5-1943

56th Annual Report of the Agricultural Experiment Station May 1943

W.W. Burr

University of Nebraska at Lincoln

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GREATER FARM PRODUCTION for Nebraska

56TH ANNUAL REPORT of the
AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, UNIVERSITY OF NEBRASKA
W. W. BURR, DIRECTOR, LINCOLN, NEBRASKA
MAY, 1943
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Cover Picture, Courtesy of the Soil Conservation Service

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Letter of Transmittal

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

W. W. Burr, Director

February 1, 1943

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

Dwight Griswold, Governor

February 1, 1943

Introduction

The war-time need for increased food production is the most urgent problem of Nebraska agriculture, and the Nebraska Agricultural Experiment Station has endeavored to assist in every way within its field in meeting this need. This has necessitated a considerable shift in the emphasis of a number of Station projects and the inauguration of several new ones.

A great deal more time than normal has been required of the staff members to answer the increasing number of inquiries that are received concerning food production and various defense programs. Special assistance was provided in determining the possibilities and limitations of increasing food production goals in Nebraska and in the survey and tabulation of
the farm labor situation. A considerable number of reports have been prepared for agencies interested in regional and national problems.

Certain staff members were loaned to the government during the past year. One man is devoting full time to the grading of cheese purchased by the government under the lend-lease program. Another staff member is with the Office of Price Administration. A number of men have gone into some branch of military service. Others have entered new phases of government work which have taken them from the Station temporarily or permanently.

In connection with the Chemurgy Division of the University, a number of new crops are being grown to determine their possibilities in the production of oils, fibers and drugs. At the request of the federal government, particular attention is being given to the study of the vitamin content in butter and the nutritive value of certain common food crops. Very satisfactory progress was made in the project to produce a much-needed cassava type of starch from Leoti red sorghum. This starch is important as a substitute for starches ordinarily imported. Progress reached the commercial stage but an early frost seriously reduced the value of the crop for starch purposes.

This fifty-sixth annual report covers briefly the research program of the Nebraska Station for the calendar year of 1942. It includes the work at the main station at Lincoln, and the substations at North Platte, Mitchell and Valentine, the experimental farm at Alliance, and the cooperative research work with farmers throughout the state. The experimental farm at Alliance is carried in cooperation with the county commissioners of Box Butte County.

A considerable part of the research program of the Station is in cooperation with federal agencies. These cooperative relationships have been entirely satisfactory and advantageous to the program. Among the various federal agencies with which the Experiment Station is cooperating are the Bureaus of Plant Industry, Animal Industry, Entomology and Plant Quarantine, Agricultural Chemistry and Engineering, and Agricultural Economics, also with the Soil Conservation Service, the Bankhead-Jones regional laboratories for swine improvement, poultry improvement, and the industrial utilization of soybeans. Cooperative studies are also being carried with a number of the state experiment stations and with the Agricultural Extension Service and the Chemurgy Division of the College of Agriculture.

Weather conditions throughout Nebraska were more favorable for crop production in 1942 than for any year in the past eight, and yields were quite satisfactory over much of the state. It is generally felt that the drought period of the past several years has ended. On the whole the research program of the Station showed satisfactory progress in most lines.

In outline this report follows those of the past several years. The financial report is for the fiscal year ending June 30, 1942, and so does not conform to the calendar year for which the research is reported.
Greater agricultural production requires that soil on Nebraska farms be conserved and improved.

Soil Research
Department of Agronomy

Erosion Control and Moisture Conservation

A few heavy rains during the 1942 season caused some of the most severe erosion that has taken place since this project was started. In early spring there were severe losses on corn land and other bare soils where the crop had been removed. Land that still had cornstalks, stubble, or other residue lost very little soil.

During the early summer an intense rain of 2.62 inches did relatively little damage to land in row crops where there was residue protection. Corn land where sweet clover had been plowed under in the spring for green manure lost one inch more water and ten times as much soil as where sweet clover had been subtilled and residues left on the surface.

In a field of sorghum, planted in small furrows on the contour, wheat residues between the rows saved an adequate stand of plants for a good crop. Where the residues had been plowed under, the young plants were so completely buried under silt that the crop was almost a failure. During the same rain, 3,000 pounds per acre of wheat residues on the surface, together with contour planting, completely controlled soil erosion on soybean land of six per cent slope. Land in small grain lost practically no water or soil because protection was afforded by the growing crops.

Effectiveness of crop residues is illustrated by results during 1942:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Treatment</th>
<th>Crop Runoff</th>
<th>Soil erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941</td>
<td>1942</td>
<td>Inches per acre</td>
<td>Tons per acre</td>
</tr>
<tr>
<td>Corn Stalks</td>
<td>Stalks removed in fall, disked</td>
<td>Oats</td>
<td>2.19</td>
</tr>
<tr>
<td>Corn Stalks</td>
<td>Stalks left on land, subtilled</td>
<td>Oats</td>
<td>0.58</td>
</tr>
<tr>
<td>Oats Stubble</td>
<td>Stubble and straw removed, plowed</td>
<td>Wheat</td>
<td>1.65</td>
</tr>
<tr>
<td>Oats Stubble</td>
<td>Stubble and straw left on, subtilled</td>
<td>Wheat</td>
<td>0.99</td>
</tr>
<tr>
<td>Wheat Stubble</td>
<td>Stubble and straw removed, plowed</td>
<td>Corn</td>
<td>2.60</td>
</tr>
<tr>
<td>Wheat Stubble</td>
<td>Stubble and straw left on, subtilled</td>
<td>Corn</td>
<td>0.93</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>Spring growth, plowed under</td>
<td>Corn</td>
<td>1.60</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>Spring growth, subtilled</td>
<td>Corn</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Now in its fifth year is a long-time comparison of residues left on the surface versus residues removed, in a rotation of corn, oats and wheat. On the average, crop yields by the two systems are similar. The outstanding advantage of residues on the surface is in runoff and erosion control. The mean annual losses of water and of soil per acre, during the past two years of this rotation, are shown below.

<table>
<thead>
<tr>
<th>Runoff</th>
<th>Soil loss</th>
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<tr>
<td>2.21</td>
<td>7.83</td>
</tr>
<tr>
<td>0.94</td>
<td>2.02</td>
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<tr>
<td>2.4:1</td>
<td>3.9:1</td>
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In tests being conducted in seeding alfalfa and sweet clover on subtilled land protected with residues, it has been found possible to obtain good stands and avoid much erosion if a considerable amount of residue is still on the surface at seeding time.
Late fall and early spring erosion (top picture) on a plot where cornstalks had been removed at harvest. During the same period cornstalks cut and left on the land gave good protection as shown in the bottom picture.


This project is directed by F. L. Duley and J. C. Russel, in cooperation with the office of research of the U. S. Department of Agriculture Soil Conservation Service.

**Nitrification Rate of Irrigated Soil**

Nitrification rates have been determined on soil samples taken in the fall of 1941 from 0–6” and 6–12” depths of the rotation plots of Field K at the Scotts Bluff Field Station. The soil was mapped as Tripp very fine sandy loam.

Applications of manure are important for maintaining the available supply of nitrogen in the soil where legumes are not grown regularly.
Land having soybeans planted in furrows up and down the hill washed badly (top picture), while land having soybeans planted on contour washed slightly where bare but did not erode where protected with residue on the surface.

The data point out the value of manure applications and the growing of alfalfa in a rotation on the nitrification rate of Tripp very fine sandy loam. Highest nitrification rate in the 0–6" depth was obtained where 12 tons of manure were applied once in two years. However, the nitrification rates of the rotations growing alfalfa one-half the time were only slightly lower. Nitrification rates in the 6–12" depths were practically equal. An application of 12 tons of manure once in three years resulted in lower nitrification rates in both the 0–6" and 6–12" depths than where 12 tons of manure were applied once in two years. Where 12 tons were applied once in six years to a rotation including three years of alfalfa, the manure did not increase the nitrification rate.

This work was supervised by H. F. Rhoades and M. D. Weldon.

**Superphosphate on Winter Wheat**

Field tests of superphosphate (45% P₂O₅) on winter wheat were conducted in Pawnee, Johnson, Cass, Sarpy and Merrick counties in 1942. Moisture was not a limiting factor in the 1942 tests. Of the 29 tests harvested, 22 were located on the upland and seven on the terrace and
bottomland. Six of 12 tests on soils derived from loess on the upland showed profitable increases in yield (four or more bushels) from an application of 40 pounds superphosphate per acre. Nine of 10 tests on soils derived from glacial material showed profitable increases. Only two of the seven tests on the terrace and bottomland showed profitable increases (these were barely profitable). The latter tests were in Merrick County.

A close agreement was obtained in 1942 between the soluble phosphorus content of the soil and the increase in yield of wheat obtained from an application of superphosphate.

Results obtained during the last six years for application of superphosphate to winter wheat indicated the following:

Only the counties in the southeastern part of the state have consistently given profitable returns from the use of superphosphates.

Soils on the upland were more deficient in available phosphorous than soils on the terrace or bottomland as judged by both field and laboratory tests. Those soils derived from glacial drift such as Carrington, Burchard, Pawnee, Steinauer, Shelby, and some of the Marshall soils (derived from loess) were especially deficient in available phosphorus.

Soil moisture conditions greatly affected the response of wheat to applications of superphosphate.

Some observations indicated that late-planted wheat showed a greater response to applications of superphosphate than wheat planted at the normal date.

The response of wheat to applications of superphosphate was greatly influenced by previous cropping and manuring practices.


J. W. Fitts, H. F. Rhoades and M. D. Weldon had charge of this project.

Some Fertilizers for Grasses

Sodium nitrate, ammonium sulfate, superphosphate, and lime were applied alone, in combination, and at varying rates to a 30-year-old blue-grass pasture in Richardson County. The soil was mapped as Grundy silt loam. Both nitrogen fertilizers greatly increased the yield of forage. The sodium nitrate gave slightly better results than ammonium sulfate. Both nitrogen fertilizers greatly increased the percentage of protein in the grass during the early stages of growth, but as maturity was reached the increases were not so pronounced. Neither superphosphate nor lime had any effect upon yield of forage or the percentage protein during any stage of growth.

