determine the amounts of phosphorus and the nature of the chemical combinations in which it is found is in progress. A fractionation procedure for separating the inorganic phosphorus on the basis of its solubility has been worked out, and the amount of phosphorus present in organic form has also been determined.

Samples taken at different depths in the profiles of various soil types have been investigated. In general, the results indicate that soils of central and western Nebraska have a large amount of inorganic phosphate
which has many of the solubility characteristics of calcium phosphate. In soils of eastern Nebraska this phosphate has been converted through the weathering processes of soil development into less soluble forms, presumably iron or aluminum phosphates. Soils of eastern Nebraska which are derived from glacial till are especially impoverished in soluble phosphate, and it is to be noted that these soils have shown large responses to phosphate fertilizers in field trials.

Analysis of samples from comparable plots, some of which have been farmed by subsurface tillage for five years, and others which have been plowed with a moldboard plow, show that there has been little if any tendency for available phosphorus to concentrate in the surface three inches of soil in subtilled plots.

More than one-half of the total phosphorus in eastern Nebraska soils is present in organic compounds, presumably in residues of plants or microorganisms. The phosphate fertility of these soils will depend largely upon the rate at which this material is broken down to forms readily utilisable by the crop.

Samples are now being collected and preserved from all field experiments where information on crop response to phosphate fertilization is secured. In time a catalog of samples of known phosphate response can thus be accumulated and the availability to crops of the various forms of native soil phosphorus be estimated.

W. H. Allaway and H. F. Rhoades.

A comparison of erosion on bare and residue-covered areas following 9.81 inches of rainfall during the month of April, 1944.
Isolation of superior strains of corn, wheat, and other crops, together with their development and increase, has contributed to the notable yield increases of recent years. Although Pawnee wheat and Cedar oats merit the wide attention and approval they have received, comparable improvements have been made in alfalfa and sweet clover, the grasses, and in the horticultural crops, potatoes and tomatoes. Improved field management studies and practices have also been studied and introduced. Increased yields mean increased Nebraska wealth.

Field Crops Research
Department of Agronomy

Improvement of Small Grains

Much of the effort in this project continued to center around the increase and distribution of superior varieties, but the search for further improvements over existing varieties was not neglected. In no crop has the perfect variety been found, but by gradual steps improvements are being made.

Although the season was not especially favorable for small grains, it was possible to make selections of desirable, surviving material. Winter wheat made very little fall growth because of the lack of surface moisture. A severe cold wave near the middle of February caused some killing in exposed places. Because of the damp, cold, late spring, development of all crops was retarded, and rusts, becoming rather heavy before harvest, did considerable damage to susceptible material. Spring barley plots were discarded because of thin stands which became weedy; also, chinch bugs caused serious damage.

At Alliance differential killing was recorded for winter wheats, but a good crop was in prospect only to be ruined by a severe hailstorm prior to harvest. At this same time the variety tests of oats, barley, and spring wheat were ruined, and hence no data are available from 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.—The acreage of the new variety, Pawnee, increased as rapidly as seed became available, but owing to unfavorable conditions this seed-increase was somewhat retarded. Pawnee, a new hard red winter wheat variety, is recommended for southeastern Nebraska, south of the Platte river and west to Highway U. S. 81. The variety is early, resistant to Hessian fly in the hard red winter wheat region, highly resistant to loose smut, and has some resistance to leaf and stem rust. It is not as winter hardy as Kharkof, may shatter under certain conditions, and its milling and baking characteristics are acceptable to the trade. In the fall of 1943 it was estimated that approximately 1800 bushels of Pawnee were available for seeding in the state. In 1944 about 1100

1 It was developed cooperatively by the Nebraska and Kansas Experiment Stations and the U. S. Department of Agriculture.
acres were certified, and it is estimated that at least 30,000 bushels were produced. Undoubtedly all of this seed was planted in Nebraska. In the fall of 1943 some farms in the southwestern part of the recommended area did not seed the variety, or, if they did, lost the crop because of drought. Thus the acreage in 1944 was smaller than expected. In general, the farmers are enthusiastic about the variety, and this year even with considerable leaf and stem rust present it performed in a very satisfactory manner, giving some very good yields.

In the field plot tests at Lincoln, Pawnee yielded 29.2 bu. per acre compared with 26.2 for Cheyenne, and 23.4 for Nebred. Wichita, an extremely early variety that has been named rather recently, yielded 23.0 bu. per acre. A few other named varieties yielded in the following order: Tenmarq, Turkey, Blackhull, Comanche, Nebraska No. 60, and Chiefkan. For the 15-year period (1930–44), Cheyenne, Tenmarq, and Nebred have had the highest average yields. Since 1936, Pawnee has had an average yield of 31.3 bu. compared with 25.6 bu. for Cheyenne, 24.6 bu. for Nebred, and 23.7 bu. for Turkey. Although not recommended for localities so far west as North Platte, Pawnee has an average yield equal to or slightly above that for Cheyenne and Nebred at that station.

In the Lincoln nursery stands were thin, partly because of winter-killing, and both leaf and stem rust did considerable damage before harvest. Those varieties which were either early or had some rust resistance gave the highest yields. In the yield tests for the first time, and showing considerable promise, were several selections from the cross Nebraska No. 60 x Mediterranean-Hope. These wheats survived the winter very well, had low leaf and stem rust readings, high test weights per bu., and good yields. Selection for resistance to both rusts was again possible in the nursery, and more material having cold resistance along with resistance to leaf and stem rust is being accumulated.

Spring wheat.—The spring wheat variety-test was rather poor in 1944 on account of a very slow start in the spring, which prevented stooling
and delayed maturity. The test was again seeded in nursery plots (seven replications). Leaf rust was heavy on nearly all varieties except Mindum durum, and Henry. Such varieties as Thatcher, Rival, and Pilot showed good resistance to stem rust.

The highest yield, 9.9 bu. per acre, was made by Merit x Pilot (C. I. 12315), followed by 6.6 bu. for Pilot, 6.4 bu. for Kearney, and 4.9 bu. for Reward. Newthatch, the new leaf rust resistant variety, Ceres, Thatcher, and Rival all gave lower yields. For a long period Kearney has given the highest average yield, but for the last two years it has been slightly below Pilot. The quality characteristics of Kearney are such that it is not acceptable to the trade. Thatcher, Pilot, and Rival all have relatively good long-time yield records at Lincoln.

Some interest was shown in spring wheat in south central Nebraska as a replacement for winter wheat in the spring of 1944. Although farmers were advised that it might not be a very profitable venture, considerable acreage was seeded. As the season turned out it is very doubtful whether many good yields were obtained.

No data were obtained at Alliance because of hail's damaging the test.

Barley.—Barley field-plots were seeded in good time but germination was slow because of continued cold, damp weather. The stands were thin and uneven. These plots first became very weedy, and then heavily infested with chinch bugs. They were abandoned with no data being obtained.

In the nursery, stands were thin and there was some damage from washing, but the crop was harvested. Five new strains gave yields higher than the average for Trebi, the highest yielding check. One of these was Hybrid Composite (C. I. 7114), a new variety selected in Nebraska and with a good yield record over a rather wide area. Another strain giving a good yield was Velvon Composite No. 11, a smut-resistant strain of Velvon, developed in Utah. A strain of Peatland x Vaughn (S. Dak. 252) produced a good yield at both Lincoln and North Platte. Among the varieties of chief interest because of malting behavior Hybrid Composite (C. I. 7114), Tregal, and Mers seem to show the most promise at Lincoln. More than 4,000 samples of barley collected from all over the world were grown and studied as possible sources of new and superior germ plasm. The seed from a few of the more outstanding rows was saved and will be used as parents of new crosses.

Oats.—Cedar, the new disease-resistant oat variety released in 1943, continued to increase in popularity. This variety, developed in Iowa, tested in Nebraska, was named in cooperation with the Iowa Experiment Station. Resistant to both crown and stem rust and to smut, it has a good test weight per bu., as well as a high yield. Approximately 2,800 bu. of Cedar were available for seeding in the spring of 1944, from which were raised about 1,200 acres yielding 42,000 bu. of seed, all of which will go back into the ground in the spring of 1945.

Yields in the oat variety test at Lincoln were much lower than in 1943. Crown and stem rust had much to do with the final ranking of the various varieties, since susceptible ones suffered considerable damage. Cedar ranked first for yield with an average of 45.9 bu. per acre. In second place was Tama with an average of 44.9 bu., followed by Boone which yielded 42.4 bu. per acre. It will be remembered that Cedar, Tama, and Boone are selections from the cross Victoria x Richland and all carry the same disease resistance. A new strain, D69 x Bond, gave a yield only slightly lower than did Boone. Yields of the older varieties were considerably lower, with Otoe, Trojan, Columbia, Brunker, and Fulton ranking in the order named. Test weights per bu. were light, especially for the varieties susceptible to rust, again emphasizing the desirability of growing resistant varieties. Of the varieties tested before 1936, Otoe continues to show the best yield record, having an advantage over Trojan, Brunker, Columbia, and Kanota. For the period 1933–44, Cedar ranks first with an average yield of 56.6 bu. per acre, compared with Marion 52.7 bu., Otoe 49.7, Brunker 49.5, Columbia 49.5, and Kherson 42.1 bu. For the 7-year period, Cedar has outyielded the original Kherson by 34.4%.
In the Lincoln oat nursery valuable information was collected since rust reaction had much to do with the determination of yield. Stem rust became so heavy on some rows as to cause severe lodging and reduce yields to a very low figure. Late varieties gave the lower yields unless the strains carried rust resistance. Some progress was made in obtaining combinations of disease resistance with more earliness. In other words there is need for varieties as early as Otoe, Trojan, and Brunker, which carry the disease resistance of Cedar, especially for the western two-thirds of the state where Cedar is not so well adapted.

In cooperation with the Nebraska Grain Improvement Association, about 200 samples of oats from northeastern Nebraska farms were grown and identified. Many of these samples were misnamed or badly mixed and pointed rather clearly to the need of directing more attention to better varieties of oats.


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Progress in sorghum improvement

Although the precipitation for the 1944 season was a few inches above that recorded in 1943, the sorghum yields were lower than those recorded last year. This response was due largely to the heavy chinch bug infestation which began early in June. The plants in a few plots of the most susceptible varieties were completely killed by these pests.

Breeding.—Progress has been achieved in the Nebraska breeding program toward developing new varieties that show considerable resistance to chinch bugs and that are otherwise better adapted. This work, started in 1936, is being done at both the Experiment Station at Lincoln and the North Platte Substation. Thirty-two new selections were tested in 1944 as to their performance. The yield of several was equal to or exceeded that of Early Kalo. They are all of the combine type. A project has been started to breed smut resistance into the commercial sorghum varieties. Considerable effort is being expended to develop improved low prussic acid, chinch bug resistant strains of Sudan grass for the state.

Grain varieties.—Seventy-one experimental and commercial varieties were included in the grain yield tests at Lincoln.

Yields ranged from 69.0 bu. per acre for Nebr. No. 44 down to 9.3 bu. for Day. This latter variety is highly susceptible to chinch bugs and was severely damaged by them. The comparative yields of the principal commercial varieties were: Pink kafir 62.2 bu., Western Blackhull 60.7 bu., Club 60.5 bu., Early Hegari 59.2 bu., Kalo (H. C. 617) 46.6 bu., Early Kalo 45.4 bu., Martin 40.7 bu., and Westland 18.4 bu. At Lincoln the later-maturing varieties usually rank higher in yield than the earlier ones that are more suitable for the grain sorghum area of south central Nebraska. In tests at the four outstate testing centers in that area and at the North Platte substation the new improved grain varieties proved superior. These include Martin, Westland, and Kalo (H. C. 617). In addition to them Early Kalo and Day are recommended. Martin, Westland, and Day should not be grown in chinch bug areas. For southeastern Nebraska such resistant grain varieties as Western Blackhull, Pink kafir, Club, Early Kalo, and Kalo (H. C. 617) give satisfactory yields.

Forage varieties.—Eleven sorgo varieties were tested for forage as well as grain production.
Grain yields ranged from 73.2 bu. per acre for Atlas selection (Conable No. 1) to 41.8 bu. for a new early-maturing variety, Leoti x Atlas (H. C. 42-27). In the production of forage figured on a 15% moisture basis, yields ranged from 6.13 tons for Atlas to 3.68 tons for Sudan grass. A new, early-maturing forage variety, developed in Kansas and named Waxy Atlas, may be of considerable value to those farmers who desire an early forage variety of the Atlas type. For those who desire a still earlier variety of this type that corresponds with Leoti as to time of maturity, Norkan has been added to the list of varieties that are certified in this state.

**Sugar varieties.**—For the third year, in cooperation with the Division of Sugar Plant Investigations of the Bureau of Plant Industry, a study has been made of the feasibility of growing sorgo for sugar production. This year, the 8 varieties tested gave an average calculated sugar yield of 1427 lbs. per acre. The sugar yields ranged from 2060 lbs. for Collier down to 1202 lbs. for Leoti. Although these are considered fair yields, they are not high enough to offer competition with the sugar beet industry in this state. For use in sugar production the stalks of sorgo must be harvested before killing frost, a limitation that would make the crop rather hazardous in Nebraska.

**Sudan grass.**—Until very recently the improvement of Sudan grass by hybridization and selection has not been carried on extensively anywhere in the United States. New strains developed in Georgia and Texas from crosses between Sudan and Leoti sorgo were tested for the first time in 1944 in comparison with the Wheeler strain of common Sudan that is now being certified in this state.

The Texas Sweet Sudan selections are lower in forage yield than is Wheeler, but they are more resistant to chinch bugs, more palatable to livestock as pasture and hay, higher in seed production, and more resistant to leaf spot diseases. Tift from Georgia is a late, high-yielding and comparatively coarse-stemmed selection. Preliminary analyses of the forage of Tift and the Texas Sweet Sudan strains indicate that they are comparatively high in prussic acid content. Whether this is high enough to cause possible loss of livestock when these strains are pastured under Nebraska conditions has not yet been determined. Three low prussic acid selections from Wisconsin were included in the yield test. They gave yields nearly equal to that from Wheeler.

**Seed increase.**—A new selection (H. C. 48) from Early Kalo, made by the Fort Hays Substation (Kansas) was again compared this year with three lots of Nebraska certified Early Kalo. It can be said that this new selection is equal to if not superior to the certified lots in yielding ability, is more uniform in plant height and type, and appears to be more lodge resistant. Seed of this new selection has been increased by certified seed growers and approximately 1400 bu. will be available for 1945 planting.

From an isolated plot of several improved selections of Leoti sorgo, 300 lbs. of seed were harvested. This seed will be planted for further increase. About 25 bu. of Fremont were increased at the Experiment Station. This seed will be distributed to farmers in the western and northern counties of the state. Fremont is an early-maturing forage variety that has yielded very well at North Platte and in other outstate tests. It has an advantage over Black Amber and Leoti by not growing so tall and thereby decreasing the labor involved in handling the bundles.

The sorghum project sponsored 10 demonstration plantings in the main grain sorghum producing counties of the state. The varieties included in these plantings were the combine types: Day, Westland, Plainsman, Martin, Nebr. No. 45, and Kalo selection (H. C. 617). They were planted in adjacent plots ranging from 1 to 4 acres each. The object was to acquaint farmers with these new varieties, and to observe their relative maturity dates and lodging at the time of harvest. All varieties stood very well even after being subjected to a few snowstorms and high winds. Of the six varieties, Kalo selection (H. C. 617) and Martin seem best adopted. As an outcome of the favorable results there will be an increased acreage of the better varieties in 1945.

These sorghum investigations are cooperative with the Division of Cereal Crops and Diseases, U. S. Department of Agriculture. O. J. Webster and T. A. Kiesselbach.
Soybeans

The 1944 season was very favorable for soybean production in eastern Nebraska. Climatic conditions permitted thorough weed control while ample soil moisture resulted in heavy yields of well-filled beans. No serious insect damage to soybeans was noted this year, but several fields in southeastern Nebraska were attacked by pod and stem blight.

Three uniform variety tests were conducted in cooperation with the U. S. Regional Soybean Laboratory. One test of early-maturing varieties was located in the vicinity of Norfolk. In this test the best yields were made by the Lincoln variety followed by Richland. Two experimental varieties, A3-149 and A45-251, were also promising. Although Lincoln was the best yielder it also was the latest maturing of the above-mentioned varieties. In years with a more normal fall frost date, the Lincoln soybean may not be sufficiently early ripening to escape frost damage in areas as far north as Norfolk.

In the uniform test conducted at Lincoln the Lincoln variety was again outstanding. It yielded 21.7 bu. per acre as compared with 20.9 for Dunfield and 20.6 bu. for Illini.

In a test at Nebraska City the late varieties, Chief, Patoka, and Viking gave the best yields. Lincoln was the best yielder of the earlier-maturing varieties in this test.

During the year the new variety, Lincoln, was admitted to the list of certified soybeans for Nebraska. In tests conducted during the past three years this variety has consistently yielded slightly more than Dunfield and Illini, the two other soybeans now certified in this state. In addition, the Lincoln variety is more lodge resistant and has better chemical characteristics. In time of maturity it is between Illini and Dunfield and is therefore best adapted to the east central area of Nebraska. Seed of Lincoln was further increased by the Nebraska Crop Improvement Association and will be available for general distribution to farmers in 1945.

Breeding and selection were continued in an effort to produce varieties better adapted to the soil and climatic conditions of this state. Included was a yield test of 450 single plant selections made the previous year. A number of these lines out-yielded available commercial varieties. Further testing, however, is necessary to definitely establish their superiority. Hybridization work between strains was carried on during the year to produce material for use in the selection of new varieties.

A test to determine the relative effectiveness of several commercial seed treatments in increasing yields was carried on cooperatively with the Department of Plant Pathology and the U. S. Regional Soybean Laboratory. The results of testing for two years indicate that stands can be improved by the use of seed treatments, but at the rate of seeding used in the experiment significant increases in yield did not result from the heavier stand.
Experiments were inaugurated to determine the reason for the general failure of seed inoculation to increase yields of soybeans in Nebraska. Unfortunately, part of the plantings connected with these studies were flooded out. Other plantings, however, showed that in agreement with many previous local tests no increase in grain yield was obtained, although the inoculated plots were all found to be well nodulated in comparison with no nodules in the untreated plots. In spite of the failure of local tests to demonstrate any enhancement in yield due to inoculation, the practice is recommended since it enables the plant to obtain part of its nitrogen from the air rather than all of it from the soil.

A test of 30 edible soybean varieties was conducted to determine their relative value for vegetable purposes. Among those tested the following varieties appeared most suitable from the standpoint of yield and other desirable characters: Bansei, Mendota, Jogun, Kanro, Toku, Willomi, Waseda, and Sousei.


*J. M. Slatensek and T. A. Kiesselbach.*

**Corn improvement**

The season of 1944 was the most favorable for corn of any experienced in this state during the current century. This fact is most evident from the record-breaking crop produced. Although hybrid seed played an important part in making the record crop possible, weather was perhaps an even greater factor.

The increasing use of hybrid seed corn is reflected in the state's total corn acreage, 72\% being planted to hybrids compared with 63\% in 1943—these figures according to the Nebraska State-Federal Division of Agricultural Statistics.

In the corn breeding program, desirable vegetative characteristics are stressed along with high yielding ability. The difference in lodging here shown is dependent upon the strength of roots transmitted by the inbred parents. Through cooperative arrangements, the Nebraska Agricultural Experiment Station can supplement its own corn breeding by use of inbred lines developed by the USDA and other State experiment stations.
Experimental hybrid combinations were compared in 19 localities within the state, in 37 different experiments. Eight of these experiments involved topcrosses of new lines; 9 were single-cross tests; and the remaining 20 were double-cross tests. The increase in testing of experimental combinations as well as of established hybrids was made possible through the outstate testing program now being conducted by means of funds provided by the State Legislature.

**Breeding.**—To evaluate the combining ability of the inbred lines available in the Nebraska breeding program, 135 lines were topcrossed in 1943 to two single crosses as testers. One single cross was used because of its susceptibility to lodging and the second because of its high yielding ability. These topcrosses (technically, 3-way crosses) were compared in triple lattice designs in 1944. Three replications of each test were planted at Lincoln and three replications were planted in the area of the state in which the lines involved were believed suited. A highly significant correlation coefficient of +.68 was obtained between the yields of the 69 midseason lines in the two tester combinations.

The single-cross tests are being used largely for the prediction of high-performing new double-cross combinations. Special emphasis is placed on new material for the northeastern and western parts of the state and on white hybrids. On the basis of this year's single-cross tests, material of considerable promise is available. These will be made up into double crosses as rapidly as possible for future testing. Some of the new experimental double crosses under test in 1944 gave very favorable results. Hybrids with significantly superior performance to those now in use should become available to Nebraska farmers in the near future.

The dent corn breeding field contained 1837 progeny rows distributed as follows: 1067 for seed increase; 360 for single-cross production; and 410 for double-cross production. Approximately 27,000 hand pollinations were made.

**Commercial hybrids.**—The testing program of the Experiment Station is designed to determine the merits of available commercial hybrids for the various regions of the state, and also to compare these with promising new experimental hybrids whose parental seed stocks can be procured for possible future use. It has been found that the Nebraska state certified hybrids are distinctly superior to the open-pollinated varieties when planted in the regions where they are adapted. The number of commercial hybrids now available on the market is so great that it would be impossible to test all of them, but an effort is made to include many of those that are found to be grown extensively by Nebraska farmers. Striking differences are found in the performance of various hybrids and in their regional adaptation. The most successful corn growers exercise a great deal of care in deciding what hybrids to plant. The Experiment Station is deeply concerned with the problem of establishing superior hybrid combinations and making seed stocks available so that anyone who wishes may produce seed corn for home use or for sale.

Yields of the commercial and experimental hybrids included in the main Experiment Station tests were exceptionally high in 1944. Among 45 entries in the test at Lincoln the highest-yielding hybrid produced 97 bu. per acre compared with 71 bu. for the open-pollinated variety. In a corresponding test in Nemaha County the highest-yielding hybrid gave 108 bu. compared with 82 bu. for the open-pollinated variety. In cooperative tests under irrigation at the North Platte Substation, corresponding yields were 160 bu. and 114 bu., whereas under dry-land conditions they were 55 and 44 bu. At the Scottsbluff Substation the highest hybrid yield was 113 bu. compared with 84 bu. for the open-pollinated variety. All of the above yields are for grain on a 15½% moisture basis.
Popcorn.—Testing of available popcorn hybrids from Kansas, together with Supergold and South American varieties, was continued this year. Tests were conducted at Lincoln, Ord, and North Loup. The hybrid superiority as to grain yield ranged from 39% to 69% over the open-pollinated varieties. Popping tests showed the hybrids to have a superiority of about 30% in popping expansion over the varieties. Work was begun in development of new popcorn inbred lines from the better varieties available in this state.

Waxy corn.—The breeding work to develop new waxy hybrids for industrial use has progressed favorably. Both white and yellow inbred lines are in process. Several years will be required before hybrids among these are available because the entire procedure must involve the development and testing of lines for high combining ability, followed by crossing and testing of double crosses.

Prospective contract-growers of waxy corn are concerned with its yields in comparison with standard available non-waxy hybrids. For the third successive year, Iowax 1 was the highest yielding waxy corn included in the variety test at Lincoln. As an average for 8 replications, Iowax 1 (waxy) yielded 44.3 bu. per acre compared with 49.8 and 59.5 bu., respectively, for the non-waxy hybrids Iowa 939 and U. S. 13.

As a 3-yr. average for the tests made in eastern Nebraska, the following acre yields are indicated: Iowax 1, 51.1 bu.; Iowa 939, 54.7 bu.; U. S. 13, 62.7 bu. On the basis of these average comparative yields, the grower of Iowa 939 would need to be paid a premium of 7% a bushel just to break even growing Iowax 1, and in regions where U. S. 13 is the standard type grown a premium of 23% per bushel would just offset the lower yield.


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New industrial crops

The search for new industrial crops that may prove suitable and profitable for production in this state continues in cooperation with the University of Nebraska Chemurgy project. The first step is to assemble and test such crops as to adaptation and general performance. If they show special promise, an effort is made further to improve them for our conditions. Two new oil-bearing crops, safflower and castor bean, are now in this latter class and are undergoing extensive breeding. Yields of existing varieties are sufficiently high to make them of interest commercially. Three years of breeding have shown that the possibilities of improvement are great. During the next few years new strains with marked advantages will be made available.

Safflower.—All existing varieties of safflower tested at this station are highly variable and badly mixed. Improvement is being made by selection within the best of these. Of approximately 20 varieties tested, those considered as the best sources for breeding material are: Special Russian (Turkestan type); Pusa 1, 2, 7, and 25; Simla, Asmednager 1, and Sholapur 1 (Indian types). Research is in progress to determine the percentage of cross-pollination; the inheritance of flower color, sterility, and spininess; and the relationship of oil content to other plant characters. In this connection, the technic of controlled cross-fertilization is being studied.

In safflower, high oil content is considered the most important breeding objective. The oil content of various varieties and even of individual plants within a variety differs greatly, varying from 20 to 34%. By
continued reselection from the higher oil content plants it should be possible to increase the oil content in a new strain to at least 34%. This percentage compares with about 20% in the best soybean varieties. Another important breeding objective is to secure strains that remain in the short, rosette stage of growth for only a brief time, this change providing better competition against weeds, and facilitating earlier cultivation.

Individual plants within a variety also vary greatly as to their yielding ability. The leaves of all existing high oil varieties have objectionable sharp spines that make the crop disagreeable to handle. Considerable effort is being made to develop spineless sorts with other good agronomic characters. Results have shown that it is possible to combine high oil content with spinelessness. Other characters being considered in the breeding program include maturity, flower color, seed size, diameter of seed heads, and resistance to shattering and lodging.

Varietal yields under irrigation at Scottsbluff averaged 2094 lbs. and at Alliance 1149 lbs. of seed per acre. Commercial yields under irrigation in the Alliance area were extremely low because of a leaf spot disease. This disease caused serious defoliations at the time of flowering. It was not found to any great extent in dry-land fields. Varietal yields under dry-land conditions at Scottsbluff averaged 275 lbs. and at Sidney 487 lbs. per acre. Safflower is also very subject to grasshopper damage.

Castor beans.—The objectives in castor bean breeding are considerably different from those of safflower. Existing varieties are available that are pure, nonshattering and of reasonably good yield. The main drawback of these varieties is that they are tall and therefore are not well adapted to machine harvesting. They are also somewhat later in maturity than is desirable. Selection has been in progress for 3 seasons to develop short, fine-stemmed, nonshattering, early-maturing strains which may be combined. Efforts are also under way to adapt combines for harvesting castor beans without cracking the seed. Results of these tests are encouraging.

Average yields of castor beans at Lincoln in 1944 were 818 lbs. and at Holdrege under irrigation, 1293 lbs. per acre.

Other chemurgic crops.—During the past year experimental work was continued with flax, sesame, hemp, milkweed, pyrethrum, sunflowers, and rape. Tests with milkweed as a substitute for kapok fiber are being discontinued.

Greater profits through timely planting

Greater yields through the timely planting of farm crops illustrate well how farm profits may be increased through good field management without added cost of production except that connected with harvesting a bigger crop. If a wise choice of superior varieties is coupled with timely planting, a remarkable increase in profits may result. And conversely, a failure to appreciate these principles and to apply them whenever possible may account for low farm income.

Oats.—The spring of 1944 will long be remembered because of continued rainfall which greatly delayed seedbed preparation and the planting of oats where these operations had not been done early. Much of the crop was not planted in eastern Nebraska until about May 10 which is fully five weeks later than the normal optimum date. This delay resulted in late maturity and heavy infection of susceptible varieties with stem rust and crown rust.
The time-of-planting tests with oats on the Experiment Station farm at Lincoln in 1944 included five dates and four varieties. The first date, February 9, was unusually early and was made possible by open winter weather. The results in bu. per acre are tabulated below:

Yield of oats per acre when planted at different dates. Lincoln, 1944.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Date planted</th>
<th>Feb. 9</th>
<th>March 1</th>
<th>April 1</th>
<th>April 13</th>
<th>May 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cedar</td>
<td></td>
<td>38</td>
<td>57</td>
<td>69</td>
<td>64</td>
<td>39</td>
</tr>
<tr>
<td>Trojan</td>
<td></td>
<td>26</td>
<td>41</td>
<td>49</td>
<td>39</td>
<td>32</td>
</tr>
<tr>
<td>Otoe</td>
<td></td>
<td>20</td>
<td>35</td>
<td>40</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>Kanota</td>
<td></td>
<td>*</td>
<td>34</td>
<td>38</td>
<td>30</td>
<td>0</td>
</tr>
</tbody>
</table>

* Not planted.

Maximum yields were obtained from planting April 1. The four varieties averaged 42, 49, 42, and 24 bu. per acre when planted March 1, April 1 April 13, and May 9, respectively. Planted April 1, Cedar yielded 29 bu. more than did Otoe and 31 bu. more than Kanota. The yield of Cedar oats for March 1 was 23 bu. higher than for the winter variety, Kanota. Even when planted on May 9, Cedar outyielded Otoe by 14 bu. per acre. Cedar is the new, superior-yielding variety that carries resistance to stem rust, crown rust, and smut. Such varieties have not been available until very recent years.

As an average for 3 years, Cedar oats yielded 74 bu. per acre when planted April 1 compared with 58 bu. for Otoe. Planted April 12 as an average for the 3 years, Cedar yielded 66 bu. and Otoe 52 bu. per acre. Otoe was considered the best variety for delayed planting in eastern Nebraska until such varieties as Cedar, Tama, and Boone became available.

Winter wheat.—The fly-safe date, as established each fall by the Department of Entomology, again proved the optimum time for planting winter wheat. This date in 1943 was September 26. Four varieties differing in susceptibility to the fly were planted on six dates ranging from September 15 to October 22. Moisture conditions in this locality were favorable for prompt germination at all dates. Nebred is a typically susceptible Turkey Red selection. Cheyenne is recognized as tolerant, being able to withstand infection better than does ordinary Turkey. Kawvale is fairly resistant in Nebraska but the milling characteristics of its grain are not satisfactory to the trade. Pawnee, originated from a cross between Kawvale and Tenmarq, carries fly resistance similar to that of Kawvale. The data are tabulated below:

Yield and Hession fly infestation of winter wheat planted at various dates, Lincoln, 1944.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Date of Planting in 1943</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sept. 15</td>
</tr>
</tbody>
</table>

YIELD OF GRAIN IN BUSHELS PER ACRE, 1944

<table>
<thead>
<tr>
<th>Variety</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebred</td>
<td>8.6</td>
<td>24.5</td>
<td>24.7</td>
<td>22.5</td>
<td>15.6</td>
<td>10.0</td>
</tr>
<tr>
<td>Cheyenne</td>
<td>13.7</td>
<td>23.1</td>
<td>21.7</td>
<td>21.9</td>
<td>12.3</td>
<td>6.7</td>
</tr>
<tr>
<td>Kawvale</td>
<td>26.6</td>
<td>28.7</td>
<td>28.2</td>
<td>26.9</td>
<td>18.4</td>
<td>13.4</td>
</tr>
<tr>
<td>Pawnee</td>
<td>32.7</td>
<td>32.1</td>
<td>28.1</td>
<td>26.9</td>
<td>20.1</td>
<td>12.5</td>
</tr>
</tbody>
</table>

PER CENT OF PLANTS INFESTED WITH FLY (FLAXSEED) DEC. 7, 1943

<table>
<thead>
<tr>
<th>Variety</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebred</td>
<td>74</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cheyenne</td>
<td>70</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kawvale</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pawnee</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
It is apparent from the data that planting susceptible varieties before the fly-safe date is very hazardous under conditions of fly prevalence. Under such conditions, the fly-safe date coincides approximately with the optimum date from the standpoint of plant development and yield. Further delay in planting progressively lowers the yield.

Pawnee proved outstanding at all dates compared with Nebred and Cheyenne for this section of the state, and especially when subject to fly infestation. Planted on September 15, 11 days before the official fly-safe date, Pawnee yielded 32.7 bu. compared with 8.6 bu. for Nebred. Planted one month later, the respective yields were 20.1 bu. and 15.6 bu.

The season of 1944 was not favorable for wheat that failed to germinate in the fall, but did germinate during a warm period in February and emerged early in March. Such early spring emergence corresponds closely with artificially vernalized wheat described elsewhere in this report. The summer growing conditions were adverse to the late crop and large acreages of such wheat on Nebraska farms yielded only 5 bu. or less per acre.

Is vernalized winter wheat practical in Nebraska?

Some years ago a seed treatment, known as "yarovization" was publicized by Russian agriculturists. Later it was renamed "vernalization" in Canada. The objective was to change the winter habit of the growing crop to the spring habit. Typical winter wheat planted in spring at the normal time of planting spring wheat and other spring small grains normally fails to joint and produce heads. This complete failure is overcome by vernalization. Much of the intended winter wheat acreage was not planted in the fall of 1943 because of dry soil conditions, and this again called attention to the question of whether the wheat acreage might be expanded profitably in the spring by use of vernalized winter wheat seed.

The vernalization in this experiment consisted of soaking Nebred seed wheat for 8 hours on February 8 in water containing an approved quantity of the disinfectant, mercuric chloride. After rinsing and draining the water, the seed was permitted to reach a mere germinated condition, with the sprouts attaining an average length of about 1/32 inch. The sprouted seed was then put in storage at 33°F. Beginning March 25, a portion of this vernalized seed was exposed to freezing temperatures ranging down to 15° F. for a period of one week. Both lots of vernalized seed remained in good sweet condition and made little additional growth. On April 1, an optimum spring grain planting date, both lots of seed were drilled in duplicate field test plots together with unvernalized Nebred winter wheat seed and a locally adapted spring wheat variety known as Kearney. Comparative plantings of unvernalized Nebred had been made on the normal fall date, October 1, and of both Nebred winter wheat and Kearney spring wheat on the late winter dates of February 8 and March 1. The resultant grain yields per acre were as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Date</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Nebred winter wheat</td>
<td>planted</td>
<td>24.7 bu.</td>
</tr>
<tr>
<td>(2) Nebred winter wheat</td>
<td>Oct. 1</td>
<td>6.8 bu.</td>
</tr>
<tr>
<td>(3) Nebred winter wheat</td>
<td>Mar. 1</td>
<td>5.0 bu.</td>
</tr>
<tr>
<td>(4) Nebred winter wheat</td>
<td>Apr. 1</td>
<td>0.0 bu.</td>
</tr>
<tr>
<td>(5) Vernalized Nebred wheat</td>
<td>Apr. 1</td>
<td>4.5 bu.</td>
</tr>
<tr>
<td>(6) Vernalized and frozen Nebred wheat</td>
<td>Apr. 1</td>
<td>4.2 bu.</td>
</tr>
<tr>
<td>(7) Kearney spring wheat</td>
<td>Feb. 8</td>
<td>6.0 bu.</td>
</tr>
<tr>
<td>(8) Kearney spring wheat</td>
<td>Mar. 1</td>
<td>7.9 bu.</td>
</tr>
<tr>
<td>(9) Kearney spring wheat</td>
<td>Apr. 1</td>
<td>10.6 bu.</td>
</tr>
</tbody>
</table>

These data confirm earlier experiments that vernalization has no practical application in Nebraska wheat production. Although such seed treatment does bring about the physiological change that enables winter
wheat to head and yield some grain when planted at the normal time for spring small grains, the yield is even less than from spring wheat. After the February 8 and March 1 plantings in this experiment, soil conditions remained favorable for early germination of the seed and provided a natural field vernalization of the winter wheat corresponding with that under controlled conditions. The data further show that freezing is not an essential factor in causing winter wheat to joint and head as is often asserted when the wheat fails to come up in the fall because of dry seedbeds.


Effect of simulated hail on corn yields

Hail damage to the growing corn crop occurred in many localities in 1944, and varied from little loss to complete failure. Since hail occurs annually in scattered areas, farmers and hail insurance adjusters are interested in any aids to the estimation of the yield effects from hail injuries. The immediate visible effects may be partial or complete defoliation, leaf and stalk breakage, and pounding of the stalk and ears. Difficulty of appraisal arises from not having unhailed corn for comparison under the same conditions. Bearing on this question, experiments have been completed in which, during 9 years, various injuries in imitation of hail have been artificially inflicted on corn plants at various stages of development. The results have been summarized for publication.

In general, grain yield reductions were found to be related to the degree of defoliation and to the stage of growth when defoliation occurs. The leaves are absolutely essential for growth as about 90% of the plant's substance is manufactured by them through photosynthesis. Complete loss of leaves at the time that the tassel first

One of the chief injuries inflicted on corn by hail is defoliation. By artificial simulation of hail injury the effect of defoliation and other injuries on the corn may be studied. Left: Untreated, yield 64 bu. per acre. Right: Leaves removed on Aug. 18 when grain was in the milk stage, yield 27 bu. per acre. Lincoln, Nebr. Photographed day after stripping, Aug. 19, 1943.
becomes visible, which is about a week before silking, proved to be the most critical time and almost invariably caused complete grain failure. As the time of defoliation is extended either earlier or later, the loss becomes less. Following the earlier dates, more upper leaves grow out and function normally. At later dates more of the plant's growth has been completed, and therefore the losses are reduced. The yield reduction is not proportional to the loss of leaf area. Removal of half of each leaf at the silking stage resulted in three-fourths of a grain crop compared with nine-tenths of a crop for loss of one-fourth of each leaf.

Miscellaneous leaf injuries such as breaking the midribs, crosscutting of the blades, and splitting of the leaves all detracted from the grain yield but did not exceed 20% loss. Shredding of all the leaves and mildly pounding the stalks and ears in close resemblance of rather severe hail without breaking the stalks or removing more than about 15% of the leaf area caused reductions between 5 and 40%, depending upon the stage of growth. The greater reduction was at the initial-tassel stage.


Sweetclover research

Investigations with sweetclover in 1944 were directed toward improvement of the crop by breeding, and to seed production problems. Favorable progress was made.

Better varieties.—Tests of sweetclover under field conditions continue to show the Madrid, Spanish, and Evergreen varieties superior to the commonly grown varieties in pasture and hay yields, rapid seedling growth, and ease of obtaining successful stands in competition with weeds or companion crop. The general use of these varieties is now dependent on the increase of seed supply. A special effort is being made to produce and distribute such seed. With this objective, 15 acres each of Spanish and Evergreen were sown by the Experiment Station in the fall of 1944 for harvest as a seed crop in 1945. The Madrid is already in small-scale farm production.

Breeding.—The main objectives of the sweetclover breeding program are improvement with respect to such characters as yield, lateness of maturity, fineness of stem, leafiness, palatability, coumarin content, and seed production.

Included in the 1944 nursery were several hundred second-generation plants from a cross between the Madrid variety and a late-maturing strain designated as Rasmussen Late Yellow. Seed was obtained from those segregates which appeared to possess the desirable combination of high yield from the Madrid parent and lateness from the Rasmussen parent. Seed of the new variety will be increased for further testing, especially in southern areas where the longer growing season will permit seed maturation before fall frosts set in. On the basis of its behavior in first and second generations, the late maturity character found in the Rasmussen strain is recessive and follows simple Mendelian inheritance.

Seed of a new fine-stemmed, very leafy synthetic variety was increased. Observational data indicate that the new variety will not yield as well as our common rank-growing types but the characters of leafiness and fineness of stem may make it of value for hay purposes. Enough seed is now available for thorough testing.

Improvement of palatability has received considerable attention in the breeding program. Such work has centered largely around the production of strains that are low or free from the bitter and toxic substance known as coumarin. In order to assay plants for coumarin content a new quantitative method of analysis based on the fluorescence principle was developed. This new method in addition to being
more rapid is simpler, less expensive, and more accurate than the colorimetric method formerly used. A comparison of results obtained with the colorimetric and the fluorometric method led to the discovery of an error in the former method. Certain varieties such as the Pioneer are rather low in free coumarin but high in “bound” coumarin. “Bound” coumarin does not contribute to the bitterness of the tissue but it may be related to the bleeding disease of cattle since it is readily released by hydrolysis. The colorimetric method as customarily performed failed to detect the “bound” coumarin in such varieties. The new method measures both free and bound coumarin. A modification of the fluorometric method permitted the rapid classification of large plant populations into high and low coumarin groups. Testing of some 18,000 plants by means of this “mass method” failed to uncover any plants which were free or nearly free of coumarin.

Reducing vegetative growth to facilitate seed harvest.—Tall, rank-growing sweetclover offers considerable difficulty in harvest. This disadvantage may be removed to a great extent by early pasturing or by clipping the sweetclover back with a mower in the spring of the second year. The effects of five clipping practices were tested with the three varieties, Madrid, Spanish, and Evergreen, with the following average results as to mature plant height and seed yield per acre. The harvests were made when 60% of the seed was estimated to be ripe, and all cuttings were 10 inches above the ground. The results: (1) No treatment, harvest height 49 inches, yield 10.3 bu. per acre. (2) Clipped once when 15 inches tall, height 38 in., yield 7.6 bu. (3) Clipped twice when 15 inches tall, height 28 in., yield 3.8 bu. (4) Clipped once when 24 to 30 inches tall, height 32 in., yield 4.1 bu. (5) Clipped once at initial bud stage, height 25 in., yield 2.7 bu.

These data indicate that clipping or pasturing to any extent in the spring of the second year will reduce the plant height materially, thereby facilitating harvest, but the yield is also greatly reduced thereby.

Maturity stage for seed harvest.—The seed of sweetclover does not mature uniformly at one time, but ripening extends over a period of two or more weeks. The seed crop is subject to loss by shattering when ripe. In 1944, the late variety Evergreen was harvested at three stages of maturity, using a grain binder that was not equipped with special devices for saving shattered seed. Harvesting August 18 when 30% of the seed was mature gave a yield of 7.3 bu. per acre compared with 5.3 bu. on August 22 when 60% mature, and 3.9 bu. on August 28 when 95% mature. The resultant seed germinated about equally for all harvests. It was determined that the losses that had occurred from seed shattering before the respective harvest dates amounted to 30 lbs., 49 lbs., and 77 lbs. per acre.

It is concluded that sweetclover should be harvested for seed when 30 to 60% of the seed is ripe, whether done with binders, mowers, headers, or self-rake reapers. At more mature stages the harvesting should be done while the atmospheric humidity is high, as very early in the morning.

Methods of harvesting seed.—Studies of harvesting methods made at Lincoln in 1944 included binding with grain and corn binders followed by threshing when cured; windrowing with grain binder followed by threshing when cured; and windrowing with a grain binder followed by a pickup-combine when cured. These plantings were harvested between 8:30 and 10:30 in the morning on different days during the period of July 18 to September 2. The average seed yield of Evergreen sweetclover was 5.50 bu. per acre when harvested with a corn binder as compared with 5.61 bu. when harvested with a grain binder, a difference of small significance. Windrowing with a grain binder and threshing gave
Winrowing the sweetclover seed crop with a grain binder. After curing 3 or 4 days under favorable drying conditions, the threshing is accomplished with a combine having a pick-up attachment. This mode of harvesting when 30 to 60% of the seed is ripe has proved very satisfactory.

an average yield of 5.38 bu. per acre. The yields indicate little difference ascribable to method of harvest, where none of the machines are equipped for the saving of shattered seed.

The availability of tractors and combines with pickup attachments has in recent years resulted in a very general use of these machines in harvesting and threshing sweetclover. The crop is windrowed with the grain binder, and after drying it is picked up and threshed with the combine. Prompt combining of the sweetclover as soon as dry is necessary to reduce the hazard of large seed-shattering losses that may result from high winds, hail, or rain. The ease of picking up and threshing is increased by leaving a high stubble in cutting with the grain binder, and using a combine with sufficient capacity to handle the large bulky crop.

A windrow made by a 7-ft. binder cutting 5-foot sweetclover proved too bulky for a 4-ft. pickup-combine. The difficulty was overcome and a splendid job of threshing was accomplished by putting a second tractor ahead of that operating the power take-off. With this arrangement, the combine was driven at higher speed while the slower travel of the head tractor pulling the outfit reduced the rapidity of combine intake.

Combining the standing crop ordinarily is not regarded as practical because serious shattering accompanies the advanced stages of maturity necessary for such harvest. The seed is also likely to contain much green material which requires spreading out to dry.

It was indicated in the 1944 experiments that yields obtained by harvesting with a grain binder, which is used most extensively for binding and for windrowing sweetclover, would have been materially higher if the machine had been equipped with pans and extensions to the rear elevator plate and binder deck to save shattered seed. The greatest amount of shattering was caused by the packers at the binding deck, and the second greatest seed loss occurred where the platform and elevator canvases meet. Between these points serious seed loss was not shown. The construction of a box or pan below each of the two points of greatest seed loss would have given an average saving of 24 lbs. to the acre, thus showing that the grain binder may be very profitably equipped as described.
Volunteer stands following seed harvest.—Volunteer stands of seedlings in late summer or fall, following a July or August harvest, sometimes give a vivid demonstration of the large amount of seed lost by shattering before and during the harvest of a seed crop. Counts made on October 25, 1944, in the stubble of plots of Evergreen that had been harvested at different dates and by various methods ranged from 53 to 178 volunteer plants to the square foot. The average numbers of volunteer plants per square foot in plots harvested on August 18, 22, and 28 were 77, 88, and 135, respectively, showing rapid increase with delay in time of harvest. Many ungerminated hard seed also were found in the soil in late fall. Such a volunteer crop may be expected to produce seed the following season.

The sweetclover research is cooperative with the Division of Forage Crops and Diseases, U. S. Department of Agriculture.


Improvement of alfalfa

The past season which produced Nebraska’s greatest corn crop was unfavorable for alfalfa seed production. Total production is estimated at 46% of that in 1943. For the entire United States the crop is 3% below the low supplies of the previous year. Seed supplies of alfalfa, as with most forage crops, have not been sufficient to meet increased demands during the past few years. The carry-over by seed dealers and farmers has been small. In this area, ideal seeding conditions in August and September increased the demand for alfalfa seed and further depleted the limited supply. In most cases good stands were obtained and with a normal winter, a high percentage of these fields should provide excellent meadows in 1945. Although this condition may reduce the number of plantings to be made next spring, the short seed supply will be insufficient to meet the demand.

Alfalfa of Argentine origin.—Since the seed crop is short over most of the country, large quantities of Argentine alfalfa seed are being imported into the United States to fill the expected demand, and recent restrictions on its sale in northern areas including Nebraska unfortunately have been removed. Seed from Argentine is considered by agronomists throughout the United States to be unadapted and its use a definite hazard, especially in those areas where winterhardiness is an important and necessary characteristic. For this reason, all lots of seed of this origin are stained 10% orange-red to permit easy identification and to indicate the danger involved in planting it.

In view of the current problem which Nebraska farmers are facing with regard to the purchase of Argentine alfalfa, it is believed worth while to present a brief summary of its performance in field plots at the Nebraska Agricultural Experiment Station. Three lots of Argentine seed were included in a field test planted in 1940, along with other varieties including Grimm as a check. As an average for the four years, 1941–1944, the three lots of Argentine produced, respectively, 96, 87, and 84% as much as Grimm. Stands in 1944 were only 70, 75, and 52%, respectively, of original stands while Grimm showed a stand survival of 100% over this same period. In variety plots at Lincoln over the period 1922–38, Argentine seed has an average productivity of 90% that of Grimm while Nebraska Common produced an average of 97%. Relative stand survivals averaged 89% for Nebraska Common and only 58% for seed of Argentine origin. Considerable variation has been found among
different lots of Argentine seed. All lack winterhardiness, some much more than others. Bacterial wilt (Corynebacterium insidiosum) has not been reported in Argentina, and, as one would expect, seed of that origin carries no resistance to this devastating disease.

Along with the risk of losing one’s entire stand in a severe winter, the use of Argentine seed will have a serious effect upon the alfalfa seed industry of Nebraska if harvested for seed or allowed to contaminate seed fields through cross-pollination by insects. Nebraska Common alfalfa has been found to possess considerable winterhardiness. Diluting this germ plasm with alfalfa from Argentina will reduce its hardiness and make Nebraska-grown seed less desirable for northern areas of the United States.

Faced with this situation, Nebraska farmers should purchase Nebraska- or northern-grown seed whenever it can be found, especially those farmers who often or even occasionally harvest a seed crop. Results at the Experiment Station show Argentine seed to be superior to the southern domestic seed and in the absence of severe winters Argentine seed may provide a farmer with satisfactory yields of forage for a few years. Planting this red-stained seed is extremely hazardous and in no event should meadows of this origin be held for seed or allowed to contaminate other seed fields at flowering time.

Seed production studies.—The present unfavorable seed situation tends to emphasize the importance of alfalfa improvement for increased seed production. Two phases of this problem are being currently pursued. Plant selections are being made with greater seed-production capacities as illustrated by the superior seed productivity of Ranger alfalfa. New selections promise to be even more productive than Ranger. In cooperation with the Department of Entomology, a study of beneficial insects is being conducted with the hope that methods may be found for increasing the number of these insects at flowering time and thereby remove one of the greatest seed-production hazards. This study continues to emphasize the importance of wild bees in pollinating alfalfa. Honey bees have been found effective in tripping the flowers only when they are gathering pollen. This is not done except in the absence of other sources of pollen, a condition which seldom exists in Nebraska. Several species of wild bees are efficient pollinators. It is believed that expansion of these cooperative insect studies holds much promise for the future.

Performance of Ranger alfalfa.—Ranger is proving superior to other varieties in those northern areas of the United States where bacterial wilt is a problem and stands are desired for more than three years. This synthetic variety developed at the Nebraska Station is a composite of five basic strains which together with Ranger have been widely tested throughout the United States. In an irrigated test seeded at Lincoln in 1943 and having 12 replications, the respective yields of (1) the unsynthesized composite of the five component strains of Ranger (Syn-0), (2) Ranger in its first seed generation after compositing (Syn-1), and (3) Ranger in its second seed generation (Syn-2), were 6.62, 6.43, and 6.59 tons of cured hay (12% moisture) per acre. The variation among these average yields is no greater than one would expect due to errors in random sampling. In this test where bacterial wilt was not a factor, Ranger averaged 92% of Grimm in forage productivity.

With the limited seed supply available, the use of Ranger is recommended for seed production areas and for forage production in those northern humid or irrigated regions where bacterial wilt is prevalent and where rotations involving three or more years of alfalfa are followed.
Hybrid alfalfa.—The improvement work dealing with the utilization of hybrid vigor in alfalfa is progressing. Superior clones have been isolated and are being widely tested in the United States and at one location in Canada. Further information is being accumulated on the basic principles, and improved techniques are being developed for testing combining ability and studying the behavior of clones differing in self-fertility. Present breeding methods are expected to isolate superior germ plasm which may be made commercially available either in hybrid combinations or synthetic varieties.

A severe infestation of potato leafhopper (*Empoasca fabae*) along with untimely and prolonged precipitation at harvest time seriously reduced the yields of seed for testing purposes. Although this condition will delay the evaluation of lines for general and specific combining ability and also other phases of the testing program, it did make possible the elimination of much susceptible material in the breeding and polycross nurseries.

Alfalfa research at the Nebraska Agricultural Experiment Station is conducted in cooperation with the Division of Forage Crops and Diseases, U. S. Department of Agriculture.


The bromegrass crop

Since the drouth of the “thirties” the acreage of perennial grass seeded down has been increasing rapidly in the general farming areas of Nebraska. The demand for such a crop was necessitated by the loss in acreage of pastures which failed to survive this unfavorable period. The loss of grass left the farms without this source of cheap roughage. In eastern Nebraska these damaged pastures have largely been replaced by fields of bromegrass (*Bromus inermis*). Among the grasses of which seed was available and of which stands could be obtained, bromegrass promised to be the one most likely to withstand a recurrence of the drouth hazard as evidenced by its survival in old fields. It was also the most promising grass for use in soil-conserving practices because of its sod-forming habit. Its relatively high palatability for livestock and its value as a cash seed crop have made it the choice of most eastern Nebraska farmers. The activities of State and Federal agencies in encouraging farmers to make plantings have had no small part in the development of the bromegrass crop to its present high place in the farm program.

Nebraska is now a leading state in bromegrass acreage and in bromegrass seed production. During the decade prior to 1940 the chief source of bromegrass seed was Canada and the Dakotas. The production of seed in the United States has now surpassed that of the Canadian provinces. The estimated production of seed in the United States for 1944 was 13,600,000 lbs. of clean seed from 74,300 acres. The estimated harvest of seed in Nebraska in 1944 was 6,300,000 lbs. from 30,000 acres, which amounts to 46% of the United States production from 40% of the acreage. The total acreage of bromegrass in Nebraska is now estimated at 373,000 acres for pasture, seed, and erosion control.
There are two general types of bromegrass in the United States. The differences between these two types were first noted in tests of farmers' seed obtained from different regional seed sources in the Great Plains. These tests were begun at the Experiment Station in 1939 and have been subsequently extended to other parts of the state. Bromegrass from northern sources has been shown to be of different type than the locally grown type coming from certain old fields in Nebraska and Kansas. The differences are greatest when the two types are compared on critical planting sites where stands are established with some difficulty and particularly in the region south of the Platte river in Nebraska and in Kansas. The characteristics of the locally adapted type of bromegrass are its seedling vigor and ease of establishment, its aggressive sod-forming habit of growth, and its high potential yields of forage and seed. These characteristics are in contrast to those of the northern type. Under local conditions the northern type, despite excellence of seed quality, is frequently lacking in seedling vigor. It is established with some difficulty under adverse conditions and the resulting open bunch-type sods are frequently low in forage production. In Nebraska this northern type is confined to good soil and moisture conditions and in the main to the northeastern part of the state. Fields of the more aggressive type are found throughout the region of adaptation of the grass in the state.

During the past four years the Nebraska station has promoted the increase of seed of the aggressive sod-forming type of bromegrass under the variety name of Lincoln. This variety originated from certain old fields whose records of performance have established them as the outstanding sources of this type of bromegrass. Only fields which can be traced to a satisfactory origin and which have met certain requirements as determined by plot tests were accepted as foundation seed. The oldest of these fields, dating to plantings during 1897 and 1898 appear to have been established from an original introduction of seed into the United States from Hungary in 1884, as distinguished from later introductions from Russia.

The production of Lincoln bromegrass seed in 1944 exceeded that of previous years. On the basis of field inspection 980 acres were approved for certification. Approximately 240,000 lbs. were certified by the Nebraska Crop Improvement Association for 45 growers. This amount of seed is 3.8% of the estimated total production in this state.

Harvest of Lincoln bromegrass seed with a combine. Yields of 300 pounds or more of seed per acre are common.
There is a great demand for the seed of Lincoln bromegrass both within and outside the state. Much of the certified seed was sold to farmers and seedsmen in states to the east of Nebraska. It is likely that this demand will continue for some time since the use of bromegrass in those regions is more likely to be for pasture than for seed production.

Although the present emphasis is on the production of bromegrass seed as a cash crop, the increasing acreage of the grass points to its most effective utilization as a pasture and soil-building crop in the rotation. The continued demand for the seed, however, will encourage the maintenance of the grass crop in a high state of productivity. This may best be accomplished by growing it with a legume such as alfalfa but may also be achieved by applications of nitrogen-bearing fertilizers. These practices will make the crop of more value for pasture and in the crop rotation. The necessity of maintaining vigorous stands in order to obtain satisfactory yields of seed should encourage its use in rotations, since the best seed production is usually obtained on the younger fields. Thus in a roundabout way the Nebraska farmer may come to practice a system of alternate husbandry similar to that practiced in systems of grassland farming in more humid regions. L. C. Newell and F. D. Keim.

The eradication of noxious weeds

Since the fall of 1942 the research work on the control and eradication of noxious weeds has been conducted on a tract of land in Denton precinct of Lancaster county, southwest of Lincoln. This research project is conducted jointly by the Department of Agronomy and the Department of Agricultural Engineering.

The purpose of the project is to determine by experimentation what methods of tillage and cropping as well as chemical control can be used.
most efficiently to eliminate such perennial weeds as bindweed, hoary cress, leafy spurge, Russian knapweed, and dogbane.

Continuous tillage at regular intervals is an important part of the eradication of perennial weeds. For this reason it is imperative that erosion control practices be integrated with the eradication methods. It is also the purpose of this project to determine experimentally what erosion control practices are most satisfactory in combination with weed eradication methods.

**Bindweed.**—Because bindweed is the most serious perennial weed in Nebraska, the main emphasis is placed on the study of methods for its control and eradication. Experiments are being conducted with nine different frequencies of cultivation, machines for cultivation, combined tillage and cropping to wheat, rye, oats, corn, and sorghum in various rotations; and contour tillage, subsurface tillage, terracing, and strip cropping for erosion control. Sodium chlorate, Atlacide, salt, borax, and sodium arsenite are chemicals being investigated.

At present the most satisfactory method for eradicating bindweed by cultural means and at the same time protecting the soil against erosion is the continuous crop and fallow method. This consists of subsurface tillage at 2-wk. intervals the first year followed by continuous wheat crops in succeeding years with subsurface tillage at 2-wk. intervals between harvest and seeding. The crop residue is left on the surface by subsurface tillage increasing the intake of moisture into the soil and reducing runoff, thereby reducing destructive erosion. This method has completed eradication of bindweed in five years with the loss of only one crop due to a full year of tillage.

Closely drilled sorghum cover crops have provided excellent competition as well as abundant forage in each of the two years in experiments near Lincoln. The stand of bindweed was reduced by 80% and 74% on duplicate plots seeded to one and one-half bushels per acre of Leoti sorgo in May of 1943. The average yield of forage was 4.09 tons per acre. Chinch bugs reduced the stand and consequently the effectiveness of sorghum cover crops in 1944; nevertheless few bindweed blossoms or seeds were produced in the sorghum plots.

Studies on corn culture in combination with the eradication of bindweed have been conducted by the Department of Agricultural Engineering. The procedure followed consists of listing corn in triple-spaced rows, subsoiling four to six inches below the listed furrow before planting, using disc-hillers to cover the bindweed growing in the row after the corn has emerged, and undercutting the bindweed between the rows with a field cultivator. The bindweed is undercut between the rows and covered in the rows at regular intervals throughout the growing season. (See the section on weed control in the Agricultural Engineering report.)

Sodium chlorate and Atlacide have proved about equal in effectiveness for eradicating bindweed when applied at the rate of four to five pounds per square rod in September and October. Crushed rock salt applied at the rate of one pound per square foot has proved satisfactory for non-agricultural lands. Borax is still being studied, but is not as yet recommended for weed eradication in Nebraska. Sodium arsenite applied at the rate of 2 to 3 gallons per square rod during the growing season has shown considerable promise for eradication of bindweed and annual weeds along railroad right-of-ways.
Hoary cress.—Because of change of ownership and tenancy of the infested area, the cultural experiments on hoary cress had to be closed before definite results could be obtained. Experiments with chemicals on hoary cress show that this weed is more tolerant to chemicals than bindweed. At least 6 lbs. of sodium chlorate per square rod are required for a satisfactory kill.

Leafy spurge.—Leafy spurge has been satisfactorily eradicated with either 4 lbs. of sodium chlorate or 15 to 20 lbs. of borax, applied in the fall.

Russian knapweed.—Good kills of Russian knapweed have resulted from fall applications of 4 lbs. per square rod of sodium chlorate. Borax treatments were effective in 1943, but did not effect satisfactory eradication in 1944.

Dogbane.—Several cultural experiments are being conducted on dogbane which include frequency of cultivation, frequency of mowing, continuous wheat and fallow, and perennial competitive crops of bromegrass and alfalfa. In one year continuous wheat and fallow reduced the stand of dogbane by 87%. Cultivation at 3- and 4-wk. intervals reduced the stand by 74%. Alfalfa as a competitive crop in one year reduced the stand of dogbane by 74% as well.

Satisfactory kills of dogbane resulted from applications of either 5 lbs. of sodium chlorate per square rod or 20 lbs. of borax per square rod when applied in the fall.


A new outstate crops testing program

Legislative Bill 284, enacted by the 1943 legislature, provided for the establishment and operation of experimental testing centers distributed throughout the state under the supervision and direction of the Department of Agronomy. The purpose of these testing centers is to “determine the effect that variation in soils, rainfall, temperature, growing season, altitude, and other factors have in the production of crops in all portions of the state.” It is the intent of this act that such experimental work shall be conducted in areas of the state which are known or believed to be enough different from existing experiment stations as to soil and climatic conditions to give different responses to various crops and cropping practices. This act, by intention, makes provision only for such experimental work as, because of the soil and climatic adaptation factor, cannot be conducted more efficiently at one of the experiment stations.

Location of outstate crops testing centers.—The plan of regionalized study was carried out in 1944 by the establishment of 15 testing centers. These are located on the farms of the cooperators listed below, and were selected as typical of the predominating soil type of the respective areas.
Written agreements were made with each cooperator which provided for compensation for the use of his land, labor, and equipment. In accordance with L.B. 284, these agreements are made on a yearly basis which permits considerable flexibility in the program.

The operation of the program is divided into two major phases, crop variety testing and soils studies. Crop variety tests, of which 40 were completed in 1944, were confined largely to the testing centers whereas soils studies were of necessity also conducted on several other farms. The work was carried out cooperatively by staff members of the Experiment Station and the Extension Service.

Outcome of the 1944 crop tests.—Since the detailed results of the first year's data are being published in an Experiment Station bulletin, only the outstanding determinations need be presented in this report. Since several years are commonly required to establish the validity of principles and practices relating to crop production, results of the first year's data are, of necessity, purely preliminary to conclusive later ones.

Corn.—The corn tests included privately controlled commercial hybrids, state certified commercial hybrids, and experimental hybrids not yet available commercially. The privately controlled hybrids were selected for entry by local county committees on the basis of popularity as reflected by use. In order to learn more about regional adaptation and type requirements, some of the state certified hybrids were included in districts where they obviously are not well adapted. It is apparent that in most districts of the state there is a rather large group of about equally good hybrids available to the grower. The experimental hybrids ranged from the top to the bottom in performance, but several indicated definite su-
The tests in western Nebraska suggest that much is left to be done in finding or developing hybrids that are unquestionably superior to open-pollinated corn on dry land in that area.

Small grains.—Recently released varieties and promising experimental strains of winter wheat, oats, spring barley, and winter barley were compared with standard varieties in various regional tests. Pawnee winter wheat and Cedar oats gave a splendid performance, ranking at or near the top in all tests across the state.

In view of the recent poor showing of barley compared with oats, the average yields of all varieties of these crops included in comparable tests are of interest: In Thayer county, oats yielded 38 bu. and barley 13 bu.; York county, oats 41 bu. and barley 12 bu.; Pawnee county, oats 44 bu. and barley 13 bu.; Custer county, oats 45 bu. and barley 20 bu.; and Cheyenne county, oats 25 bu. and barley 11 bu. Averaging all five tests, oats yielded 39 bu. and barley 14 bu. per acre. On the basis of 15% hull in barley and 30% in oats, these yields are, respectively, 874 lbs. hull-free oats and 571 lbs. hull-free barley per acre. Thus the hull-free yield of barley averaged 65% that of oats.

Of the commercially available varieties, Velvon yielded highest in the Southeast, Velvon and Ezon in the Central West, and Trebi and Tregal on dry land in the West. Under irrigation in Scotts Bluff County the new variety “Mars” gave a distinctly higher yield and tested much heavier than Trebi as well as being far more resistant to lodging. None of the winter barley varieties planted in Hayes County and Cheyenne County tests satisfactorily survived the winter.

Grain sorghum.—In nonirrigated tests in south central Nebraska the grain sorghum varieties averaged from 27 bu. to 58 bu. per acre with an average of 38 bu. The new variety, Martin, yielded 41 bu. compared with 38 bu. for Day and 33 bu. for Early Kalo. Plainsman yielded very well but appeared too late for the average season.

Other crops.—The new Lincoln soybean with a yield of 23 bu. was the highest yielding variety for east central Nebraska. The new variety of field bean, the “Scottsbluff Pinto,” proved superior to the common pinto. In a flax test in Pawnee County, four varieties averaged 12 bu. per acre under conditions where oats yielded 44 bu.

Soil studies.—Studies on the use of commercial fertilizers and moisture penetration during irrigation were done in cooperation with other soil projects. The results obtained were given earlier in the Soils Research section under the titles: “Fertilizers for corn, sugar beets, and oats,” “Methods for applying nitrogen fertilizers for irrigated corn,” and “Moisture penetration during irrigation.” In addition, a series of plots were established on the Tri-County demonstration farm near Holdrege to compare benefits derived from the application of barnyard manure and from the growing of alfalfa, sweetclover, and bromegrass in the cropping system.

Soil samples were removed from a field of buffalo grass sod that was being put under cultivation in the Tri-County Irrigation Project. Studies will be made on these samples and on others which will be taken periodically to determine changes in the soil brought about by cultivation and irrigation.

Crop yields frequently are limited by the amount of moisture available during the growing season. Stored moisture in the soil is an important factor in determining the crop to be grown, thickness of stand that is most desirable, and the use of fertilizers. It may also influence the variety of crop that should be selected. In all the fields where the various crop variety tests will be conducted in the coming years, soil moisture studies will be made at the time of planting. This information
together with rainfall data collected at each station will make it possible to ascertain the approximate amount of water available to the crops. At the time of planting the crops to be used in the variety tests and the fertilizer tests (the spring of 1944) all fields were found to contain moisture to the field carrying capacity of the soil to a depth of five feet or more.

G. T. Webster and J. W. Fitts.
"The Land of the Bright Red Nebraska Potato" might be the name applied to the potato-growing region of western Nebraska. Among its many other interests, the horticulture department maintains its studies of potato varieties, cultural practices, and the storage and shipment of potatoes. The proper conservation of foodstuffs after harvest is as economically important as the production of them.

Horticultural Crops
Department of Horticulture

Storage of Potatoes and Storage Structures

SEED potato storage and shipping temperature.—Of two carloads of seed potatoes, warmed for several weeks before shipping, one car was shipped warm (60°F. or higher), the other cold (40 to 50°F.). In the cases of two other carloads, stored cold, one was shipped warm, the other cold. These cars were shipped on December 10 to the Rio Grande Valley of Texas where they arrived on December 16. Sample bags from six definite positions in each car were held at the shipping temperatures from December 17 till they were removed for planting on January 10. Potatoes stored cold and shipped at temperatures just above freezing (the customary procedure) were the last to come up and yielded least. The potatoes stored and shipped warm produced a 75% stand of plants 15 days earlier and produced 38.3 bu. more per acre than those stored and shipped cold. Potatoes warmed up but shipped cold or stored cold and shipped warm and kept warm in Texas emerged about half way between the two previously mentioned lots and produced intermediate yields. Early emergence was very important in that region in 1944 since late blight killed vines early and yields were very low where potatoes were slow in starting.

Thermostatically controlled heaters and fans under the false floor proved excellent in maintaining high temperatures en route throughout an entire carload of potatoes in the cases of the two cars so equipped. By thoroughly preheating the cars and the potatoes, by wrapping paper completely around the pyramid load of potatoes, and by shipping them by the regular heater service of Carriers' Protective Service higher temperatures were maintained in another pair of cars dispatched to Alabama in January. The potatoes shipped warm produced plants more quickly and yielded sufficiently more in Alabama to warrant the adoption of this practice.

With small quantities of potatoes stored at different temperatures for definite periods of time, it was found that warming seed potatoes at any time during the storage period was useful in hastening early emergence of plants and in increasing early yields. Best results both as to plant growth and early yield were secured when potatoes were held for a short period at low temperatures before being warmed.

Types of storage structures for seed potatoes.—The studies with large (1200 bu. capacity) warehouse bins were continued.

To a bin which had been found to give superior results in 1942-43 because of a false floor with circulating air space beneath, additional vertical ventilation was added by inserting two flues in the center line. These flues, one located at the end of the first third of the distance from front to rear, the other at the end of the second third of that distance, conveyed air from the space under the false floor through the pile of potatoes into the cellar space above the potatoes. These vertical flues increased the efficiency of the false floor bins still further by facilitating the maintenance of more uniform temperatures throughout the entire pile of potatoes.
During most of the storage period, the average temperature in this bin was 5 to 7° lower than in the bin not equipped with a false floor. Moreover, the potatoes were held without sprouting more than a month later.

The "shell cooled" bin at Alliance equipped with a thermostat and fan functioned with great efficiency. It was possible to hold the temperature throughout most of the bin within a few degrees of uniform. Any desired temperature could be had. In spite of a serious error in the operation of this bin, potatoes were kept from early October of 1943 till May 31, 1944, with little or no serious sprout growth. When removed on May 31 the sprouts from 38,507 lbs. of potatoes put into the bin weighed only 453 lbs. or 1.3% of the original weight of the potatoes. For the 237 days of storage, the entire loss in weight, including that of the sprouts removed and the coating of soil, was only 4.4%. By the addition of a central ventilated partition and with slightly closer attention to management, it should be possible to hold such an entire bin of potatoes without undesirable sprout growth till mid-June and with a total shrinkage of 3% or less.

Deep earth-covered pit.—An attempt is being made to determine the feasibility of using the principle of a fireless cooker in reverse—that is to thoroughly cool the walls of a pit, then fill it with dormant potatoes and close it up and keep it closed as long as permissible. A comprehensive record of the temperatures of the potatoes in the pit and of the ground surrounding it for a distance of 3 to 6 feet in various directions was obtained weekly by means of 90 thermocouples. Results of this first attempt were sufficiently promising to warrant further testing. The possibility of a very practical storage method exists.

Modern storages built by the State Board of Control according to our recommendations functioned very satisfactorily. In these cellars potatoes kept well and with relatively little loss from early September to the middle of May.

Sugar changes at different storage temperatures.—Because the relatively large amount of sugar present in Triumph potatoes causes difficulties when they are dehydrated or are prepared for use otherwise, changes in the sugar content of potatoes stored at various temperatures has been investigated. With fall-grown Triumph potatoes placed at constant temperatures a few days after harvesting, a very rapid increase in sucrose occurred during the first two weeks of storage at 40 or 42.5°F. Thereafter the percentage of sucrose decreased slowly, but at the end of storage it was still greater than in potatoes stored at higher temperatures. At 45 or 47.5°F. the amount of sucrose did not increase to an appreciable extent and was not much greater than at 50° or higher. The sweetness in taste of the potatoes was in proportion to their sucrose content.

When present in large amounts, reducing sugar impairs the culinary quality of potatoes. Reducing sugar causes potatoes to take on a yellow or brownish color, since it carmelizes when subjected to the high temperatures used in frying in deep fat or in dehydrating.

Reducing sugar was found to increase rapidly at 40°F. (but not so rapidly as sucrose), attaining the maximum for the storage season in about 90 days, or at approximately that point where the rest period was complete. It decreased slowly for the remainder of the season. At each succeedingly higher temperature from 40 to 50°F. reducing sugar accumulated more slowly and less was found. At 60°F. the amount of reducing sugar remained practically constant throughout the storage life of the potatoes, whereas at 70°F. it diminished so rapidly that, after a few weeks, relatively little was found.

When potatoes were transferred from 50 to 40°F. the amount of reducing sugar increased very rapidly, that of sucrose more slowly. With each delay in the transfer to 40°F., the maximum amount of each type of sugar found was slightly less than for the previously transferred lot. In all potatoes placed at 40°F. before January, sufficient sucrose developed to give the potatoes a definitely sweet taste and sufficient reducing sugar to cause too much browning when fried in deep fat or possibly to inhibit development of mealiness when cooled. When potatoes were cooled in
January or later, these sugars did not accumulate in amounts sufficient to impair the culinary quality appreciably.

In tubers stored initially at 70°F. more sugars of both types accumulated after being moved to 40°F. than when stored initially at 50°F. As the season advanced, the difference due to these initial storage temperatures increased.

One month at 70°F. was generally sufficient to bring about the disappearance of most of the sugar that had accumulated. At 50°F. large amounts of previously accumulated sugar disappeared quite slowly.

In the summer of 1944 sugar determinations were made of a number of lots of freshly harvested Warba potatoes held at various temperatures and interchanged between 50 and 70°F. With these immature Warba potatoes, the reducing sugar content increased very rapidly at 40, 50, 60, and 90°F., increasing most at the lowest and least at the highest of these temperatures. At all these temperatures the percentage of reducing sugars decreased slowly after 3 weeks when the maximum was attained. Sucrose increased rapidly at 40°F. for 7 days, then decreased almost as rapidly. At 50 and 60°F. the increase in sucrose was slight and at 70°F. it was always practically constant. At 90°F. the amount of sucrose increased at a rapid rate for about 28 days when they contained twice as much as the highest amount found in the 40°F. tubers. Very low temperature impaired the culinary quality of these Red Warba potatoes, but it did not impair the taste whereas very high temperature (90°F.) caused them to be excessively sweet.