Ammonium sulfate and superphosphate were applied alone, in combination, and in varying amounts to a sod-bound bromegrass field. The soil was mapped as Wabash silt loam. The field was covered with several feet of water during a flood a month after the fertilizers were applied. Plots which received the ammonium sulfate recovered quickly after the flood. Increases of approximately 30 pounds of seed per acre were obtained for each 100-pound increment of ammonium sulfate up to a 300-pound application. There was no difference in percentage protein of the forage at the time the seed was harvested. Superphosphate had no significant effect on the yield of seed.

J. W. Fitts had charge of the project.
Fertilizers for Potatoes and Tomatoes

An extensive test with commercial fertilizers on potatoes was conducted on the same field in Merrick County as in 1941. Large increases in yield were obtained from the use of a 10–20–0 fertilizer. Superphosphate alone and a complete fertilizer gave somewhat lower but significant increases in yield. Ammonium sulfate or potash fertilizer alone had no significant effects on the yield. No improvement in quality of the potatoes was noted for any of the fertilizers.

A fertilizer test with tomatoes was conducted on a Waukesha very fine sandy loam near Beaver Crossing. Superphosphate at varying rates was compared with a starter solution (10 pounds of a 5–10–5 fertilizer in 50 gallons of water). A hard freeze in early September greatly reduced the potential yield. Superphosphate hastened slightly the maturity of the tomatoes. The starter solution aided the plants greatly in recovering from the shock of transplanting, but maturity was retarded. Although the vines were loaded with fruit, little had ripened before the freeze.

J. W. Fitts was in charge.

Chemical Changes in the Soil

Analytical work has been continued on the soil samples from the Nebraska fertility plots at Lincoln. The samples studied were taken from the surface six inches at the time of establishment of the plots (1921), and at the end of a 16-year rotation period (1936).

Sixteen years of cropping resulted in small and not statistically significant decreases in exchange capacity and exchangeable calcium in the surface six inches of the check plots. In this layer the pH, oxidizable material, and nitrogen were all decreased significantly.

Manured plots received the following applications: 18 tons every fourth year, 12 tons every fourth year, six tons every second year, and three tons every year. On the average, differences between the exchange capacity and exchangeable calcium of the manured and check plots were not statistically significant. A barely significant difference in the pH and a significant difference in the oxidizable material and nitrogen were found among these plots.

As compared with the check plots, those receiving manure (six tons every second year) plus lime (two tons every fourth year) did not exhibit a statistically significant difference in the exchange capacity. Differences in oxidizable material and nitrogen were almost and barely significant, respectively. Statistically significant differences were found for exchangeable calcium and pH.

This work was conducted by Henry W. Smith.

Variations in the Butler Soil Series

Further investigation of the Butler soils was made during 1942 as part of the study of the physical and chemical properties of Nebraska soils in relation to their genesis, classification and mapping.

Butler soils can be separated from those of the Crete and Fillmore series by the characteristics of the A and upper B horizons. Butler soils have an incipient B2 horizon which in the field is sometimes described as a zone of “gray sprinklings.” This horizon, as compared with the A2, is slightly lighter in color, has a phylliform rather than a granular structure, and has slightly less clay. It can be delineated by these characteristics under most moisture conditions. In the Fillmore profile the A2 is a definite horizon;
as compared with the A₁, it is much lighter in color, has a platy rather than a granular structure, and has much less clay. Crete soils lack A₃ horizons, the order in the profile being A₁, A₃ or B₃. The B₂ of the Crete is commonly more brown than the B₂ of the Butler and Fillmore soils.

Profiles which have the morphology described for Butler soils have been observed under the following topographic conditions in Nebraska: shallow depressions and the better-drained portions of deeper depressions in the Chernozem region of south central Nebraska; those portions of flat loessial uplands in the prairie region of southeastern Nebraska which either are micro-depressions at the present time, or could have been in the past; flat uplands with a slope of one or two per cent on loessial caps over-drift within the prairie region of southeastern Nebraska.

Some areas which have been called Butler on the survey field sheets, but which have soils with the characteristics of the Crete series have been studied. These include many of the flat loessial uplands with a slope up to and occasionally beyond five per cent in the prairie region of southeastern Nebraska. Some of these areas are being correlated with the Crete, rather than with the Butler series.

During the year some additional sampling was done, and field observations were made in connection with the study of the physical and chemical characteristics of soils of the Pawnee, Carrington, Shelby, Burchard and Steinauer series.


Studies were supervised by Henry W. Smith and H. F. Rhoades.

Microbiological Studies of Soil

The microbiological studies started last year are proving of value in connection with the work on soil and moisture conservation. Although plant materials left on the surface give more protection against runoff and erosion than where plowed under, they are subject to rather rapid decay by soil organisms. Attention has been given to the rate of decay of differ-

Influence of microbiological decomposition products on soil structure. At left, loessial subsoil with .25 per cent organic matter; right, loessial subsoil with four per cent concentration of colloidal organic decomposition products.
ent crop residues when used as a protective soil cover, and a method developed for determining amount of undecomposed but finely disintegrated plant material on or in the soil. Tests have indicated that legume residues decompose most rapidly, followed by oats straw, wheat straw and cornstalks. Residues left on the surface decay slower than those that are incorporated.

It has been found that soil organisms such as fungi and bacteria may affect greatly the structure of a soil beneath decomposing residues. These effects on structure are reflected in a higher infiltration rate for the soil, particularly when the surface is protected with residue. A brown loess subsoil almost devoid of organic matter was treated with the black colloidal material from decomposed straw, and a very marked effect in producing a more granular structure was observed.

Effects of microorganisms on the decay of residues and in the production of soluble plant nutrient materials where residues are left on the surface have been compared with residues plowed under or mixed with the soil. Nitrate production has been slightly lower on land with the residues on the surface. However, there has been sufficient nitrate present for normal crop growth on the soils tested.

Tests were conducted by F. L. Duley and T. M. McCalla.

**Physical Properties of Alkali Soil**

A study was made to determine the influence of calcium carbonate content and the ratio of exchangeable sodium to calcium on several physical properties of soil. Two soils were used, one with a moderately low and the other with a high clay content. Here is a summary of results.

The lower plastic limit values were not significantly influenced by exchangeable sodium. The liquid limit values of one soil were greatly increased by exchangeable sodium whereas the liquid limit values of the other soil were not significantly changed. Additions of eight and 16 per cent calcium carbonate increased the values of both plastic limits without changing the values of the plasticity index significantly.

The scouring point values of one soil were increased by exchangeable sodium whereas the scouring point values of the other soil were not changed significantly. Additions of calcium carbonate increased the scouring point values of one soil but had a variable effect on the other.

Significant increases in residual shrinkage values were obtained with an increased replacement of calcium-ion by sodium-ion. Additions of calcium carbonate to calcium-saturated soils also increased the residual shrinkage markedly.

Significant increases in moisture equivalent values were obtained with an increased replacement of calcium-ion by sodium-ion. Additions of calcium carbonate also increased the moisture equivalent values significantly. Small but insignificant increases in hygroscopic coefficient values were obtained with either an increased replacement of calcium-ion by sodium-ion or by addition of calcium carbonate.

The results were explained on the assumption that two types of hydration of the soil colloid were active in determining the properties studied.

Studies were supervised by H. F. Rhoades and J. W. Fitts.
For more production, crops and cultural practices must be improved and adapted to Nebraska conditions.

Field Crops Research
Department of Agronomy

Effective Land Use in Crop Production

A NALYSIS of agricultural production possibilities was continued during the year with emphasis on conservation and wartime production needs. With respect to soils and crops, generalized land-use capability charts were prepared for each of the ten major land type areas of the state and suggested cropping and conservation systems were outlined for the land-use capability classes. Land type areas were differentiated on the basis of general uniformity in physical characteristics and conservation requirements, whereas the land-use capability classes were established on the basis of different levels in intensity of use and conservation practices. This involved an estimation of the amount and type of land that should be retained in cultivation, and the cropping and conservation practices believed necessary to maintain a desirable level of productivity.

Although recommendations involve converting some crop land to permanent grass and shifts in major crops, together with wider use of certain practices to attain greater conservation, total production as expressed in feed units would probably not be materially changed. More precise means of measuring the effects of the various cropping and conservation practices upon yield, farm organization and income must be found to permit a more complete analysis for localized conditions.

This analysis, cooperative with the Bureau of Agricultural Economics and other U. S. Department of Agriculture agencies, was conducted by Arthur Anderson, H. F. Rhoades and T. A. Kiesselbach.

Corn Breeding and Testing

Hybrid corn popular. The growing season of 1942 was relatively favorable for the corn crop in Nebraska. Drouth that has prevailed for eight years was distinctly broken. Yield of corn per acre for the state has been officially estimated at 33.5 bushels which is six bushels higher than the long-time average prior to 1934 and is the highest annual state average in this century. It is credited to improved climatic conditions and to increased use of hybrid corn. The acreage in hybrids was 3,431,000 acres or 47 per cent of the entire corn acreage, being concentrated in the more favorable corn regions of the state. This is an acreage increase of 15 per cent over 1941.

New hybrids for Nebraska. One objective of the Experiment Station corn improvement program is to establish superior commercial hybrids, seed of which may be produced by anyone. Seed stocks required in any hybrids developed by the U. S. Department of Agriculture and other state experiment stations are available for use in this state. For this reason it is found practical to test the more promising hybrids from these sources along with those developed locally.

Four new outstanding hybrids have been added to the list of Nebraska certified hybrids for 1943 commercial production. Iowa 4059, Iowa 306, and Indiana 608C are of mid-season maturity, ripening at the same time to a few days later than Iowa 939. Illinois 201 is late ripening and suitable for southeastern Nebraska. Seed stocks of these four and also of five other hybrids being continued in Nebraska certification (Nebr. 463, Iowa 939,
U. S. 35, U. S. 13 and Ohio 92) are available to any farmer in the state to produce hybrid seed for home use or for sale to others.

The nine commercial double-cross hybrids available for certification in 1943 have averaged a fourth higher yield than standard open-pollinated varieties in sections of the state where they are adapted and during periods ranging up to eight years. However, to retain only the best in the certified list, five have been dropped in recent years.

**White hybrids.** As a white hybrid adapted to Nebraska and for which the seed stocks would be available for general farm use, Illinois 2023 has proved the most promising. This is a large late type similar to Ill. 201 and should be confined to southeastern Nebraska. As an average for the last two years in Experiment Station tests it has yielded 52.8 bushels per acre compared with 56.9 bushels for Ill. 201 and 57.9 bushels as an average for the highest 10 yellow hybrids among 80 in the tests. Thus the best open pedigreed white hybrid so far located yields 10 per cent less than a standard yellow hybrid of similar adaptation.