Robert Pahl, Box Butte Experiment Farm, the Nebraska Certified Potato Growers Cooperative, D. F. Fisher, A. L. Ryall, J. Lutz, all of Fruit and Vegetable Division, U. S. Department of Agriculture, Dr. Pickett, Experiment Station, Weslaco, Texas, Frank Garrett, Experiment Station, Fairhope, Alabama, Union Pacific and Burlington Railroads, P.F.E. and B.R.E. Refrigerator Car Companies, and the Refrigeration Research Foundation, Inc., cooperated in the studies. H. O. Werner.

Potato cultural experiments on dry land

Summer-fallowing methods with and without spring plowing before potatoes.—In 1943 plots fallowed by subsurface tillage (litter mulching) yielded no more No. 1 potatoes than where fallowing was accomplished by plowing and rod weeding, or by basin listing and cultivation. In that year fallowed plots that were plowed yielded only very slightly more No. 1 potatoes than those not plowed. In 1944 total yields in plowed plots were 156 bu. in contrast with 135 bu. per acre in unplowed plots. There was no difference in total yields following various methods of summer tillage where the land was plowed before planting. Where the land was not plowed yields were less after subsurface tillage than when summer tillage was done by plowing and rod weeding or by basin listing. The yield of US No. 1 Size A tubers was slightly less in the plowed than in the unplowed plots largely because of the greater amount of scabby tubers in the plowed plots. In the unplowed plots following basin listing the percentage of scabby tubers was much greater and the yield of US No. 1 Size A tubers was much less than following other methods of summer tillage.

Date of planting.—Because of a hailstorm that damaged plants of early plantings at a critical period, the June 20 planting of both Triumph and Kasota was more productive than the earlier plantings. The yield of U. S. No. 1 potatoes from July 6 plantings was equal to that of the June 22 planting because of the superior quality of the former. Both these plantings were much more productive than the earlier ones.

Date of harvesting.—Replicated plots of Triumph and Kasota potatoes were harvested for the ninth year at semimonthly intervals. As in most
former years, tuber weight increased more during the last two weeks of August than during any other period. Contrary to common opinion the increase in the crop of potato tubers was much less during the first two weeks of October than during any other 2-wk. period.

Value of potatoes harvested or planted on different dates for seed purposes in the South.—When planted in early January in south Texas, the most mature potatoes, whether mature because of late harvesting or early planting on dry land, produced the most potatoes.

Robert Pahl and Kerwin Jantz assisted in the experiments.

H. O. Werner.

Crop rotations on dry land near Alliance

In this long-time rotation project the best yields of potatoes were again produced in plots that had been summer fallowed. In most of the plots where potatoes followed corn, very definite symptoms of nitrogen shortage were apparent in late August and early September. Probably this was responsible for the potato yields generally having been lower after corn than after small grain. In 3-yr. rotations yields of potatoes after beans were generally greater than after either small grain or corn.

Yields of wheat were greatly influenced by previous cropping. Yields were greatest after fallow; next greatest after corn; and least after small grain. Barley was damaged too severely by hail for yields to have any comparative significance. Yields of corn were very poor because of very poor stands—this in spite of three plantings.


Potato breeding

The search for lines of potatoes with bright red skin color continues. Several lines that can be used as pollen parents in crosses to produce numerous lines with bright red skin tubers of desirable characteristics have been acquired. Several high-yielding medium-to-early lines producing red tubers are being increased for commercial testing. One of these appears to possess some scab resistance. Two early white tuber selections are being increased as rapidly as possible for commercial testing. The variety Kasota, introduced in 1943, produces considerably more U. S. No. 1 potatoes than the Triumph variety and continues to show resistance to fusarium. Because of this resistance it may be planted earlier than the Triumph variety.

Each year in conducting this project parent plants are grown in the greenhouse during the winter, using 24 hour photoperiods so as to induce abundant blooming, and make 200 to 300 crosses. In the greenhouse each fall and in the early winter we raise about 12,000 potato plants from the seed produced the previous winter. At the Scotts Bluff Substation we plant 12,000 or more seedling tubers and from them select the tubers from about 300 of the plants that appear most desirable. At Alliance (dry land) and Scotts Bluff (irrigation) we raise 10 plants from each of about 500 previously selected lines and 50 plants from about 30 to 40 of the lines selected for advance testing. Indexed seed tubers from the 10 or 12 best lines are increased in large dry-land plots and these lines are included in yield tests conducted at several places for comparison with 5 or more established varieties. The cooking quality of all lines and varieties in these yield tests is determined by means of specific gravity determinations and cooking tests.

This project was conducted in cooperation with J. H. Jensen, Plant

H. O. Werner.
Vitamin C content of vegetables

All vegetables used in this experiment were produced under the desired conditions by Horticulture; all analyses are made by Home Economics.

Potatoes.—A comprehensive study was made of most of the major factors that might alter the ascorbic acid (vitamin C) content of potatoes as grown and stored in Nebraska. The major conclusions that appear to be established by this work are the following:

Variety: Differences in ascorbic acid content to the extent of 30% were found to persist consistently among tubers of different varieties. Among 5 varieties the values were the highest with the Kasota; next highest with Triumph and Warba; and lowest with Irish Cobbler.

Age of plants: Ascorbic acid content is high in the first tubers produced by plants stilling growing; it increases slightly to a maximum (generally 38 to 50 milligrams ascorbic acid per 100 grams fresh potato) when plants have attained their maximum vegetative growth and then diminishes slowly to 30 or 20 mgs. when the tops are dead.

Age of tubers, or loss in storage: Under typical storage conditions ascorbic acid was lost at varying rates during the storage period. To determine the loss, the amount retained was calculated using the amount found in western Nebraska potatoes when storage began on October 10 as 100%. The results are as follows:

<table>
<thead>
<tr>
<th>Duration of storage</th>
<th>Removal date</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>November 10</td>
<td>85</td>
</tr>
<tr>
<td>2 months</td>
<td>December 10</td>
<td>65</td>
</tr>
<tr>
<td>3 months</td>
<td>January 10</td>
<td>55</td>
</tr>
<tr>
<td>4 months</td>
<td>February 10</td>
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<td>35</td>
</tr>
<tr>
<td>6 months</td>
<td>April 10</td>
<td>30</td>
</tr>
<tr>
<td>7 months</td>
<td>May 10</td>
<td>25</td>
</tr>
</tbody>
</table>

Cultural conditions: In western Nebraska the ascorbic acid content was considerably higher in dry land than in irrigated potatoes. In eastern Nebraska it was higher in straw-mulched than in potatoes grown without a straw mulch. These differences were between 20 and 30%.

Storage temperature: When potatoes were stored at constant temperatures ranging from 40 to 85°F., they appeared to lose ascorbic acid at the same rate throughout the first 15 or 20 days. After that time tubers stored at 40°F. lost ascorbic acid very rapidly, but at successively higher temperatures ascorbic acid was retained more successfully so that maximum retention occurred at 60 to 70°F. At low temperatures losses were exceedingly rapid during the first two months. Tubers stored at 45° and higher did not suffer this rapid initial loss and retained as much ascorbic acid till March as 40°F. tubers retained only to early November. Storing tubers at 50° till sprouting began in December and then storing at 40° to maintain dormancy resulted in much more retention of ascorbic acid than when tubers were stored constantly at 40° F. Dehydro-ascorbic acid—which is considered to be equal in physiological value to the reduced ascorbic acid—has been found to occur in our analysis at the average rate of 4 to 7 mgs. per 100 gms. of fresh potatoes. The amount of dehydro-ascorbic acid has not been found to decrease during the storage period. Therefore old potatoes in the spring of the year still constitute a relatively good source of ascorbic acid even though the amount of reduced ascorbic acid may then be relatively low. Much attention has been given to this dehydro-ascorbic aspect in the analysis of the 1944–1945 potatoes.
The most practical application of this work is this: potatoes not to be kept beyond midwinter should not be stored at temperatures below 50°F. Potatoes that must be stored for a long time should be held at a temperature close to 50°F during the first 6 or 8 weeks, after which it should be reduced to 40° to maintain dormancy.

**Tomatoes.**—Great differences in the ascorbic acid content of various individual fruits were observed. This variation appeared to be due to variety, size of fruit, stage of growth of plants, exposure of fruits to sunshine, place where grown, weather conditions, and season. Our results indicate that extensive sampling and careful consideration of all factors are necessary to determine such an apparently simple fact as the difference in the ascorbic content of fruits from two different varieties.

The new variety Sioux consistently produced fruits with relatively high ascorbic acid content. High ascorbic acid content appeared to be associated with small fruit size, exposure of fruit to sunshine and possibly with vegetative maturity of the plant or moderate temperature and bright light. Fruit produced in 1944 had higher ascorbic acid content than that produced at the same place in 1943. Tomatoes produced in different localities frequently have very different ascorbic acid content, but we have not determined what factors in these localities are responsible for the differences. Tomatoes produced at Lincoln and Scottsbluff have relatively high ascorbic acid values when compared with those produced in other parts of the country. Mean values for large samples of ripe fruit from these places ranged from 20 to 30 mgs. ascorbic acid per 100 grams of fresh fruit with most samples averaging 24 to 27 mgs.

Extensive work has been done on the losses of ascorbic acid during the canning process. Tomatoes have been canned by open kettle, hot pack and cold pack; cooked in small amounts and in large amounts; and canned in pints and in quarts. The amount of ascorbic acid per 100 grams of canned product was not greatly influenced by the method of canning or the amount canned at one time. There was more difference, however, in the amount of ascorbic acid if calculated on the basis of the original raw weight. The most significant finding was the difference in loss of ascorbic acid depending on whether the tomatoes were blanched for one-half minute or one minute. The average loss when the fruit was blanched one-half minute was 16% whereas the loss amounted to 24% if the fruit was blanched one minute.

*Ruth Leverton, Home Economics, and H. O. Werner, Horticulture.*

**Tomato breeding**

Two varieties—Sioux and Red Cloud—were named and introduced prior to the 1944 tomato growing season. Preliminary reports indicate that the Sioux variety has been found meritorious in widely separated parts of the country. The Red Cloud, a determinate variety requiring rather specific cultural conditions, constant adequate moisture and high fertility, has been received very enthusiastically by those who have grown it under the proper conditions but has been disappointing when the importance of these conditions has not been properly recognized. The Sioux tomatoes have relatively high vitamin C (ascorbic acid) content.

Additional segregates are being observed critically with a view to possible introduction.
Yield tests and observational plantings were made at Lincoln (irrigated and dry land), North Platte and Scottsbluff.


**Vegetable crops**

**Sweet potatoes.**—In most seasons more pounds of sweet potatoes than of Irish potatoes can be produced on a given area of garden. In 1944, under irrigation, 5 out of 8 varieties of sweet potatoes tested produced between 15,700 and 21,300 lbs., No. 1 grade. On a fresh weight basis those yields are equivalent to 262 to 355 bu. of No. 1 grade Irish potatoes. Since the dry matter content is about one fourth greater, in sweet potatoes, their food value exceeds that of the Irish potatoes still further.

The lowest yield of No. 1 grade sweet potatoes was 11,514 lbs. per acre. As most of the potatoes produced were suitable either for human food or for livestock, the total yields of 20,000 lbs. per acre are of great interest. Estimating their dry matter at the relatively low value of 25%, this would represent a yield of 5001 to 8142 lbs. per acre in terms of dry matter, or a quantity of dry matter equivalent to that of more than 100 bu. per acre of shelled corn of 15% moisture content. These sweet potatoes received only two moderate irrigations. The most productive varieties were Maryland Golden, Red Bermuda, and Porto Rico. Two new varieties North Carolina No. 1 and Florida White produced very good yields and a very good quality of tubers.

Ridged sweet potatoes produced about one-fifth more of No. 1 quality roots than non-ridged.

**Asparagus.**—Again in 1944—a very favorable season for asparagus production—no differences in yield occurred as a result of manure application, irrigation or duration of cutting period. Apparently the asparagus plantation at Lincoln is growing under conditions where none of those factors has become a limiting one.

**Peas.**—Variety trials with 47 varieties were again carried on at Lincoln.

H. O. Werner.

**Fruit culture and improvement**

**A study of the use and value of supplemental water for orchards in eastern Nebraska.**—Soil samples taken in 1944 in the leveled area indicate that although the closely spaced trees in the orchard under study are in just their second growing season, they are now beginning to draw upon the subsoil reserve moisture. Regular checking of this moisture situation will be continued.

Irrigation water was applied to nearly all parts of the older orchard in order to supply fully the water requirement of the trees. Where specific comparison was possible between irrigated and nonirrigated trees, the watered trees always presented foliage of much better appearance and correspondingly longer twig length.

Rainfall for the 1944 season totals considerably more than the average for the past several years, having reached a level of more than 31 inches by December 1. Precipitation in the early part of the growing season averaged over 5 inches per month, and no month during the year could be called exceptionally dry. As a result of this moisture supply trees in general made a good growth during the 1944 season and matured a crop of good-sized, well-finished fruit on trees which had an adequate bloom.

E. E. Brackett cooperated in the engineering phases of the study.

C. C. Wiggans.

**Orchard culture**

Careful observation and comparison of the appearance of the surviving
plants still indicates that cultivation is preferable to straw mulch as a system of soil treatment in a vineyard. The superiority of cultivation seems a justifiable conclusion in spite of the fact that the mulched area still maintains a considerably larger amount of reserve moisture in the upper thirty feet of soil.

Yields for 1944 were so poor, because of bud loss from unduly low temperatures in February following an unusually mild January, that no data were taken.  

C. C. Wiggans.

Orchard spraying

No special spray programs were necessary in 1944. A rather late cool season kept the codling moth infestation in the Union orchard at a comparatively low level. Necessary materials for a “Stop Drop” spray were at hand but cool weather at harvest time kept the drop at a minimum and no extra spray was required.  

C. C. Wiggans and E. H. Hoppert.

Pruning tree fruits, small fruits and grapes

Because of a lack of suitable experimental material this project remained inactive again in 1944. New cherry plantings contemplated for the spring of 1945 should supply plants for later use.  

C. C. Wiggans.

Fruit breeding

The selfed Latham raspberry seed produced in 1943 were stratified and held at a favorable temperature until February 1944. When placed in the germination chamber, they grew satisfactorily and numerous seedlings were produced. These were transplanted into four-inch pots and held in the greenhouse. When planted in the field later, however, there was no survival and hence all experimental material was lost.

With additional help available for the coming season, the revival of work on this project is contemplated.

New cherry plantings planned for 1945 will involve a number of strains of the Montmorency which will be used for observation and comparison.  

C. C. Wiggans.

Fruit stocks investigation

Top-budding in the Lincoln orchard continued in 1944. A great majority of the Virginia Crab trees are now very nearly completely top-worked. A few of the Hibernal had sufficient growth to permit the beginning of the budding work. Difficulty was encountered early in the season in getting buds mature enough for use. Many of the Virginia Crab twigs worked early had considerable restriction develop from the use of the rubber budding strips. Budding strips made of synthetic rubber did not serve too satisfactorily.

Growth on the Hibernal and Virginia Crab trees at Union in 1944 was good and these trees will be ready for top-budding next summer.  

C. C. Wiggans.

Water relations of the potato plant

During the year Mr. Joseph Frankford initiated some studies to determine the differences of varieties in the rate of water usage or transpiration. Much time was devoted to a development of methods. Preliminary results indicate that varieties absorb and transpire water differently and because of that differ in their ability to survive periods of stress.

With the arrival of Dr. R. H. Moore on December 1, plans are being made to revise this project and to initiate basic studies on the metabolism and water economy of the potato.  

H. O. Werner.
Plant pathologists seek to understand the organisms that cause plant diseases, environmental conditions favorable to their increase and spread, and then by the development of control measures to prevent the costly production losses caused by charcoal rot, scab, bacterial spot, fusarium wilt and other pernicious plant diseases. The conquest of a single disease can save to the state and its farming citizens many thousands of dollars.

Plant Diseases

Department of Plant Pathology

Bean Diseases

Breeding for resistance to halo and common blight.—The program of bean improvement through breeding, a general outline of which has been presented in previous annual reports, was continued. A number of crosses were made between various well-known but susceptible garden varieties and four halo-resistant varieties. Selections from crosses made in previous years were exposed to infection in artificially produced epidemics in both field and greenhouse, thus permitting the elimination of susceptible individuals.


Sprays and dusts for control of halo blight.—A field test designed to compare the efficacy of Bordeaux spray, copper-lime dust, and copper-lime-sulphur dust in the control of halo blight on Giant Stringless Green Pod beans was conducted at the station in Lincoln. Each treatment was applied to 3-row quadruplicate plots. Each plot was surrounded with a row of seed-inoculated Red Kidney plants from which halo blight spread naturally. Seven applications of sprays and dusts were made, starting about two weeks after planting and continued at approximately weekly intervals thereafter. Under conditions of epidemic halo blight infection Bordeaux spray treatments resulted in significantly fewer plants showing halo blight systemic infection. Plots sprayed with Bordeaux also produced significantly larger plants and greater yields of pods. This test was conducted jointly by the Departments of Entomology and Plant Pathology with the intent of developing a combined treatment for the control of bean insects and diseases.

Field bean tests.—Four yield tests, two of which were in cooperation with the Outstate Crops and Soils Testing Program and one each with the North Platte Substation and the Scotts Bluff Substation, were conducted with dry bean varieties. Comparison tests were conducted with an unnamed white field bean selection, Great Northern U. I. 15 and U. I. 59, and between Scottsbluff Pinto and common Pinto. Great Northern U. I. 15, too late in maturing in western Nebraska, gave fair yields in central Nebraska, where it was planted about June 1. Great Northern U. I. 59 gave best yields in western Nebraska of all beans tested. Scottsbluff Pinto outyielded or equaled common Pinto in all tests for the past season.
In a replicated field test 14 seed lots of Pinto beans obtained from various localities in western United States were compared. Only four lots of the 1944 plantings were early enough under western Nebraska conditions to mature satisfactorily under irrigation. These were Scottsbluff Pinto, common Pinto, and two Pinto lots from Utah-grown seed. Lots too late to mature satisfactorily included a number of New Mexico selections, Akron selection No. 27, and several seed lots from southwestern Colorado.

The Scottsbluff Pinto Bean.—A new Pinto field bean variety, from a Great Northern x Common Pinto cross, has been released to the Nebraska Crop Improvement Association for further increase and seed distribution. Although this variety possesses no notable disease resistance, its earliness, vigor, yield, and quality are believed to be of sufficient superiority to commend it to Nebraska growers.


Cereal diseases

Charcoal rot of corn and sorghum.—The main phases of the study of the effect of environmental conditions on the development of charcoal stalk rot have been completed, and the results are being submitted for publication as a Nebraska research bulletin. In determining the experimental conditions necessary for a high percentage of infection in susceptible varieties it was found that in addition to the effect of soil temperature and soil moisture previously reported, the development of seedling blight of sorghum was very low in nonsterile soil but high in soil steam sterilized before inoculation. The effect on stalk rot was not so great although the percentage of rot was highest in the steam-sterilized soil.

Lodging of sorghum caused by the charcoal rot organism.
Considerable variation was observed in the susceptibility of sorghum varieties to charcoal rot in greenhouse tests; however, no varieties showed any outstanding resistance.

**Seed treatments.**—The sorghum seed treatment tests conducted during 1942 and 1943 were continued, with results similar to those reported in 1943. Some stand improvement was effected when Sharon kafir seed was treated and planted on May 26 at Lincoln. In this series of tests the most significant stand increases were secured in 1942 with Early Kalo planted on May 15 and Sharon kafir planted on June 3. In the two succeeding years only slight stand increases have been obtained, thus pointing to the conclusion that the primary value of sorghum seed treatments is to control kernel smut; in years when conditions are not optimum for seed germination, there will also be an improvement in stands. The two most commonly used cereal seed disinfectants satisfactorily controlled smut. This work has been carried on in cooperation with the U. S. Department of Agriculture, and the results are being prepared for publication.

Soybean seed treatment tests were conducted in 1943 and 1944. Some increases in stand resulted from the seed treatments during both years; however, there were no increases in yield.

**Outstate Crop and Soils Tests.**—Stalk and ear rot records were taken in Nemaha, Pawnee, Washington, and York counties on 37 commercial hybrids and 30 hybrids developed by the Nebraska Agricultural Experiment Station. Five hybrids showed some resistance to stalk rot. An average decrease of 13.0% in weight of ears from rotted stalks in comparison to ears from healthy stalks was recorded. Variations from this average decrease by county ran from 18.9% in Washington County to 2.6% in Nemaha County. Differences in the susceptibility of the various hybrids to ear-rotting fungi were also noted. Field surveys indicated about an 11% total loss to Nebraska farmers because of stalk and ear rots of corn.

**J. E. Livingston.**

**Potato diseases**

A disease which caused severe losses in 1943 was again present although in lesser incidence than in 1944. This disease was found to be associated with high soil moistures, particularly where those were present late in the season. The disease results in a wilt and tuber rot similar to the symptoms described for "pink-rot." The tuber rot occurs in the field following a wilt of the plant and starts at the stolon end of the tuber instead of centering around wounds. A pythiaceous fungus was isolated, which, when added in a water suspension to soil in which potato plants were growing, infected roots, stems, stolons, and tubers. Some tubers were completely rotted when dug; others had symptoms at the stem end, ascribable to infection from the stolon. Infection resulting from soil inoculation was greater at 22° than at 30°C. and with high rather than low soil moisture. Isolates tested by wound inoculation of tubers produced a rapid rot at 20° to 30°C. The maximum development of the rot was at 25°, whereas only a slight amount of rotting occurred at 5° to 10° and at 35°C.

**Fusarium wilt and scab.**—Field tests of selected seedlings for resistance to these diseases were continued at the Scottsbluff Substation. Of the 77 seedling lines tested 25 had less than one-half as many tubers infected.
as Bliss Triumph and 12 of these seedling lines were promising enough to warrant further testing. Nineteen of the seedlings were resistant to scab and 5 of these were of promising types. Three of these showed some resistance to both scab and fusarium.


**Tomato diseases**

Favored by frequent rains, Septoria leaf spot, a defoliating disease of tomato, caused widespread concern in home gardens. The effect of partial defoliation is much exaggerated on the new varieties of determinate growth habits because of their inability to replace the lost leaf surface through continued terminal growth.

Bacterial spot continued to be the most damaging disease in commercial canning fields. A survey of fields in canning areas indicated that the disease had been introduced on transplants, further demonstrating the need of disease-free plants. To test the effect of a standard fungicide on bacterial spot, five thorough applications of a fixed copper dust were made at 10-day intervals to alternate blocs in a 4-acre tomato field at Nebraska City. Bacterial spot, the only disease of consequence present in this field, was well established at the time of the first application and subsequently developed in epidemic proportions. As is usual in this area, foliage and fruit cluster infection was a conspicuous phase of the disease. When harvesting began in early September, a striking difference in favor of the dusted blocs, both in plant appearance and amount of clean fruit was observed. The results warrant further tests, using a number of disease-control materials.

Frequently varieties growing side by side display marked differences in amount of bacterial spot infection. That some varieties escape serious infection may be due to variations in maturity and fruit setting during natural infection periods. Thirteen varieties and 16 selections were planted in randomized and replicated blocs of 4 plants each. After the varieties had reached fruit-setting stage, all fruits over ¼ inch in size were stripped from the plants, which were then inoculated. Two additional inoculations were made at 2-day intervals. Under these circumstances when all varieties had fruit of comparable age no outstanding differences in either number or type of fruit lesions were found.

An understanding of the causes for variation in symptoms is essential, particularly when material is being tested for possible disease resistance. Controlled inoculations in greenhouse experiments demonstrated that a wide range in number and types of lesions result from variations in the causal organisms, differences in age of tissue, and differences in temperature. These factors must be considered in any varietal trial where bacterial spot resistance is measured.

M. W. Felton.
The application of chemistry to the complex problems of crop and animal production continues profitable. The effect of insect damage on the nutritive value of certain forage crops; digestive inhibitors present in certain plants; amylase investigations pertinent to the production of industrial alcohol—these are some of the current interests of the agricultural chemists. Their contributions to the farmer and to industry continue in usefulness and value.

Chemical Studies With Plant Materials
Department of Agricultural Chemistry

Effect of Leafhopper Damage Upon the Carotene Content of Alfalfa

THE yellowing of growing alfalfa because of damage by the potato leafhopper is a serious problem. In view of the fact that alfalfa, both as hay and as an ingredient of mixed feed, is an important source of vitamin A in the form of carotene, research was undertaken in cooperation with Dr. H. M. Tysdal of the U.S.D.A., Division of Forage Crops and Diseases, to determine the effect of leafhopper damage upon the carotene content of alfalfa plants. Comparisons were also made of the carotene content, under equal hopper-damage conditions, of several alfalfa strains and hybrids which had been developed for resistance to damage by leafhoppers. Samples were taken first from plantings of alfalfa suffering from leafhopper damage and again later from the regrowth, at harvesting stage, of the same plantings. The regrowth suffered no hopper damage. The carotene and moisture content of both stems and leaves, together with the per cent of leaves in the total weight of the plants, were determined immediately after cutting. Large differences in carotene content were found between the damaged and undamaged plants.

Factors which influenced the carotene content of the plants when damaged by leafhoppers were found to be:

(a) Leafhopper-damaged plants were stunted and so were more mature when cut. There was a large decrease in carotene content in the plants as they progressed from the green, fresh stage to the more mature, woody one.

(b) In hopper-damaged plants, the ratio of leaves to stems decreased because of the action of the hoppers. An average of 77% of the total carotene of the plants was found to be concentrated in the leaves—therefore any factor which damaged or destroyed the leaves greatly lowered the level of carotene in the whole plant.

In comparing the effect of leafhopper damage upon the carotene content of several alfalfa strains and hybrids it was found that:

(a) Under similar conditions, strains resistant to leafhopper damage were higher in carotene than those which yellowed badly.

(b) Strains or hybrids having a high percentage of leaves were higher in carotene content.

(c) Strains and hybrids differed inherently in their carotene content.

The results of this research are in final manuscript form as a journal article “The carotene content of alfalfa strains and hybrids differing in
resistance to leafhopper attacks" by W. E. Ham and H. M. Tysdal and will be submitted shortly for publication.

This work has been carried out in cooperation with H. M. Tysdal and Bliss M. Crandall of the U.S.D.A., Division of Forage Crops and Diseases.

Wendell Ham and R. M. Sandstedt.

**Further studies upon the protein-digestion inhibiting substance from raw soybeans**

In the 57th Annual Report a substance found in the dilute acid extracts from raw soybeans which inhibited the digestion of protein by trypsin was described. Further studies were carried out during the year upon this proteolytic inhibitor, principally in efforts to prepare the substance in a more purified form. A large amount of the soluble protein in the extracts was removed without appreciable loss of inhibitor by shaking with kaolin followed by centrifuging and filtering. The inhibiting substance in these deproteinized extracts could be further separated from extraneous protein by precipitation with cold acetone or alcohol. These precipitates contained the inhibitor which could, however, be removed by extraction with water. This final extract was relatively free of extraneous protein but contained some soluble carbohydrate. Efforts to crystallize the proteolytic inhibiting substance in pure form have so far been unsuccessful.

At present, research is being conducted also by Major I. A. Mirsky, M.C., A.A.F., to find possible applications of the proteolytic inhibitor in certain fields of medicine. Major Mirsky is working with materials and extracts supplied by this department.

Further work is being carried out in an effort to determine the nutritional significance of this digestion-inhibiting factor.

A report of this research was made in a journal article "A proteolytic inhibiting substance found in the extract of unheated soybean meal" by Wendell E. Ham and R. M. Sandstedt, published in Jour. Biol. Chem. 154, 505 (1944).

Wendell E. Ham and R. M. Sandstedt.

**Cereal amylases**

Three publications have been released dealing with the subject of cereal amylases:


This work outlines the amylase make-up of seven cereals—barley, wheat, rye, oats, maize, sorghum, and rice, in both the ungerminated and germinated (malted) states. Wheat, barley, and rye were found to be similar, in having abundant beta-amylase in the ungerminated grain and abundant alpha- and beta-amylase when germinated. The other grains were low in beta-amylase and produced malts having a predominance of the alpha-amylase component. Thus it becomes possible to select from the cereals, germinated and ungerminated, individual samples containing almost any desired ratio of the two amylase components.

In "Sorghum amylase" by Eric Kneen in Cereal Chem. (in press), a complete discussion of the properties and mode of action of the starch degrading enzymes of sorghum malt is presented.

The system includes an alpha-amylase of comparable properties to that of barley malt, together with small amounts of a beta-amylase. The presence of a third enzyme, important in the splitting of dextrins to fermentable sugars, was indicated by the results. New methods of amylase evaluation were outlined and industrial applications discussed.
Enzymes from bacteria and fungi

An extensive survey of bacterial isolates for amylase-, proteinase-, and lipase-producing capabilities has been conducted and the results are being prepared for publication. This survey has provided a number of isolates that appear very promising for further investigation.

Microbial amylases.—The starch degrading enzyme systems of bacterial and fungal preparations have been investigated in detail. Those systems resulting from bacterial growth may be divided, depending on the type of organism, into two groups. One is a starch liquefying, dextrinizing, and saccharifying system similar in many respects to the fungal type. The action of the other is confined primarily to liquefaction and dextrinization; potential starch saccharification is at a minimum. The saccharifying type is sensitive to the amylase inhibitor present in wheat; the nonsaccharifying is not. Both systems are capable of degrading starch at relatively high temperatures.

The enzyme system of both the fungal and the saccharifying bacterial preparations is unique in respect to composition. Instead of having the mixture of alpha- and beta-amylase typical of cereal malts, it apparently is composed of an alpha-amylase and a dextrin-splitting enzyme which converts the products of alpha-amylase action to fermentable sugar. The studies of the properties of these materials and the comparisons made with other preparations should have pronounced practical as well as fundamental significance.

Considerable investigation related to the production of amylases by bacterial growth has been conducted. Studies made on the use of agricultural products, such as wheat bran and distillery by-products, have been directed towards establishing the optimum environmental conditions for growth; e.g., temperature, time of culture, and the necessary supplements for the basic medium. This has been extended to the establishment of the necessary nutrients, both organic and inorganic, for growth of the microorganism and production of amylase in synthetic media. The research is not complete but gives promise of achieving the desired end: production of "tailor-made" enzymes by proper selection of microorganism and growth conditions.

The research on the production and properties of microbial enzymes is being carried in cooperation with George L. Peltier of the Department of Bacteriology.

Baking properties of flour

To make further progress in studies of the changes which take place in the flour proteins during the baking procedure, it is necessary to develop more accurate methods for the determination of the more active "polar" groups which are component parts of the protein molecule.

A method has been developed for the determination of sulfhydryl groups using dehydroascorbic acid as a selective oxidizing agent. This
method is one result of the work reported in the 57th Annual Report concerning the use of ascorbic acid as an oxidizing agent in doughs. A paper “Ascorbic acid and some related compounds as oxidizing agents in doughs” by R. M. Sandstedt and B. D. Hites has been submitted to Cereal Chem. for publication.

Improvements have been made in the formol titration method as applied to the determination of amino nitrogen in flour. A method for the estimation of phenolic groups has also been adapted to use in the study of flour proteins. 

R. M. Sandstedt and B. D. Hites.

Yield of nutrients from cereal hays

Research was continued during the past year upon immature cereal hays as sources of protein and vitamins. Plots of barley, oats, rye and wheat were harvested as hay at eight stages of maturity ranging from prejointing to ripe. Samples of these cuttings were analyzed for their content of dry matter, crude protein, carotene, thiamin, and riboflavin. Yields in dry matter of hay per acre were also determined. The results which were reported in the 57th Annual Report were confirmed. The data obtained this year, however, were more complete and extensive. The content of all the nutritive factors determined decreased with stage of maturity. As examples, the values for carotene dropped from an average content of 550 micrograms (dry basis) per gram at the prejointing stage progressively through intermediate values to an average of 9 micrograms per gram in mature plants. The decrease in percentage protein as the cereal hays matured was from about 30% for the prejoint to 11% in the mature stage.

The yield of dry matter per acre, however, increased very rapidly during the earlier stages of growth. The analytical data and yield data will be combined in an effort to determine the stage of growth of these cereal hays for optimum yield of the above-mentioned nutrients. A comparison between the nutritive values of the different cereals will also be obtained.

The nitrate content of these samples was determined also. The percentage nitrate varied with the stage of growth, increasing until about the preheading stage and then decreasing. Percentages as high as 5% (dry basis) occurred in the wheat hay samples—with the maximum in oats 3.0%, rye 2.5%, and barley 1.5%. These quantities and the time at which the maximum occurred were probably dependent on the weather.

Work upon this project is continuing. These studies are being carried in cooperation with T. A. Kiesselbach of the Department of Agronomy. 

Wendell E. Ham and R. M. Sandstedt.
Station entomologists, working with the new insecticide DDT, found it of distinct value in the control of potato insects and other ancient enemies of crop production. The high toxicity of this potent insecticide makes caution in its use imperative.

**Insects and Rodents**

**Department of Entomology**

**Potato Insects and Their Control**

**Tuber flea beetles.**—In western Nebraska emergence of overwintering flea beetles began as usual about May 20. After this date they moved into early-planted potato fields and reached peak abundance during late June. As was true in 1942 and 1943 the early spring population was very heavy. The relatively light flea beetle damage in 1944 in the presence of an abundance of overwintered adult beetles to more effective control weather conditions probably can be attributed to more effective control efforts. Larger numbers of growers adopted the control program which has been developed and recommended during the last few years; namely, planting only late potatoes and the correct application of timely sprays or dusts.

A field experiment designed to compare the effectiveness of cryolite-sulfur dust, basic copper arsenate-sulfur dust, zinc arsenite-wettable sulfur spray and DDT (dichloro-diphenyl-trichloroethane) was conducted at the Scotts Bluff Experiment Farm. In this test DDT, either as a spray or dust, proved superior to the other materials for flea beetle control. The DDT treatments consisted of a dust of 3 per cent DDT in pyrophyllite and a spray containing 4 lbs. of 10% DDT in 100 gal. of water. Cryolite-sulfur dust, zinc arsenite-wettable sulfur spray and basic copper arsenate-sulfur dust were about equally effective.

In preliminary field tests a reduction in larval injury to tubers was obtained by means of a light application of DDT in the soil around the potato plants.

In toxicity tests under controlled laboratory conditions, a 3% DDT dust gave almost twice as great adult mortality as the cryolite-sulfur dust now commonly used. These data indicate that DDT produces a high mortality of beetles which come in contact with the treated foliage regardless of whether they actually feed.

**Flea beetle host plants.**—Additional data were obtained regarding host plants of both adults and larvae. In controlled laboratory experiments it was found that fecundity is influenced directly by the plant upon which the adult beetle feeds. Largest numbers of eggs were laid by beetles fed on potato, tomato and buffalo bur. Relatively few eggs were deposited by adults confined on the foliage of a number of other plants which commonly grow in and around potato fields of western Nebraska and are commonly attacked by adult beetles. Most of these plants likewise were found to be unfavorable for larval development. The potato plant proved to be the most satisfactory diet from the standpoint of adult beetle feeding, egg production and larval development. Adults confined on marsh elder and a number of other plants on which they feed extensively in the field, especially in the early spring, produced very few eggs. However, the adults remained active on such a diet and when transferred to potato foliage they started depositing eggs at a normal rate. These facts emphasize the importance of eliminating early garden and commercial plantings of potatoes as a means of reducing flea beetle infestation on the late-planted crop in western Nebraska.

**Date of planting and flea beetle damage.**—Potatoes were planted at the Scotts Bluff Experiment Farm on May 20, June 1 and June 20 which cor-
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responds to early, medium and late plantings. Each planting was treated five or six times with the standard cryolite-sulfur dust at comparable stages of maturity. The yield of "good potatoes" or potatoes free of serious flea beetle injury was approximately 11 times greater in the June 20 than in the early and medium planting.

**Number of insecticidal applications and flea beetle control.**—An experiment was conducted in western Nebraska to determine, first, the number of insecticide applications necessary to control flea beetles in late-planted fields (June 20) and, second, to evaluate the relative importance of applications made at different periods during the growth of the crop. Plots receiving the maximum number of treatments were dusted on July 17 and 28 and on August 8 and 19. Various combinations were used on other plots in which one or more of the four treatments were left out. As would be expected, best results were obtained when all four applications were made. However, there was no statistically significant difference between plots receiving four treatments and those receiving the last three or even the last two applications. Each application proved increasingly important as the season progressed. Control was more effective in plots receiving only the third or fourth treatment than in those receiving only the first or second. These results show that although it is important to apply sprays and dusts early, it is even more important to carry the program through the season. An application made just before the vines close the rows is especially important.

**Potato psyllid.**—In 1944 western Nebraska experienced the heaviest psyllid infestation since 1938. Yields in early commercial plantings and untreated garden plots were materially reduced by this insect. Although the effect in the late commercial fields was less severe, some damage did occur and in certain cases there were very definite reductions in yields.

Adult and nymphal psyllid population records and yield records were obtained at Scottsbluff on replicated plots treated with DDT dust (3% in pyrophyllite), DDT sprays (4 lbs. of 10% DDT in pyrophyllite), 325 mesh dusting sulfur and wettable sulfur spray. Each of the four treatments gave good psyllid control, and all were about equally effective.

**Potato leafhopper.**—The heaviest potato leafhopper population on record developed in eastern and central Nebraska during the 1944 season. Many plantings, particularly small garden plantings in the eastern part of the state, were practically a total loss. In the commercial potato section of central Nebraska yield reductions due to leafhopper damage were variously estimated at from 50 to 75%. The failure to prevent such losses can be attributed largely to two factors: first, growers did not fully appreciate the importance of the potato leafhopper and were not prepared to start control measures early, and second, a shortage of materials, such as pyrethrum, which are effective in quickly eliminating heavy leafhopper populations.

At Lincoln replicated plots of Triumph potatoes heavily infested with leafhoppers were treated three times, beginning June 22, at 2-wk. intervals with 1% DDT dust. Twelve hours after the first treatment the population had been reduced from an average of 14.8 nymphs per leaf on checks to an average of 3.9 on treated plants. Practically all nymphs on the treated foliage were newly hatched, and apparently they were killed as soon as they began to move about and come in contact with the DDT. At the time the last records were taken on July 28 about 95% of the foliage was dead on the untreated plants whereas the treated plants were only slightly affected, and they remained green for about two weeks longer. The harvest records showed an increase in yield for the treated plants of 265%.
Aphids.—Aphid populations again were found to increase in commercial fields and experimental potato plots which had been sprayed with zinc arsenite. An average of 247 aphids were recorded from leaf samples taken in plots sprayed with zinc arsenite, whereas in plots not receiving zinc arsenite the average population varied from 3 to 25. Although these increases are of little importance in fields grown for table stock, the very low tolerance for virus diseases in certified potatoes makes any increase in the number of vectors a matter of great importance. During recent years leafroll, a virus disease, has become more common in certain localities and this increase seems to be correlated with relatively higher aphid populations. Although weather conditions recently have been more favorable for aphid development, it is entirely possible that the widespread use of zinc arsenite sprays during the past few seasons has also contributed to the present serious leafroll situation.

Miscellaneous potato insects.—Additional information was obtained from the field control experiments regarding the effects of different insecticides on several other insect species commonly occurring on potatoes in western Nebraska. It was found that DDT (spray and dust) significantly reduced populations of the leafhopper, *Aceratagallia uhleri,* and that in plots treated with zinc arsenite-wettable sulfur spray or basic copper arsenate-sulfur dust a significant increase of leafhoppers occurred as compared with the checks. The difference between populations on checks and plots dusted with cryolite-sulfur was insignificant. Although fewer aphids were present in plots dusted with DDT, there was no important difference between treatments except that significant increases occurred when zinc arsenite-wettable sulfur spray was used. DDT also gave best control of Lygus bugs, the false flea hopper (*Chlamydatus asso- ciatus*), potato leafhoppers, and lepidopterous larvae. Certain beneficial insects were also considerably reduced in numbers by the various treatments, especially when DDT was used.
DDT and potato insects.—Perhaps the most promising development of the 1944 season was the finding that DDT is highly effective against all the important insect pests found on potatoes in Nebraska. In general it proved superior to any material or materials previously tested. Of special interest and importance is the fact that DDT acts both as a stomach poison and contact insecticide and has a prolonged residual toxicity. The possibility of using this one material where combinations of two or more were necessary in the past has distinct advantages.

Insects and varietal resistance.—Records of potato leafhopper and potato flea beetle resistance and hopperburn tolerance were obtained on 12 varieties and selections of potatoes growing at Lincoln.

The lowest nymphal leafhopper populations were found on Red Warba, Mesaba, Pawnee and Katahdin; Kasota and Irish Cobbler occupied an intermediate position, and Triumph and Triumph crosses were most heavily infested. At the time these records were made there was no evidence of foliage dying due to unfavorable weather conditions or maturity.

To measure resistance or tolerance to hopperburn, an estimate was made of the amount of dead foliage present on July 5 and again on July 9. At this time the leafhopper population was heavy and evidence of injury markedly increasing from day to day. Katahdin showed the least amount of damage, and injury to Mesaba and Pawnee was light to moderate. Although heavy leafhopper populations developed on Irish Cobbler, only light to moderate damage occurred, indicating considerable tolerance. Kasota was heavily infested and showed heavy hopperburn damage. Red Warba, which had only a light leafhopper population, was moderately to severely damaged. Triumph and Triumph crosses showed significantly more hopperburn damage than any other varieties.

Damage by the potato flea beetle (a different species from that found in western Nebraska) was determined by counting the number of feeding holes on representative leaf samples. The total number of holes in these samples varied from 166 to 2386, and when the data were treated statistically the varieties fell into four groups. In the order of increasing amount of damage, the first group included Triumph, Pawnee, Kasota, Red Warba, Irish Cobbler and three numbered varieties; second, Katahdin; third, Mesaba; and fourth, a selection from a cross between Katahdin and an early white variety. These records show that there was a statistically significant difference in varietal susceptibility to foliage damage by the potato flea beetle.

The varietal resistance tests were conducted in conjunction with the breeding program of the Horticulture Department.


Roscoe E. Hill.
Grasshoppers

The 1943 fall survey showed a threatening grasshopper population in about 30 counties of central and western Nebraska. A cool wet spring and abundant vegetation tended to prevent grasshoppers moving into crops. Also, rainfall and heavy plant growth encouraged farmers to feel that grasshoppers would not become a problem. Consequently relatively little bait was spread early in the season. The major portion of damage in 1944 occurred in the late summer and early fall to legume seedings and fall wheat. Hundreds of acres of fall-sown wheat were severely damaged in the Panhandle region, particularly in Box Butte, Cheyenne and Kimball counties. Definite records of parasites playing a major role in grasshopper control were obtained in only one instance: During July in Valley County, 95% of Melanoplus bivittatus, which were present at the rate of 100 per square yard, were found to be infested with hairworms.

Thirty-six counties participated in the control program, and 3025 farmers used a total of 259,575 sacks of mixed bait or approximately 6430 tons of dry bait. Approximately 225,000 acres of croplands were baited.

In 1944 threatening grasshopper populations were confined to a few sections of the state. Under the assumption that these foci of infestation serve as a source of origin of populations to spread into other areas and into crops, a federally financed program of roadside baiting was undertaken in conjunction with bait distribution by farmers in some of the more critical counties. The primary objective was to determine, if possible, the value of preventive measures in grasshopper control. The program was carried on in 10 counties, four of them in central Nebraska and six in the Panhandle region. Bait was spread on 14,395 miles or 56,254 acres of roadsides and 1388 miles of railroad right-of-ways. Shortage of labor on farms limited farmer participation. This combined with weather unfavorable for timely bait distribution does not permit a conclusive evaluation of this type of program. The results indicate, however, that it should be continued on an experimental or demonstrational basis.

An analysis of the cooperative statewide grasshopper control program, which has now been in progress approximately 10 years, indicates certain major weaknesses in local participation: (1) failure of counties to anticipate needs and maintain adequate bait reserves; and (2) failure of counties to provide adequate storage space. As a result bait is not available at the time needed and control efforts often are of little value. Obviously the program can be greatly improved if local agencies meet this obligation. H. D. Tate, D. B. Whelan and Harold Hauke.

Chinch bugs

A heavy-to-moderate chinch bug population was present in 22 counties of southeastern Nebraska in the spring of 1944. However, weather conditions were unfavorable for chinch bug development, and as a result there was only light damage by first generation bugs. Because of favorable weather in August, September, and October a very heavy second or fall generation developed and in some sections damaged corn, Sudan grass, and bromegrass seedings.

A fall (1944) survey showed 15 counties to be heavily infested, 11 with a moderate infestation and several with light infestations. This situation indicates a potential need of 1½ million gal. of creosote or 1½ million lbs. of dinitro dust for barrier construction in 1945.

During the last two years (1943 and 1944), field tests and demonstrations have been conducted in Nebraska with dinitro dusts for chinch bug barriers. These results together with the results of extensive work in other states, particularly in Iowa and Illinois, have led to the conclusion that this new dust barrier is a distinct improvement over creosote. The dinitro dust barrier has the twofold advantage of being easier and more convenient to build and maintain, and from the standpoint of the
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dust itself less disagreeable to handle. It also has the distinct capability of killing all of the bugs that come in contact with the barrier, thus eliminating or killing bugs which otherwise would contribute to the second generation. At present the cost of dinitro dust for barrier construction is somewhat greater than that of creosote, and because of manufacturing difficulties, the outlay for preseason storage is considerably greater. It seems evident, however, that the increased efficiency and saving in crops would more than offset the difference in cost.

Tests with dinitro dust barriers.—Experimental dust barriers of dinitro-ortho-secondary butyl phenol were built around a 2-acre barley field, heavily infested with chinch bugs, just prior to nymphal migration to corn. Four and 8% concentrations of the dinitro dust in talc were tested, and applications were made at the rates of roughly 1/2 lb. and 1 lb. per rod. Effectiveness of barriers under these different conditions was checked on three successive days during the heavy afternoon migration.

Although the dinitro dust acted as a repellent to some extent, many of the bugs moved directly across the barrier and eventually most of them either crossed or at least came in contact with the dinitro dust as they moved along the line. Samples of bugs were collected after they had been observed to cross the barrier or after they came in contact with the dust. The 8 and 4% concentrations and the 1/2 and 1 lb. rates all gave virtually complete kills within one hour. Although 1/2 lb. of 4% material per rod was effective, it was more difficult to obtain a continuous line with this quantity if the ground surface was at all rough. In view of this fact it seems likely that the tendency will be to use dinitro dust up to 1 lb. per rod. H. D. Tate and O. S. Bare.

Hessian Fly

Hessian fly damage to wheat in the spring of 1944 was light except in a few local areas in southeastern counties. A "wheat stubble survey" in late June and in July showed a fly infestation heavy enough to be a threat to fall wheat. The more heavily infested counties were chiefly in the southeastern quarter of the state.

An abundant moisture supply in August and September provided conditions favorable for the growth of volunteer wheat and early emergence of fall generation flies. Along with a tendency to ignore safe-planting-date recommendations, many growers failed to destroy volunteer wheat. In some fields of volunteer wheat in Lancaster and adjoining counties more than 90% of the plants were infested and heavy damage was evident. Samples of volunteer wheat taken from fields at intervals during the fall showed that about 5% of the fall generation emerged as a supplementary brood. A threatening situation exists in the southeastern quarter of the state for 1945, and if weather conditions are favorable for fly development, heavy damage may occur.

The Hessian Fly Uniform Nursery Plantings were continued at Lincoln in cooperation with the Agronomy Department and the U. S. Bureau of Entomology. Spring plantings (1944) included 10 varieties and selections. A check variety (Thatcher) was 34% infested; one of the test varieties (Marvel) 2%; the remainder showed no infestation. Fall plantings comprised 17 varieties and selections. Infestation in this field, for some undetermined reason, was not high enough to give critical results.

Corn rootworms

The Colorado corn rootworm continued to cause extensive damage in southwestern Nebraska and in the Platte valley of the central part of the state in 1944. Large acreages of hybrid sweet corn grown for seed and hybrid field corn were destroyed or badly damaged. Infestations were especially heavy in irrigated fields. The continuous planting of corn for several years in succession is conducive to the building up of heavy rootworm populations and consequently extensive damage. In all probability losses will continue unless rotations are lengthened.

As with the northern corn rootworm, available information indicates that no damage is caused by the Colorado corn rootworm in fields not planted to corn the previous year. Evidence indicates that corn usually can be grown on the same soil for two years, and sometimes three, with only minor damage. Shorter rotations may result in important losses. Volunteer corn, growing in other crops, occasionally attracts enough beetles to damage corn planted in the field the succeeding year. This usually accounts for rootworm damage on soil not planted to corn the previous year.

Records of the percentage of infestation by the Colorado corn rootworm were obtained on 30 varieties and strains of corn, all hybrid except one, at Lexington. Damage was determined on the basis of the degree of lodging. The percentage of stalks affected ranged from 34 to 89%. These differences probably indicate tolerance or ability to withstand or recover from injury rather than actual resistance to attack. The records were obtained in cooperation with the county agricultural agent and the Agronomy Department.

Left: Corn continually for 6 years. Note severe damage by corn rootworm. Right: Corn after wheat. Note absence of damage by northern corn rootworm.
At Lincoln additional evidence was obtained to indicate that fall plowing reduces damage by the northern corn rootworm. Since these tests were in a field that had been in corn continuously for several years there was a very heavy rootworm infestation. In spring-plowed plots 95% of the stalks were affected and 52% or more were severely affected (lodged 30% or more). Although there is no reason to believe that fall plowing might be a substitute for long rotations, the results do indicate that wherever other conditions permit, fall plowing might be profitably employed in conjunction with rotation.

Field observations over a period of years in Nebraska indicate that listed corn is damaged somewhat less than checked corn, probably because of its being more deeply rooted in the soil.

The phase concerned with cultivation was cooperative with the Soil Conservation Service and the Agronomy Department.

H. D. Tate and Doris Gates.

Insecticides

DDT on vine crops.—Replicate plots of cucumbers, acorn squash, and hubbard squash were treated six times with a 3% DDT dust between June 1 and June 30. Check plots included cryolite and untreated plants. Frequent, heavy rains increased the number of treatments necessary.

Heavy populations of Diabrotica vittata appeared on June 1 indicating a sudden influx of beetles. Moderate populations of Diabrotica 12-punctata appeared on June 1. Hubbard squash was especially susceptible to attack by cucumber beetles, and was followed in susceptibility by acorn squash and last by cucumber. Adult squash vine borers were first observed on June 27.

Young acorn squash plants were severely stunted by DDT; hubbard squash, somewhat less; and cucumbers, only slightly. Although much less so, mature plants appeared to be adversely affected. DDT and cryolite were about equally effective, and both gave satisfactory control of cucumber beetles. Squash vine borer infestation records for the different treatments were as follows: Plants treated with DDT, 14% infested; cryolite, 42%; and untreated, 84%.

DDT and eggplant flea beetles.—Eggplants were dusted six times with DDT between June 14 and July 28; check plots consisted of cryolite-treated and untreated plants. As with vine crops, heavy and frequent rains increased the number of treatments necessary to secure protection. Effectiveness was measured by counting the number of flea beetle feeding holes in the leaves. Readings were made on June 27, July 27, and September 21. The average number of holes per leaf was as follows: DDT, 69; cryolite, 81; untreated, 523. As indicated by these figures and also by the general condition of the plants, both cryolite and DDT gave satisfactory control with an indication that the latter was slightly superior.

In early September DDT-treated plots became heavily infested with red spider mites whereas only a trace of infestation was evident on checks. On September 21 ratings were made on mite infestations and general condition of the plants with results as follows: DDT-treated plants, very severe mite infestation; cryolite, light; untreated, only a trace. At this time the DDT-treated plants showed a marked yellowing as a result of mite damage whereas plants in the other plots had a relatively normal green color.

DDT and potato leafhopper control on beans.—Field plots of beans heavily infested with potato leafhoppers were treated with 1% and 3% DDT dusts on June 19. Nymphal population records were taken four times between June 20 and July 6. During this interval two heavy rains

\[\text{DDT}^1\text{ on vine crops.} \]

\[\text{DDT and eggplant flea beetles.} \]

\[\text{DDT and potato leafhopper control on beans.} \]

\[\text{DDT}^1 \text{ Dichloro-diphenyl-trichloroethane.} \]
occurred. The average number of nymphs present on 30 leaflets was as follows: 1% dust, 12.2; 3% dust, 2.2; and check, 126.5. On the treated plants nymphs were practically all newly hatched whereas on untreated plants all instars were about equally represented.

These records indicate that effective protection was obtained with DDT over a 16-day period in spite of heavy rains, with the 3% dust apparently somewhat more effective.

**DDT and potato insects.**—Extensive field tests were conducted during 1944 with DDT for the control of potato insects. To summarize, the results indicate that DDT is a very promising material for the control of all of our major potato insects, including flea beetles, psyllids, leafhoppers and Colorado potato beetles, along with a number of other chewing and sucking insects of lesser importance. A more detailed account of experimental results is given in the “Potato Insect” section of this report.

**Sabadilla and chinch bugs.**—The toxicity of sabadilla dusts and sprays to chinch bugs was determined under field and controlled laboratory conditions. Field tests were conducted at the time first generation bugs, which were predominantly nymphal forms, were migrating from small grain to corn. Small areas (about 4 by 8 feet) of grass heavily infested with chinch bugs were surrounded by dinitro-ortho-cresol barriers and then treated with a 10% sabadilla dust. The barrier was maintained and the bugs kept under observation for five days. Practically a 100% kill was obtained. Approximately 1000 bugs were collected from the treated areas and kept under observation for four days. One hundred per cent mortality was obtained.

In August and September second generation bugs were treated under controlled laboratory conditions with sabadilla dusts at concentrations of 1, 3, 5 and 10% sabadilla powder, and sprays at concentrations of ½, 1 and 2 lbs. of sabadilla powder per 100 gal. of water. The results reveal that either a 5% dust or a spray containing 2 lbs. of sabadilla powder per 100 gal. of water gave virtually complete kills, 98 and 99.4%, respectively.

Sabadilla may have a practical use in controlling chinch bugs under certain conditions; for example, in protecting especially valuable experimental material, seed crops, or in destroying chinch bugs which have collected in large numbers on the outer rows of a field of corn at the time of migration from small grain. There was no evidence of plant injury by sabadilla either as a water suspension or as a dust—a point of practical significance.

**Sabadilla and squash bugs.**—Tests to determine toxicity of sabadilla dusts and sprays to squash bugs were conducted under controlled laboratory conditions and to a limited extent in the field.

A 10% dust or 4 lbs. of sabadilla powder per 100 gal. of water gave a high percentage kill, 96 and 99%, respectively. Lower concentrations (5% dust or 2 lbs. per 100 gal.) were effective for early instars but only moderately so for fourth and fifth instars and adults.

Results of field tests indicated that satisfactory control can be secured under field conditions provided good coverage can be obtained. Where vine growth is heavy the bugs quickly find shelter when disturbed and are difficult to hit directly with sprays or dusts. This appears to be one of the chief difficulties in obtaining satisfactory field control. Sabadilla is believed to be a very promising material for controlling these pests.

H. D. Tate, Roscoe E. Hill and Doris Gates.
Bean insect control

Sprays and dusts.—Tests with sprays and dusts were conducted in cooperation with the Department of Plant Pathology to determine the value of Bordeaux mixture, certain insoluble copper compounds and sulfur as a combined treatment for leafhoppers and certain diseases.

Adult leafhoppers were observed first on May 29. They appeared suddenly in large numbers indicating a more or less sudden migration. Following their initial appearance on June 12, nymphs rapidly increased and remained abundant throughout June. A rapid decline occurred during early July, and by July 7 they were not present in significant numbers on beans. Apparently leafhoppers develop in large numbers and may do important damage as pests of beans in the spring while plants are young, but they are relatively less destructive later in the season.

Spray and dust applications were made at 2-wk. intervals from late May until early July. Leafhopper nymphal counts were made on four different dates during June. The mean population per 160 leaflets in the different treatments was as follows: Bordeaux mixture spray, 84 (practically all of these were newly hatched and very few matured on these plants); copper-sulfur dust, 130; copper-lime dust, 132; and check, 136. Bordeaux mixture gave a highly significant reduction in population whereas the other treatments were not significantly better than the untreated from the standpoint of leafhopper control. The Bordeaux-treated plants retained a healthy green color two or three weeks longer than plants in the other plots and gave yields two to four times greater. Results of this test together with the results obtained in 1943 indicate that spraying beans in eastern Nebraska with Bordeaux would be a profitable procedure. From the standpoint of leafhopper control alone, three or four sprays during June probably would be sufficient.

VARIETAL RESISTANCE OF BEANS TO THE POTATO LEAFHOPPER.—Potato leafhopper infestation records were obtained during late June on five varieties of beans at Lincoln. U. S. Refugee No. 5 and Idaho Refugee were practically immune, apparently very few, if any, nymphs being able to mature on these varieties. Significantly greater numbers were present on Giant Stringless Green Pod and still greater numbers on Agrow Stringless Green Pod and Landreth Green Pod. Doris Gates.

Insect pollinators

A study of the habits and development of wild alfalfa pollinators was started in the spring of 1944, the primary objective of which was to find ways and means of encouraging an increase of pollinating insects. The study was confined almost entirely to a single species of wild bees, Calliopsis andreniformis, which previous observations had shown was an abundant and efficient pollinator of alfalfa in eastern Nebraska. It was found that the adult bees make their nest in the ground but only in hard packed soil free of vegetation. Their nests were numerous in and around alfalfa fields in bare spaces. In an experimental field of drilled alfalfa they were nesting in bare spaces between rows, and in the tracks of an infrequently used road at the edge of the field nests were very abundant. No nests could be found in solid stands of alfalfa.

There is one generation of this bee per season. The adults appeared in late June and were present until about late July in considerable numbers. The winter is passed as a mature or nearly mature larva in the ground at a depth of two to six inches. These results indicate the practical possibility that increases in numbers of this bee could be obtained by providing small areas of suitable nesting places in and about alfalfa fields. Doris Gates.
Insects cause most of the tripping of alfalfa flowers, which is necessary for good seed setting. A wild bee (Melissodes sp.), which is similar to the common Megachile sp., both being very effective, tripping 80 to 90 per cent of the alfalfa flowers visited. Note that this bee has already tripped a flower at the left, and that it enters the flower in front of the keel, thereby insuring cross-pollination by contact of the stigma with parts of the bee laden with foreign pollen.

**Cattle grubs**

Entomologists cooperated with workers in Entomology and in Animal Husbandry, Dairy Husbandry, and other agencies in a cattle grub control program. Between 8 and 10 thousand lbs. of rotenone were distributed by commercial agencies in the state for cattle grub control and approximately 15,000 head of cattle were treated.

The cattle grub is generally regarded as a pest of major importance and controlling it undoubtedly pays dividends, if not immediately, then certainly in succeeding years. Available information indicates that the best avenue for attacking the cattle grub problem is through the treatment of breeding herds and stock cattle. A successful program depends on community cooperation in reducing the heel fly population to a low level; with cooperation local eradication seems possible.

The Department of Entomology cooperated with the Animal Husbandry Department in an experiment designed to determine the relative rates of gain made by untreated animals and those made by animals treated with a rotenone dust to control grubs. One hundred and forty-two calves and 72 yearling heifers, all on feeding tests being conducted by the Animal Husbandry Department, were used in the test. Weight records extended over a period of 84 to 112 days following the first treatment. Two dust applications were made, the first in late January and early February and the second 28 days later.

About 95% control of grubs was obtained. In these tests little, if any, advantage in the rate of gain of treated over untreated animals was shown. Examination of hides at time of slaughter, 96 days after treatment, indicated that grubs had emerged from the untreated cattle and the openings had healed more rapidly than in the treated animals. Unabsorbed larval grub skins in the hides of treated animals had apparently temporarily interfered with healing.

H. D. Tate and D. B. Whelan.

It should be remembered that the chief benefit of grub control becomes evident in the succeeding year.

**Cockroach control**

Experiments were conducted in an effort to develop an effective and practical bait material for controlling the German cockroach. Sodium fluoride, borax, and boric acid powder were used as toxic agents. Pow-
dered skim milk, rancid butter, confectioner's sugar, wheat malt flour, barley malt flour, sorghum malt flour, butyric acid, malt extract and beer were tested as attractants. Large numbers of roaches, both adult and immature stages, were used in replicated tests. In some of the tests small glass containers were used to confine the experimental insects whereas in others a large, constant temperature chamber providing an environment similar to a room was employed. Foods generally available to roaches in such places as home kitchens or dairy establishments were supplied along with the test baits.

Results of the experiments indicated that butter, honey, and powdered confectioner's sugar have promise as bait materials, although the difference obtained between these and ordinary foods was not statistically significant. Stale malt containing 2% boric acid tended to increase the rate of kill, but final mortality was not significantly increased over that obtained by using plain water.

The following poison baits are regarded as having practical value in controlling the German roach: (a) 10% boric acid in powdered confectioners' sugar; and (b) a 50-50 mixture of honey and butter plus 10% by weight of boric acid powder. Although relatively slow in action, complete kills were obtained with either of these baits. Since both are relatively nonpoisonous to man and domestic animals, they can be used with safety in the home and in food establishments.

O. S. Bare.

Miscellaneous Insects

Mosquito survey.

Use of wheat flour in sprays.

Rodent control

Rodent and predator control work in 1944 consisted largely of demonstrations, organized control programs, and related educational activities by the Extension Entomologist and personnel of the Fish and Wildlife Service assigned to this state. Control of rats, which have increased greatly during the last few years, received special attention. Approximately 20 demonstrations and educational meetings were held. Intensive control programs were started in six cities and towns, and arrangements made for an increasing number in 1945.

Because they gnaw and tear away insulation material, pocket gophers are responsible for serious damage to underground telephone cables along the Platte Valley. A control test area has been set up near North Platte in cooperation with the American Telephone and Telegraph Company in an effort to determine cost and practicability of an effective control program.

Reports indicate increasing loss of livestock and poultry from coyotes. Twenty meetings and demonstrations were held in connection with predator control. Additional funds are needed for expanding activities in this direction.

O. S. Bare and Howard J. Martley.
Animal nutrition studies during 1944 threw further light on the protein requirements of farm animals. Of particular interest is the study of the use of fermentation by-products in the fattening of calves and other meat-producing animals.

Feeding Cattle, Hogs, and Sheep
Department of Animal Husbandry

Substitutes for Alfalfa Meal in Rations for Pigs in Dry Lot

FIFTH of a series of trials designed to find suitable substitutes for alfalfa meal in dry-lot rations for pigs, this trial comprised three lots of 15 pigs each, self-fed, free choice, on ground yellow corn and a supplement of equal parts (by weight) of tankage, soybean meal, and forage. Forages used were as follows: Lot 1—ground, field-cured, third-cutting alfalfa; Lot 2—artificially-dried Sudan grass; Lot 3—ground, field-cured, Sudan grass hay. In addition, a fourth lot of 15 pigs was self-fed a mixed ration of ground yellow corn, tankage, and soybean meal to which 4% of a proprietary liver compound was added in place of the forage fed the other lots. All lots were self-fed a simple mineral mixture.

The alfalfa used in this trial was cut in the early bloom stage and was leafy. Stacked in the field, it had heated somewhat before it was ground. The Sudan grass was cut at a height of 12 to 15 in. and was dehydrated with very little exposure to the sun. The Sudan grass hay, cut at a height of 12 to 15 in., was allowed to cure, mostly in the shock, for 5 days before being baled for storage. When it was ground several months later, it was noted that it had heated and that there was some mold.

The following table shows the carotene and protein content of the roughages used:

<table>
<thead>
<tr>
<th>Roughage Type</th>
<th>Moisture %</th>
<th>Crude Protein %</th>
<th>Carotene Content in mgs. per 100 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa, third cutting</td>
<td>13.3</td>
<td>15.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Sudan grass, artificially dried</td>
<td>7.1</td>
<td>16.4</td>
<td>16.0</td>
</tr>
<tr>
<td>Sudan grass, field cured</td>
<td>11.3</td>
<td>16.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Excellent results were secured with all of the rations fed. The pigs fed alfalfa and those fed artificially-dried Sudan grass made more rapid gains than the other two lots—1.31 and 1.33 lbs. per head daily as compared with 1.23 and 1.25 lbs. per head daily for the pigs fed Sudan grass hay and the liver compound, respectively. Feed requirements per unit of gain were very similar for all lots.

The results of this and previous trials support the conclusion that Sudan grass cut at an immature stage and artificially dried is a very satisfactory substitute for alfalfa meal in the rations of growing pigs fed in dry lot. Sudan grass hay (field cured) has not been entirely satisfactory. Most of our difficulties with the field-cured Sudan grass have been with the curing. To date we have not succeeded in producing a clean, bright, unbleached hay by field curing.

The liver compound used in this trial is a proprietary mixture, relatively high in the vitamin B complex; it is used principally for fur-bearing animals. The pigs fed this compound developed unusually sleek, glossy hair coats.

L. E. Hanson and William J. Loeffel.
Protein requirements of pigs in dry lot

Six lots of 13 pigs each were self-fed a concentrate mixture composed of ground yellow corn, ground alfalfa hay, and a mixed protein supplement. The protein supplement was composed of equal parts, by weight, of fish meal (sardine), tankage, soybean meal and linseed meal. The percentage of corn and supplement were varied to get the desired protein level. The trial was divided into two periods as follows:

<table>
<thead>
<tr>
<th>Average weight of pigs</th>
<th>Per cent protein in the ration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 1</td>
<td>Lot 2</td>
</tr>
<tr>
<td>73 lbs. to 125 lbs.</td>
<td>18</td>
</tr>
<tr>
<td>125 lbs. to 200 lbs.</td>
<td>15</td>
</tr>
</tbody>
</table>

During the first period the ration fed to each lot contained 7.5% of ground alfalfa. During the second period the alfalfa was fed at a level of 10% of the ration. All lots were self-fed a simple mineral mixture.

As in last year's trial, the pigs fed the 18% protein mixture made more rapid gains than the pigs fed the 15% protein mixture. The latter required slightly more feed per unit of gain but since this mixture contained less protein supplement, it was a less expensive mixture, at present feed prices, and actually produced gains at slightly less cost than the 18% protein mixture.

During the second period the pigs fed the 15% mixture made more rapid gains than either of the other two groups. They also required slightly less feed per unit of gain. The ration containing 10.9% protein was composed of corn and alfalfa. As in the previous trial good results were obtained with this mixture, but it was the least efficient ration fed and produced significantly slower gains than the other two mixtures. From this and the previous year's data, it is concluded that the 18% protein ration which was fed is superior to the 15% protein ration for pigs between the weights of 70 to 125 lbs. For pigs between the weights of 125 to 200 lbs. the 15% protein ration fed produced slightly more rapid gains than the 13% protein ration. At present feed price relationships the 13% ration is more economical than the 15% ration. After they reach a weight of 125 lbs., pigs fed only corn and alfalfa will make satisfactory gains.

But it is clear that even at present feed prices some protein supplement will be an economical addition to such a ration. A corn and alfalfa ration without a protein supplement has a higher value for pigs approaching market weights than it has for 125-lb. pigs.

L. E. Hanson.

Protein requirements of weanling pigs in dry lot

Two trials have been completed with weanling pigs fed rations containing different levels of crude protein. The pigs were placed in the test lots at an average age of 9 weeks and fed until they attained an average weight of approximately 75 lbs. each. The control lot (Lot 1) was self-fed ground yellow corn and a protein supplement, free choice. Three other lots were fed mixed rations of the same ingredients adjusted to provide mixtures containing 20%, 24% and 27% crude protein, respectively. The protein supplement fed to the control pigs was composed of 15 lbs. tankage, 15 lbs. fish meal, 15 lbs. soybean meal, 15 lbs. linseed meal and 20 lbs. artificially-dried Sudan grass meal. The mixed rations fed contained 5% Sudan grass meal and sufficient mixed supplement (equal parts of tankage, fish meal, soybean meal and linseed meal) to reach the desired protein level.

In the first trial 20 pigs with an average initial weight of approximately 34.5 lbs. were placed on each ration. During the first two weeks of the trial the average daily gain per pig was 0.61, 0.77, 0.81, and 0.65 lb. for the controls, the 20%, the 24%, and the 27% ration, respectively. At that time all of the pigs were vaccinated for cholera by the simultaneous method. The vaccination was subsequently followed with an outbreak of pig typhus which largely invalidated the data. However, it was
obvious that the high protein rations were not palatable to the pigs. The self-feeders were adjusted in various ways but no matter how they were set, the pigs would root out the feed. No attempt was made to measure the refuse, but it was apparent that the amount wasted was positively correlated with the percentage of protein in the mixture. In addition, the pigs fed the 24 and 27% mixtures always acted as if they were hungry, even while standing in feed several inches deep.

When a pig developed typhus and began to lose weight, he was removed from the test lot for treatment. The test was continued until the average weight per pig (survivors) was 71 lbs. for the lightest lot. At that time the pigs had been fed the experimental rations for 54 days, and the number of pigs removed for treatment were: 7 from the control lot (16.7% protein ration consumed), 3 each from the lot fed the 20% protein ration and the 24% ration, and 5 from the lot fed the 27% protein ration. It is the opinion of some that a high protein ration is conducive to the development of pig typhus. These data are not in agreement with such opinions.

In the second trial 14 pigs with an average initial weight of approximately 42 lbs. were fed on each ration. In this trial the pigs again showed a dislike for the high protein mixtures. The pigs were fed on concrete floors which made it possible to salvage some of the waste (between rains). The amount salvaged amounted to 59.5 lbs. from the 20% group, 184.7 lbs. from the 24% group, and 311.2 lbs. from the 27% group. It was estimated that this represented from 50 to 65% of the total waste of these lots, and the figures are given merely to show the proportionate waste from the various mixtures. Frequent rains precluded the possibility of complete salvage. There was no waste from the pigs which were self-fed, free choice, and their self-balanced ration contained 17.2% protein. Analyses of the wasted feed indicated that the waste was about 35% corn and 65% supplement, 13% corn and 87% supplement, and 3% corn and 97% supplement for the 20%, 24% and 27% protein rations respectively.

All lots of pigs made exceptionally good gains for pigs of that age and size, from 1.00 to 1.09 lbs. per head daily. The efficiency of gains varied inversely with the level of protein fed. At least part of this difference was due to the wasted feed. In these trials the corn was ground moderately coarse, and it appeared that the pigs were searching for corn particles and wasting the finer particles of the ration in their search. This observation is supported by the analyses made on the recovered waste.

In a third trial, not yet completed, we have eliminated most of this waste by grinding the corn more finely.

L. E. Hanson.

**Waxy corn versus non-waxy corn for pigs in dry lot**

Two additional trials have been conducted to study the feeding value of waxy corn.

In the first of these, three lots of 10 pigs each were self-fed, free choice, on shelled corn and a protein supplement. The corn used was as follows: Lot 1—yellow, non-waxy corn (the common commercial type); Lot 2—yellow, waxy corn; and Lot 3—both types of corn, free choice. The supplement was composed of equal parts by weight of tankage, soybean meal, and alfalfa meal. A simple mineral mixture was self-fed to each lot.

In the second trial, 2 lots of 14 pigs each were self-fed mixed rations. One lot was fed non-waxy corn and the other was fed waxy corn. Both rations contained 7% alfalfa meal, and sufficient supplement (equal parts tankage and soybean meal) was added to each mixture to obtain the same level of crude protein for each. The level of crude protein fed was 22% until the pigs reached a weight of 70 lbs., 18% from weights of 70 to 125 lbs., and 18% thereafter.

The results of these trials were similar to those reported last year. The pigs given a choice of both types of corn preferred the non-waxy. This lot consumed 2.1 times as much non-waxy as they consumed waxy corn. However, the pigs fed only one kind of corn responded very similarly, and it is concluded that waxy corn is equal to non-waxy in feeding value for growing fattening pigs fed in dry lot. The waxy corn used in these trials contained more crude protein, fat, fiber, ash, and less nitrogen-free extract than the non-waxy corn.