**Testing of commercial hybrids.** Regional tests known as “Official Corn Yield Tests” were conducted in 12 places in Nebraska in 1942. Nine materialized satisfactorily and were harvested. Commercial growers of privately-controlled hybrids were invited to make entries for comparison with each other and with certified hybrids.

**Evaluation of inbred lines.** A regular phase of the Experiment Station corn-breeding program is to evaluate promising new inbred lines through the regional testing of top-crosses in which the respective lines have been crossed on a standard open-pollinated variety. Lines with choice combining ability impress themselves favorably on the top-cross progeny, resulting in superior yield and character of grain, strong stalks, good ear retention, freedom from suckers, etc. These are evidence of high heritable prepotency. Lines giving inferior top-crosses are eliminated from further use in crossing. The top-crosses are grouped as early, medium, and late, in accordance with the lateness of the line parent, and are accordingly tested in northeastern, east-central, and southeastern Nebraska.

In 1942, the Nebraska line known as N6 gave the highest yielding top-cross among 51 tested in Thurston County and 70 tested in Saunders County, while it ranked fourth among 55 in Richardson County. In these three tests this N6 top-cross gave the respective acre-yields of 58.1 bushels, 56.9 bushels, and 88.0 bushels, compared with corresponding Svec Reid yields of 51.1 bushels, 49.0 bushels, and 72.1 bushels. Averaging the 10 highest yielding top-crosses grown in each locality and also the 10 lowest top-crosses, the mean yields were 65.7 bushels and 51.6 bushels or 114.5 and 89.9 per cent of Svec Reid, respectively.

**Prediction tests for possible double crosses.** Three single-cross tests were conducted in 1942 for predicting all possible double crosses that might have their basis in three groups of inbred lines. One of these tests contained 55 single crosses, the entire number that may be made from 11 unrelated inbred lines. The other two tests were cooperative with the U. S. Department of Agriculture and other corn belt experiment stations and are known as the U. S. D. A. uniform mid-season and early single-cross tests, respectively. Each of these contained 45 single crosses representing all possible combinations between 10 inbred lines. A total of 990 different double crosses may be predicted as to performance through careful testing of the 55 single crosses, and 630 from each of the 45 entry tests. Per-
Views in the 1942 Nebraska Experiment Station corn breeding nursery, taken August 6. Top, single crosses being inter-crossed by controlled hand pollination to produce double-cross seed for performance tests in 1943. Below left, Krug, a standard open-pollinated variety, and a new Nebraska Experiment Station hybrid at right. Outstanding features of recommended hybrids are superior yield and strength of stalk and root system.
formance of 2,250 double crosses may be estimated by testing the far smaller number of single crosses.

In the 1942 test containing 55 entries made up as all possible single-cross combinations among 11 inbred lines, four of the five top yielders contained the Nebraska line N6 as one parent and N6 x Hy was at the top. The predicted yield of the standard U. S. 35 double cross is 53.4 bushels per acre, while its actual yield in the same test, where it was included as a standard for comparison, was 57.7 bushels. In comparison, the predicted yield of (N6 x 38-11) (Hy x I 198) is 62.3 bushels, and that of (N6 x 38-11) (Hy x WF9) is 61.8 bushels.

Nebraska contributes a waxy variety. One hundred fifty acres of the open-pollinated variety of corn, Nebraska Waxy, were grown under contract by Nebraska farmers in 1942 for National Starch Products, Inc., of New York. Approximately 8,000 bushels were produced at an average yield of 53 bushels per acre. Most of this crop is being shipped to the Company's mill for experimental use in processing into a special-purpose starch which is expected to prove to be a satisfactory substitute for tapioca starch.

Waxy corn should be grown by Nebraska farmers only under contract at some suitable premium over the price of ordinary corn which compensates for lower yield and isolated production to prevent out-crossing with other corn. Enough additional waxy corn was grown by the Experiment Station this year to provide for a study of its value as a hog and poultry feed by the Departments of Animal Husbandry and Poultry Husbandry.

Nebraska Waxy is a variety developed at this Station during the last 18 years by successively out-crossing a varietal cross between an inferior Chinese waxy corn and standard Yellow Dent corn with various productive dent varieties. Selection of the recessive waxy kernel type by the iodine test was practiced after each out-cross. Five regional performance tests were conducted in the eastern third of Nebraska in 1942. As an average, it yielded 52.5 bushels and was surpassed four per cent by the standard Svec Reid variety. In four regional tests in which the productive hybrid Iowa 939 was also included, the Nebraska Waxy yield of 53.7 bushels per acre was exceeded seven per cent and 19 per cent, respectively, by Reid and Iowa 939. The two-year average relative yields are 100 per cent, 112 per cent, and 127 per cent for the three kinds.


These tests are conducted by T. A. Kiesselbach and Lewis M. Camp.

Improvement of Small Grains

At Lincoln the 1941-42 season was considered good for small grains, with ample moisture available most of the time. Winter wheat made very heavy growth, with high yields and good grain quality, although there was considerable lodging which caused some difficulty at harvest. Leaf rust was observed as early as March 23 but failed to become serious except on a few varieties. In spite of the abundant moisture and succulent growth, little stem rust developed. Of the spring crops, oats were good, giving high yields in spite of very short straw. Barley was only fair, being rather unpromising all season, and before maturity chinch bugs caused serious damage, especially in the nursery. Spring wheat was somewhat better than in 1941, but the crop yielded only a fraction as much as did winter wheat, and some varieties were nearly a failure. Part of the
damage to spring wheat was caused by Hessian fly, but apparently foot rot and possibly other diseases were present.

At Alliance winter wheat survived with no winter-killing and unusually high yields were recorded. Spring grains made a heavy growth early in the season, but drouth and grasshoppers caused some reduction in yield.

On the Box Butte Experiment Farm, the use of large field plots in varietal tests was discontinued and in their place were substituted nursery tests. Varieties were grown in three-rod-row plots with the center row being harvested for yield. The varieties were randomized and replicated seven times. Results obtained were very satisfactory and the cost was much less than for the other method. Used on spring grains only in 1942, the plan was extended to winter wheat in the fall of 1942.

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

**Pawnee wheat is outstanding.** Considerable work was done to increase Pawnee wheat because of its outstanding performance. This variety was developed in cooperative experiments of the Nebraska and Kansas Stations and the Division of Cereal Crops and Diseases of the U. S. Department of Agriculture. It is the result of a Kawvale x Tenmarq cross made at the Kansas Experiment Station in 1928. The F₁, F₂, and F₃ generations of the cross were grown at Manhattan and in the fall of 1931, 52 F₃ plant selections were obtained by the Nebraska Station where they were grown, studied, re-selected, and the best ones advanced to yield tests. The selection now known as Pawnee has proved exceptionally superior in Nebraska, and has been thoroughly tested in nursery and plot experiments in the southern Great Plains.

Pawnee is a winter wheat with glabrous, white glumes, awned spike and hard red kernels. It is earlier ripening than either of its parents, and carries moderate resistance to bunt. In epidemic bunt tests Pawnee developed about one-third as much bunt as did Kharkof. It is resistant to Hessian fly in the hard winter wheat region, is highly resistant to loose smut, has some resistance to leaf rust, and is either slightly resistant to or able to escape severe stem rust damage because of its earliness. The test weight per bushel is heavier than that of Turkey but the grain is somewhat lighter in color.

Milling and baking characteristics indicate that while Pawnee is not outstanding for quality, it is nearly equal to Turkey and Kharkof. It is somewhat less winter hardy than Kharkof and Cheyenne. In the uniform winter-hardiness nursery, Pawnee has an average winter survival which is 94 per cent of Kharkof and 92 per cent of Cheyenne. The variety has a tendency to shatter when ripe, apparently inheriting this character from its Kawvale parent, although it is not as bad as Kawvale. In yield tests over a wide area the variety has been high in both nursery and plots. Grown in plot tests at Lincoln for seven years (1936–1942), Pawnee has had an average yield of 28.4 bushels per acre compared with 23.7 bushels for Cheyenne, 23.0 for Nebred, and 21.8 for Turkey. During this time it has been the highest yielding variety in the test. Pawnee has not yielded so well at either North Platte or Alliance, due in part to its lower winter-hardiness, and for that reason is not recommended for the western part of the state. The recommended area is south of the Platte river and as far west as U. S. Highway 81. This will take in the area in which winter wheat has suffered rather severe damage from rust during recent years.
and it is felt that Pawnee will give some protection against these diseases.

In the fall of 1942, seed of Pawnee was sold to 24 farmers in the south-eastern part of Nebraska. From this source should come seed for further distribution in 1943. Nineteen acres also were planted by the Experiment Station for the production of foundation seed to be distributed in 1943.

With yields above 50 bushels per acre, Pawnee and two other Kawvale selections surpassed all other varieties in field plot tests in 1942. Some of the named varieties yielded in the following order: Comanche, Cheyenne, Red Chief, Tenmarq, Nebred, Turkey, Chiefkan, and Blackhull. For some reason the yield of Blackhull was unusually low, being barely half as much as that of Pawnee. During the period 1930–1942 Cheyenne, Tenmarq, Nebred, and Kharkof have yielded in the order mentioned. In more recent years Pawnee and other early wheats have given the highest yields.

In the nursery considerable hybrid material, combining resistance to leaf and stem rust with winter-hardiness and yield, is available. Much of this material is being grown as bulk hybrids and nature is eliminating the undesirable types.

At Alliance some of the more tender varieties such as Tenmarq, Red Chief, and Chiefkan were injured by winter-killing. In spite of this, very high yields were obtained on fallowed land, ranging from 48 bushels for Comanche and Cheyenne to 30 bushels for Chiefkan. For the long-time period, varieties such as Cheyenne and Nebraska 60 developed by this Station continue to give the highest average yields and even for the shorter periods no variety has out-yielded Cheyenne.

**Thatcher is the most desired spring wheat.** In the plot test at Lincoln, Mindum gave a yield of 14.9 and Kearney 13.9 bushels per acre and these were the only varieties that yielded more than 10 bushels per acre. The crop was very late and poor because of Hessian fly, foot rot, and grasshopper damage. For the long-time average at Lincoln, Kearney ranks first and Mindum second. Neither of these varieties is recommended for the state because of grain quality considerations, and apparently Thatcher is still the most desirable variety to grow when considered from all angles. At Alliance the spring wheat crop was slightly better. Kearney, Pilot-13, Thatcher, and Premier yielded in the order named. For a long-time period Thatcher ranks first and Mindum second.

**New barley varieties.** The barley variety test at Lincoln was continued with 13 varieties grown in four replications. Although seeding was timely, development was poor throughout the season and yields were only slightly better than last year. Some of the varieties gave the following yields in bushels per acre: Velvon 32.1, Spartan 30.6, Flynn 25.4, Beecher 25.1, Trebi 23.4, and Ezond 21.3. For the period 1930–42, Flynn, Spartan, and Ezond have had averages above the standard Trebi. For shorter periods the same varieties have yielded well, and in addition Velvon and Lico rank among the leaders.

At Alliance the yields in the variety test on fallowed land ranged from 32.7 to 41.8 bushels per acre. Ezond, Velvon, Trebi, and Lico gave the highest, and Beecher, Club Mariout, and Spartan the lowest yields. Ezond has had the highest average yield of any variety grown at Alliance, while Flynn and Trebi have had good records.

Because of its good record at Alliance and fair record at Lincoln except in 1942, Ezond was increased at both stations in 1942. This is a selection
of a Louden x Trebi cross and was developed in Idaho. It is best described as a smooth-awned Trebi, although it is slightly earlier. Because it has had a better record at Alliance than at Lincoln, the variety will be recommended more strongly for western Nebraska where a smooth-awned six-row variety is desired. Velvon will be considered for distribution in eastern Nebraska. This variety, selected from a Coast-Lion x Trebi cross, was developed in Idaho. It is a six-row, smooth-awned variety with a white aleurone color. It has good straw and some resistance to covered smut, and is a little earlier than Trebi. At Lincoln during the last five years Velvon has had an average yield 18.5 per cent higher than Trebi. Neither Ezond nor Velvon produces grain having as high test weight as Spartan.

**New outstanding oats.** Two oat varieties were increased in 1942. These were Trojan and Cedar. Trojan is a Burt selection that is early, has white grain, stiff straw, and some resistance to smut. It will be recommended in western Nebraska, especially under irrigation where a strong-strawed variety is desired. At the three Nebraska experiment stations, Trojan is one of the earliest ripening varieties under test and in addition is one of the highest yielders. Over a period of 11 years Trojan has out-yielded Kherson by 12 per cent at both Alliance and Lincoln, while at North Platte the advantage is approximately 20 per cent in favor of Trojan.

Cedar is a selection developed at the Iowa Experiment Station at Ames, and has been grown in plot tests at Lincoln for five years. This is one of the hybrid strains that carries resistance to both crown and stem rust, and to smut, but in 1942 was found to be susceptible to halo blight. During the five years the variety has been tested, it has out-yielded Kherson check by 30 per cent. Because of this, it has been named by this Station. This strain has proved especially adapted and has been higher yielding in the Nebraska tests than any of the newer, named varieties from Iowa, such as Marion, Boone, and Tama; in fact for the five-year period it has ranked first in yield at Lincoln. On the average, Cedar heads about three days later than Otoe or about the same time as Kherson. The test weight per bushel of this selection averages about two pounds higher than Otoe and nearly five pounds above Kherson. The new variety will be recommended for eastern Nebraska, although during the last four years it has yielded well at Alliance. It has not made a good record at North Platte.

Otoe continues to rank first for yield among the varieties grown for 11 years at Lincoln, and during this time it has had an average yield 16.1 per cent above Kherson. In the 1942 variety test some of the named varieties gave the following yields (in bushels per acre): Columbia 73.9, Fulton 73.2, Tama 71.5, Brunker 68.5, Otoe 67.7, Trojan 63.0, Iogold 59.4, and Kherson 56.9.

The new strain has proved especially adapted and has been higher yielding in the Nebraska tests than any of the newer, named varieties from Iowa, such as Marion, Boone, and Tama; in fact for the five-year period it has ranked first in yield at Lincoln. On the average, Cedar heads about three days later than Otoe or about the same time as Kherson. The test weight per bushel of this selection averages about two pounds higher than Otoe and nearly five pounds above Kherson. The new variety will be recommended for eastern Nebraska, although during the last four years it has yielded well at Alliance. It has not made a good record at North Platte.

These projects supervised by K. S. Quisenberry and T. A. Kiesselbach.

**Cultural Practices with Small Grains**

**Timely seeding of winter wheat.** In the fall of 1941 four varieties of winter wheat differing in Hessian fly resistance and other characteristics were planted at six intervals of approximately one week. The first planting was on September 18 which was a week earlier than the “fly-safe” date, while the last planting was on October 24. All plantings emerged in the fall and survived with satisfactory stands. The four varieties were Kawvale, Pawnee, Cheyenne, and Nebred. The last three comprise Ne-
Nebraska certified varieties and their respective reactions to local forms of Hessian fly are (1) resistant, (2) tolerant, and (3) susceptible.

Sowing a week before the fly-safe date lowered the yield of the susceptible Nebred by 7.4 bushels per acre compared with 3.9 bushels reduction for the tolerant Cheyenne and 1.6 bushels for the resistant Pawnee. All varieties took a distinct drop as in other years when planted after October 1.

**Early seeding of oats.** Four varieties of oats were planted in 1942 at four dates of seeding ranging from early to late: March 24, April 1, April 10, and April 20. Three of the varieties, Otoe, Kanota, and Logold, are certified in Nebraska and the fourth, Cedar, is to be recommended for certification in 1943.

Yield of all varieties decreased materially with delay in planting date and averaged more than 20 bushels loss per acre by planting April 20 instead of April 1. The reduction of Otoe at the last planting date was ten bushels less than for any other variety, showing its ability, as in other years, to withstand late planting exceptionally well.

T. A. Kiesselbach and W. E. Lyness conducted the tests.

**Sorghums**

Several new phases of sorghum work were initiated in 1942 as a result of the war. New projects were: the testing of sweet sorghums, with the possibility of using them as a source of sugar; the improvement, testing, and distribution of sorghum varieties which, because of their distinctive endosperm character, may be used as a replacement for tapioca starch; and the testing of new seed treatments.

**Sugar sorghum.** Because of the shortage of sugar, a project was established in the Bureau of Plant Industry of the U. S. Department of Agriculture to investigate the possibilities of using sweet sorghums for sugar production. In cooperation with this agency, two tests were conducted at this Station in 1942. One test consisted of six varieties, all of which have shown promise in similar tests in the southern part of the country. In this test the total yields, on a basis of 70 per cent moisture, ranged from 8.67 tons per acre for Early Folger to 10.08 tons for Straightneck. The yields of stripped and topped stalks from the same varieties were 6.17 and 7.58 tons per acre, respectively. Determinations made at other stations indicate that the juice of certain varieties of sorgo may contain as much as 17 per cent sugar. The other test consisted of 14 entries, some of which are normally grown in the South and others being standard Nebraska forage sorghum varieties. In general, the larger, later southern types gave highest yields.

**Waxy sorghum.** It has been known for some time that a satisfactory substitute for tapioca starch could be made from certain cereals having the so-called “waxy” endosperm. The Department of Agricultural Chemistry was successful in developing a method of manufacturing tapioca-like starch from the grain of waxy Leoti sorghum. Leoti is normally grown in Nebraska to the extent of about 100,000 acres, solely for the production of forage. Last spring, therefore, a cooperative effort was made to encourage the planting of good seed of waxy Leoti sorghum to supply the seed requirements, should a demand for waxy sorghum grain develop. The demand has now materialized and a market is assured for all the 1942 crop of Leoti grain that meets requirements of the trade.

A strain of Blackhull kafir having the waxy endosperm was introduced...
from Texas for testing and increase. Approximately 40 bushels of seed were produced. The variety is too late for much of the state, but might be expected to mature in the southeast and south-central areas.

A breeding program was initiated to introduce the waxy character into standard Nebraska grain sorghum varieties.

**Seed treatments.** Spergon and sulfur were compared with the standard sorghum seed disinfectants, copper carbonate and New Improved Ceresan, in cooperation with the Department of Plant Pathology. All treatments were applied at the recommended rate. Spergon, copper carbonate, and New Improved Ceresan all gave complete smut control. The plots in which sulfur had been used as the treatment had an average of 0.3 per cent smutted heads, compared with an average of 23.7 per cent in the untreated plots. Spergon and copper carbonate were equally effective in controlling seed-rotting organisms. Both gave significant increases in stand over the checks. New Improved Ceresan gave no improvement in stand, while the sulfur treatment was somewhat injurious.

**Selections of Early Kalo.** Fourteen re-selected strains of Early Kalo, along with Nebraska Certified Early Kalo, were compared in a yield test of the balanced lattice design. The highest yield, 43.2 bushels per acre, was produced by a selection from the Fort Hays, Kansas, Branch Station in comparison with 37.9 bushels for the standard Early Kalo. There proved to be some advantage in using the balanced lattice design for plot tests, since there was a gain in precision of 52 per cent over the randomized block design.

**Testing varieties for grain yield.** There were 36 entries in the variety test. This included the standard varieties, some new ones introduced from other stations, seven new selections made at this Station, and a standard corn hybrid. In general, the grain yields were good. Chinch bugs damaged some of the susceptible varieties. The five highest-yielding varieties were Club, Nebr. No. 44, White Darso, Western Blackhull, and Norkan, with acre yields of 51.6, 48.9, 45.0, 44.6, and 43.7 bushels, respectively. Nebraska No. 44 is a selection from the cross Western Blackhull x Day. It has white seed, is somewhat earlier and slightly shorter than Western Blackhull. A dwarf selection from this same cross is very similar to Day in plant type, but is much more resistant to chinch bugs and has greater lodging resistance. It yielded 32.0 bushels per acre, in comparison with 19.7 from Day. The corn hybrid (U. S. 35) yielded 41.4 bushels per acre.


These experiments were conducted by R. L. Cushing and T. A. Kiesselbach, and were cooperative with the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.