A paper is being prepared for early publication. L. E. Hanson.
Protein requirements of fattening pigs, fed on Sudan grass pasture

Second of a series of trials designed to obtain data on the protein supplement requirements of pigs on pasture when soybean meal is used as the primary source of protein, this trial consists of four lots of 12 pigs, each self-fed as follows: Lot 1—ground corn (negative controls), Lots 2, 3, and 4—a mixture of ground corn, 2% tankage and soybean meal. For these lots, the amount of soybean meal was varied from 2% to 14% to obtain mixtures containing 11, 13 and 15% crude protein. All lots were allowed free access to a simple mineral mixture.

The pigs had an average initial weight of approximately 105 lbs. They were fed for 28 days whereupon it became necessary to discontinue the trial because the pasture was being destroyed by chinch bugs. The average daily gains per pig were: 1.08 lbs. on corn alone; 1.36 lbs. on the 11% ration; 1.67 lbs. on the 13% ration; and 1.82 lbs. on the 15% rations. The pigs fed the 13% and 16% ration consumed approximately the same amount of feed daily, 6.5 lbs. per pig, whereas the negative controls consumed 4.9 lbs. and the 11% groups 5.5 pounds daily.

The feed requirement for each 100 lbs. of live weight increase was as follows: 457 lbs. on corn alone; 465 lbs. on the 11% ration; 387 lbs. on the 13% ration; and 355 lbs. on the 15% ration. L. E. Hanson.

Cattle feeding investigations

The relation of grain and forage sorghums to the incidence of lithiasis, anasarca, and pathological liver conditions in cattle.—Twenty-four steer calves with an average initial weight of 348 pounds were placed on feed December 15, 1943. They were started on sorgo silage, ground sorgo heads, ground rye, soybean oil meal and ground limestone. The grain allowance was increased as rapidly as consistent with good feeding practice. Because of difficulties in securing certain feeds, substitutions had to be made from time to time. The plan followed was to feed a ration considered nutritionally adequate except for vitamin A value.

The calves made satisfactory gains for approximately 26 weeks. By this time they began to show symptoms considered to rise from vitamin A deficiency. From the 26th to the 33rd week inclusive the rate of gain was unsatisfactory and by August 2, all of the calves showed to some degree, discharge from the eyes and edema. In general, the calves were listless, had harsh unattractive coats, and generally appeared not to be doing well. Their eyelids were pale in color and the eyes appeared abnormally prominent. The calves seemed to shun direct sunlight. Some of them breathed rather heavily with increased respiration and some showed marked muscular incoordination when walking. Other steers were observed to fall to the ground in convulsions and sometimes to fall without struggling. Usually they were able to regain their feet and apparently recovered within a few seconds. Droppings generally were excessively thin and watery.

On August 2 the twenty-four head were divided into 6 groups of 4 each. The division was based on gain in weight and the apparent conditions of the steers.

The six lots were then fed as follows:
Lot 1—Ground oats, dried beet pulp, ground rye, soybean oil meal, oat straw and ground limestone.
Lot 2—Same as Lot 1 with the addition of sardine oil to supply approximately 40,000 USP units of vitamin A per head daily.
Lot 3—Same as Lot 1 with the substitution of 2.0 pounds of ground, brown alfalfa hay for 2.0 pounds of oat straw.
Lot 4—Same as Lot 3 with the addition of sardine oil to supply approximately 40,000 USP units of vitamin A per head daily.
Lot 5—Same as Lot 4 with the substitution of a commercial carotene concentrate for the sardine oil.
Lot 6—Same as Lot 3 with the substitution of green alfalfa hay for brown alfalfa hay.
Immediate improvement in the condition of the steers in Lots 2, 4, 5 and 6 was noted and the rate of gain returned to normal within a short time. There was no apparent difference in the response made by these four lots.

Lots 1 and 3 continued to gain only at a slow rate and constantly deteriorated in general appearance. The edematous condition and muscular incoordination became more pronounced with steers having more frequent convulsions. One steer from Lot 3 died nine days after the steers were divided.

Ante-mortem and post-mortem examinations were made by Dr. L. V. Skidmore. Ante-mortem examination showed excessive foamy saliva from the mouth; respiration short, rapid, difficult and agonal; cornea of both eyes marked cloudiness; left eye corneal ulcer, apparent loss of sight in both eyes; thin, watery feces, containing red shreds of intestinal mucosa; temperature 106.2.

Post-mortem examination disclosed sero-gelatinous infiltration of subcutaneous and intermuscular tissue in region of the fore and hind limbs; excess fluid in abdominal cavity; brachial and sciatic nerves swollen; liver, spleen and kidneys congested; walls of urinary bladder thickened and edematous; lymph glands throughout body enlarged and edematous; lungs extensively edematous and emphysematous with areas of solidification; extensive pleuritic and diaphragmatic adhesions; small intestines, cattarrhal enteritis; large intestines, localized areas of congestion; colon, hemorrhagic enteritis; left eye, corneal opacity, corneal ulcer, one-third in both eyes; thin, watery feces, containing red shreds of intestinal mucosa; temperature 106.2.

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Post-mortem examination disclosed: coarse, dry, patchy hair; dry and scurfy skin; nervous and apparently totally blind; unsteady and uncertain in movements; small, white spot on cornea of left eye; bilateral nasal discharge of thin, yellowish mucus; saliva drooling from mouth; slight paralysis of lower lip; diarrhea; noticeable subcutaneous edema in regions of shoulders, brisket, belly, front and hind legs extending to hoofs.

Post-mortem examination disclosed: subcutaneous edema of yellowish sero-gelatinous exudate over most of carcass, most extensive in regions of shoulders, brisket, belly, front and hind legs; walls of blood vessels thickened in these regions; muscle tissue pale in color, lacking in muscular tone; the nerves of the brachial plexus greatly enlarged and edematous; sciatic nerves slightly enlarged; lymph glands throughout the body enlarged and edematous; excess yellowish fluid in thoracic and abdominal cavities; excess fluid in pericardial sac; heart muscle somewhat soft and of pale color; kidneys and liver light-colored with small necrotic foci in liver; retina loose and swollen with faked spots in retinal pigment; partially covered with pinkish cottony gelatinous strands radiating from the optic nerves, both of which were enlarged.

The remaining steers in Lots 1 and 3 continued to deteriorate and on October 18 and November 8 were given different supplements high in vitamin A value. These steers are still on feed.

Marvel L. Baker, W. J. Loeffel, L. E. Hanson.
The substitution of distillers' wheat dried grains or urea for soybean oil meal for wintering heifer calves.—Much interest has developed in the response of calves to the feeding of wheat fermentation by-products. The following feeding trials provide data on the merits of these products as shown under certain experimental conditions. Four lots of 12 heifer calves with an average initial weight of 432 lbs. were fed from December 23, 1943, to April 13, 1944, a period of 112 days. The four lots were given access to block salt and were given a full feed of corn silage which averaged 29.17 lbs. per head daily for all four lots. In addition the four lots were 1.97 lbs. of ground shelled corn plus 0.99 lb. of expeller process soybean oil meal; 1.65 lbs. of ground shelled corn plus 1.32 lbs. distillers' dried wheat grains; 0.99 lb. ground shelled corn and 1.97 lbs. of the distillers' grains; and approximately 2.85 lbs. of ground shelled corn and 0.11 lb. of urea per head daily.

Lot 1, fed soybean oil meal and corn, gained an average of 171 lbs. per head and consumed 1915 lbs. of silage, 130 lbs. of corn and 65 lbs. of soybean oil meal per 100 lbs. of gain. Lot 2, which was fed distillers' dried wheat grains with solubles, plus corn at approximately the same level of crude protein as that fed Lot 1, gained an average of 148 lbs. per head and consumed 2198 lbs. of silage, 114 lbs. of corn and 100 lbs. of distillers' dried grains per 100 lbs. of gain. Increasing the proportion of distillers' dried grains in the combination of distillers' grains and corn did not affect results appreciably as Lot 3 gained an average of 149 lbs. per head and required 2190 lbs. of silage, 74 lbs. of corn and 148 lbs. of distillers' dried grains per 100 lbs. of gain. Lot 4, fed ground shelled corn and urea gained an average of 143 lbs. per head and consumed 2299 lbs. of silage, 224 lbs. of ground shelled corn and 9 lbs. of urea per 100 lbs. of gain.

Feeding distillers' dried grains to fattening heifer calves.—Five lots of 12 heifers with an average initial weight of approximately 580 lbs. were fed for 93 days from April 13 to July 15, 1944. All five lots were given a full feed of corn silage and ground shelled corn, and had access to block salt. In addition they were fed 1.50 lbs. of expeller process soybean oil meal; 1 lb. of expeller process soybean oil meal plus 0.75 lb. distillers' dried grain; 0.50 lb. of expeller process soybean oil meal and 1.50 lbs. of distillers' dried grains; 2.25 lbs. distillers' dried grains; and 3.00 lbs. of distillers' dried grains per head daily.

The distillers' dried grains used in this trial were a by-product from the manufacture of alcohol from a mixture of 10% barley and 45% each of corn and wheat. They contained only the insolubles and analyzed 28.1% crude protein.

The average daily silage consumption for the five lots was 19.71, 20.21, 20.25, 20.56, and 20.07 lbs. per head. Four of the five lots consumed an average of 13.18 lbs. of total concentrates per head daily. The fifth lot consumed 10.01 lbs. of ground shelled corn plus 3.00 lbs. of distillers' grains or a total of 13.01 lbs. of concentrates per head daily.

Average gains per head for the five lots were 181, 186, 199, 192 and 169 lbs. The feed required per 100 lbs. of gain for the five lots was 1011 lbs. of silage, 599 lbs. of corn, and 77 lbs. of soybean oil meal; 1011 lbs. of corn, 572 lbs. of corn, 50 lbs. of soybean oil meal and 38 lbs. of distillers' dried grains; 946 lbs. of silage, 522 lbs. of corn, 23 lbs. of soybean oil meal and 70 lbs. of distillers' dried grains; 906 lbs. of silage, 520 lbs. of corn and 109 lbs. of distillers' dried grains; 1103 lbs. of silage, 550 lbs. of corn and 165 lbs. of distillers' dried grains.

Heifers fed the combination of soybean oil meal and distillers' dried grains showed slightly more finish than the other lots and the lot fed 3.0 lbs. of distillers' dried grains showed slightly less finish than any of the other lots as judged by selling price, yield and carcass grades.

In this trial, distillers' dried grains seemed approximately equal on an equivalent protein basis to soybean oil meal when both were fed to pro-
vide approximately the same level of protein. There was no advantage in increasing the amount of distillers' dried grains above this level. Mixtures of distillers' dried grains and soybean oil meal proved slightly superior to either fed singly. Marvel L. Baker.

**The use of pasture in producing finished cattle.**—Three lots of 11-year-old heifers with an average initial weight of approximately 520 pounds were grazed on pasture without grain from April 26 to August 31, 1944, a period of 127 days; they were fed grain in addition to pasture from August 31 to October 19, or for 49 days, and were finished in dry lot from October 19 to December 29, a period of 71 days.

The three lots were grazed together on a 20-acre bromegrass pasture until June 14. On June 14, Lot 3 was moved to a 10-acre pasture consisting largely of grama and on July 5, Lot 2 was moved to a 10-acre pasture of Sudan grass. Pasture gains per head were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1 Brome</th>
<th>Lot 2 Brome</th>
<th>Lot 3 Brome</th>
<th>Lot 3 Grama</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 days</td>
<td>13</td>
<td>11</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>21 days</td>
<td>42</td>
<td>40</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>21 days</td>
<td>-8</td>
<td>-4</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>28 days</td>
<td>52</td>
<td>48</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>29 days</td>
<td>35</td>
<td>27</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>127 days</td>
<td>134</td>
<td>122</td>
<td>156</td>
<td></td>
</tr>
</tbody>
</table>

Conditions under which the weights were taken were such that they do not reflect actual gains too well. This was due to the fact that the heifers were weighed full to the pastures. Other weights were taken after the heifers were driven in from the pastures. On the basis of the weights as given, 130 lbs. of gain were secured from each acre of bromegrass pasture, 83 lbs. per acre of Sudan grass, and 110 lbs. per acre of grama. Because of weighing conditions, it is probable that 160 lbs. per acre would more nearly represent the actual per-acre gain produced on bromegrass. The Sudan provided a great excess of pasture early in the grazing period, whereas in the last two weeks of August chinch bugs destroyed the pasture. Therefore, the gain of 83 lbs. per acre is not an accurate measure of the productive capacity of the Sudan grass pasture.

The bromegrass maintained its growth much better throughout the summer of 1944 than is usual. During the last 57 days of the period the heifers gained an average of 87 lbs. per head on bromegrass, 75 lbs. on Sudan grass, and 89 lbs. on the grama grass pasture.

The total production of dry matter from the bromegrass pasture was 2.75 tons per acre of which 1.92 tons or 70% were utilized. The grama pasture produced 1.38 tons dry matter per acre, including some weeds, of which 0.96 ton or 70% was utilized. Yield and utilization data were furnished by Dr. L. C. Newell of the Agronomy Department.

From August 31 to October 19, a period of 49 days, all three lots were fed separately on other bromegrass pastures which had been used earlier in the season for stock cattle. During this period the heifers were gradually put on grain feed. They went on feed very slowly, the average consumption of ground corn per head daily by weeks being 0.96, 1.84, 4.06, 5.45, 7.66, 10.13, and 12.01 lbs. for the seven week period or a total consumption for the period of 295 lbs. of ground shelled corn per head. The average gain per head for the 49 days by lots was 96, 86 and 82 lbs.

For the next 71 days, or until December 29, all of the heifers were fed together in dry lot and gained an average of 138, 138, and 132 lbs. per head for the three lots. They consumed an average of 997 lbs. of ground shelled corn, 1308 lbs. of corn silage, 103 lbs. of soybean oil meal, and 68 lbs. of prairie hay per head during the 71 days.
For the 247-day period the three lots made the following average gains per head:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>127 days' pasture without grain</td>
<td>134</td>
<td>122</td>
<td>156</td>
</tr>
<tr>
<td>49 days' pasture with grain</td>
<td>96</td>
<td>86</td>
<td>92</td>
</tr>
<tr>
<td>71 days in dry lot</td>
<td>138</td>
<td>138</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td>368</td>
<td>346</td>
<td>370</td>
</tr>
</tbody>
</table>

Assuming that the feed consumption per lot during the last 71 days was equal for the three lots, average feed consumed per heifer for the 247 days was 127 days' pasture without grain, 49 days' pasture with grain, 1292 lbs. or approximately 23 bushels of ground shelled corn, 1308 lbs. of silage, 103 lbs. of soybean oil meal and 68 lbs. of prairie hay.

The feed requirement per 100 lbs. of gain was as follows for the three lots:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days' pasture, without grain 1 heifer</td>
<td>brome 34.5</td>
<td>20.2</td>
<td>13.2</td>
</tr>
<tr>
<td></td>
<td>Sudan</td>
<td>16.5</td>
<td>.....</td>
</tr>
<tr>
<td></td>
<td>grama</td>
<td>.....</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>brome with grain</td>
<td>13.3</td>
<td>14.2</td>
</tr>
<tr>
<td>Ground shelled corn</td>
<td>351</td>
<td>373</td>
<td>349</td>
</tr>
<tr>
<td>Corn silage</td>
<td>355</td>
<td>378</td>
<td>354</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>28</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Prairie hay</td>
<td>18</td>
<td>20</td>
<td>18</td>
</tr>
</tbody>
</table>

The poorer showing made by the heifers grazed for a part of the season on Sudan grass may have been due to the chinch bug damage suffered by this pasture, especially during the last two weeks of the grazing period. In 1944 the bromegrass showed up to better advantage through the summer in comparison with grama grass than is frequently the case, probably because of the better growing condition for bromegrass during the summer of 1944.

Marvel L. Baker.

The use of urea for fattening yearling steers.—Six lots of 12 yearling steers with an average initial weight of approximately 630 pounds were fed for 159 days from June 28 to December 4, 1944. They had access to block salt and were fed corn silage and ground shelled corn. In addition they were given calcium carbonate and steamed bone meal to equalize approximately the intake of calcium and phosphorus and were fed either soybean oil meal, urea or a combination of the two. Lot 1 was fed 1.0 lb. of soybean oil meal per head daily. Lot 2 was fed 0.114 lb. of urea per head daily which, with the corn fed, supplied approximately as much nitrogen as that supplied by the corn and soybean oil meal fed to Lot 1. Lots 3, 4, 5, and 6 were fed a somewhat higher level of nitrogen than Lots 1 and 2. Lot 3 was fed 1.5 lbs. of soybean oil meal; Lot 4, 1.0 lb. of soybean oil meal plus 0.0575 lb. of urea; Lot 5, 0.5 lb. of soybean oil meal and 0.114 lb. of urea; and Lot 6, 0.172 lb. of urea per head daily.

The average daily feed consumption per head of the steers did not vary greatly between lots. For the six lots the average daily consumption of corn silage per head was 19.53, 20.81, 22.17, 19.50, 22.22 and 20.83 lbs. They also consumed an average of 17.19, 17.19, 17.20, 17.19, 17.25, and 17.07 of ground shelled corn or ground shelled corn and soybean oil meal. The average daily gain was quite good in all lots amounting to 2.68, 2.60, 2.71, 2.59, 2.68, and 2.68 lbs. per head. The feed requirement per 100 pounds of gain for the six lots was: Lot 1, 730 lbs. of silage, 665 lbs. of corn and 37 lbs. of soybean oil meal; for Lot 2 it was 800 lbs. of silage, 661 lbs. of ground shelled corn and 4.4 lbs. of urea; for Lot 3, 819 lbs. of silage, 580 lbs. of corn and 55 lbs. of soybean oil meal; for Lot 4, 754 lbs. of silage, 626 lbs. of corn, 39 lbs. of soybean oil meal; and for Lot 5, 785 lbs. of silage, 647 lbs. of corn, 40 lbs. of soybean oil meal; and for Lot 6, 804 lbs. of silage, 655 lbs. of corn, 38 lbs. of soybean oil meal.
meal and 2.22 lbs. of urea; for Lot 5, 829 lbs. of silage, 625 lbs. of corn, 19 lbs. of soybean oil meal and 4.27 lbs. urea; and for Lot 6, 782 lbs. of silage, 641 lbs. of corn and 6.45 lbs. of urea.

In this trial the nitrogen from urea apparently was utilized to advantage. No ill effects were observed from any of the rations. The steers differed very little in apparent finish at the close of the trial, and all sold at the same price.

The substitution of distillers’ wheat dried grains, urea, or ground rye for soybean oil meal for wintering steer calves.—Six lots of 14 steer calves were fed for a 140-day period from December 15, 1943, to May 3, 1944. The calves averaged approximately 427 lbs. at the beginning of the period. They were given a full feed of sorgo silage and had access to block salt and a mineral mixture composed of two parts of steamed bone meal and one part salt. In addition the six lots were fed the following amounts of supplements per head daily; 1.0 lb. of ground shelled corn; 1.0 lb. of a mixture of ground shelled corn and urea to provide the same level of nitrogen as that supplied by 1.0 lb. of soybean oil meal; 1.0 lb. of soybean oil meal; 1.29 lbs. of distillers’ wheat dried grains; 2.0 lbs. of distillers’ wheat dried grains; and 2.0 lbs. of ground rye. The distillers’ dried grains referred to as distillers’ wheat dried grains were distillers’ dried grains with solubles made from corn 4%, whole wheat 53%, granulated wheat flour 33%, and barley malt 10%. It contained 32.8% crude protein.

Lot 1, fed ground corn, consumed an average of 27.92 lbs. of silage and 1.0 lb. of ground corn per head daily, gained an average of 114 lbs. per head, and required 3420 lbs. of silage and 123 lbs. of corn per 100 lbs. of gain. Lot 2, fed the combination of corn and urea, consumed 1.0 lb. of the combination and 30.75 lbs. of silage per head daily, gained an average of 150 lbs. per head, and required 2870 lbs. of silage and 93 lbs. of the corn and urea mixture (approximately 82 lbs. of corn and 11 lbs. of urea) per 100 lbs. of gain. The addition of urea increased the gain made by the calves. Eleven lbs. of urea reduced the feed required per 100 lbs. of gain by 41 lbs. of corn and 550 lbs. of silage. The nitrogen from the urea apparently was utilized to some extent. However, it apparently was not utilized as fully as that from the soybean oil meal. Lot 3 consumed 1.0 lb. of soybean oil meal and 20.73 lbs. of silage per head daily. They gained an average of 194 lbs. per head and required 2215 lbs. of silage and 72 lbs. of soybean oil meal per 100 lbs. of gain. Distillers’ dried wheat grains produced approximately the same gain as soybean oil meal where fed to supply approximately the same level of crude protein. Lot 4 consumed an average of 1.29 lbs. of distillers’ dried grains and 31.66 lbs. of silage, gained an average of 191 lbs. per head and required 2327 lbs. of silage and 95 lbs. of distillers’ grains per 100 lbs. of gain; increasing the level of distillers’ dried grains to 2.0 lbs. per head daily increased the average gain to 211 lbs. per head and reduced the amount of silage required per 100 lbs. of gain to 2034 lbs.; however, 132 lbs. of distillers’ dried grains were required per 100 lbs. of gain. The calves in the lot consumed an average of 30.67 lbs. of silage per head daily. The calves in Lot 5 consumed an average of 2.0 lbs. of ground rye and 29.88 lbs. of silage per head daily. They gained an average of 171 lbs. per head and required 2451 lbs. of silage and 164 lbs. of rye per 100 lbs. of gain.

The amount of mineral mixture consumed varied little among lots.

Marvel L. Baker.

Sheep feeding investigations

The validity of progeny testing rams for improving Corriedale sheep.—A project was started in the fall of 1943 to improve Corriedale sheep through the use of progeny-tested rams. A year ago ten purebred Corriedale rams were mated with 150 head of white-face western ewes. The lambs produced from these matings are still under test to determine which of the rams will be used in the flocks at the main station and at
the North Platte and Mitchell Substations. Weaning weights, feed lot gains, wool, production and general acceptability of the lambs will be made the bases of comparison.

In the fall of 1944 two of the rams used in 1943 and eight new rams were under test.

**Improvement of pastures and meadows.**—In cooperation with the Agronomy Department, two pastures were seeded to a mixture of brome and alfalfa for use in a pasture management study. One pasture was divided into three equal parts which were grazed in rotation. The other pasture was not subdivided, thus giving the sheep access to all parts of it at all times. Exclusive of the first year that the pastures were established, five years' grazing observations have been made.

The lot where rotation grazing has been followed yielded 20 to 25% more days' grazing than the pasture which has been grazed continuously. Where rotation grazing has been followed, pasture has been available throughout the entire season with the exception of the first year. The continuously-grazed pasture has failed to furnish a full season of grazing every year. From the first of July to the middle of August the continuously-grazed pasture furnished no feed. This pasture steadily deteriorated because of a gradual influx of weeds so that at the end of the fourth year it had to be abandoned.

The pasture which was rotation-grazed was practically free from weeds after five years and provided a high carrying capacity throughout the grazing season. 

Through continuous and persistent observation of the dairy animal discoveries important to increased milk production occur. Relationships between weight and milk production, factors of reproduction, and studies in the nutrition of growing calves were conducted at this station during 1944 and progress made in answering many other complex problems relating to the dairy industry.

Dairy Production & Manufacture
Department of Dairy Husbandry

Growth Relationships

SINCE much animal experimentation uses growing animals as subjects, it is obvious that standards of growth must be established for proper comparison. A great many growth studies have been limited to weight or at most to one or two skeletal measurements. Although these are significant, the relationship of development in different parts of the skeleton may be equally important.

In the study of a series of measurements on growing dairy cattle (Holsteins) including height at withers; height at hooks; height at pinbones; diagonal length from the point of the shoulder to the point of the pinbones; length of top line from the second cervical vertebra to the end of the pinbones; length of rump; width of chest; width at hooks; width at pinbones; depth of chest; depth of barrel; heart girth; and barrel girth, various relationships were studied to determine if growth takes place in various parts of the body according to a particular pattern. The animals studied varied in numbers from 260 at birth to 124 at three years of age, and the resulting monthly measurements exhibited a very smooth curve of growth. In this study of data already collected, which covers the first three years of life, the most active growing period, it was clearly evident that growth was most rapid during the first year. After that the curves tend to flatten. All measurements presented smooth curves indicating that growth is a continuing process and does not occur at irregular intervals.

In order to determine the relationships between measurements of length, tabulations were made at 6-month intervals, using the diagonal length as a standard. With that measurement was compared the length of top line and the rump length. In the 6-month intervals from birth to 36 months, the top line showed a variation between 56.41% and 59.72% of the diagonal length, and the rump length varied from 28.02% to 29.34% of the diagonal length. It is apparent that all of these length measurements maintain a very close relationship throughout the period of active growth.

Using as a standard the height at withers, similar comparisons were made at 6-month intervals for measurements of height at hooks and height at pinbones. Height at hooks showed a variation in terms of the height at wither (100%) of from 100.73% to 103.91% which is a very small variation. In the case of height at pinbones, the variation was from 96.74% to 102.62%. This was a wider variation and there was an indication that the growth in height at pinbones slows down as compared with the height at withers towards the end of the active growing period for there was a gradual decrease from six months on to three years.

Comparing width measurements of opposite ends of the pelvis, using width at hooks as the standard (100%), it was found that width at pinbones was very constant, varying from 65.65% to 70% of the width at hooks. Here again there was a slight tendency for the growth to be proportionately slower as the animal grew older although this difference is probably not significant. When the width at chest is compared with the width at hooks, the relationship is not close. At birth the chest measure was 101.18% of the width at the hooks, but this ratio gradually reduced to 81% at the end of three years.
Using heart girth as a standard and comparing barrel girth with it, we find that at birth barrel girth is 102.68% with heart girth being 100%. At six months this relationship jumps to 121.10% for barrel girth and from that time on the variation ranges from 117.54% to the figure previously mentioned. Inasmuch as the measurements used carried through at least one pregnancy and in many cases two pregnancies for the animals involved, it is interesting to note the slight relative variation between the heart girth and the barrel girth.

With depth of chest used as a standard of 100%, depth of barrel taken in the region of the last rib at birth was 97.19%. This jumped up to 105.88% at six months and varied down to 102.6% at 36 months.

Using diagonal length as the standard of 100%, comparisons showed that the following weights prevailed: the height at withers starting at 105.56% gradually decreased to 84.81% at three years; the width of hooks starting at 24.22% increased to 34.38% at 36 months of age; heart girth starting at 111.82% increased by two years to 122.86% after which point it remained constant. Depth at chest starting at 40.6% showed a gradual increase to 44.96% at three years of age. *H. P. Davis and R. F. Morgan.*

**Factors affecting reproduction in the herd**

In order to serve the farmers in Lancaster and surrounding counties until such times as they are able to set up their own organization for the ownership of bulls, sires owned by the University of Nebraska have been made available for artificial breeding. This service provides a return benefit to the station for it has made it possible to study on a monthly basis the breeding record of ten bulls representing the Holstein, Guernsey, and Jersey breeds. The study indicates very clearly a great variation in the conception rate of cows inseminated with semen from various bulls at different times of the year. Not only is there an individual variation but the month-to-month variation is considerable. Although a certain amount of error is obviously involved in determining when the cow conceives, it is believed that the study represents a practical determination of what happens. Altogether 1470 cows were bred of which 931 conceived, an average conception percentage of 63.33. The variation by bulls ranged from 53.66% to 75%. This study emphasized the importance of a careful and constant monthly check on the breeding ability of bulls that are to be used in artificial insemination associations. The use for any lengthy period of a poor breeding bull would cause much loss due to delayed breeding.

In an 8-month study of the same 10 bulls, it was found that the first four services resulted in a total conception percentage of 61.7. When the tabulations were made of the length of semen storage as to its effect upon the conception of the cows, it was found that for first-day storage the conception rate was 68.5%; for two-days storage 58.9%; for three-days storage 55.5%; and for four-days storage 59.7%.

These figures are derived from samples, in the case of semen stored for longer than one day, which showed at least 50% progressive motility. *H. P. Davis and G. W. Trimberger.*

**Artificial insemination**

Much interest has developed in the shipment of semen over long distances. Although long distance shipments have been made, certain practical limitations tend to discourage the procedure. In order to determine what might be excepted in the way of breeding efficiency from such shipments, long distance shipments by air mail were made between Lincoln and Moores Mills, New York, through the cooperation of Mr. J. H. Cooper, creator of the Cooper Foundation, and his veterinarian, Doctor George L. Stringham. Air shipments were made sufficient for 25 inseminations of 15 cows. The procedure was as follows:
The veterinarian, keeping careful check of the heat periods of cows in New York state, informed the investigators at this station of the heat expectancies. In an endeavor to have the semen arrive about 24 hours before the expected heat period, the shipments were made by air.

Since the work was carried on in the winter, certain difficulties, such as one period during which air transportation was suspended, arose. The cows showed considerable variation from their expected heat periods. All in all, however, the results are not without significance. Of the group, six conceived—four at the first, and two at the second service. The semen samples used for such inseminations were of the following ages: 56, 80, 97, 129, 144 and 152 hours old at the time of the insemination.

The response provides another indication that semen of good quality can be kept for considerable periods and still bring about a reasonable percentage of conception.

Studies have been in progress to determine the percentage of females coming into estrus in the forenoon and the afternoon, the duration of estrus, the time of ovulation after estrus, and the rate of conception from artificial insemination at eight different intervals before and after ovulation. It is believed that these studies will indicate procedures for use in artificial insemination associations which will be of much benefit in improving the efficiency of breeding.

H. P. Davis and G. W. Trimberger.

Studies in milk substitutes for growing calves

It has been demonstrated by previous experiments at this station that with certain combinations of dry calf starters, calves that are three weeks old can be grown successfully from that age on with a minimum of 50 lbs. of skim milk. In an effort to determine if there were definite differences in the effects obtained from calf starters where the chief source of protein was from different high protein concentrates, an experiment was conducted using 56 calves with a basal ration consisting of 150 lbs. ground yellow corn, 150 lbs. ground oats, 100 lbs. wheat bran, 100 lbs. soybean meal expeller process (41%), 12 lbs. steamed bone meal, and 6 lbs. iodized salt. Various high protein supplements were added to balance the grain mixture so as to obtain about 15.8% digestible protein. Six lots of calves were used with two lots consisting of 10 calves and the remainder being 9 animals each. Lot 1 had an addition of 50 lbs. soybean meal to the basal ration; Lot 2 had 27 lbs. of 55% tankage to the basal ration; Lot 3 had 168 lbs. ground soybeans substituted for the soybean meal in the basal ration; Lot 4 had 100 lbs. of dried whey and 24.5 lbs. of blood meal added to the basal ration; Lot 5 had 55 lbs. dried skim milk (non-fat milk solids) added to the basal ration; and Lot 6 had 17.5 lbs. blood meal added to the basal ration. The calves were weighed, measured, and fed according to the same procedures used in previous experiments. One calf died in each of the groups 1, 4, 5, and 6. A post-mortem failed to reveal that these deaths were due to any procedure in the experiment.

The results may be summarized:

Fifty-one grade Holstein calves which had received whole milk for three weeks were fed to six months of age. Each group was allowed 50 lbs. of skim milk after which they were expected to obtain their nutrients from the protein supplement provided in liquid form, a dry calf starter, and green alfalfa hay (U. S. No. 1). The source of supplemental protein in the dry calf starter for each group was: Group 1, soybean meal; Group 2, tankage; Group 3, ground soybeans; Group 4, dried whey and blood meal; Group 5, dried skim milk powder; and Group 6, blood meal. A vitamin A and D concentrate first was fed to each calf in the liquid and later it was thoroughly mixed with the calf starter. The several calf starters were fed to four months of age after which all the groups received the same basal grain mix.
The calves on the soybean meal (Group 1) and the ground soybeans (Group 2), lost weight and became very emaciated but were allowed to remain on experiment as long as possible with the hope that they might recover from the temporary setback. However, when these calves became too weak, they were switched to a more desirable ration. Recovery was gradual and the rate was apparently dependent upon the degree to which growth had been checked and also on the quantity of skim milk or whole milk supplied. When fed the additional milk they eventually gained sufficiently to be normal in weight for their age. These two groups had the highest requirements for total digestible protein and total digestible nutrients per 100 lbs. of gain which indicates that it is poor economy to feed improper rations to young calves. It may be concluded that under the conditions of this experiment, soybean meal and ground soybeans were not satisfactory as the principal source of protein in a dry calf starter for calves of approximately one month of age.

The four groups of calves receiving the animal protein in the dry calf starter, namely, tankage, dried whey and blood meal, dried skim milk, and blood meal, made normal growth. Average weights at six months of age per calf and the average daily gain per calf were as follows: Group 2 (tankage) 349.0 lbs., 1.49 lbs.; Group 4 (whey and blood meal) 338.1 lbs., 1.34 lbs., Group 5 (dried skim milk) 361.4 lbs., 1.49 lbs.; and Group 6 (blood meal) 352.5 lbs., 1.44 lbs.

The results were studied statistically by analysis of variance, and the differences in the gains between the calves on the soybean meal and soybeans when compared to the gains in weight of the four groups receiving animal protein were highly significant at eight weeks of age. The statistical test was also applied at the age of four months when the feeding of the dry calf starter was discontinued and again at six months at the completion of the experiment. No significant differences were obtained among the six groups, indicating that the two groups which originally were stunted on the poor rations had recovered on the more desirable rations. Except for the tankage group at eight weeks, there were no significant differences in the gains among the four groups of calves receiving the animal protein in their rations at any period of the experiment.


Meeting wartime problems in ice cream making

The demand for milk solids either in whole milk, skim milk, condensed milk, or milk powder has multiplied the problems of the ice cream maker since he has been limited to a definite quota of milk solids. The body and texture of ice cream is very greatly improved by the milk solids content and the reduction of the milk solids has tended to produce an ice cream of inferior quality. In an effort to meet this problem, studies have been conducted with the use of commercial cereal (oat) and soybean flours as well as marshmallow and whole eggs. The effect of these products upon the whipping quality of mix and the body and flavor of ice cream have been studied. In all cases the quantity used was additive to the maximum serum solids allowable when the mix contained 10.5% butterfat rather than as a replacement of a portion of the serum solids. The use of the flours in these trials tended to increase the time required to obtain 100% overrun but did not affect the maximum obtainable. The use of oat or soybean flour in quantities of 1% or more improved the body but adversely affected the flavor of the mix and of vanilla flavored ice cream made from it; while the use of 0.5% of these products produced no noticeable improvement in the body nor did it adversely affect flavor. One per cent whole egg either fresh or frozen improved the body,
whipping ability, and was not deleterious to flavor. The marshmallow was added at the freezer in quantities up to 20% of the volume of the mix. When 20% was used, the resulting ice cream had a definite marshmallow flavor and was criticized as being too sweet. Marshmallow improved the body of the finished ice cream and slightly increased the whipping rate. L. K. Crowe.

**Vitamins in cheese**

The riboflavin (vitamin G) values of 20 different kinds of cheeses and cheese spreads were determined by the biological method in a total of 11 experiments. These products were either made in the College Creamery or were obtained at local stores. Approximately 1100 rats were used in the studies, and other experiments are now in progress.

The cheeses and cheese spreads assayed were Wisconsin Cheddar, New York Cheddar, Cornhusker (a cheese developed at Nebraska being somewhat of a blend between Cheddar and Brick), Limberger, Roquefort, Swiss, Edam, Brick, Velveeta, Munstetti, Kraft American, Goat, Liederkranz, Smoked Kaukauna Club, Cottage, Vegetable Cottage, Cream, and Pimento Cream. A generalized view of the range of the riboflavin values is shown by the highest content, 7.59 mg. per gram for Smoked Kaukauna Club, and the lowest 1.17 mg. per gram for Pimento Cream.

The results of these experiments will be published in the near future. I. L. Hathaway.