**Soybeans Gain Importance**

With the greatly increased industrial need for vegetable oils and for high-protein feed for livestock, there has been a doubling of the Nebraska soybean acreage in 1942 to approximately 50,000 acres. Being entirely resistant to chinch bug damage, this crop merits consideration on suitable land in eastern Nebraska where this insect is prevalent. Under prevailing conditions it might be substituted for part of the barley and oats. Soybeans are best grown in cultivated rows spaced 35 to 40 inches apart, employing recognized practices for weed and soil-erosion control.
Fourteen varieties were tested in field plots at the Experiment Station. With a yield of 12.8 bushels per acre, Dunfield yielded highest among the mid-season varieties while Scioto was highest, 12.7 bushels, among the late-ripening varieties.

In a nursery test in another Station field, cooperative with the Regional Soybean Laboratory, 24 varieties were grown. Selection No. 64-45 yielded 25.4 bushels compared with 23.0 bushels for Dunfield, 22.6 bushels for Illini, and 18.9 bushels for Chief. Of the available commercial varieties, Dunfield and Illini are most highly recommended.


Tests were under direction of T. A. Kiesselbach and W. E. Lyness.

**Alfalfa**

Investigations of production practices and of varietal performance were continued as part of the alfalfa research program, which is cooperative with the Division of Forage Crops and Diseases, U. S. Department of Agriculture. Further progress has been made investigating production of hybrid alfalfa.

**New bacterial wilt resistant variety, Ranger.** Ranger alfalfa, formerly known as A136, is a new synthetic variety produced through the cooperative efforts of the Nebraska Station and the Division of Forage Crops and Diseases, U. S. Department of Agriculture. On recommendation of the Agronomy Department it was admitted as a certified variety in Nebraska on November 19, 1942. It was released for commercial distribution by the Alfalfa Improvement Conference on November 11, 1942. Approximately 12,000 pounds of seed are available for planting.

Ranger may be called a multiple-strain variety, having been synthesized from five selections developed from the varieties Cossack, Turkistan, and Ladak. Some of the selected strains entering Ranger were from Turkistan introductions brought direct from that country by H. L. Westover, explorer for the U. S. Department of Agriculture. In morphological char-
acters, Ranger exhibits considerable variability, both in habit of growth and flower color. It is distinctly variegated in flower color, but only occasionally, if at all, are yellow-flowered plants observed. Plants vary in habit of growth from decumbent to upright. The variety has greater rapidity of recovery after cutting than do Ladak or Cossack, being about the same as Grimm in this respect. It is slightly more susceptible than Grimm to leaf spot diseases and leaf hopper yellowing, but not as susceptible as Hardistan or the Turkistans in this respect. These latter characteristics should not prove a handicap under Nebraska conditions, but may be detrimental for areas east of the Mississippi River. However, where bacterial wilt is a serious factor, its resistance to this disease may more than offset its susceptibility to leaf diseases.

Ranger is superior in seed production to Hardistan or the Turkistans, being about equal to Grimm. In forage production it is intermediate between Grimm and Hardistan. It is about equal to Grimm in cold resistance. Outstanding characteristic of this variety is its resistance to the bacterial wilt diseases, being greatly superior to all domestic strains and equal or superior to the Turkistans, including Hardistan and Orestan.

Alfalfa seed production. Investigations on alfalfa seed production have been underway at the Experiment Station at Lincoln, and at the Scotts Bluff Field Station since 1935. Some of the most favorable conditions for alfalfa seed production may be listed as follows: 1. Warm, sunny weather. 2. Slow, steady growth, with sufficient moisture to maintain the plant in a thrifty condition. 3. Thin stands. Only under unusually favorable seed-setting conditions will thick stands produce more seed.

Since thin stands, or alfalfa planted in rows, cause more weed trouble, the Experiment Station during the past two years has investigated the possibility of planting a grass between rows. Among the several grasses tried, bromegrass has been the best, and alfalfa seed production in this combination has been very successful in western Nebraska under irrigation. Some farms in central Nebraska have demonstrated successful alfalfa seed production using this combination. Under exceptional conditions it may be possible to obtain a bromegrass seed crop and an alfalfa seed crop the same year. A spring grain such as oats or barley may also be drilled into a thin stand of alfalfa in the spring, after disking the alfalfa to kill the weeds, without harmful effects on the seed crop. In eastern Nebraska, conditions may be unfavorable for alfalfa seed production when normal rainfall prevails, although heavy seed crops have been obtained during some of the past years. Alfalfa sown thin or in rows for seed production is not recommended for eastern Nebraska unless it be mixed with bromegrass, in which case it would be handled as hay or pasture except when seed-setting conditions are favorable.

4. Pasturing off the first crop and allowing the second to produce seed is often more successful than mowing the first crop for hay. This may be particularly advantageous if bromegrass is mixed with the alfalfa. 5. An abundance of beneficial tripping insects is a prerequisite to successful seed production. Alfalfa flowers require tripping before an appreciable number will set seed, and this tripping is done chiefly by wild bees. Honey bees are not effective trippers, but when present in abundance may benefit alfalfa seed production.

Conditions harmful to seed production. 1. Cloudy, cool, rainy weather. It tends to increase vegetative production as against seed production,
Rank-growing alfalfa seldom sets seed well except under the most favorable conditions. Such weather also decidedly retards beneficial insect activity, thus decreasing the amount of tripping. 2. New growth within the current older growth can be expected to be harmful to seed setting. Experiments show that if irrigation water is supplied suddenly in abundance so as to induce considerable new growth the resulting seed crop is greatly reduced. When irrigating for seed production the object should be a continuous slow growth throughout the seed-setting period.

3. Lodging usually is very harmful to seed production chiefly because it tends to expose the crown, resulting in rapid and heavy new growth. Seeds forming on stems that become lodged apparently stop developing, resulting in a lowered yield with a high percentage of shrivelled seeds. In most cases, when a field is badly lodged it may as well be cut for hay, unless there is time for the new growth to set on a crop of seed. 4. The presence of many harmful insects such as Lygus bugs and others may cause a seed crop failure. Studies in Utah, Arizona, and other western states indicate these bugs have a very harmful effect on seed production. Dusting with insecticides controls the insect, but is too expensive for commercial use. Studies in the Scotts Bluff area indicate that the Lygus are present, and that they can be controlled by dusting, but dusted areas have not produced more seed than undusted controls, indicating that the Lygus are not present in numbers sufficient to cause a decrease in the alfalfa seed crop.


Experiments were directed by H. M. Tysdal and T. A. Kiesselbach.

Grasses for the Farm

Experiments with perennial grasses for pasture, hay, and erosion control have dealt with methods of grass establishment, with the testing and evaluation of grasses in nurseries and under grazing, and with the further improvement and propagation of promising selected strains. These studies are cooperative with the Division of Forage Crops and Diseases, Bureau of Plant Industry, and the nursery section, Soil Conservation Service, U. S. Department of Agriculture.

What grasses to use. In eastern Nebraska, and elsewhere under favorable moisture conditions as on irrigated land farther west, bromegrass has been the outstanding grass. Pure stands and mixtures of grama grasses and buffalo grass offer considerable promise in southern Nebraska and on upland soils in eastern Nebraska for summer grazing. Big bluestem and switchgrass may have an important place in the re-seeding of limited areas in southeast Nebraska and sandy lands. Crested wheatgrass appears to be well adapted and is being used with considerable success in western and northwestern Nebraska. The native species, western wheatgrass, blue grama, side-oats grama, and buffalo grass, have been used successfully in southwestern and western Nebraska seedings.
The forage production of ten species of grasses is being measured over a period of years on fertile soil near Lincoln. Yields are determined by mowing replicated plots of each grass in two ways: once each season as hay at the approximate time of maximum production, and several times during the season to simulate grazing. Because of favorable rainfall, maximum yields of the experiment were obtained for most of the grasses in 1942. The cool-season grasses in the test when cut once for hay gave yields in the following order: brome grass, crested wheat grass, western wheat grass, Russian wild-rye, and Kentucky blue grass. Russian wild-rye out-yielded the others of this group except brome grass when cut as pasture. Brome grass gave the highest yields of all grasses in the test. Of the warm-season grasses, big bluestem approached the yields of brome grass. The warm-season grasses with both methods of harvest gave yields in the following order: big bluestem, blue grama, buffalo grass, side-oats grama, and switch grass. Due to the cumulative effect of previous mowing treatment, all grasses except buffalo grass gave lower yields on the more frequently clipped plots. Buffalo grass withstood the clipping treatment and gave somewhat higher yields under frequent clipping, probably because of the removal of weed competition. Switch grass suffered the greatest loss in stand and yield with frequent mowing.

Establishment of stands. Experimental seedings to study the effects of previous crop, kind of seedbed preparation, time of seeding, and seeding method on the establishment of stands, have been conducted with six grasses since the fall of 1938. Experience has shown the necessity of preparing a mellow yet very firm seedbed for the successful establishment of all grasses. A good seedbed is of primary importance in securing a suitable shallow depth of seeding, this depth varying with different species according to size of seed. Effect of the previous crop is of great importance in securing such a seedbed. If proper seedbed preparation and depth of seeding are obtained, time of seeding remains as the chief con-
trollable factor in coping with the effects of weather and also is an important factor controlling weed competition.

Generally, satisfactory stands of the cool-season grasses have been obtained from seedings made during the periods August 20 to September 15 and April 1 to 10. Best results with the warm-season grasses, big bluestem, switchgrass, blue grama, side-oats grama, and buffalo grass have been obtained by seeding in late April or early May. Weed competition has been reduced considerably by delay of planting these grasses until weed seeds had germinated and were killed by harrowing or other tillage.

**Importance of adapted strains.** Striking variations have been found in the adaptation and yield of strains of grasses obtained from different regional seed sources. One cause of failure in establishment of suitable stands of bromegrass is the seeding of unadapted, low-producing strains. More than 60 different regional strains of bromegrass ranging in origin from Canada to Kansas have been observed in adaptation tests. Data have been obtained at Lincoln over a three-year period concerning the behavior of 24 strains selected regionally within the Great Plains area. On the basis of their origin and performance, the strains tested were placed into two general groups referred to as northern and southern types.

The strains of southern type from old fields in southern Nebraska and northern Kansas produced more vigorous seedlings under the short days of fall and early spring, were more tolerant of drought and heat during the period of establishment, possessed more vegetative vigor, and were more productive than strains of northern type. Dakota and Canadian strains have been especially unsuccessful in southern Nebraska where, if stands were obtained, they have proved so unproductive that they soon have been plowed. A number of strains of both northern and southern types are being grown successfully in northeast Nebraska where hazards of establishment are not as great. Preliminary tests indicate that the differences between the strains are less pronounced when they are grown farther north or at higher altitudes.