**Nebraska cheese studies**

As a result of the grading of Cheddar cheese for the War Food Administration, opportunities for the study of factors influencing the production of high quality cheese have been available. A study of the monthly production of cheese in an attempt to determine any influence due to weather conditions has indicated that No. 1 cheese can be produced in all seasons of the year if the milk supply and the methods of manufacture are properly controlled. The influence of pasteurization was very apparent in the production of No. 1 cheese. Although first grade cheese can be produced from raw milk, the pasteurization of the milk greatly increases the likelihood of obtaining top quality cheese. There was a wide variation in the methods of handling cheese after removal from the press. It is believed a more uniform system of manufacture together with a uniform method of handling after its removal from the press would bring a higher percentage of high quality cheese. Grading records show that the main flavor defect is described as "acidy." Other flavors designated as "utensil" or "yeasty" appear but do not have any significant relationship to the season of the year. The most common body defect in the cheese was "openness" and this is probably the result of the method of manufacture. It is believed that by the use of pasteurization a high percentage of first quality cheese can be made.

In observations made during the regrading of cheese at different stages of ripening, a marked variation of the keeping quality of different lots was noted. Fifteen lots of cheese were held in storage and were examined at 15, 45, 105, and 245 days in storage with the cooperation of the Food Distribution Administration. Certain bacteriological and chemical studies are being continued. The results are not complete but there is evidence to show that the quality of cheese as determined by grading at 15 days of age is correlated with its quality throughout the storage period.

The intent of these studies is the determination of procedures which can be recommended for Nebraska plants. P. A. Downs.
Preserving dairy products

Pasteurization of cream.—Home pasteurization studies were conducted by heating cream in a closed container on the following basis: 30 minutes at a temperature ranging from 145 to 150°F.; 12 minutes at a temperature of from 158 to 164°F.; 9 minutes at a temperature of from 170 to 175°F.; and 4 minutes at a temperature of 180 to 185°F. These experiments indicated that where the lower temperatures were used, the cream soured, but at a normal rate. With some lots gases and undesirable flavors developed after holding at 70°F. The high temperatures of pasteurization seemed to retard the acid production and encouraged gas formation with undesirable flavors. The use of pasteurization in closed containers practically eliminated mold growth in the cream. These studies indicate that cream separated on the farm can be improved in quality by pasteurization, when fresh, at 145 to 150°F. for 30 minutes. This might be a means of getting cream of better quality to market. Experiments have also shown that by cooling cream to 70°F. as soon as separated, by keeping it covered to protect from air contamination, and by storing at that temperature or lower, a sour cream of good quality can be produced.

P. A. Downs and F. D. Yung.

Vitamin content of commercial butter

As a part of the research project of the National Research Council, studies on the vitamin content of commercial butter have been carried on during the year. Vitamin A, carotene, moisture, and fat analyses have been made on samples of commercial butter at monthly intervals since October of 1943. These samples, obtained from the sampling centers at Hastings, Alliance, Grand Island, and Lincoln, were analyzed upon their arrival and were re-analyzed after having been stored at zero degrees for six months.

From one year's work it was found that commercial Nebraska butter contained an average of 16,552 International Units per pound. This study has been expanded and will be continued for another year.

I. L. Hathaway.
Producing healthy, productive poultry requires careful investigation into their nutrition, environment, and heredity. To this end poultry husbandry continues its vitamin, feedstuffs, and poultry equipment studies—these in the interests of producing better poultry in Nebraska more economically.

Poultry Nutrition & Management
Department of Poultry Husbandry

Safflower Seed as a Feedstuff for Chicks

SAFFFLOWER, a recently introduced plant of high oil content, seems to be adapted to the climate and soil of western Nebraska. Although it is being investigated primarily as a possible oil-producing crop, it is also desirable to learn its value as a feedstuff. A preliminary experiment with chicks was carried on during the past year with this objective in mind.

The purpose of the first experiment was to determine the tolerance of chicks for rather high levels of safflower seed and to determine the effect of cooking the seed on its growth-promoting value. The latter inquiry was suggested by the results of repeated experiments, indicating that cooked soybeans, also a high fat seed, were significantly more valuable in poultry rations than are raw soybeans.

A comparison of the raw and the cooked safflower seed reveals that some of the fat is lost in cooking. Cooking the seed was effected by autoclaving for 30 minutes at 15 pounds pressure. The seed was spread on trays to a depth of about 1½ inches, thus allowing the heat to penetrate the seed very quickly. Chemical composition of the two samples was as follows:

<table>
<thead>
<tr>
<th>Protein</th>
<th>Fat</th>
<th>Crude fiber</th>
<th>Nitrogen-free extract</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Raw safflower seed 16.6 26.8 31.1 18.8 3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooked safflower seed 16.6 26.8 31.1 18.8 3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Experimental.—For a base ration carrying adequate amounts of vitamin and mineral essentials was used. This ration (Saff X) was composed of the following ingredients to make a 660-lb. mix.

Base “Saff-X”

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorts</td>
<td>200</td>
</tr>
<tr>
<td>Bran</td>
<td>100</td>
</tr>
<tr>
<td>Pulverized oats</td>
<td>100</td>
</tr>
<tr>
<td>Alfalfa leaf meal</td>
<td>50</td>
</tr>
<tr>
<td>Meat scraps</td>
<td>100</td>
</tr>
<tr>
<td>Fish meal</td>
<td>20</td>
</tr>
<tr>
<td>Dried buttermilk</td>
<td>50</td>
</tr>
<tr>
<td>Limestone</td>
<td>20</td>
</tr>
<tr>
<td>Salt</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin A + D blend</td>
<td>10</td>
</tr>
</tbody>
</table>

Sixty-six per cent of “Base Saff-X” was included in each ration, the variable being included in the remainder of the formula. For a control ration (Lot No. 670), a blend of 5.5 lbs. of soybean meal and 28.5 lbs. of yellow cornmeal was used to provide the same amount of protein as was provided by 34 lbs. of ground safflower seed. Details of ration variations are given in Table I.
Table I

<table>
<thead>
<tr>
<th>Lot Nos.</th>
<th>668</th>
<th>669</th>
<th>670</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base &quot;Saff-X&quot; lbs.</td>
<td>66</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Safflower seed (raw)</td>
<td>34</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Safflower seed, (autoclaved 30 min. at 15 lbs.) ...</td>
<td>34</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Soybean + corn blend (16.6% protein) ...</td>
<td>...</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Protein (analysis), per cent</td>
<td>21.6</td>
<td>22.4</td>
<td>21.7</td>
</tr>
<tr>
<td>No. chicks per lot</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Average weight at start, gm.</td>
<td>42</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>28 day weights, gm.</td>
<td>244</td>
<td>238</td>
<td>276</td>
</tr>
<tr>
<td>56 day weights, gm.</td>
<td>630 + 14</td>
<td>663 + 14</td>
<td>714 + 16</td>
</tr>
<tr>
<td>Deaths</td>
<td>19</td>
<td>14</td>
<td>6</td>
</tr>
</tbody>
</table>

Conclusions.—The relatively high fiber content of safflower seed (26.6%) will probably limit its use in chick rations to a level of less than 10%. Most of the losses which occurred during the feeding of the safflower ration were experienced during the first 28 days, a period when chicks have limited tolerance for fiber. Slightly better results were obtained with the cooked safflower seed than with the raw.

These results indicate that, should the production of safflower seed prove feasible from the agronomic standpoint, more investigational work should be directed to the use of the seed and the meal by-products in rations for hens and turkeys. Because of the high oil content, grinding the seed presents somewhat of a problem.

F. E. Mussehl and Wendell Ham.

Low cost rations for Leghorn broilers

The practice of sexing Leghorn chicks in order to permit the sale of pullets and cockerels separately has developed because many producers, whose primary poultry product is market eggs, are interested in raising pullets only for the replacement of birds in their laying flocks. The cockerels are for them merely a by-product, and, as such, are often sold at $3.00 to $4.00 per hundred.

Several experiments were carried on in an effort to develop low cost rations which could be used satisfactorily for growing these surplus Leghorn cockerels to a two-pound weight, a weight normally achieved in 10 weeks. The necessity for reinforcing this ration with the vitamin B complex factors, riboflavin and choline, was investigated. The first experiment indicated that with Ration No. 672, made up of corn, wheat, oats, and alfalfa, with 23% of soybean meal and 3% of meat scraps used as the protein supplement, a satisfactory growth can be obtained without the addition of riboflavin or choline. The replacement of 3% of soybean meal in the basic ration with 3% of a typical wheat fermentation by-product improved the growth rate slightly.

Further research work on this problem is contemplated.

F. E. Mussehl.

Vitamin B complex requirements for growing poults

Since poults grow very rapidly during the first eight weeks, a relatively high requirement for the vitamin B complex factors concerned in growth can be anticipated. Fortunately, the B complex vitamins are generally well distributed in the common turkey feedstuffs. With certain combinations, however, two B complex factors, riboflavin and choline, may limit the growth.
Both of these factors now being available, in synthetic form, experimental work was carried on to determine whether growth rate could be improved when these vitamins were added to a particular ration, a ration, specifically, in which the concentrates consisted of a relatively high proportion of soybean meal and a small amount of animal protein. For a control ration, the combination of concentrates used in previous experiments, and referred to as P.V.M. No. 2, was used.

Two experiments, involving a total of 825 poults, were undertaken. Riboflavin values for all of the basic and supplemented rations were determined in our laboratory by the microbiological method. The ration with the lowest riboflavin content still carried 1488 units per pound, an amount apparently sufficient to promote a normal growth rate. The addition of one-fourth of a per cent of choline chloride likewise failed to promote an improved growth rate.

F. E. Mussehl.

A comparison of battery brooding and floor brooding for chicks

Questions are constantly asked about the relative value of battery brooders and good floor-brooding equipment for growing chicks. To obtain information on the relative growth rate, labor requirements, and the general condition of the birds brooded under battery and floor conditions, an experiment was carried on with White Rock chicks from pullorum-free stock. A ration known to be complete for all protein, vitamin and mineral factors was used.

For the battery-brooded lot, 25 chicks were placed in each one of two units, measuring 36 x 30 inches. This is approximately twice the amount of space usually recommended for battery brooding, so that conditions were unusually favorable from this standpoint. The battery units were heated with electric units adjusted to 95 degrees under the heated section for the first two weeks, and 90 degrees Fahrenheit for the last two weeks of the observation.

The floor-brooded lot was placed in a small pen, 4 x 12 feet, with an electric brooder equipped with an automatic thermostat and adjusted to the same temperatures on the floor as were provided in the battery.

Conclusions.—For the first two weeks, the growth rate and general condition of the chicks were comparable in both lots. From the 14th day on, however, the chicks in the floor-brooded unit developed much more normally. At the beginning of the third week, there was some evidence of cannibalism in the battery-brooded lot, but the chicks receiving the same ration in the floor-brooded unit were contented and showed no inclination toward cannibalism.

It is concluded that for best results the use of batteries is limited to the first two weeks of the brooding period. The theoretical advantage of lower labor costs is not apparent, because more items of equipment must be cleaned regularly under the battery system to keep them sanitary.

F. E. Mussehl.

Will moldy corn kill chicks?

Reports of heavy losses among chicks, which it is believed were caused by moldy feed, are received each spring. Actually, very little research data seem to be available on this very perplexing question. With the common methods of storing corn, both before and after shelling, some loss of quality, using the common market grade standards, can be observed. Whether the reduction in grade also reduces the nutritional value is a pertinent and a practical question.

Because it is much more likely to be altered under normal storage and handling conditions, corn was taken as a basic feedstuff for preliminary investigation.
For the experiment, corn, grown on the same farm and having the same natural
exposure to microorganisms, was used. A description of the three lots with the
basal ration used follows:
Lot 690. Control. No additional processing except grinding.
Lot 691. The corn was soaked in tap water and fermented at a tempera-
ture of 70°F. for 24 hours and then dried in an incubator as quickly as possible.
Lot 692. The corn was soaked at 70°F. for 24 hours, then left in a pile on the floor
to ferment and mold for six days at summer temperatures. The pile was about six
inches deep and was kept covered with burlap sacks to encourage the growth of the
mold type of microorganisms. After six days of fermentation in this manner, the
corn was dried in an incubator at 100°F., ground and mixed with the other ingredients.
The balance of the ration, which is referred to as Base NCX, consisted of the
following ingredients:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Base NCX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorts</td>
<td>10 lbs.</td>
</tr>
<tr>
<td>Bran</td>
<td>10 lbs.</td>
</tr>
<tr>
<td>Pulverized oats</td>
<td>10 lbs.</td>
</tr>
<tr>
<td>Alfalfa leaf meal</td>
<td>5 lbs.</td>
</tr>
<tr>
<td>Meat scraps</td>
<td>5 lbs.</td>
</tr>
<tr>
<td>Fish meal</td>
<td>3 lbs.</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>15 lbs.</td>
</tr>
<tr>
<td>Salt Mix No. 45</td>
<td>3 lbs.</td>
</tr>
<tr>
<td>D blend (200 D per gm.)</td>
<td>1 lb.</td>
</tr>
</tbody>
</table>

Conclusions.—The growth rate on all three lots was very satisfactory,
and the mortality not excessive. In fact, no losses occurred in the lot
receiving 38% of corn despite the fact that it had been permitted to
become very moldy. Moreover, not a single kernel of this corn would
have been graded as of No. 2 quality. Although this one experiment does
not prove that microorganisms of the type which develop when corn
becomes wet and moldy may not occasionally be harmful, it does indicate
that moldy corn cannot always be considered as pathogenic or harmful
to baby chicks.

Riboflavin determinations were made of the three samples of corn used in the
experiment. The following are the values:

<table>
<thead>
<tr>
<th>Lot</th>
<th>Units per lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 69, control</td>
<td>672</td>
</tr>
<tr>
<td>Lot 691</td>
<td>688</td>
</tr>
<tr>
<td>Lot 692</td>
<td>1498</td>
</tr>
</tbody>
</table>

It appears from this preliminary experiment that fermentation processes
should be further studied, not only from the standpoint of pathogenic
hazards, but also as regards the enhancement of growth-promoting and
general nutritional value.

F. E. Mussehl.

Wheat fermentation by-products in rations for laying hens

Various grains are now being fermented for the production of industrial
alcohol. During recent years, considerable amounts of surplus wheat
have been used, and various fermentation by-products have been made
available for feeding livestock and poultry. Certain of these by-products
have been found to carry high concentrations of B complex vitamins, for
which laying hens and growing chicks have a relatively high requirement.

The product used in our experiments was described by the manufacturers as "distil-
lers' dried grains with solubles." Although the ratio of the dried grain residue
to solubles was not stated, it may be considered a typical commercial fermentation
by-product. The chemical composition was as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>34.7</td>
</tr>
<tr>
<td>Fat</td>
<td>6.8</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>14.3</td>
</tr>
<tr>
<td>Total ash</td>
<td>4.2</td>
</tr>
<tr>
<td>Nitrogen-free extract</td>
<td>33.9</td>
</tr>
<tr>
<td>Moisture</td>
<td>6.1</td>
</tr>
</tbody>
</table>
Riboflavin assays on six samples of this material taken at random showed a value of 2916 units per pound.

A 26% protein mash mixture, carrying 4.3 and 13.5%, respectively, of this product, was used in this ration for laying hens. A mash mixture known to carry all nutritional essentials at a satisfactory level, was fed to the control group. Three lots of 250 selected Leghorn pullets were started on the experiment on September 1 under conditions which were intended to approximate those on a typical Great Plains area general farm, where corn, wheat, oats and barley are available as basic feedstuffs. Data were obtained on egg production, livability of birds, and hatchability of eggs. A summary of the results will appear in a bulletin now in preparation.

Conclusions.—At least 13.5% of the particular type of wheat fermentation by-product used in these experiments, can be included in a 26% concentrate formula for layers and breeders with good results. Whether or not higher levels can be used advantageously remains to be investigated. The physiological effect of the ration containing 13.5% of fermentation by-product was very good. The hatchability of eggs laid was most satisfactory in all lots.

F. E. Mussehl, R. M. Sandstedt and Wendell Ham.

Riboflavin distribution in poultry feedstuffs

Riboflavin, also known as vitamin B₂ or G, is included in the B complex group. One of the most important vitamins required by laying hens, chicks and turkeys, it is, fortunately, widely distributed in natural feedstuffs. Nevertheless, despite its prevalence, information should be obtained concerning its distribution and stability under different conditions of feed processing and storage.

The method of determining riboflavin values known as the microbiological method was used to determine the riboflavin values of representative samples of feedstuffs obtained from ordinary market sources.

Average values are listed in Table I.

<table>
<thead>
<tr>
<th>Description</th>
<th>No. of samples assayed</th>
<th>Gamma per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydrated alfalfa leaf meal (No. 319)</td>
<td>2</td>
<td>5,221</td>
</tr>
<tr>
<td>Alfalfa (field-cured) leaf meal (No. 320)</td>
<td>2</td>
<td>5,144</td>
</tr>
<tr>
<td>Alfalfa (cured under cover) leaf meal (No. 321, subdued light)</td>
<td>2</td>
<td>5,552</td>
</tr>
<tr>
<td>Alfalfa leaf meal (dehydrated) (No. 323)</td>
<td>3</td>
<td>10,306</td>
</tr>
<tr>
<td>Alfalfa leaf meal (dehydrated) (No. 324)</td>
<td>3</td>
<td>7,396</td>
</tr>
<tr>
<td>Fair quality alfalfa meal (stemmy) (No. 325)</td>
<td>2</td>
<td>4,408</td>
</tr>
<tr>
<td>Turkey greens (dehydrated) (No. 326)</td>
<td>2</td>
<td>5,434</td>
</tr>
<tr>
<td>Dry distillers' by-product (wheat) (No. 327)</td>
<td>3</td>
<td>3,069</td>
</tr>
<tr>
<td>Soybean oil meal (43% protein) (No. 328)</td>
<td>2</td>
<td>1,752</td>
</tr>
<tr>
<td>Soybean oil meal (No. 329)</td>
<td>3</td>
<td>1,643</td>
</tr>
<tr>
<td>G 220 Calcium Carbonate Co. (No. 330)</td>
<td>1</td>
<td>2,718</td>
</tr>
<tr>
<td>Produlac-corn fermentation by-product (No. 331)</td>
<td>2</td>
<td>4,785</td>
</tr>
<tr>
<td>Chicken scrap (No. 332)</td>
<td>2</td>
<td>6,006</td>
</tr>
<tr>
<td>Dried whey, (No. 333)</td>
<td>2</td>
<td>9,847</td>
</tr>
<tr>
<td>Fish meal (Menhaden) (No. 334)</td>
<td>3</td>
<td>3,055</td>
</tr>
<tr>
<td>Dried buttermilk (No. 335)</td>
<td>2</td>
<td>13,246</td>
</tr>
<tr>
<td>Meat scraps (No. 336)</td>
<td>3</td>
<td>1,516</td>
</tr>
<tr>
<td>Fermentation solubles (Omaha plant) (No. 337)</td>
<td>4</td>
<td>4,817</td>
</tr>
<tr>
<td>Wheat fermentation by-product (No. 338)</td>
<td>1</td>
<td>3,391</td>
</tr>
<tr>
<td>Yellow corn, control (No. 339)</td>
<td>3</td>
<td>672</td>
</tr>
<tr>
<td>Yellow corn (soaked 24 hrs.) (No. 340)</td>
<td>2</td>
<td>688</td>
</tr>
<tr>
<td>Yellow corn (fermented 6 days) (No. 341)</td>
<td>2</td>
<td>1,498</td>
</tr>
<tr>
<td>Liver meal (No. 342)</td>
<td>4</td>
<td>21,520</td>
</tr>
</tbody>
</table>
Research into the causes of mortality among animals together with investigations into epidemic diseases affecting livestock was the animal pathologists' contribution to more profitable farming in Nebraska. The station also serves this livestock-producing state by answering the inquiries of practitioners and producers concerning the prevention of disease and the care of animals stricken by disease or injury.

Animal Diseases

Department of Animal Pathology and Hygiene

Bacteriologic, Serologic and Pathologic Examinations

As in past years specimens for laboratory examination were submitted by private individuals and others during the year which came to a close Dec. 31, 1944; a total of 7,275 specimens were subjected to examination and the results reported to the parties interested. F. R. Woodring.

A study of the nature of swine erysipelas

Progress in the work on this project was somewhat retarded by difficulties in securing labor and by the uncertainty of procuring feedstuffs for the experimental livestock. In addition, the dry ice needed to preserve the material coming from the field was not always available. The labor and feed problem was particularly acute during the earlier part of the year, but in the course of the last few months of the year the situation improved.

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

1. The validity of the culture-vaccines used in the state. This work was undertaken with the cooperation of the Nebraska Bureau of Animal Industry, which provides the Department with culture specimens for bacteriologic analysis. Attention is called to the fact that culture-vaccines to be acceptable for vaccination practice, must be highly virulent and show a good capacity for growth when transplanted on a suitable culture medium. When these qualities are lacking, vaccination results are liable to be unsatisfactory.

The results of our tests of 250 culture samples made since 1942 indicate that a relatively large number of specimens failed to come up to reasonable specifications. These results are presented in Table I. From them it can be inferred that a number of producers more or less constantly succeed in the production of acceptable materials, and that some concerns, more or less periodically, fail to produce valid material.

Table I. The total of all tests of E. rhusiopathiae culture-vaccines for growth capacity and virulence between October 28, 1942, and December 14, 1944

<table>
<thead>
<tr>
<th>Producer's identification</th>
<th>Number of samples tested</th>
<th>Number of samples acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>43</td>
<td>11 (25.58%)</td>
</tr>
<tr>
<td>B</td>
<td>41</td>
<td>40 (97.56%)</td>
</tr>
<tr>
<td>C</td>
<td>41</td>
<td>20 (48.78%)</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>E</td>
<td>32</td>
<td>29 (90.62%)</td>
</tr>
<tr>
<td>F</td>
<td>31</td>
<td>10 (32.25%)</td>
</tr>
<tr>
<td>G</td>
<td>19</td>
<td>17 (89.47%)</td>
</tr>
<tr>
<td>H</td>
<td>42</td>
<td>32 (76.19%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>250</strong></td>
<td><strong>160 (64%)</strong></td>
</tr>
</tbody>
</table>
Cultures submitted for examination are tested on their expiration dates, which for a considerable period was fixed at 60 days after production. This department had always objected to such an extended expiration date, believing that the cultures are likely to become inferior in quality when more than 30 days have elapsed since production. To determine, if possible, the influence of aging, duplicate samples were collected and placed on test 30 days after production as well as 60 days after. The results of this study are set forth in Table II.

Table II. Summaries of results of tests of E. rhusiopathiae culture-vaccines 30 and 60 days after production.

<table>
<thead>
<tr>
<th>Classification of results</th>
<th>Identification of producers</th>
<th>Totals</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nos. of identical samples tested 30 and 60 days after production</td>
<td>A 16, B 13, C 15, D 7, E 8, F 3, H 72</td>
<td>72</td>
<td>......</td>
</tr>
<tr>
<td>Nos. of samples which proved nonacceptable by both 30 and 60 day tests</td>
<td>16 11, 15 0, 7 4, 8 0, 3 5, 3 2</td>
<td>23</td>
<td>31.94%</td>
</tr>
<tr>
<td>Nos. of samples found to be acceptable by 30 day test but not acceptable by 60 day tests</td>
<td>5 0, 0 4, 1 1, 3 2, 2 15</td>
<td>15</td>
<td>20.83%</td>
</tr>
<tr>
<td>Nos. of samples found to be acceptable by both 30 and 60 day tests</td>
<td>0 0, 13 5, 6 6, 0 6</td>
<td>30</td>
<td>41.67%</td>
</tr>
<tr>
<td>Nos. of samples found to be acceptable by 60 day test but not acceptable by 30 day tests</td>
<td>0 0, 0 2, 0 0, 2 4</td>
<td>4</td>
<td>5.55%</td>
</tr>
</tbody>
</table>

Since the completion of this experiment regulatory authorities reduced the expiration date to 40 days. This action resulted in some improvement as shown by our analysis, although recently some cultures tested at the 40-day expiration date proved to be nonacceptable. The number of cultures with a 40-day expiration date thus far tested is not sufficient as yet for a final analysis.

(2) In view of the importance of valid culture-vaccines to be used in the protection of Nebraska swine, this department inaugurated an investigation in order to discover if possible those influences which may impair the quality of culture material. This study is still being pursued, but the accumulation of results proceeds so slowly that whatever data may become available are as yet not sufficiently numerous to hazard a definite analysis. Hence these efforts are being continued in the hope that eventually the Department may be in a position to explain why some producers nearly always submit acceptable material whereas others so frequently fail to do so.

(3) This phase of the swine erysipelas problem consists in an effort to determine the presence or absence of an ultramicroscopic virus as an essential contributory factor in the etiology of the disease. Thus far it has not been possible to bring to light the presence of such a factor in Nebraska swine affected with swine erysipelas. Owing to the great importance of the problem, the work must be continued so as to accumulate a sufficient number of observations to warrant definite conclusions.

All three phases of the swine-erysipelas problem will be further studied in the new year.

L. Van Es and J. F. Olney.

Immunity studies of hog cholera

Work on this project was concluded in the course of the year covered by this report. The accumulated results are reported in Research Bulletin 135 published by this station in October 1944. L. Van Es and J. F. Olney.

Mortality in turkey flocks and its prophylaxis

In the course of 1944 a beginning was made with this study. An orientation survey with reference to the comparative morbidity of a number of diseases was made. Most of this work could not get under way until after the peak of juvenile morbidity had already passed. This unavoidable delay, no doubt, somewhat impairs the results of the survey.

Material examined in this connection consisted of 94 turkey specimens which had been submitted for purposes of diagnosis.
The following disorders were encountered and their comparative prevalence expressed as percentages: coccidiosis 18.08%; paratyphus 15.85%; blackhead 11.70%; pullorum disease 9.57%; colibacillosis 7.44%; trichomoniasis 5.19%; rickets, sinusitis, nutritional deficiency, and fowl cholera, 2.12% each; food poisoning, heart stroke, botulism, external parasites, leucocytozoonosis, arthritis, and tuberculosis, 1.06% each.

Some attention has already been given to the apparently increasing morbidity of paratyphus, and this disease will be given most consideration in further studies.

L. Van Es, J. F. Olney, and I. C. Blore.

A total of 2188 letters were written during 1944 and the following publications were prepared and issued:


Profit, comfort, and convenience are the rewards for the careful storage of food. An important phase of the research in Agricultural Engineering is the refrigeration of food—that for home use as well as that produced for sale. Other interests of the agricultural engineers are those related to the efficient functioning of tillage and harvesting machinery, the control of noxious weeds, and the proper construction of farm buildings and equipment.

**Agricultural Engineering**

**Department of Agricultural Engineering**

**Study of the Use of Electric Power on Nebraska Farms**

This subproject has continued active to a limited extent. A low-cost immersion-type thermostat, developed for control of electric stock-tank heaters, is in service on a farm near Lincoln and tests of the thermostat are being continued.

A small-volume watering trough with float-controlled water level and automatic water heating has been designed, built, and installed on a small dairy farm. The trough is made of 2-inch redwood, is approximately 18 in. wide, 16 in. deep and 36 in. long. It holds slightly more than 2½ cu. ft. or about 20 gal. of water. Heating is by means of soil-heating cable, and water temperature is regulated by a bulb-and-bellows type thermostat.

The trough is mounted on posts in an open lot against a windbreak built of lumber. It is also protected by enclosing the sides, ends, and bottom in a box-like frame filled with straw. Two horses and 14 head of milk cows, heifers and calves are supplied with drinking water at the trough.

**Eradication and control of noxious weeds**

The Department of Agricultural Engineering, cooperating with the Department of Agronomy on a noxious weed program, has confined its efforts to mechanical methods of eradication of bindweed. This cooperative project was started in 1943 and the work on bindweed focused on 80 acres 12 miles southwest of the Agricultural College campus. Previous work by the department corroborated that done elsewhere that clean tillage can eradicate bindweed. Some of the objections to clean tillage have been (a) exposure of the soil to wind and water erosion, and (b) no production from the land.

The department attempted to overcome these objections by checking corn on bindweed land; then cultivating sufficiently to eradicate the bindweed between the rows and hoeing out what could not be reached with the cultivator. It was shown that corn could be grown and bindweed eradicated in three years by this procedure. The necessity of employing handwork has been a retarding factor in this project. Therefore in continuing its efforts, the Department of Agricultural Engineering decided to devote 10 acres of the 80-acre tract it has been using to the growing of some corn while eradicating the bindweed—this, without resorting to handwork. Corn is drilled with a lister in rows 126 inches apart, a procedure which results in one-third the number of rows normally planted. Furthermore, the spacing of seed in the row is reduced, making possible more than one-third the normal number of plants. This procedure makes it possible to cultivate all season between rows with a sweep cultivator and throw enough soil to the corn to cover bindweed in the row. Equipment for doing this is being investigated. The photograph shows the most satisfactory equipment made up thus far for getting soil into the row after corn has been hilled a time or two. When this work is done on the contour, it puts the field
Throwing soil to bind weedy corn with two-disk attachments and two rigid coulters to hold machine straight ahead.

in a terraced condition for more than half of the season. This is the second season the project has been carried on in this manner and it remains to be seen whether one more year of the procedure will eradicate the bindweed.

For a complete report on noxious weeds see the Department of Agronomy section. C. W. Smith.

**Study of the adaptation of insulated electric brooders in uninsulated poultry houses**

Material on electric chick brooding is being prepared for publication early in 1945. Results of brooder studies since 1937 are summarized in this study and suggestions made on management.

Plans for the spring of 1945 include the study of reflector-spot or reflector-flood lamps when used to provide some warmth at the feeding troughs in front of electric brooders in unheated houses during unusually cold weather. Observations made in previous electric brooding studies have indicated the need for some auxiliary heat for early-season chicks up to two or three weeks old to encourage regular feeding habits.

**Home dehydration of food**

During May and June 1944 several dehydrating runs were made for the purpose of comparing the results of storing dehydrated asparagus in sealed glass jars at room temperatures and at 0°F.

Products dehydrated during the summer of 1943 were divided into 2 lots, one of which was stored at room temperature and the other at 45°F. After a year of storage the advantages of low temperature were definitely indicated. Asparagus and rhubarb showed the greatest difference in quality whereas corn and apples seemed the least affected by storage conditions. Peaches dehydrated during the summer of 1942 and stored for 1 year in cloth bags at room temperature followed by 1 year in sealed glass jars also at room temperature were badly discolored but were pronounced good as to flavor and texture by a number of judges when samples were refreshed and tasted.

On March 1, 1944, samples of asparagus, peas, rhubarb, green beans, yellow beans, corn and apples from both 70°F. (room temperature) and 45°F. storages were shipped to the Western Regional Research Laboratories at Albany, California, for test. Reports returned on May 8, 1944, on color, flavor, taste and texture also indicated definite advantage in low temperature storage and ranked apples and sweet corn as the best keepers under both conditions. Peas made the poorest showing at both temperatures whereas yellow and green snap beans ranked above asparagus and rhubarb and showed little difference attributable to storage temperatures.
A general purpose farm refrigerator

The 3-zone, reach-in, side-opening refrigerator of approximately 80 cubic feet capacity is now in the laboratory trial stage. The freezing compartment of about 14 cubic feet is maintained at 0°F and is equipped with a horizontal low temperature plate and a fan to promote rapid freezing. The 28 cu. ft. frozen-storage space is maintained at zero by means of vertical cold plates at the sides and is located below and separated from the freezing compartment. The 35–40°F, cool storage space of 38 cu. ft. measures 30 in. by 30 in. and is 73 in. high, thus providing sufficient room for hanging a whole hog carcass or two quarters of beef. When not being used for chilling meat it will accommodate four 10-gallon cream cans or several 30-dozen egg cases. Removable shelving is also provided to make possible the most flexible use of all freezing and storage compartments.

The entire refrigerator occupies a floor space of 84 by 44 in. and is 88 in. high. It is built in sections to facilitate moving and is insulated throughout with approximately 6 inches of shredded redwood bark.

An inexpensive differential thermostat for potato storages

The bimetal differential thermostat which has been developed for controlling the ventilating fans in a potato storage is in its second year of operation at the Alliance Experimental Farm. The thermostat starts the ventilating equipment whenever the outdoor temperature drops below that of the storage interior, thus taking full advantage of the cold autumn night air for cooling the potatoes in storage.

Attempts to find equipment from which an all-electric differential thermostat can be made have been unsuccessful as yet, but the search is being continued. The bimetal thermostat is limited in its application to installations in which the outdoor and indoor temperature-sensitive elements can be located within a few feet of each other. These elements are connected by means of a rod and operate the fan-control switch mechanically. An all-electric thermostat would permit the temperature elements to be placed in any location that could be reached by wire.

Emergency methods of cooling milk and cream

A cream-receiving cabinet for use in small cream stations has been designed, constructed and tested in the laboratory and is in actual use in a nearby cream station. The primary purpose of the cabinet is to provide favorable conditions for preserving the quality of cream while it is held in the cream station and at the same time to eliminate the lifting of heavy 10-gallon cream cans into and out of immersion type coolers which are of necessity top opening. Small cream stations are frequently operated by persons who are physically unable to lift full 10-gallon cans into cooling tanks and as a result cooling equipment of the immersion type has been left unused and the cans of cream allowed to stand on the station floor either unprotected from the warm air of the room or, as a makeshift, covered with wet burlap bags or blankets. Under such conditions cream delivered by the producer to the station as first grade may deteriorate to second grade before it reaches the creamery. The Nebraska cream-receiving cabinet has side-opening doors for easy movements of cans which are placed in position empty. The
Nebraska cream-receiving cabinet. Eliminates heavy lifting; preserves cream quality.

cans are filled through openings in the top of the cabinet, these openings being fitted with special funnels and insulated covers. Full cans are removed through the side-opening doors without lifting. Refrigerated air, circulated around the cans while they are in the cabinet, furnishes a sufficient amount of cooling for desirable preservation of cream quality. Capacity is 4 cans.

The cabinet was installed for trial during the months of August and September 1944 in a typical cream station located near Lincoln. During August, the warmest month of the season, the operator reported a net profit of approximately $10 on about 200 lbs. of butterfat from cream handled through the cabinet as compared with cream kept in the usual way under burlap bags. Cream at 80°F. was cooled to below 70°F. in 1 to 2 hours and when left in the cabinet overnight was cooled to below 40°F. Electric energy consumption was 110 kilowatt hours for the month of August.

Investigation of the power, labor and machinery requirements for the production of corn in Nebraska

Five seedbed preparations were used in this investigation of corn production requirements for the season of 1944. These were the same as used in 1943 and thus for the first time each seedbed preparation was on the same plot as in the previous season. For several years, including 1943 and before, ground was chosen which had a fairly heavy residue, usually wheat stubble. In 1944 the cornstalk residue from 1943 was used. The five seedbed preparations were: (1) plowed, disked, harrowed; (2) double disked; (3) listed; (4) undercover planted in the stalk residue
with the 922 cultivator with planting attachment; and (5) undercover planted in the stalk residue with a lister, the bottoms having been removed and 18-inch sweeps mounted in their place.

The cornstalks were cut preceding planting by a disk weighted and running straight. The field was covered twice with the disk, first diagonally to the rows; then at right angles to the first course. A stalk cutter was not available at the time which made the use of the disk necessary. The purpose was to stir the soil the least possible amount. Although success was attained in this latter aim, only a fair job of stalk cutting was accomplished.

The cornstalk residue introduced a new problem into this work insofar as cultivation the first time over was concerned. The spring was wet, and weeds as well as corn grew rapidly. It was necessary to cultivate when the corn was no more than two or three inches high. With the residue so coarse and the plants so small it was impossible to cultivate close to the row without injuring too many plants. The rotary hoe was tried, and it proved to be a lifesaver at that time. All except the listed plots were covered by it the first time over. The rotary hoe helped considerably in killing tiny weeds on the disked and plowed plots, and on the two with residue it ground the stalks up considerably and laid them down parallel with the rows, making it possible to follow immediately with a two-row cultivator fitted with sweeps and narrow shovels next to the row. All plots were given three cultivations in addition to the work with the rotary hoe. The year was favorable for corn. The location of this plot work was on medium-to-poor soil. No plot in any of the five treatments (and all were replicated six times) made less than 50 bu. per acre. None of the listed plots made less than 70 bu. per acre, and the best plot of all was listed and made 91.2 bu.

For the second year the plowed plots and the disked plots have given the most trouble in weed control. These seedbed preparations have been at least as favorable for weeds as for corn. The three other methods lessened the number of weeds in the row when compared with plowing or diskng.