Tests of regional strains of native grasses collected over a wide range of conditions in the Great Plains have been conducted at Lincoln, Albion, North Platte, and Alliance, Nebraska. Results of these tests show in general that native grass strains from local sources or sources up to 200 miles south of the area in which they are to be grown are best adapted. Warm-season native grasses from Oklahoma, Texas, New Mexico and Arizona have suffered some winter injury when grown at Lincoln. Strains from northern sources usually are less productive than are strains from local or southern sources. This is illustrated by the relative 1942 yields of side-oats grama and blue grama strains in their second year of growth at Lincoln. If the forage yield of side-oats grama from central Kansas is taken as 100 per cent, then the forage yields of strains from southern Nebraska, northern Nebraska, and from North Dakota were 85, 65, and 60 per cent, respectively. Similarly, the forage yields of strains of blue grama from northern Texas, southern Nebraska, and central South Dakota were 100, 88, and 22 per cent, respectively.

**Seed increase of new strains.** The superior productivity of seed harvested from certain old bromegrass fields in Nebraska and northern Kansas compared with seed from northern sources has been established. To build up a seed supply of adapted bromegrass, these old fields and their progeny have been studied as to purity, uniformity, and freedom
from disease, and seed from the best of them has been increased for distribution and certification under the name of Lincoln bromegrass.

Lincoln bromegrass is highly suitable for Nebraska conditions. It is a large vigorous type which is productive of both forage and seed. Characterized by an excellent seedling vigor and rapid early spring growth, it is recommended for southern Nebraska where limitations in the adaptation of northern strains are pronounced. Approximately 73,000 pounds of Lincoln bromegrass were certified in 1942.

The seed supplies of several superior strains of native grasses have been increased for distribution in small quantities to farmers. These selections include strains of big bluestem, blue grama, Russian wild-rye, sand lovegrass, and two strains of switchgrass. In addition, 37 selected strains within 17 different species are being increased from small quantities of seed for further increase and testing.

A paper entitled “Field performance of bromegrass strains from different regional seed sources” by L. C. Newell was presented at the St. Louis meetings of the American Society of Agronomy.

These studies were under the direction of L. C. Newell, E. C. Conard, G. C. Klingman and F. D. Keim.

**Sweet Clover Improvement**

Sweet clover has staged a decided comeback in acreage, there being 1,116,634 acres in Nebraska in 1942, more than that of any other legume.

**New varieties.** In recent years, a number of new varieties of sweet clover have come to the fore in varietal tests at Lincoln. Their first- and second-year yields have averaged distinctly superior to those of Common White and Common Yellow. The most outstanding of the new varieties are Evergreen, Spanish, and Madrid, all of which are now recommended certified varieties in this state. They range from exceptionally late to medium early maturing in the order listed.

Averages of first- and second-year pasture yields taken in 1941 and 1942 show that Evergreen yielded 1.88 tons of cured forage per acre, Spanish 1.67 tons, and Madrid 1.53 tons, in comparison with 1.36 tons for Common White and 1.31 tons for Common Yellow. In the total of three cuttings taken in the first year to simulate grazing, Evergreen gave an average yield of 1.40 tons per acre, Spanish 1.29 tons, and Madrid 1.08 tons, in comparison with 0.62 ton for Common White and 0.58 ton for Common Yellow. In the total of four cuttings taken to simulate grazing in the second year, the average yield of Evergreen was 2.36 tons per acre, Spanish 2.03 tons, and Madrid 1.95 tons in comparison with 2.07 tons for Common White and 2.02 tons for Common Yellow. Ability to compete with weeds in the first year and give good yields is very desirable in sweet clover, and Evergreen, Spanish, and Madrid possess this characteristic to a high degree. These varieties usually attain sufficient height for grazing by June 10 of the first year, which is several days earlier than a comparable height is attained by Common White, Common Yellow, and Grundy County, and more pasturage continues through July.

Second-year pasturing season of the commonly grown varieties usually begins in late April or early May. Common Yellow normally furnishes pasture until July 15 and Common White until about August 1. The new varieties give more abundant early pasturage in the second year, but the grazing season of Madrid will terminate at about the same time as Common Yellow, and Spanish about the same time as Common White. The
late-maturing Evergreen, however, may prolong the pasture season into late August when summer moisture conditions are favorable. Under actual pasture conditions, small-growing varieties have been preferred by cattle to the large coarse types.

Sweet clover is not in common use in Nebraska as a hay crop. Seedings harvested for hay yields at Lincoln showed approximately the same yield relationships between varieties as in those harvested as pasture.

True Common White sweet clover is of large growth and productive of good yields of forage, particularly in the second year. Seed stocks that are available to farmers through commercial channels have become so mixed, however, that crops obtained generally contain high percentages of smaller, less productive plants, and often considerable mixture with biennial yellow is shown. It would seem timely to replace the older common varieties with more recently selected superior kinds. For the purpose of making desirable seed stocks available for distribution, a seed supply is being increased of the varieties Evergreen, Spanish, and Madrid.

Field treatment and seed production. Plots of sweet clover utilized for the grazing of livestock in the first year were found to have better stand survival and to yield more seed in the second year than were fields used in the first year for hay production. Harvesting the first-year crop as hay resulted in 80 per cent as good stand in the second year as when handled as pasture. There was an estimated seed yield of 3.5 bushels per acre in 1942 where the first-year crop was utilized for pasture and 2.8 bushels per acre where it was harvested for hay. The seed crop in the second year followed one early clipping to simulate early grazing.

First growth of sweet clover in the second year normally produces the best seed yield, but the large coarse-growing types may become so rank that great difficulty is experienced in harvesting and threshing. Under conditions at Lincoln in 1942, the first growth of Common Yellow in the second year attained a height of 48 inches and gave an estimated seed yield of 5.0 bushels to the acre, in comparison with a height of 33 inches and 3.5 bushels of seed where one early clipping had first been removed to simulate early grazing. Where a hay crop in the early bud stage was first removed, the seed crop attained a height of 22 inches and gave an estimated seed yield of 1.3 bushels to the acre.

Sweet clover breeding. Breeding work has centered largely around improvement with respect to such characters as seedling vigor, lateness of maturity, increased palatability, leafiness, and fineness of stem.

Studies conducted during 1942 to determine the relative seedling vigor of sweet clover varieties showed the new Spanish variety to have greatest seedling vigor under both cool and warm temperature conditions. Varieties tested in this respect ranked in the following order: Spanish, Evergreen, Madrid, Redfield, Common Yellow, and Common White.

Efforts have continued to extend the time of maturity of *M. officinalis* into autumn. Hybridization between high-yielding Madrid and several aberrant, very late maturing but low-yielding yellow sweet clovers forms the basis of this work. This material is now in the second generation.

Investigation of the possibility of incorporating the character of low coumarin content with other desirable qualities in one sweet clover has proceeded along several lines. Hybridization work with the low coumarin Pioneer variety has been one method of approach. Crosses between Pioneer and other higher yielding, better adapted strains have now ad-
vanced to the second generation. Selection of strains combining low coumarin content and high yield will be undertaken in 1943. In the search for more palatable strains, chemical analyses of plant tissue continue to be used for the determination of coumarin content.

Seed is being increased for further testing of a new synthetic variety developed by combining desirable inbred lines in which the characters of leafiness and fineness of stem were very pronounced. This strain appears to possess superior seedling vigor and good seed-producing ability.

The use of alpha-naphthalene acetamide for inducing self-fertility in the otherwise highly self-sterile *M. officinalis* species was investigated. Results indicate that this substance did not increase selfed-seed production. It did, however, tend to prevent the drying up and dropping off of floral parts.

Investigations conducted for several years on a serious root-rotting disease in the nursery culminated in 1942 with the taking of disease notes in the nursery. In the light of previous data which showed the disease to be the result of excessive first-year plant growth, the 1941–42 nursery was started late in spring so that the first-year plants would develop only to normal size. In its second year this nursery was entirely free of the root rot as a result of this treatment.

These investigations, cooperative with the Division of Forage Crops and Diseases of the U. S. Department of Agriculture, were conducted by Samuel Garver, J. M. Slatensek and T. A. Kiesselbach.

**Miscellaneous Crops**

A number of miscellaneous crops were tested regionally throughout Nebraska in 1942 in cooperation with the University of Nebraska Chemurgy Project. The most extensive work was done with the oil crops: flax, safflower, sesame, castor beans, sunflowers, annual rapes, perilla and peanuts. Of these crops flax, safflower and sesame proved to be the most promising.

**Flax.** Although flax has been tested since 1933 at Lincoln, there have not been extensive tests in other areas of the state. Previous tests with this crop during the drought years at Lincoln had given unfavorable results. In 1942 good yields were obtained throughout the state. Averaging tests of four prominent varieties at Lincoln, Fremont, Allen and Ord, and two tests at North Platte (upland and bottom land) the yields were: Biwing 20.1 bushels, Redson 18.3 bushels, Redwing 17.7 bushels, and Bison 17.3 bushels per acre. The first three of these are approximately eight days earlier maturing than Bison. In the eastern part of the state, earlier maturing varieties showed a distinct advantage in yielding ability, whereas in the western area under irrigation the later ripening sorts were outstanding. At Scottsbluff on irrigated land of high fertility, Bison was the highest yielder, producing an average of 45.9 bushels per acre.

Since the most serious problem in flax culture in this state is weed competition, a special study was made in which flax was planted in wide-spaced rows 18 and 24 inches apart and given several shallow, timely cultivations in comparison with standard close drilling. Results indicated that when flax was grown on relatively weed-free land in the eastern part of the state, material reduction in yields was obtained in wide-spaced rows. In the western part of the state at Alliance under dry land conditions, this wide spacing did not result in yield reduction.

Seed treatment with New Improved Ceresan to control seed-borne
organisms resulted in materially better stands when applied to seed produced under the relatively humid conditions of eastern Nebraska.

**Safflower.** Results with safflower, an oil crop, at Lincoln during the past several years have not been encouraging. This year's results also indicate that it is poorly adapted to eastern and central Nebraska. However, the crop appears to be fairly well adapted to conditions in the western part of the state. At Scottsbluff, under irrigation, 14 varieties averaged 2,800 pounds of seed per acre, though variations between varieties were great. Under conditions of continuous cropping on dry land at Scottsbluff, six varieties produced an average of 1,013 pounds of seed per acre. Varieties from India such as Pusa, Simla, and Ahmendager are considerably higher in oil content and seem to have more yielding ability than do the Common and Russian varieties which also were included in tests. The Indian varieties are very spiny, much more so than the Common and Russian varieties. Sorts highest in oil content contained from four to eight per cent less oil than did flax grown under the same conditions. Early April seeding was far superior to any later dates.

**Sesame.** An oil crop, the seed is used also for flavoring rolls and bread. In the eastern part of the state different varieties of this crop produced from 240 to 740 pounds of seed per acre. Only two varieties matured satisfactorily.

**Castor beans.** Extensive castor bean tests were made at several locations in the eastern part of the state. Cooperative U. S. D. A. Uniform Castor Bean Nurseries were grown at Lincoln, Brownville and Fremont. Average seed yields for varieties at Brownville ranged from 987 to 1,736 pounds, at Fremont from 939 to 1,504 pounds, and at Lincoln from 697 to 1,082 pounds per acre. The U. S. No. 4 variety was the highest yielder at all three locations. Five California selections also were tested at a number of locations. Of these selections, California 61 and 45 show some promise. This year only a small percentage of the beans of the varieties U. S. No. 4 and No. 7, and Kentucky No. 38 were lost through shattering when harvested at a single picking.

**Annual rapes.** The annual rapes are of interest as oil crops. Varieties tested were: Bird rape (*Brassica campestris*), Summer rape (*B. napus* var.), Yellow and Brown (*B. juncea*). Early April seeding produced higher yields of all varieties than at any later date. Bird rape matured at Lincoln July 6, Summer rape July 25, and the varieties of *B. juncea* from July 9 to 15. All annual rapes shattered badly. Yields of Summer rape were very poor. Bird rape from early April seeding produced from 756 to 1,200 pounds per acre in eastern and central Nebraska. The oil percentage varied from 24.2 to 36.1 per cent. The higher oil yields were obtained in the western part of the state. Flea beetles retarded the early growth of all annual rapes in western Nebraska tests.

**Other chemurgic crops.** Sunflowers tested as an oil crop were a complete or nearly complete failure because of insect pests. The larva of *Lepidoptera* spp. is a very serious pest, especially of all inbred lines tested. Perilla showed no commercial possibilities in this state. Of the flavoring crops, coriander, anise, sage, cumin, fennel and sweet basil showed sufficient promise to merit further study. Russian dandelion and guayule are being investigated as possible rubber crops at several locations in Nebraska.

Carl E. Claassen and T. A. Kiesselbach are in charge of experiments.
Bindweed Eradication

Since field bindweed has been both economically and numerically the most important noxious weed in Nebraska, it has received the most attention in the eradication research program. A cooperative bindweed research project with the U.S. Department of Agriculture was set up at York, Nebraska, in 1936. Its specific purpose was the study of bindweed eradication methods and closely related factors. Ten different experiments were conducted that were uniform with experiments at similar projects in six other states. A few other experiments pertaining to problems of a local nature were included.

A natural minimum in total available carbohydrates occurs in bindweed roots about three weeks after spring emergence, which approximates May 15 in the York area. The root reserves increase gradually throughout the season in undisturbed bindweed. Where the infestation is clean cultivated every two weeks the reserves continue to decrease until the plants are starved out, usually in the second year. Root reserves decrease gradually from the time of cultivation until eight days after re-emergence. No appreciable increase in reserves results until 16 days following re-emergence. Cultivation may be started at any time during the growing season. Because of the natural minimum in reserves about three weeks after spring emergence, it is unnecessary to start cultivation before that time. Greatest efficiency can be gained by cultivating 16 days after each re-emergence of the bindweed. Cultivation at two-week intervals is generally recommended because allowance is thereby made for a few days delay caused by other work or by the weather.

In the alternate crop and fallow method the infested area is cultivated at two-week intervals until seeding time of the first and third year when either winter wheat or rye is planted for harvest in the second and fourth year. The area is cultivated at two-week intervals following harvest. In the continuous crop and fallow method the area is cultivated at two-week intervals until seeding time of the first year and after harvest in subsequent years. The area is cropped with winter wheat every year after the first until eradication is completed.

Bromegrass, alfalfa, crested wheatgrass, and sweet clover were tested, but proved unsuccessful for either the control or eradication of bindweed during the period of these experiments. Millet, sorgo, and Sudan grass have been of questionable value for bindweed eradication, largely because poor stands and light growth have been the result of drouth conditions.

Applications of sodium chlorate made during September and October have been most effective. No previous or subsequent tillage of the soil is necessary with the application of sodium chlorate. It may be necessary to remove some trash before treatment in order to get the chemical onto the ground. The surface soil should be firm. There is no appreciable difference between the effectiveness of dry and spray treatment. On average soils, an application of four pounds of sodium chlorate per square rod has proved to be the optimum rate. Larger amounts are necessary on soils high in organic matter. Spot-treatment of scattered plants is usually necessary as a follow-up.

Atlacide, common salt, carbon bisulphide, sodium arsenite, borax, and borax-chlorate mixtures have been used with varying degrees of success. Borax is the most likely substitute for sodium chlorate, if the war makes a substitute necessary. More research is necessary before borax can be recommended.
A new joint project in cooperation with Agricultural Engineering has been set up at a new location near Lincoln. For this purpose an 80-acre tract of land that is heavily infested with bindweed was rented by the Experiment Station. This land is very susceptible to erosion. Experiments will be conducted in combining established bindweed eradication methods with soil conserving practices such as contouring, terracing, strip cropping, sub-tillage, and cover crops. Several other noxious and pernicious weeds such as perennial peppergrass, leafy spurge, Russian knapweed and dogbane are located in the same area. Experiments will be conducted on these weeds as well as on bindweed.


N. S. Hanson and F. D. Keim have conducted these experiments.

Seed Treatment with Hormones

Considerable inquiry developed last spring concerning the benefits to be derived from treating the seed of farm crops with growth-regulating substances, known as hormones. Such materials prepared as commercial seed treatments were being recommended for farm use by their manufacturers. In the absence of experience with their use, thorough investigations which might provide the desired information were undertaken by this Station. Tests were conducted on the Agronomy Farm at Lincoln. The seed treatments included soaking eight hours in water solutions of five standard synthetic hormones (levulinic acid, indole acetic acid, indole butyric acid, phenylacetic acid, and naphthaleneacetic acid) and dusting with two commercial hormone dusts (GrainO and Staymone). The crops under test were corn, soybeans, oats, and barley.

Although applied at several dosages, no seed treatment gave significant benefits as to germination, seedling development, maturity, or yield of any of the crops. Practically identical crop performance was obtained from the five pure hormones whether in solutions of 100, 50, or 10 parts per million. This is taken as evidence that no more favorable results would have been obtained from more dilute solutions.

Two stronger solutions of naphthaleneacetic acid, 500 and 1000 parts per million, were distinctly harmful, indicating need for great care to avoid excessive treatment. There was no more tendency for favorable response by an ordinary open-pollinated variety of corn than by a good first-generation hybrid. Judged by the outcome of these studies and those reported elsewhere, no hormone seed treatment can be recommended in Nebraska for any farm crop. These findings are in no way in conflict with the recommended use of suitable seed disinfectants for the successful control of seed-borne disease organisms.

Results of these studies were presented at the 1942 annual meetings of the American Society of Agronomy.

T. A. Kiesselbach conducted this research.
Greater production of better fruits and vegetables will contribute to Nebraska's economy and war effort.

Horticultural Crops
Department of Horticulture

Potatoes for Nebraska

With the isolation of lines of known disease resistance and others that produce good red skin tubers, it has been possible to make crosses that produce a high percentage of segregates possessing characteristics sought in potatoes for Nebraska. The customary 12,000 seedlings were produced in Lincoln greenhouses and together with the 8,000 secured in exchange from the North Dakota Experiment Station were again increased at Scottsbluff. About 600 clones were grown in ten hill plats, at Alliance on dry land and Scottsbluff with irrigation. About 100 that appeared to be early tuber producers were grown at Lincoln and North Platte. A number of lines with dark red skins and white flesh have been saved for increase for commercial testing.

In conjunction with the Minnesota Experiment Station one selection is being introduced under the name Kasota. This line produces plants with dark green glossy leaves that are quite heat enduring. Tubers are of excellent type, being round and relatively flat, with dull red skin. They are produced in mid-season and possess fairly good cooking quality. One of the factors of greatest significance to Nebraska potato growers is the possession by this variety of a relatively high degree of resistance to fusarium wilt.

One other variety, possessing excellent type white tubers, is being increased and tested with a view to introduction in 1943-44.

Dry seeds, germinated seeds, and seedlings of an inbred strain (Nebraska No. A9-2) of Solanum tuberosum were treated with colchicine in an attempt to bring about doubling of the chromosome number. The treatment of seedlings with a .5 per cent colchicine-lanolin paste emulsion was the most effective method.

Picture of the Kasota potato plant, a variety recently introduced. Rugged, with dark green leaves, it has been able to withstand Nebraska summers.
Two types of periclinal chimeras were obtained. One type was found to have an octoploid epidermis and tetraploid internal tissues. The reverse of this situation existed in the second type. The first was less vigorous than untreated plants but more vigorous than the second type. Thus vigor decreases as the volume of octoploid tissue increases. Octoploidy is concluded to be of no direct value for commercial potato production.

Plant Pathology and Home Economics departments cooperated on this project with H. O. Werner and R. E. Baker.

Problems of Seed Potato Storage

Causes are being studied for the slow and variable rate of emergence of potato plants from western Nebraska seed potatoes that are planted in the South during the winter. Investigations during 1942 have concerned the effect of: (a) holding seed potatoes at different storage temperatures for intervals of varying duration at different times during the storage period and (b) the position of the seed potatoes within the bin. Results were measured by sprouting seed potatoes in constant-temperature rooms, by planting them in the field at Brownsville, Texas (January), southern Alabama (February), and central Nebraska (April) and by analysis for reducing sugar and sucrose.

The 1942 work revealed that prompt and uniform sprouting or emergence with correspondingly high yields were secured when potatoes were held at high storage temperatures (60–65°F) either continuously or for four or more weeks before planting. A period of low temperature (40°F) prior to warm storage seemed to bring about more rapid and more uniform sprout growth than constant storage at a high temperature. Lots stored in cellars according to the regular commercial practice gave least satisfactory sprout growth.