Listing was again the low-cost procedure. Whereas listing has in the past accelerated runoff when rows ran up and down the hills, it lends itself readily to contouring and a consequent retarding of moisture loss by runoff. Shallow listing saves power; it leaves more trash on the surface between furrows and exposes less moist soil to wind and sun. Where shallow listing was practiced it more nearly approached conditions obtaining on trashy or undercover plots. Weeds were most easily controlled on listed as opposed to nonlisted plots.

Observations made on the effectiveness of tilling machinery include the following: (a) The rotary hoe can be very useful in handling trashy plots with cornstalk residue. (b) Narrow shovels next to the row when corn is small disturb residue very little and move as much soil into the row for weed control as the corn can take. (c) For the fourth season corn has been successfully planted in residue by removing the bottoms from a lister and placing 18-inch sweeps in their places. Experience with this equipment shows that it lends itself to the procedure very well.

C. W. Smith.
Of the numerous major and minor economic problems of agriculture those rising from land use, the productive capacity of our farm lands, the cost of operating farm machinery, farm credit, and marketing most persistently confront the rural economists of this station. Particularly interesting because of the perspective that it offers on the state as a whole are the long-term comprehensive studies of actual and potential land use and the development of plans that may be applied to the various production areas of Nebraska. The analysis is unique in scope and thoroughness and will be invaluable as a guide and reference for Nebraska agriculturalists now and in the future.

Studies in Rural Economics

Department of Rural Economics

Cost of Producing Farm Crops

Between 1940 and 1943 basic information for calculating the cost of operating most of the common farm machines was procured from a large number of farmers in several Nebraska counties. These data, summarized in Experiment Station Bulletin 366 by Frank Miller and W. L. Ruden, show: the average annual use of each type of machine in acres; the number of hours used; the annual cost for depreciation, repairs and lubricants; the combined cost of shelter, insurance, interest and taxes; and the total cost per acre and per hour of use.

Field records have also been kept upon the cost of producing wheat and corn in several counties of the state and under somewhat different conditions in each county. A limited number of records have been obtained which reveal the cost of putting down wells to secure the necessary water and the cost of leveling land for irrigation.

Information upon the cost of corn production, given in Experiment Station Bulletin 370 by W. L. Ruden, was collected in Gage, Otoe and Pawnee counties. Cost records, which form the basis of the study, establish a definite relationship between the yield of corn and the productive capacity of the land. The more fertile the land in this area, the higher were the average corn yields. The per-bushel cost of producing corn was lower on the best land than on the poorer land.

Other conclusions rising from a study of the cost records data are: Listing corn on disked ground cost the operator an average of five cents less per bushel than the practice of plowing and then listing. Hybrids produced an average of 19% more corn than the open-pollinated varieties in the five years for which reports are available. The production of a bushel of hybrid corn required on the average three minutes less labor and four cents less expense than the growing of open-pollinated corn. Slightly over one-half as much man labor was required to raise an acre of corn up to husking when tractor power was used as when horses were used. The use of tractor power decreased the cost of corn production eight cents per bushel during the five years. The saving resulting from the use of tractor power is not uniform, however, because wages, cost of horse labor per hour, cost of operating tractors and various other cost items fluctuate from one year to the next. Three cultivations produced 10% more corn per acre than two cultivations during the 1940-1943 period.

It is of interest to note that soil improvement practices, chief of which was the inclusion of sweetclover in the cropping system, increased corn
yields an average of six bushels per acre in 1942 and 1943. The average decreases in the operator’s cost per bushel associated with the better practices were six cents in 1942 and eight cents in 1943.


**Farm organization and farm costs**

The farm account book which had been in use for several years was revised in the summer of 1943. A summary of the records in this revised edition can be easily transferred to a federal income tax form.

The records themselves show a number of interesting things. They show, first of all, the type or types of farm organization most profitable in each of the various sections of the state. For example, in south central Nebraska, the only farmers who derived a fairly satisfactory return from farms with fewer than 80 acres in crops were those who specialized in livestock enterprises giving a high return for the value of the feed consumed. Dairying and poultry and egg production are enterprises of that type.

The records reveal that the four most important factors affecting income in this region of the plains area are size of business, crop yields per acre, efficiency in feeding livestock, and the number of crop acres tended per man.

Farmers who changed from horse power to tractor power, and failed to increase the amount of work accomplished, usually received a smaller income than before making the change. The men who profited by changing to tractor power tilled more land with the same amount of labor, or did custom work, or expanded livestock production.

The studies are useful in many ways. They provide definite information for use in answering inquiries that come to this office concerning farm practice. They are of interest and value to the farmer himself. A farmer who keeps an accurate record is usually interested in comparing his results with the average of the results secured by other record keepers in his community. Finally, there is the value to the individual farmer’s management program. Many farmers have made changes in the organization of their farms as a result of record keeping.


**Land use planning in county and agricultural production areas**

Since Nebraska is an agricultural state, the soil is its most important natural resource. The distribution of soil types is important in understanding the economic make-up of the state. Scientists in the Bureau of Chemistry and Soils, United States Department of Agriculture, cooperating with those in the Conservation and Survey Division of the University have classified the soils of Nebraska on the basis of the type of parent material from which they were formed and their physical characteristics such as texture and structure. More than 65 soil series and 250 soil types have been described in terms of their geological origin and physical characteristics.

Using this information and also information secured from other sources as foundation material, scientists in the Soil Conservation Service have classified the soils of the state according to their use capabilities under conservation farming. The soil series and types have been grouped into units of similar physical characteristics in
which the soil-conserving problems are comparatively uniform. General recommendations have been made for adjustments to conservation farming in each of these units. This analysis reveals that there are approximately 16,678,000 acres of tillable land in farms that need some form of special treatment such as contour planting, strip cropping, subsurface tillage or terracing for protection against wind and water erosion.

Control of erosion, maintenance of fertility through balanced crop and livestock production, and maximum utilization of the available moisture on individual farms are the major conservation problems in Nebraska. During the year an attempt has been made to estimate the effect of applying measures that will solve these problems. In some areas a change to conservation farming will shift the principal sources of farm income from cash grain crops to livestock and animal products. In other areas the recommended crops and practices will cause very little change in present source of income.

There are approximately 20,949,250 acres of land in Nebraska farms that are physically suitable for tilled crop production. In 1942 only 20,156,658 acres were cultivated. For the state as a whole, it appears that no drastic reduction in the cropland base is needed. A regrassing program is desirable in some sections and on many individual farms. A shift to conservation farming would decrease the acreage of intertilled crops and increase the area planted to grasses and legumes. The effect on net farm income is not clear. Basic data are not available for a detailed analysis of this phase of the conservation problem. The net income from grass and legume crops when used alone or with grain in livestock production has not been determined. In fact, it is impossible to make an accurate estimate of the net farm income that will probably be secured from any type of farming without knowing wage rates, the price of commodities purchased by farmers for use in production, and the comparative prices of grains, livestock and livestock products.

A manuscript presenting the results secured has been completed and after the customary processes of criticism and revision will be published.

Frank Miller.

Agricultural productive capacity of Nebraska

In 1944 members of the Agricultural Experiment Station and Extension Service staffs cooperated with the Bureau of Agricultural Economics and other agencies in preparing three reports to the United States Department of Agriculture dealing with Nebraska’s capacity to produce farm commodities during the war period and the problems that will confront the people of the state after the war. These studies present an analysis of agricultural conditions and suggest the major adjustments that will be needed to develop and preserve the physical and human resources of the state after the war.

The productive capacity of the state has been enhanced during recent years by increasing the area under irrigation and the growing of improved varieties of crops. The major part of the increase in the irrigated area in 1943 and 1944 is the result of pumping water from wells.

The following problems are examined critically and suggestions are made for dealing with them: (1) Development and conservation of physical resources. (2) Adjustments in the production of crops and livestock. (3) Problems of marketing agricultural products. (4) Opportunities for settlement on the land after the war through water development. (5) Tenure problems. (6) Farm credit in the postwar period. (7) Social security. (8) Rural health services and facilities in Nebraska. (9) Postwar housing and equipment needs. (10) Postwar needs in nutrition.

These reports will be used by administrative officials in developing national agricultural policies.

Frank Miller.

Land tenure problems

During 1944 members of the Agricultural Experiment Station staff cooperated with representative of other North Central states and the Farm Foundation in the preparation of a publication dealing with farm tenure in the Midwest. This study entitled “Improving farm tenure
problems in the Midwest" was issued in June 1944 by the Illinois Experi­
ment Station as Bulletin 502 and is available for distribution in each of
the Midwestern states.

The percentage of Nebraska farms operated by tenants has increased steadily
since 1880. In 1940, 50.8% of the farms in the state were rented. This situation
indicates the need for a careful study of man's relationship to the land from which
he derives his food, clothing, and shelter. Farm ownership, land prices, the transfer
of property through inheritance, mortgage credit, size of farm units, landlord-tenant
relations and conservation of the soil are parts of the tenure problem. These are
discussed in broad outline in the bulletin.

After making an extensive study of farm leases in common use and
discussing desirable lease terms with landlords and tenants, the Depart­
ment of Rural Economics prepared a crop-share cash lease and a livestock­
share lease about twenty years ago. These leases were printed by the
Agricultural Extension Service and have been widely circulated. Each
of the leases has been revised several times in an effort to secure equity
for landowner and tenant. These lease forms were rewritten again in
1944 in order to bring the provisions into line with increased mechaniza­
tion and changes in the efficiency of agricultural production.

H. C. Filley and Frank Miller.

Credit

Farmers of Nebraska need credit for the following purposes:

(1) To provide funds for those engaged in agriculture who do not have
enough capital to finance the operation of a farm business of the size
required for efficient operation.

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

(3) To provide additional funds for farmers who have accumulated
capital to make substantial down payments on land but are unable to
pay the entire cost of an efficient farm unit. During the past year 577
farm records from 6 southeastern Nebraska counties have been analyzed
to determine the average total capital required for businesses of various
size and the distribution of the investment among the capital items of
land, buildings, machinery, feed, and livestock. Some of the results are
given in Table 1. The analysis will be carried further to determine the
debt-carrying capacity of farms on the different grades of land in this area.

Frank Miller.

Table I. Distribution of the investment in farm businesses in six southeastern
Nebraska counties.

<table>
<thead>
<tr>
<th>Item</th>
<th>Range in size of farms (acres)</th>
<th>60–139 acres</th>
<th>140–219 acres</th>
<th>220–299 acres</th>
<th>300–379 acres</th>
<th>380–459 acres</th>
<th>460–539 acres</th>
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</thead>
<tbody>
<tr>
<td>Number of farm records</td>
<td>80</td>
<td>254</td>
<td>136</td>
<td>74</td>
<td>13</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Average size of farms</td>
<td>99.9</td>
<td>168.7</td>
<td>243.4</td>
<td>334.9</td>
<td>419.4</td>
<td>517.7</td>
<td></td>
</tr>
<tr>
<td>Average investment in:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>$9,695</td>
<td>$13,489</td>
<td>$18,813</td>
<td>$27,876</td>
<td>$42,722</td>
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<td>Buildings</td>
<td>2,251</td>
<td>2,193</td>
<td>3,421</td>
<td>3,621</td>
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<tr>
<td>Feed, grain and supplies</td>
<td>636</td>
<td>961</td>
<td>1,226</td>
<td>2,015</td>
<td>2,382</td>
<td>3,374</td>
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<tr>
<td>Machinery and equipment</td>
<td>963</td>
<td>1,130</td>
<td>1,496</td>
<td>1,712</td>
<td>2,182</td>
<td>1,971</td>
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<tr>
<td>Horses</td>
<td>278</td>
<td>274</td>
<td>339</td>
<td>652</td>
<td>715</td>
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<td>Productive livestock</td>
<td>1,125</td>
<td>976</td>
<td>1,040</td>
<td>3,936</td>
<td>4,567</td>
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<td>Total</td>
<td>$14,848</td>
<td>$19,023</td>
<td>$26,335</td>
<td>$38,812</td>
<td>$59,386</td>
<td>$60,956</td>
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Marketing

The Nebraska Experiment Station is one of 14 Corn Belt states cooperating with the Bureau of Agricultural Economics, U. S. Department of Agriculture, in assembling information upon livestock marketing. A part of the data secured from the study has been published in Nebr. Agr. Exp. Sta. Bul. 369 entitled “Livestock auctions in Nebraska” by H. C. Filley.

The department continues to assemble annual data from the audit records of cooperative elevators, but these will not be published until records for 10 years are available. H. C. Filley and L. B. Snyder.

The levels of living and social status of farmers in selected counties in Nebraska

This project, carried on cooperatively between the Agricultural Experiment Station and the Bureau of Agricultural Economics, is designed to compare certain economic with certain social indexes of farm levels of living.

A survey was made in Lancaster county, the data tabulated, and a manuscript prepared by Dr. L. B. Snyder with the assistance of A. H. Anderson of the Bureau of Agricultural Economics. The manuscript derived from this survey was published in September as Nebr. Agr. Exp. Sta. Bul. 368, entitled “Determinants of levels of living for farmers of Lancaster County, Nebraska.”

The study compares farm income, size of farm, age of operator, quality of farm, and tenure of operator with the following five indexes of level of living: material possessions, cultural possessions, cash expenditures, total living value per family, adult male equivalent, and social participation. A close relationship was found between these indexes and farm income.

To the extent that tenure of operator, size of farm and age of farm operator affected farm income they affected levels of living. L. B. Snyder.

Farm work simplification

The Departments of Rural Economics and Agricultural Engineering, the Agricultural Extension Service, and the Farm Simplification Fund of the general Educational Board of the Rockefeller Foundation are cooperating on this project, the purpose of which is to promote efficient and economic use of labor on the farm.

Pictures were taken during the summer showing various methods of putting up hay, and data have been collected concerning the amount of labor required by the methods commonly used. Pictures showing practices on a dairy farm have been taken, also, and data on the cost of these operations been obtained.

Farm operators who have seen the pictures have been quick to note the more efficient methods. It is believed that a wide circulation of the pictures will result in a more efficient use of man labor on many farms. Procedures to insure such circulation are being taken. A. W. Epp.
Home economists carried forward their investigations into nutrition, the vitamin content of foods, and the welfare of the Nebraska rural family. Numerous other studies relating to the economy of the home were initiated or continued.

Home Economics
Department of Home Economics

Human Nutrition Studies

A study of blood regeneration in college women blood donors.—Blood regeneration was studied in 17 healthy college girls who served as blood donors and subjects on a controlled dietary regimen. After the first donation they followed a diet that furnished approximately 75 gm. protein daily and after the second donation 16 weeks later a diet that furnished 50 gm. of protein daily. Regeneration, especially of hemoglobin, was significantly better on the higher protein intake; but return to the blood values determined at the time of donation was not complete, except in the instance of serum protein, even at the end of 10 weeks. The need for the woman donor to select a diet that will furnish at least 75 gm. of protein daily is stressed.


The work on blood donors was continued in the fall of 1944 with 55 girls as volunteer blood donors. Each girl gave one pint of blood following which she was given in addition to her self-chosen diet a supplement which contained 40 gm. of protein. Weekly blood tests have been taken over a period of six weeks. These results will be compared with the results obtained when the procedure is repeated, at which time the girls will not receive additional protein.

A paper, “Hemoglobin concentrations, red cell counts, and erythrocyte volumes of college women of the north central states,” by Ohlson, Cederquist, Donelson, Leverton, Kinsman, Himwich and Reynolds, has been accepted for publication by the Amer. Jour. Physiol. Ruth Leverton.

Family relationships

Validity of the “participant observer” method of studying family life.—During the past year considerable attention has been given to testing the validity and general usefulness of the “participant observer” method of studying family life. This method involves the services of a corps of homemakers and mothers who reside in representative rural communities of the state. These women observe family relationships in operation as they themselves participate in the life of their communities. They report anonymously their observations upon specific families from time to time. These reports are made by means of carefully constructed information schedules and rating scales. Some 60 observers have thus been furnishing data for the study of more than 500 rural families.

Several sorts of data have been collected: (1) general information about the family, its size, its make-up as regards the sex, age, and educational status of each member,
the out-of-school activities of the children, the occupations of parents and other members, the general level-of-living of the family, and similar data; (2) family-neighborhood relationships as revealed by ratings on “sociability” and family prestige in the community; (3) the general quality of family life as disclosed in ratings on discord-harmony in the home, and smoothness and efficiency in household management; (4) interpersonal relationships within the family as shown in ratings on domination by father or mother, closeness of relationship between parent and child and between father and mother, tendency of parents to be overcritical of child, democratic or dictatorial enforcement of regulations by parents, strictness of parental control and severity of punishment.

Two methods have been employed to test the reliability of these ratings by the field observers. First, after a lapse of eight months and without any warning the observers were asked to repeat certain ratings of their families. Correlations were then computed between the two sets of rating scores. The coefficients derived there-from ranged between .76 and .80.

The second method involved the organization of another group of observers. With the help of the county agent and the home agent of one county a group of six pairs of observers was organized. To each pair was arbitrarily assigned for study eight to twelve families from among their neighbors. The assignments were made individually and confidentially. Thus it was possible to get two sets of independent ratings by different observers on some 60 families. Coefficients of agreement between raters were calculated for 15 different variables. The coefficients ranged between .28 and .85 with most of them clustering about .45. In the light of these results it was evident that certain of the rating scales in their present form could not be accepted as reliable and valid research instruments. Certain others, however, seemed to merit further use. Possibilities for improvement of certain scales were also suggested by the results.

In addition to the factual data and the quantitative rating scores, the observers were also asked to write out, in their own words, descriptions of each family and how it relates itself to the community. These descriptions included “personality sketches” of each family member and an account of his relationships with the rest of the family.

An attempt was also made through the cooperation of the schools to obtain scores on personal and social adjustment tests from the children of these families. The attempt was only partially successful. The purpose is to study the personality adjustments of the child in relation to the home and family situation as revealed by the family life data.

Considerable progress was also made on the construction of a battery of scales for rating the personal and social adjustments of young children. These scales are being designed for use by adult observers. They should provide another important means of obtaining data on the development of the children of the families under study.


Investigations into the efficiency and other qualities of household equipment

For a period of over two years investigations dealing with household equipment were placed on the inactive list, but in the spring of 1944 the equipment laboratory was re-opened and studies have been continued on a part-time basis.

Small portable food mixers.—Tests on the small portable food mixer had shown that many mixers will not perform satisfactorily with relatively heavy loads at low speed. The experimental procedure of this study has been given in previous reports. The results of this investigation are being published as a joint publication of the Experiment Stations of Iowa State College, Purdue University and the University of Nebraska. Data received for review from the Iowa State and the Purdue Stations have shown that the food mixers adapted at the Nebraska Station for the study of mixing and beating of foods under controlled conditions have performed satisfactorily. Results of the food mixer tests have indi-
cated that best results are obtained with a mixer which has a governor for regulating speed. Round beaters produced best results in some types of mixing and long oval beaters produced best results in other types. By rotating the mixing bowl under controlled conditions it was definitely shown that better mixing and beating were obtained when the bowl was stationary.

**Farm lighting with kerosene and gasoline lamps.**—This investigation had just been started when the laboratory was closed in 1942. Measurements have been made upon flat wick, round wick, mantle and pressure kerosene lamps and pressure gasoline lamps to determine the horizontal candlepower distribution. Plans and test procedure for obtaining illumination measurements have been revised to cover measurements in the laboratory and in the home for various wall finishes and various combinations of lamps. The survey method will be employed to secure illumination values under actual home conditions; the Macbeth illuminometer for determining illumination intensity will be used.

**Canning experiments on method of jar closures.**—With the introduction of the three-piece lid for sealing Mason jars a problem, the breaking of the glass disc, has been reported. Several experiments have been performed to determine the pressure that might be exerted in the jar when this lid is completely sealed before processing. The experiments were extended to cover the zinc lid and the metal disc. Further tests were made to determine the vacuum obtainable for different methods of processing and for various head spaces in the jar. Results of the tests showed that it is possible to attain a gauge pressure of 20 pounds per square inch in a tightly sealed jar that does not vent; in some cases excessive pressure caused the rubber rings to “blow out” to relieve the pressure, a condition which in actual canning might account for a subsequent faulty seal. Vacuum reading of 25 inches of mercury were obtained when the metal disc was used. The data secured from these experiments are being prepared for publication.

**Coal and wood ranges.**—Plans for a study of the coal and wood range have been formulated, and preliminary tests have been outlined. Fuels to be used are bituminous coal, wood, and cobs. Five ranges have been secured, and a test room is being adapted to the purposes of the investigation. Many of the tests will be of a technical nature, involving temperature measurements, flue gas analysis, and combustion analysis. However, since the range must be used for cooking and baking, test plans include a study of these stoves under actual cooking conditions.

*Arnold E. Barager.*
Farming practices employed on irrigated land differ from those used in farming dry-land areas. The substations provide opportunities for the study of responses under each system as well as, by virtue of their respective locations, the effects of climate on crops and on cultural practices. Crop rotation data accumulated from long-term experiments now completed have been published.

Box Butte Experiment Farm

The following phases of investigative work have been continued on the Box Butte Experiment Farm in 1944:

1. Dry-land crop rotation experiments; in these comprehensive studies the three station departments cooperating are Horticulture, Plant Pathology and Agronomy.

2. Department projects for which the farm provides land and cultural facilities, etc.:
   a. Horticulture (H. O. Werner)—seed potato storage; study of various storage structures; cultural tests with potatoes; potato breeding; and vitamin C study of potatoes.
   b. Agronomy.—Hybrid corn yield test (T. A. Kiesselbach); winter wheat nursery (K. S. Quisenberry); grass nursery, inactive, (E. C. Conard); and summer fallow tillage methods (J. C. Russel and F. L. Duley).
   c. Plant Pathology.—Increasing and testing bean varieties (J. H. Jensen).

3. General farm projects—
   a. Production of foundation seed potatoes.
   b. Increasing new varieties of small grains.
   c. Maintaining a windbreak and attractive lawn plantings.

Moisture conditions, although somewhat short for potatoes toward the end of the growing season, were relatively favorable throughout the year. Several hailstorms occurred, one of which damaged about 80% of the barley, 10 to 30% of the wheat, 100% of the early beans, and perhaps 10% of some plantings of potatoes. Most of the rainfall came in the form of very rapid downpours, and as a consequence runoff was excessive and absorption generally not very great. A serious erosion problem has developed, but by means of retarding diversion ditches to prevent building up of heads of water and by establishing water courses for flood water it is being solved.

The farm was much undermanned during the greater part of the year. Little time could be spared from the field program, but necessities of upkeep were taken care of as they arose. Portions of buildings most in need of it have been painted, for example, and sundry repairs made as required.

In early September the Farm Committees of the Station held a one-day conference at the farm; on another day a one-day conference was held with a group of 6 farmers and several other informed and interested parties to review the work the farm has already accomplished and to consider the work that it should or could be doing. The consensus of these conferences was that all lines of activity ought to be continued but that in addition some attention might well be given to studying problems of soil conservation. The use of grass on dry land was given especial consideration.

Robert Pahl was supervisor of the Farm to June 30, 1944; Kerwin Jantz has been acting in that capacity since July 1, 1944.

H. O. Werner.
North Platte Substation

Dry-Land Crop Rotations

Rainfall for the year was near normal in amount but erratic in distribution. Dry soil at seeding time in the fall delayed germination of winter wheat on cropped land. Favorable spring moisture permitted better than usual recovery, but delayed growth encountered heavy rust infestation and yields were fair to poor. After fallow, with less delay in germination and growth, rust injury was less severe, and yields were generally more than double those from cropped land. The average yield of winter wheat from all tillage methods and sequences was 13.6 bu. per acre. The average yield on cropped land was 8.5 bu. and on fallowed land 19.7 bu. Following row crops, the average yield after corn was 6.7 bu., after grain sorghum 7.6 bu., and after potatoes 11.3 bu. Following small grain, yields from different preparations were diskng 10.2 bu.; early fall listing 9.4 bu.; subtilage 9.2 bu.; early fall plowing 7.8 bu.; drilling stubble without tillage 6.5 bu.; and late fall plowing 4.4 bu.

The yield of winter wheat on cropped land was relatively poorer than the yields, respectively, of barley and oats, but its response on summer-fallowed land was better than that of barley or oats.

Row crop yields ranged from very good to excellent. The average yield per acre of 156.6 bu. of potatoes was the third highest in 32 years. Yields after fallow, early fall plowed wheat stubble, and disked corn were, respectively, 181.1, 164.7, and 119.2 bu. per acre.

Early Kalo continuously cropped produced 38.3 bu. on spring plowing, and 37.5 on fall plowing, after wheat on spring plowing 43 bu. and after fallow 51.4 bu. The average corn yield of 35.3 bu. was third high since 1907. Yield differences ascribable to crop sequences and tillage practices were minor. In two-year rotations with winter wheat, corn yields in rows spaced 40, 80, and 120 inches were respectively 30.4, 24.0, and 18.6 bu.


Grain varietal tests

Winter wheat.—Fifteen varieties of winter wheat were grown in duplicate plots on both fallow and corn stubble ground. On fallow, stands were complete. Rust injury was severe on late and susceptible varieties. Yields ranged from 27.0 to 54.3 bu. per acre. On corn ground stands were poor, growth delayed, and rust injury very severe. Yields ranged from 4.0 to 13.3 bu. per acre. Early maturing varieties were generally least injured by rust and on that account produced best yields. Wichita, a new early wheat from Kansas, produced the highest yield on both fallow and corn ground. Nebred occupied eighth place on fallow and fifth place on corn ground. The yield of Cheyenne was only 68% of Nebred on fallow and 51% on corn ground. Powers outyielded Nebred by 2.7 bu. per acre on fallow but its yield on corn ground was 3.7 bu. lower than that of Nebred.

Over a 10-year period, seven varieties have these yield averages and rank as follows: Nebred, 20.7 bu.; Cheyenne, 20.8 bu.; Local Turkey,
20.7 bu.; Kharkov 19.1 bu.; Tenmarq, 19.0 bu.; Nebraska 60, 18.2 bu.; and Blackhull, 17.4 bu.

**Spring wheat.**—Seventeen spring wheat varieties were grown in nursery rows. Rust resistance was the dominant factor in determining yield. The average yield of four well-known rust-susceptible varieties Reward, Kearney, Ceres, and Marquis was 5.5 bu. per acre. The yield of Thatcher, which is resistant to leaf rust but susceptible to stem rust, was 9.9 bu. Yields of five new varieties, all of which are immune to leaf rust and highly resistant to stem rust, averaged 19.3 bu. These varieties were Ceres x Pilot C. I. 12263; Mercury C. I. 11872, Merit x Pilot C. I. 12315, Mida 12008, and Pilot x Mida C. I. 12316.

**Oats.**—A wide range in yield between eleven varieties of oats tested in field plots was observed. The four top varieties, Otoe, Ventura, Trojan, and Brunker, yielded, respectively, 56.9, 52.2, 49.4, and 36.9 bu. per acre. At the lower end of the list, Kanota, Osage, Fulghum, and Kherson made yields of 33.8, 26.3, 25.6, and 24.1 bu. Varieties grown five years or more rank as follows: Otoe, Kanota, Fulton, Trojan, Fulghum, Brunker, with average yields of 42.6, 41.6, 41.3, 41.2, 38.3 and 37.1 bu. respectively.

**Barley.**—Of twelve varieties grown in field plots, the top yielding four were Ezond, Trebi, Sandrel, and Blackhull, with respective yields of 31.2, 28.5, 26.0, and 23.3 bu.

Intermediate yields were made by Velvon, Atlas, Composite Selection, and Spartan with yields of 22.7, 22.5, 22.3, and 22.3 bu. Lowest yields were made by Lico, Club Mariot, Flynn x Vaughn, and Beecher with yields of 20.4, 18.3, 17.5, and 15.4 bu. Varieties grown for five years or longer rank in the following order: Trebi, Ezond, Blackhull, Velvon, Spartan, Sandrel, Atlas, Lico, Club Mariot, with averages ranging from 33.8 to 29.6 bu. per acre.

**Winter barley.**—Twenty-three selections of winter barley exhibited a wide range of survival, maturity, and yield. Numbers in survival classes were as follows: good 5, fair 7, poor 8, very poor 3. For the five selections having good survival, maturity dates ranged from July 1 to 3, and the average yield was 39.8 bu. For the seven selections with fair survival, maturity dates ranged from July 1 to 3 and the average yield was 33.3 bu. For the eight selections with poor survival, maturity ranged from July 3 to 15, and the average yield was 26.6 bu. For the three selections with very poor survival, maturity was July 6 and 7, and the average yield 22.4 bu.

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

**Corn hybrids and varieties**

Yields of corn in both irrigated and dry-land tests were good to excellent. The average yield of 43 hybrids and 2 open-pollinated varieties under irrigation was 135 bu. per acre. Hybrid yields ranged from 100.4 to 160.1 bu. Open-pollinated yields were 103.9 and 118.5 bu. The average yield increase of hybrids over open-pollinated varieties was 24.2%.

On dry land, the average yield of 43 hybrids was 44.9 bu. and of the single open-pollinated variety 44.3 bu. The open-pollinated variety was exceeded in yield by 28 hybrids, and 15 hybrids were exceeded by this variety. The average yield of the 10 best hybrids exceeded the open-pollinated variety by 14% and the average yield of the 10 poorest hybrids was exceeded by the open-pollinated by 11%. Average yields of four
varieties in a rate-of-planting test under irrigation were 106.2 bu. from the 2 per-hill rate, 118.6 from the 3 per-hill rate, 131.2 from the 4 per-hill rate, and 126.6 for the 5 per-hill rate. J. H. Lonnquist and L. L. Zook.

**Sorghum varieties**

In a test on dry land of 23 grain sorghum varieties and selections, the highest production was made by Early Kalo, Early Hegari, Fremont, Coes, Martin, and Highland with yields of 41.4, 36.1, 35.6, 34.4, 33.5, and 32.8 bu. per acre. In comparisons of Early Kalo and other varieties covering periods of 1 to 11 years, the only varieties that have exceeded Early Kalo in average yield have been Club (3.6% for 10 years) and Early Hegari (5.2% for 4 years). Club frequently does not mature completely and Early Hegari is lacking in uniformity. Early Kalo thus remains the most satisfactory grain sorghum so far grown at this station.

**Forage sorghum**

Yields of forage on a 15% moisture basis from five highest in a test of 10 varieties were 3.43, 3.16, 3.09, 2.99, 2.87 tons per acre, from Leoti, Fremont, Atlas, Early Sumac, and Black Amber, respectively. For a 5-year period, the order of average yield of these varieties has been Leoti, Fremont, Atlas, Early Sumac, and Black Amber with yields of 3.43, 3.16, 3.09, 2.99, and 2.89 tons per acre respectively.

O. J. Webster and H. E. Weakley.

**Grass seed production**

Trials of grass seed production are being conducted in cooperation with the Soil Conservation Service. From a 25-acre field seeded in contoured cultivated rows in the fall of 1942, the average per-acre yield of Brome, Russian Weld Rye, and Crested Wheat grass in 1944 was 254 lbs. of cleaned seed per acre.

E. C. Conard and L. L. Zook.

**Pinto beans**

A new pinto bean No. 3749-54 developed by the Department of Plant Pathology was grown for test and increase. Its per-acre yield on fallow was 980 lbs. and on cropped land 868 pounds in comparison with yields of 625 and 499 lbs. on these same seedbed preparations from Colorado commercial pintos.


**Horticulture**

The three test orchards at the station contain 132 varieties of apples, plums, cherries, and small fruits, including some older kinds and numerous new introductions of promise as regards adaptation to the environment of the Great Plains area.

The Manchu cherry (Prunus tomentosa) is of special interest as a small fruit and understock for use on other cherry varieties. The better selections bear annually and produce good crops of fruit of excellent flavor. Two new strawberries from the Cheyenne Horticultural Station appear to be well adapted to western Nebraska conditions. Several selections from native plums are being increased for test plantings.
Ornamentals

From 3000 seedling chrysanthemums grown in 1944, 123 have been selected for further study and propagation. These include a wide variety of maturity, plant habit, and flower color, and have been of much public interest.

Vegetables

Trials of vegetable seed production in cooperation with the Cheyenne Horticultural Station were continued for the second year. Satisfactory seed yields of beet, carrot, and parsnip were produced, indicating possibilities of commercial production. Carrots from 1943 station-grown seed produced at the rate of 19 tons of No. 1 market roots per acre. Two strains of Sweet Spanish onion produced at the rate of 23.9 and 21.5 tons per acre.

In a trial of 21 selections and varieties of tomatoes, six produced at a rate exceeding 20 tons per acre. The highest rate was 28 and the lowest 10.5 tons per acre.

Glen Viehmeyer.

Pump irrigation limited

High precipitation early in the season delayed the beginning of irrigation and reduced the amount of water required. The electric pump was operated on 13 days for a total of 146.5 hours. A total of 372 acre-inches of water was pumped onto 23 acres of corn. The amount of water used per acre was 16.17 inches in two applications. Electric current costs of 2.6 cents per kwhr for 2350 kwhrs totaled $61.10, making the per-acre cost $2.66. Distributing cost at 50 cents per hour amounted to $3.17 per acre, making the total operating cost per acre $5.83. The yield per acre of ensilage was 16.9 tons. If left to maturity, the corn yield would have been 75 bu. per acre. Operating costs on the basis of these yields were 34.4 cents per ton of ensilage or 7.8 cents per bushel of corn. Fixed costs were high on account of the limited use of the plant. The usual charge of $300 distributed over only 23 acres amounts to $13.04 per acre and increases total irrigation costs per unit of yield to $1.12 per ton of ensilage or 25.1 cents per bushel of corn.

The pump, operated with a fuel oil power unit, was used on leased land to irrigate 24 acres of corn. Fuel, lubricating oil, and labor costs totaled $71.74 or $2.99 per acre. With yields of 12.3 tons of ensilage or 70 bu. of corn per acre, irrigation costs per unit of yield were 24 cents per ton of ensilage or 4 cents per bushel of corn.

H. E. Weakley.

Effect of winter feeding on growth and reproduction of range cattle

Studies of five lots of 20 grade Hereford heifers described in the 57th Annual Report were continued through their second season. Weights from pasture to feed lot on November 17, 1943, for the five lots were respectively, 681, 703, 705, 720, and 718 lbs. per head. Winter rations as of the previous year were continued, i.e., Lot 1 prairie hay; Lot 2, prairie hay plus 1 lb. soybean meal; Lots 3, 4, and 5, 6 lbs. alfalfa and a full feed of mixed sorgo and corn ensilage. In addition, Lot 5 received 3 lbs. of grain (½ corn and ½ rye) per head daily.

The 40 head of Lots 4 and 5, bred in 1943, produced 37 calves. In Lot 4 one cow died at calving and one cow did not calve. In Lot 5 one calf died at birth.
During the 164-day wintering period, Lot 1 lost 52 lbs. per head, Lots 2 and 3 gained 69 and 141 lbs. In Lots 4 and 5, the gains per head were 132 and 157 lbs. Average birth weight of calves in each of these lots was 72.3 lbs.

The weights per head of the five lots were respectively 629, 772, 846, 852, and 875 lbs. when turned to pasture on May 3, 1944. As in the previous year, the heifers going to pasture in thinned flesh made the heaviest summer gains. Weights per head on return from pasture on November 21, 1944, were, respectively, 870, 935, 961, 818 and 854 lbs. Second summer gains for Lots 1, 2, and 3 for cows without calves were, respectively, 241, 163, and 115 lbs. In Lots 4 and 5 cows with calves lost 34 and 21 lbs. per head respectively. Their calves averaged 328, and 345 lbs. Second year average gains for the unbred heifers of Lots 1, 2, and 3 were 189, 232, and 256 lbs. respectively. Gains of the heifers producing calves in Lots 4 and 5 were, respectively, 98 and 136 lbs. Two-year average gains of the five lots were 425, 490, 516, 373, and 409 lbs., respectively.

All of the cows were bred in the summer of 1944 to calve in the spring of 1945. Marvel L. Baker and Guy N. Baker.


Deferred feeding of yearling heifers

This was the second deferred-feeding trial, steers having been used in the first. In the present trial, six lots of yearling heifers of 12 head each, weighing approximately 700 lbs., were fed a ration of equal parts of ground corn and rye for 112 days at three different levels. Lots 1 and 2 were fed 6 lbs. per head daily; Lots 3 and 4 were fed 10 lbs.; and Lots 5 and 6 consumed 12.3 lbs. per head daily. Lots 1, 3 and 5 were fed 4 lbs. ground alfalfa hay and ½ lb. soybean meal. Lots 2, 4, and 6 received 1½ lbs. soybean meal. All were fed as much sorgo and corn silage as they would eat. They had access to a mineral mixture and salt.

The six lots were marketed at the same date. Although Lots 1 and 2, 3 and 4, and 5 and 6 were sold together, there was a slight difference in price, Lots 3 and 4 selling at the highest price and Lots 1 and 2 selling at the lower figure.

Results of the first trial were published as Mimeographed Circular No. 36 by Guy N. Baker and Marvel L. Baker; and the second trial as Circular 37 by Guy N. Baker.

Delayed feeding of yearling heifers

Four lots of 12 head of heifers were purchased February 5, 1944, wintered and turned on rye and native grass and sweetclover pasture. They were fed from July 18 to November 11 in the dry lot. Lots 1 and 2 were fed 9 lbs. of grain consisting of ½ dried beet pulp and ½ ground yellow corn until October when the ration was increased as rapidly as possible. They consumed an average of 9.19 lbs. per day of the grain mixture for the feeding period. Lots 3 and 4 were full-fed on the same mixture. They consumed 14.79 lbs. per head daily. Lots 1 and 3 were fed 1.5 lbs. soybean meal daily. Lots 2 and 4 received ½ lb. of soybean meal and 4 lbs. cut alfalfa hay daily. Their gains were: Lot 1, 288 lbs.; Lot 2, 296; Lot 3, 306; Lot 4, 315.
Lots 3 and 4 showed more condition than 1 and 2, and sold higher in Omaha. The lots receiving the alfalfa hay showed more finish than the lots receiving no hay, and Lot 2 outsold Lot 1.  

**Guy N. Baker.**

**Swine breeding**

The breeding project in cooperation with the Regional Swine Breeding Laboratory of the Bureau of Animal Industry, U. S. Department of Agriculture, was continued during 1944 much the same as during the preceding year. One new line was established by crossing two Oklahoma inbred lines with inbred North Platte females. Another new line was established by combining four North Platte inbred lines. Pigs from six North Platte lines as well as cross lines matings were included in 1944 farrowings.  

**Marvel L. Baker, Guy N. Baker, and Myron Rumery.**

**Corriedale sheep**

A flock of 52 Corriedale ewes is being used in conjunction with the flocks at Lincoln and Scottsbluff in a ram-testing project. The purpose is to speed flock improvement by breeding. The flock at the North Platte station was divided into four groups as nearly equal as possible, the basis of division being breeding, wool production records, and the individuals themselves. With two of these divisions rams selected by the usual means, i.e., the individual, his record, and that of his sire and dam, are used. With the other two groups are used rams that have been tested at the Lincoln station. This test involves the mating of a selected ram to a flock of ewes (15% western) and using the lambs of this mating as a criterion of the ram's ability to transmit desirable conformation, rate of growth, etc.  

**Guy N. Baker.**

**Poultry cost accounting**

The Substation poultry flocks of White Leghorns and White Rocks were entered as a commercial unit in the Nebraska Cost Account Project. With an average of 967 hens in production, the average number of eggs per hen was 225 for the Substation flock in comparison with an average of 153 for the 12 flocks completing the year. The net income per hen of the Substation flock was $2.87 per hen in comparison with $1.95 per hen for all 12 flocks. The total income from the Substation flock was $8,381.18; total expense including labor $5,811.67, leaving a net income of $2,569.51.  

**E. A. Wolfe.**
Scotts Bluff Substation

THIS brief review of experimental work conducted at the Scotts Bluff Substation during 1944 includes 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. A discussion of important climatic conditions provides a frame of reference for the work done.

Climatic conditions

The total precipitation recorded at the Scotts Bluff Substation during 1944 amounted to 11.88 inches. The 35-year mean is 13.56 inches. Of the total precipitation during 1944, 8.72 inches occurred during the growing season (April to September), an amount which may be compared with the 35-year growing season mean of 11.01 inches. As compared with the 35-year mean, precipitation was above normal during January, February, March, July, and November. During June, August, and December precipitation was near normal, but during the remaining months considerably below normal. Although below normal precipitation occurred during April, May, and June, the amounts received were sufficient to provide adequate soil moisture for favorable germination of spring-planted crops. Unusually low precipitation occurred during September and October, a condition very favorable for harvesting operations. During July and August several extremely destructive hailstorms struck the Sunflower, Dutch Flats, Mitchell Valley, and Gering Valley areas of the North Platte Valley. The total crop destruction caused there totaled several million dollars, and represented the greatest damage by hail in the history of the Valley. No hail occurred in the vicinity of the Scotts Bluff Substation nor in areas directly east of the Substation on the north side of the North Platte river.

Compared with the 34-year means, temperatures during February, March, April, June, July, and August were below normal. Temperatures during the fall months were generally above normal. Low temperatures during March delayed spring plowing and the preparation of seedbeds for early-planted crops. Continued cool weather through April retarded germination of early-planted crops such as sugar beets and small grain. Sugar beets planted April 10 at the station failed to emerge until about May 10. The temperature during March and April continued on a relatively low plane, but no extremes of unusually cold or unusually hot weather were encountered. Cool weather during the summer proved to be favorable for potatoes and pastures but retarded the growth of corn. Although cool weather was favorable for potatoes, it also encouraged the development of the psyllid, an insect which attacks this crop with serious consequences. A vigorous dusting and spraying program had to be carried out in order to control the pest.

Evaporation during the growing season of 1944 amounted to 31.12 inches compared to the 34-year mean of 36.22 inches. Except in September evaporation during 1944 was below normal during all months of the growing season.
The mean hourly wind movement during the growing season of 1944 was approximately normal. During several days in April and May, unusually high wind movement caused serious wind erosion, particularly on the lighter soils. One severe windstorm in May entirely destroyed a large acreage of sugar beet seedlings just in the process of emerging. A large portion of this acreage was replanted.

The last frost in the spring occurred on May 8 and the first in the fall on October 11, leaving a frost-free period of 155 days, which is approximately 20 days longer than normal. The long growing season proved to be of great advantage for the proper maturing of corn, which had been retarded by cool weather during the summer. A short labor supply necessitated later-than-usual plantings of potatoes. The long growing season permitted this crop to mature and produce good yields.

Crop rotation experiments

The new rotation program inaugurated in 1942 and carried forward in 1944 includes studies of the value of farm manure; commercial fertilizers, chiefly phosphate and nitrogen; alfalfa as green manure; and sweetclover as a pasture and green manure crop. The rotation experiments comprised, in addition to the ones on continuous plots, rotations varying in length from two to six years. The new rotation experiments have been designed for the study both of yields and of quality of crops. For example, it has become apparent that there is no advantage in nor justification for operating a rotation which produces high yields of scabby potatoes. Considerable emphasis is therefore being placed upon the study of factors responsible for the development of scab on potatoes in the different rotations.

During 1944 the untreated continuous plot of sugar beets yielded 5.0 tons of beets per acre compared with 4.9 tons on the plot treated with phosphate and nitrogen. Sugar beets on the continuous plot, treated with phosphate and nitrogen, emerged satisfactorily and made a rapid early growth; later, however, various diseases killed most of the plants before harvest. Most of the diseases were also present in the untreated plot, but their destructive action appeared to be considerably less vigorous and decisive. The continuous untreated plot of barley yielded 43.5 bu. per acre compared with 63.0 bu. for the plot treated with manure; 67.5 bu. for the plot treated with nitrogen; and 61.3 bu. for the plot treated with both phosphate and nitrogen. The continuous untreated plot of beans yielded 31.2 bu. compared with 37.9 for the plot treated with manure. The untreated continuous plot of corn produced 30.3 bu. as compared with 69.7 bu. for the plot treated with manure. This yield represents one of the greatest responses ever made by any crop grown at this station to an application of farm manure. A continuous alfalfa plot, treated with manure yielded 5.1 tons per acre compared with 4.6 tons on a continuous untreated plot. The alfalfa on the manured plot started growth earlier after each cutting and bloomed about ten days later than on the untreated plot. The plants on the manured plot also appeared to have a greater proportion of leaves. The continuous plot of potatoes, treated with manure, yielded 108 bu. per acre compared with 52 bu. on the untreated plot. A large proportion of the potatoes on both of these plots were seriously affected by scab with the result that the yield of U. S. No. 1 grade amounted to only 2 bu. per acre on the untreated and 3 bu. per acre on the manured plots.
The highest yields of sugar beets were obtained from alfalfa rotations treated with phosphate and nitrogen and a sweetclover rotation treated with manure. The yields in these rotations amounted to 17.6 tons per acre. Alfalfa rotations treated with manure produced yields of 15.8 tons per acre compared with 11.4 tons in alfalfa rotations with no treatment. Sugar beets in the untreated rotations yielded 7.0 tons compared with 15.9 tons in the manured rotations and 16.0 tons in the rotations treated with phosphate and nitrogen. A sweetclover pastured rotation, treated with phosphate and nitrogen, produced 13.7 tons of beets per acre compared with 11.3 tons for a similar untreated rotation.

Barley in alfalfa rotations yielded 55.0 bu. per acre compared with 66.0 bu. in alfalfa rotations treated with manure, and 65.9 bu. in alfalfa rotations treated with phosphate and nitrogen. An untreated rotation without alfalfa produced 23.0 bu. per acre compared with 58.0 bu. in rotations treated with manure, and 48.0 bu. in rotations treated with phosphate and nitrogen. A sweetclover pasture rotation treated with phosphate and nitrogen produced 69.0 bu. of barley compared with 54.0 bu. in a similar untreated rotation.

The highest yield of beans (42.0 bu. per acre) was obtained from an alfalfa rotation treated with manure. In a similar rotation treated with phosphate and nitrogen, beans yielded 37.9 bu. Manured rotations without alfalfa produced 38.8 bu. of beans per acre compared with 37.8 bu. in rotations treated with phosphate and nitrogen.

The mean yield of potatoes in alfalfa rotations treated with manure was 311 bu. per acre compared with 269 bu. in alfalfa rotations treated with phosphate and nitrogen, and 265 bu. in untreated alfalfa rotations. The yield of potatoes in untreated rotations was 121 bu. compared with 202 bu. in manured rotations, and 253 bu. in rotations treated with phosphate and nitrogen. The pastured sweetclover rotation treated with phosphate and nitrogen produced 291 bu. compared with 241 bu. in a similar, untreated rotation.

The most important feature about the yield of potatoes concerns the portion of the total yield which may be classed in the U. S. No. 1 grade. A great variation in this feature occurred among the different rotations. The highest percentage of No. 1 potatoes was obtained in alfalfa and sweetclover rotations of either four or six years in length. Only seven per cent of the potatoes from the untreated rotations passed in the U. S. No. 1 grade compared with 25% in the manured rotations, 38% in the rotations treated with phosphate and nitrogen, and 40% in alfalfa rotations. The chief cause of potatoes failing to make the U. S. No. 1 grade was scab, and in general, the rotations which produced the lowest amount of No. 1 potatoes showed the highest percentage of scab. Scab on potatoes from the different rotations varied from 14% in alfalfa rotations treated with manure to 65% in the untreated rotations. The longer rotations developed less scab whether alfalfa was involved as one of the crops in the rotation or not.

**Lamb feeding experiments**

Lamb feeding experiments at the Scotts Bluff Substation during 1944 were a continuation of the death loss studies begun in 1941 together with studies of specialized rations fed for a particular purpose. During the first two years of these studies (when lambs received a ration of corn,
cottonseed meal, bone meal, and beet top silage) heavy death losses from urinary calculi resulted. In the current test extensive studies were made with beet top silage in several different rations in an attempt to isolate, if possible, the factor or factors responsible for the outbreaks of urinary calculi. For the current test, cottonseed meal could not be procured, and in view of the scarcity of corn, a grain mixture of equal parts of corn, barley, and dry pulp was used in place of corn. Soybean meal was used as the protein supplement in place of cottonseed meal. Consequently, in the current test, the calculi-producing ration consisted of the grain mixture, soybean meal, bone meal, and beet top silage. The other rations, designed to develop information about the causes of urinary calculi in this particular calculi-producing ration, involved the exclusion of bone meal in one instance, the exclusion of both bone meal and the protein supplement in another, the addition of ground limestone in comparison with bone meal, and the addition of alfalfa hay to the ration designed to produce calculi.

In the current test no serious outbreaks of urinary calculi occurred in the ration designed to produce the ailment, nor in any of the other rations designed to develop information about the calculi-producing ration. In the two earlier tests it was considered possible that the heavy outbreaks of urinary calculi might have been caused by the heavy consumption of beet top silage, a highly palatable and apparently tasty food as judged by the vigorous appetite with which the lambs consumed it. However, in the present test some of the lambs consumed the silage at the rate of 5 lbs. per lamb daily for a period of 80 days and showed not the slightest symptoms of urinary calculi. The results of the present test indicate that the soybean meal used in place of cottonseed meal, or the grain mixture in place of corn, or both factors might be responsible for the failure of the development of urinary calculi. Future tests will be necessary in order to supply more data about these factors.

The results of the comparisons in the test conducted during 1944 are as follows:

**Alfalfa vs. cured beet tops vs. beet top silage.**—A grain mixture of equal parts by weight of yellow shelled corn, whole barley, and molasses dried beet pulp was used as the concentrate in rations to compare the value of alfalfa, cured beet tops, and beet top silage as roughages for lambs. The lambs fed alfalfa gained 0.26 lb. per lamb daily compared with 0.23 lb. for those fed cured beet tops, and 0.22 lb. for those fed beet top silage. Both the lambs fed alfalfa and those fed beet top silage consumed 1.2 lbs. of the grain mixture per head daily compared with 1.14 lbs. for the lambs fed field-cured beet tops. Although the daily gains in these lots were not satisfactory, no serious trouble from excessive scouring or urinary calculi developed as the result of using field-cured beet tops in one instance and beet top silage in another as the only roughages.

**Alfalfa as a supplement to cured beet tops and beet top silage.**—The addition of alfalfa hay at the rate of 0.7 lb. per lamb daily to a ration of grain mixture and cured beet tops increased the daily gain from 0.23 lb. to 0.31 lb. The addition of alfalfa hay at the rate of 0.76 lb. daily per lamb to the beet top silage ration increased the daily gain from 0.22 to 0.27 lb. The addition of alfalfa hay produced lambs of a better bloom, reduced scouring, and helped to maintain a more uniform appetite for the ration.
Alfalfa hay vs. soybean meal as a supplement to beet top silage—Soybean meal fed at the rate of 0.24 lb. per lamb daily in a ration of grain mixture and beet top silage produced a daily gain of 0.32 lb. per lamb compared with 0.27 lb. for lambs receiving alfalfa hay at the rate of 0.76 lb. per lamb daily. Part of the difference in the daily gain may be attributed to the fact that the lambs fed soybean meal received more available nutrients than the lambs fed alfalfa. The lambs in both lots maintained a vigorous appetite for the rations throughout the test, and no serious symptoms of urinary calculi occurred in either lot.

The value of alfalfa hay as a supplement to a ration of grain mixture, soybean meal, and beet top silage.—The addition of alfalfa hay at the rate of 0.69 lb. daily per lamb in this comparison increased the gain from 0.32 lb. to 0.36 lb. per lamb daily. The lambs in both lots maintained a brisk appetite for their feed throughout the test, and no serious trouble from any cause developed.

Cured beet tops vs. beet top silage when measured in lamb gains per acre of beets.—The yield of edible beet top silage produced per acre during 1943 at the Scotts Bluff Substation amounted to 4.98 tons whereas the yield of moisture-free field-cured tops amounted to 2.09 tons. With these data it was possible to determine the lamb gains per acre from beet top silage as compared with those from field-cured beet tops. The lambs in Lot 4, fed the grain mixture, cured beet tops, and alfalfa hay, produced 1,215 lbs. gain per acre of beets grown compared with 692 lbs. when the tops were fed in the form of silage plus the grain mixture and alfalfa hay in Lot 5. In Lot 8 the lambs produced 960 lbs. gain per acre of beets grown when the tops were fed in the form of silage plus the grain mixture, soybean meal, and alfalfa hay. These results indicate that field-cured beet tops were somewhat superior to beet top silage. However, unusually favorable weather prevailed during the season for curing the tops in the field, and the results may be difficult to duplicate under less favorable weather conditions.

Dried molasses beet pulp vs. a grain mixture.—Dried molasses beet pulp fed with alfalfa hay produced a daily gain of 0.18 lb. compared with 0.26 lb. for lambs fed the grain mixture and alfalfa hay. The lambs fed the dried pulp made slow gains and lacked plumpness, but no other ill effects were noticeable.

Steamed bone meal and ground limestone as mineral supplements to a beet top silage ration.—The results of this test showed little evidence of the need for adding steamed bone meal or ground limestone to a ration of beet top silage, soybean meal, and a grain mixture of corn, barley, and molasses dried pulp, equal parts by weight.

Irrigation investigations

The irrigation input and runoff was measured on each plot in the irrigated rotation experiments, involving over 100 quarter-acre plots and various types of cropping programs. The rotation program includes several levels of soil productivity and is representative of the practical farming operations in irrigated areas. The irrigation water has been measured for the purpose of obtaining information on the water requirements of crops under practical conditions.
Tomato investigations

This project represents a continuation of work carried on in cooperation with the Horticulture Department of the University of Nebraska. The work during 1944 included chiefly variety and cultural tests.

Experimental work with safflower

This project has been carried on in cooperation with the Chemurgy Division of the University of Nebraska. Tests conducted during 1944 at the Scotts Bluff Substation comprised spacing and date-of-planting experiments. The breeding project was continued with attention directed toward the production of a spineless, high oil-producing strain of safflower. The work with safflower to date indicates that this crop is very sensitive to soil moisture conditions. It appears that extensive irrigation tests will be necessary to solve the problems encountered in the irrigation of safflower.

Field bean investigations

Varieties and strains of field beans grown at the Scotts Bluff Substation during 1944 were tested for yield, and a breeding project involving a test of various varieties and strains for resistance to halo and bacterial blight was conducted. This work has been carried on in cooperation with the Plant Pathology Department of the University of Nebraska. The new pinto bean, selected from a cross between Great Northern and pinto, continued to show favorable characteristics in this area. Seed of this new bean was increased at the station for widespread planting in 1945. In the bean-breeding project various varieties and strains were inoculated artificially with halo and common blight organisms. Considerable variation was observed in the resistance of selected strains to these diseases. Definite progress has been made in selecting a bean resistant to the halo blight.

Potato improvement work

This project has been carried on since 1936 in cooperation with the Horticulture and Plant Pathology Departments of the University of Nebraska. The object of this work involves the improvement of disease resistance and horticultural qualities of potatoes grown under irrigation in western Nebraska. The method used to attain the objective comprises a breeding program and the testing of numerous seedlings under field conditions.

Potato insect investigations

During 1944 a determination was made of the value of various dusts and sprays in the control of flea beetles and psyllids, the most destructive of the insects affecting potatoes in this area. These dusts and sprays (see Entomology section) were used on potatoes planted at different dates. The problem of controlling insects has been found to be much greater on early plantings.

Although the supply did not permit extensive applications, the new DDT dust showed unusually promising results in the control of the worst insects affecting potatoes. This work has been carried on in cooperation with the Entomology Department of the University of Nebraska.
Hybrid corn tests

This test comprised a study of commercial hybrids in comparison with experimental hybrids designed for this area, and a preliminary study of single cross strains to determine the value of parent strains in the production of a satisfactory hybrid for this area. At present, most of the hybrids which mature satisfactorily have been undesirable in yield or other characteristics. In the corn hybrid work, efforts have been directed toward the production of a high-yielding, moderately tall, sturdy-stalked, and early-maturing variety.  

*Lionel Harris.*
Valentine Substation

On account of the war, activities at this substation were curtailed somewhat, and the superintendent has assumed additional duties as agricultural agent in Cherry County.

Climatic conditions and crops

The year 1943 was very erratic as regards weather conditions. The fall of 1942 was dry with an accumulated deficiency in moisture of 3.56 inches. Soil condition was such that little fall grain was seeded. Heavy snow fell the latter part of January and more in February and March. The spring was late and small grain yields were generally poor. Spring wheat was severely damaged by rust. Rainfall in both June and July was almost 3 inches above normal, bringing the accumulated precipitation since January 1 to 7.14 inches. Sandhill lakes filled to overflowing and the subirrigated meadows were mostly under water. Early settlers had never seen so much water on the meadows. Haying was delayed several weeks and some areas had to be abandoned. August was dry, but September and October were drier. A total of .26 inch of precipitation fell in the latter two months. The soil became so dry that much of the early-seeded fall grain killed out. But there was one compensating factor. Since the first killing frost was a month later than normal, one of the biggest corn crops on record was assured.

A Nebraska Regional Corn Test was conducted on the tableland north of Valentine. Nineteen hybrids and a local open-pollinated variety were planted in five replications of 20 hills each. All varieties were standing well at the time of harvesting. In only five of the hybrids was the moisture content higher than in the open-pollinated variety, which carried 27.8%. Four hybrids showed a significant increase in yield, three of which are Nebraska Certified hybrids.

Supplements to prairie hay for wintering calves

In recent years, soybean oil meal has become the most accessible protein concentrate for feeding in the range area. Eight lots of Hereford calves were put on three feeding rations of soybean oil meal with and without mineral supplement, using cottonseed cake for one lot as a check. Each lot consisted of ten calves averaging approximately 370 lbs. They were wintered on prairie hay plus supplement for 168 days and were on grass 135 days during the summer. The following data give the results of the test.

<table>
<thead>
<tr>
<th>Winter supplement</th>
<th>Winter gain</th>
<th>Summer gain</th>
<th>Total gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ lb. soybean oil meal</td>
<td>108</td>
<td>161</td>
<td>269</td>
</tr>
<tr>
<td>½ lb. S.O.M. &amp; .08 lb. bone meal</td>
<td>137</td>
<td>157</td>
<td>294</td>
</tr>
<tr>
<td>¾ lb. S.O.M.</td>
<td>123</td>
<td>158</td>
<td>281</td>
</tr>
<tr>
<td>½ lb. S.O.M. &amp; .06 bone meal</td>
<td>141</td>
<td>142</td>
<td>283</td>
</tr>
<tr>
<td>1 lb. S.O.M.</td>
<td>144</td>
<td>161</td>
<td>305</td>
</tr>
<tr>
<td>1 lb. S.O.M. &amp; .04 lb. bone meal</td>
<td>162</td>
<td>116</td>
<td>278</td>
</tr>
<tr>
<td>1 lb. S.O.M. &amp; .1 lb. limestone</td>
<td>122</td>
<td>156</td>
<td>278</td>
</tr>
<tr>
<td>1 lb. cottonseed cake</td>
<td>145</td>
<td>140</td>
<td>285</td>
</tr>
</tbody>
</table>
Because of the late spring the range was in poor condition when the heifers were turned out the 10th of May. The lot making the largest winter gain actually lost 1.1 lbs. per head during the first four weeks on grass, and the lot wintered on cottonseed cake gained only .6 lb. per head.

The increased winter gain from adding steamed bone meal to the three feeding rates of soybean oil meal disappeared during the grazing season except in the half-pound rate. Feeding .1 lb. of ground limestone definitely retarded winter gain.

**Dual-purpose cattle project**

The Milking Shorthorn herd has increased to 70 females of all ages. Twenty-nine head were in production in 1944 with butterfat records ranging from 37.6 to 317.4 lbs. The average was 192.4 lbs. of butterfat and 4,626.4 lbs. of milk.

Thirteen head produced over 200 lbs. of butterfat each, the average for the 13 being 255.6 lbs. Three of the 13 were two-year-old heifers. Exclusive of pasture, the feed required by the 13 head to produce a pound of butterfat was 6.6 lbs. of grain, 19.8 lbs. of hay, and 25.5 lbs. of silage. The pasture was native sandhill grasses.

**ADDITIONAL LAND, BUILDINGS, AND EQUIPMENT**

During the year the Board of Regents purchased 835 acres of additional farm land, located adjacent to the Havelock Farm. A considerable part of the livestock program will eventually be taken care of with this additional land.

To guarantee the domestic water supply, an additional well was put down at the North Platte Substation.

Although it has not been possible to furnish completely the new Foods and Nutrition Building, a part of the third floor has been equipped, and research in foods and nutrition is being carried on in the laboratories.

**EXPERIMENT STATION PUBLICATIONS DURING 1944**

**Annual Report**

Fifty-seventh Annual Report, presented to the Governor February 1, 1944. 1,500 copies.

**Bulletins**


No. 357. Wintering Steer Calves in the Nebraska Sandhills. E. M. Brouse. February, 1944. 8,000 copies.


No. 361. Potato Flea Beetle Control in Western Nebraska. Roscoe E. Hill and H. Douglas Tate. August, 1944. 4,000 copies.

No. 362. Summer Fallow in Nebraska. L. L. Zook and H. E. Weakley. August, 1944. 6,000 copies.


No. 365. Commercial Fertilizers for the Irrigated Sections of Western Nebraska. E. S. Lyons, J. C. Russel and H. F. Rhoades. December, 1944. 7,000 copies.


No. 368. Determinants of Levels of Living for Farmers of Lancaster County, Nebraska. L. B. Snyder and A. H. Anderson. September, 1944. 4,000 copies.

No. 369. Livestock Auctions in Nebraska. H. C. Filley. August, 1944. 3,000 copies.


Research Bulletins


No. 134. Protein Supplements in Dry Calf Starters for Calves on Limited Quantities of Milk. George W. Trimberger and Herbert Perry Davis. August, 1944. 2,000 copies.


Experiment Station Circulars

No. 76. Effect of Manganese and Iodine Additions in a Specific Ration for Laying Hens. F. E. Mussehl. 5,000 copies.


No. 78. The Scottsbluff Pinto Bean. James H. Jensen. 2,000 copies.

Journal Series, Technical Articles and Papers


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


1944 EXPERIMENT STATION ADMINISTRATION AND STAFF

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JOHN K. SELLECK,¹ Comptroller of the University

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MARTIN S. PETERSON, Ph.D., Acting Agricultural Editor

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H. C. FILLEY, Ph.D., Rural 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, 1943, for military service.
³ On leave effective January 1, 1942, for military service.
⁴ On leave effective September 16, 1942, for military service.
⁵ Detailed from the U. S. Department of Agriculture, Washington, D. C.
⁶ On leave, September 1, 1944, to February 28, 1945.
⁷ Resigned March 1, 1944.
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R. E. PAHL,7 B.Sc., Supervisor, Box Butte Experimental Farm, Alliance
K. S. QUIGENBERRY,9 Ph.D., Agronomist
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C. F. REINMILLER,8 M.Cc., Junior Animal Husbandman, North Platte Substation
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RAYMOND ROBERTS,10 M.Sc., Associate Entomologist

1 Resigned August 31, 1944.
2 Detailed from the U. S. Department of Agriculture, Washington, D. C.
3 On leave effective February 15, 1943, for military service.
4 Resigned December 31, 1944.
5 On leave effective February 1, 1943, for military service.
6 Appointed December 1, 1944.
7 Resigned June 30, 1944.
8 On leave effective November 1, 1942.
9 Resigned December 1, 1944.
10 On leave effective August 15, 1942, for military service.
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. SANDSTEDT, M.Sc., Agricultural Chemist
DORETTA SCHLAPHOFF, M.S., Assistant in Home Economics
JOHN M. SLATENSEK, B.Sc., Assistant Agronomist
C. W. SMITH, M.Sc., M.E., Agricultural Engineer
L. B. SNYDER, Ph.D., Associate Rural Economist
LELAND STOTT, Ph.D., Associate Home Economist
H. D. TATE, Ph.D., Entomologist (Chairman)
G. W. TRIMBERGER, M.Sc., Assistant in Dairy Husbandry
L. VAN ES, V.S., M.D., D.Sc., Animal Pathologist (Chairman)
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 Detailed from the U. S. Department of Agriculture, Washington, D. C.
2 Resigned November 1, 1944.
3 Resigned October 15, 1944.
4 On leave effective January 20, 1942, for military service.
FINANCIAL STATEMENT

NEBRASKA AGRICULTURAL EXPERIMENT STATION FINANCIAL REPORT
Money Received from the United States Government

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, 1944, under act of Congress approved March 2, 1887. Total $15,000.00

For salaries Total $15,000.00

Expenditures

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, 1944, under act of Congress approved March 16, 1906. Total $15,000.00

For salaries Total $15,000.00

Expenditures

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.

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, 1944, under act of Congress approved February 24, 1925. Total $60,000.00

Salaries and wages
Regular employees $42,045.12
Temporary employees 3,731.00
Total $45,776.12

Supplies
Office supplies $32.28
Laboratory supplies 2,897.53
Foodstuffs 50.00
Educational supplies 136.43
Janitor and barn supplies 9.05
Feedingstuffs 1,210.55
Agricultural supplies 135.00
Total $4,470.74

Expense
Postage $126.89
Telephone and telegraph 44.00
Freight, express and drayage 30.67
Public printing, advertising and photo supplies 1,241.36
Water, heat, light and power 12.43
Traveling expense 994.48
Rentals 10.00
Special and temporary services 5,296.24
Miscellaneous 1.65
Total $7,757.72

Repairs
Building $140.03
Equipment 472.98
Total $613.01

Equipment
Furniture and fixtures $137.78
Apparatus, labor and equipment 1,160.18
Machinery 38.91
Books, magazines and maps 40.54
Total $1,377.41

Fixed Charges
Refunds $5.00
Total $5.00

GRAND TOTAL $60,000.00

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.

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, 1944, under act of Congress approved June 29, 1935. Total $38,776.60

Salaries and wages
Regular employees $24,186.67
Temporary employees 1,882.57
Total $26,069.24

Supplies
Office supplies $33.03
Laboratory supplies 1,089.01
Feedingstuffs 2,017.13
Agricultural supplies 207.03
### NEBRASKA AGRICULTURAL EXPERIMENT STATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janitor and barn supplies</td>
<td>68.06</td>
</tr>
<tr>
<td>Educational supplies</td>
<td>75.51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3,489.77</strong></td>
</tr>
</tbody>
</table>

**Expense**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage</td>
<td>19.00</td>
</tr>
<tr>
<td>Freight, express and drayage</td>
<td>6.50</td>
</tr>
<tr>
<td>Public printing, advertising and photo supplies</td>
<td>1,147.16</td>
</tr>
<tr>
<td>Water, heat, light and power</td>
<td>13.44</td>
</tr>
<tr>
<td>Traveling expense</td>
<td>624.39</td>
</tr>
<tr>
<td>Rentals</td>
<td>207.00</td>
</tr>
<tr>
<td>Special and temporary services</td>
<td>5,137.51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$7,155.30</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repairs</td>
<td>$311.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$311.26</strong></td>
</tr>
</tbody>
</table>

**Supplies**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office supplies</td>
<td>$718.40</td>
</tr>
<tr>
<td>Laboratory supplies</td>
<td>6,791.74</td>
</tr>
<tr>
<td>Fuel (coal)</td>
<td>727.92</td>
</tr>
<tr>
<td>Foodstuffs</td>
<td>2,964.18</td>
</tr>
<tr>
<td>Educational and recreational</td>
<td>935.46</td>
</tr>
<tr>
<td>Janitor and barn supplies</td>
<td>935.46</td>
</tr>
<tr>
<td>Feedingstuffs</td>
<td>54,950.03</td>
</tr>
<tr>
<td>Agricultural supplies</td>
<td>5,516.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$73,664.44</strong></td>
</tr>
</tbody>
</table>

**Expense**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage</td>
<td>$606.55</td>
</tr>
<tr>
<td>Telephone and telegraph</td>
<td>1,330.82</td>
</tr>
<tr>
<td>Freight, express and drayage</td>
<td>2,014.06</td>
</tr>
<tr>
<td>Water, heat, light and power</td>
<td>5,492.34</td>
</tr>
<tr>
<td>Public printing, advertising and photo supplies</td>
<td>3,252.65</td>
</tr>
<tr>
<td>Traveling expense</td>
<td>5,208.61</td>
</tr>
<tr>
<td>Special and temporary services</td>
<td>58,364.51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$79,428.37</strong></td>
</tr>
</tbody>
</table>

**Repairs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>$2,575.28</td>
</tr>
<tr>
<td>Lands</td>
<td>62.71</td>
</tr>
<tr>
<td>Equipment</td>
<td>8,813.31</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$11,451.30</strong></td>
</tr>
</tbody>
</table>

**Equipment**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture and fixtures</td>
<td>$1,429.09</td>
</tr>
<tr>
<td>Apparatus, labor and equipment</td>
<td>2,233.66</td>
</tr>
<tr>
<td>Livestock</td>
<td>20,906.66</td>
</tr>
<tr>
<td>Machinery</td>
<td>5,752.13</td>
</tr>
<tr>
<td>Books, magazines and maps</td>
<td>153.85</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$30,368.39</strong></td>
</tr>
</tbody>
</table>

**Lands and buildings**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>$461.00</td>
</tr>
<tr>
<td>Land improvement</td>
<td>1,219.56</td>
</tr>
<tr>
<td>Buildings</td>
<td>1,730.21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3,410.77</strong></td>
</tr>
</tbody>
</table>

**Fixed charges**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refunds</td>
<td>$263.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$263.50</strong></td>
</tr>
</tbody>
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**GRAND TOTAL**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$260,060.36</td>
</tr>
</tbody>
</table>

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

**FINANCIAL STATEMENT EXCLUSIVE OF FEDERAL FUNDS**

Statement of Expenditures for the Agricultural Experiment Station, University of Nebraska, for the year ended June 30, 1944, including expenditures for central station at Lincoln and substations at North Platte, Scottsbluff, Valentine, Union and Alliance and for Outstate Testing.

**Salaries and wages**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular employees</td>
<td>$55,406.31</td>
</tr>
<tr>
<td>Temporary employees</td>
<td>6,067.28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$61,473.59</strong></td>
</tr>
</tbody>
</table>

**Supplies**

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</tbody>
</table>

Dated at Lincoln, Nebraska                        JOHN K. SELLECK, Comptroller.
A SYNOPSIS OF THE ORGANIZATION OF RESEARCH AT THE NEBRASKA AGRICULTURAL EXPERIMENT STATION

TOWARD GREATER CROP PRODUCTION

Physical and biological experiments in erosion control and moisture conservation; soil structure stability; fertilizer tests; properties of Nebraska soils; amount and nature of phosphorus soils in Nebraska.

Improvement of small grains, sorghums, sudan grass, soybeans; corn, etc.; search for new industrial crops (safflower, castor beans) adapted to Nebraska; profitable cultural practices; weed eradication (bindweed).

Control of plant diseases: bean diseases; cereal diseases (charcoal rot of corn); potato diseases (fusarium wilt and scab); tomato diseases.

Control of insect pests: tuber flea beetles, leafhoppers, aphids, etc. Research into effects of DDT and other insecticides.

TOWARD GREATER ANIMAL AND ANIMAL PRODUCTS PRODUCTION

Studies in economic livestock rations; protein requirements of pigs; substitution of various nutrients (distillers' dried grains, urea, etc.) for other elements of the diet; use of pasture in finishing animals.

Low cost rations for poultry; vitamin requirements for growing poults; efficiency of various feedstuffs (safflower seed, wheat fermentation by-products).

Studies in growth of dairy animals; factors affecting reproduction; artificial insemination; milk substitutes for growing calves. Research in the manufacture various dairy products.

Studies in the nature of livestock diseases; bacteriologic, serologic, and pathologic examinations of specimens submitted by Nebraska livestock growers; investigations into mortality in turkey flocks.

TOWARD BETTER FARM ECONOMY AND WELFARE

Studies in the use of electric power on farms; dehydration and refrigeration of food; cooling of milk; electric brooders for chickens.

Studies in land use planning; cost of producing farm crops; productive capacity of agricultural Nebraska; land tenure studies; credit; marketing; and farm work simplification.

Studies of storage structures for potatoes; vitamin C content of vegetables; control of rodents; vitamins in cheese; preserving dairy products; farm account books; livestock auctions. Nebraska land values with respect to current land prices.

Miscellaneous: answers to inquiries from agriculturists; cooperative studies with federal and state agricultural scientists in all fields; guidance to industries associated with agriculture in problems related to the war effort.