Chemical analysis revealed a relatively constant percentage of reducing sugar in tubers at a constant temperature of 50°F and a rapid loss at 75 degrees. Percentage of reducing sugar increased rapidly immediately after potatoes were moved to a 40-degree storage. This increase was more rapid and to a higher percentage if the transfer to 40 degrees took place in the early part of the storage season than if delayed. When transferred back to 50 degrees the amount of reducing sugars diminished rapidly, but never to as low a point as when 40-degree storage had not been used. It is thought that the rapid sprouting of lots that were cooled early and warmed later was due to the large amount of readily available carbohydrate (as reducing sugars) found in these potatoes just as they were completing the rest period.

To determine the commercial feasibility of warming up seed potatoes for mid-winter shipment, and also to determine the possibility of accomplishing the desired objectives by shipping potatoes at higher temperatures than are used under “standard heater car service,” commercial tests involving about 20,000 bushels of potatoes were set up and are now being carried out. These tests involved the following carload treatments for shipments to south Texas in mid-December:
1. Stored in cool cellar—shipped warm (65°F).
2. Stored in cool cellar—shipped cool (35–40°F).
3. Warmed to 65°F for one month—shipped warm (65°F).
4. Warmed to 65°F for one month—shipped cool (35–40°F).
5. Warmed to 65°F for ten days—shipped warm (65°F).
6. Stored in cold farm cellar—shipped warm (65°F).
7. Stored in cold farm cellar—shipped cool (35-40° F.).
8. Farm cellar gradually warmed during three weeks—shipped warm (65° F.).
9. Farm cellar gradually warmed during three weeks—shipped cool (35-40° F.)

Each car contained 45,000 pounds of potatoes (750 bushels).

By means of electrical thermometers, temperatures were procured at twelve different places in each car immediately after the cars were loaded and at frequent intervals during the week or ten days the cars were en-route to south Texas.

Heating large piles or cellars of potatoes has been found relatively inexpensive. Warming up potatoes in storage has reduced the amount of tuber cracking as the potatoes were handled in sorting, hauling and loading into cars. An additional benefit is the more comfortable working temperature.

The great variation in conditions within large bins of potatoes (holding 1,000 to 2,000 bushels each) was found to be responsible for much variation in emergence time and rate. Potatoes from crates buried at thirty different positions in each bin produced sprouts which varied according to bin position. Potatoes from crates in the center of the bin sprouted most promptly; those in peripheral portions sprouted last. The difference in length of time for half of the tubers from each crate to sprout at 50 degrees ranged from three to 20 days. When some of these potatoes were planted in February at Fairhope, Alabama, the differences in plant emergence rate were of the same order as the differences in sprouting in the controlled-temperature rooms. In Alabama, highest yields were produced from early emerging and lowest from late emerging lots.

Last fall (1942) the construction of three large bins was modified so as to provide different degrees of air circulation around or through the bin to secure more uniform conditions. Thermocouple junctions were placed at 42 different places in each of the three bins. Readings made at weekly intervals show that there is a great range in temperature—8 to 15° F. throughout November, a little less in December—in various parts of some bins. The central parts, where earliest sprouting occurred last year, are the warmest. Greater uniformity of temperature has been secured by means of false floors under a bin or by flues that circulate air within a bin. Sprouting rate of potatoes in various parts of these three bins will be determined by removing potatoes from crates placed in various positions in each bin and observing their sprouting in a room held at 50 degrees.

Due to the serious disintegration of supporting timbers in the Box Butte Experiment Farm cellar, that structure was rebuilt so as to provide storage that research indicates to be essential. The entire cellar is now equipped with shell-cooled bins, exposed areas of concrete wall that provide for heat loss without excessive ventilation and loss of humidity, and a water-proof and heavily insulated roof. In addition a shell-cooled bin equipped with an automatically controlled ventilating fan, designed by F. D. Yung of Agricultural Engineering, was installed. A complete record of temperature changes is being procured by frequent reading of thermocouples placed at 38 places in this bin. The fan control is adjusted so as to circulate cold air around the bin whenever the outside temperature is lower than the inside temperature. An automatic safety shut-off will prevent operation of the fan at dangerously low temperatures (below 35 or 36° F.). It is thought that this type of storage may provide a practical
solution for keeping western Nebraska seed potatoes reasonably dormant until needed for planting in mid-June. This problem is the opposite of the southern seed growers' problem.

Much of the storage work is conducted in cooperation with A. D. Edgar of the U. S. Department of Agriculture. Much of the detail work was carried through at the Box Butte Experiment Farm. Shipping studies are conducted in cooperation with the U. S. D. A. office of fruit and vegetable storing and shipping studies—D. F. Fisher in charge—and the Burlington, Union Pacific, Missouri Pacific and several other southern lines, the Burlington Refrigerator Express, the American Fruit Transit Company, and the Pacific Fruit Express. The Nebraska Certified Potato Growers Cooperative has been an active partner in most of these tests, providing potatoes, storage facilities, arranging various details, and financing many aspects of the work. One of its directors—Chas. Barbour—has provided numerous facilities, and has cooperated actively in this project. In Texas the firm of Porter and Wentz, buyers of the seed potatoes used, and the Experimental Substation at Weslaco, Texas, are rendering indispensable service in conducting field tests. In Alabama similar cooperation is planned with Corte Bros. and the Gulf Coast Agricultural Experiment Station at Fairhope, Alabama. Without the cooperation of all these parties the results reported and the work in progress would not have materialized so quickly and effectively.

Shipping tests conducted by the U. S. Department of Agriculture with potatoes shipped from the Platte Valley in mid-summer have shown that shipping washed potatoes with standard ventilation is very undependable. Pre-cooling with artificial refrigeration is much better, but pre-icing either without or with re-icing enroute is much more satisfactory. Less difficulty has been encountered in shipping Triumph and Red Warba potatoes than with Irish Cobbler.

H. O. Werner is in charge of these experiments.

Potatoes and Hot Weather

This study concerns differential water usage rates and drouth endurance of potato varieties. During the summer of 1942 numerous transpiration measurements were made with several varieties of potatoes by means of the cobalt-paper leaf-test method. These readings have shown that varieties differ in the rate of water loss from their leaves, in the ratio of water loss from the upper and lower leaf surfaces, and also in their ability to keep leaves turgid. Varieties that survive heat periods best transpire most rapidly. Efforts are also being made to determine the relationship between heat endurance in tests with a heat machine and drouth endurance in the field.


Research is in charge of H. O. Werner.

Some Other Potato Experiments

At Alliance and Scottsbluff, potatoes were planted at successive intervals and harvested at successive intervals to procure more data concerning the production of tubers and occurrence of defects such as scab,
knobs, etc., in each season. This year some of the tubers produced have been and are being used in the southern plats (Texas and Alabama) to determine the relation of maturity and tuber size to time and rate of tuber sprouting in mid-winter.

In cultivation experiments a slight ridge thrown up late in the summer was found to be of great value in reducing the percentage and severity of field frost to tubers harvested after the severe frost of September 26.

H. O. Werner conducted these experiments.

**New Tomato Varieties Have Quality**

Tomato lines now in the third to seventh generations were found to be equal or superior to practically all existing varieties for the production of good quality, early tomatoes in the warmer parts of the state, and for the production of commercial crops in the high altitude irrigated regions in western Nebraska. These lines all have determinate or semi-determinate vines and most of them have fruit with a uniform whitish green color before ripening. Although 1942 was cooler than most seasons, excellent yields of tomatoes have been secured with a number of these varieties when they were widely spaced on dry land. At Alliance a good crop (eight to twelve tons per acre) was produced on land that was summer fallowed, even though no effective rainfall occurred after mid-June. In

These pictures show the contrast between the new type of tomato plant with more fruit than vine, and the old heavy-vine type. Lower picture shows the All Red-Stokesdale cross variety which is being distributed for seed, and is considered a most promising tomato variety for Nebraska.
Banner County, at an altitude of 5,400 feet, very good crops were produced by all the selections. The best selections were derived from crosses between All Red and Break-O-Day, All Red and Stokesdale, Danmark and Break-O-Day, and Danmark and Self Pruning. An exceedingly promising line is a semi-determinate, apparently homozygous F3 selection from the All Red-Stokesdale cross that produced very large, excellent quality, relatively early fruits.

Tests have been conducted over a wide enough variety of conditions and during enough years, most of which have been unusually hot, to permit assurance that several of these varieties can be depended upon to produce tomatoes anywhere in Nebraska in any type of summer that has yet been encountered in the state. Considering the general failure of most of the standard varieties during the dry hot years of the 'thirties, the significance of these new varieties is apparent. Present efforts are devoted (a) to improving the interior characteristics of the fruit, (b) investigating the vitamin C content of the fruit as influenced by variety, culture and processing methods, (c) determining the significance of the uniform or white-green fruit color in relation to temperature of fruit, sunburning, rate of ripening, etc.

Work is under supervision of H. O. Werner.

Seeking Larger Raspberries

Raspberry fruits are often too small, particularly toward the end of the harvest season, and growers would welcome any means by which their size could be increased without unduly increasing seed size. Such improvement has been noted in some fruits where the chromosome number has been increased from diploid to tetraploid. Cumberland and Latham raspberries are both diploid and hence offered good foundation material for such a project.

At the beginning of the 1942 growing season 100 shoots of these varieties were treated with a colchicine-lanolin emulsion. Concentrations used were .1 per cent and .5 per cent, and were applied to the terminal buds when the shoots were only 2-3 inches tall. Outer leaves were pressed back so that the central portion of the bud could be reached.

The higher concentration was lethal to all buds of each variety. The .1 per cent concentration was ineffective on all Cumberland buds, possibly because penetration was not sufficiently rapid. With the Latham, however, the lower concentration apparently caused some changes in 12 shoots. Gross morphological observations revealed that beyond the point of treatment, the leaves were thicker and a different shade of green.

All efforts to root these altered stems by asexual means were ineffective. Plans for the coming season involve further efforts to secure roots on these parts, and an examination of pollen mother cells for chromosomal counts.

C. C. Wiggans and R. E. Baker are in charge of this project.

Orchard Spraying Experiments

Many of the Jonathan apple trees recovered sufficiently from the severe freeze in the fall of 1940 to produce a fair crop. This was the only winter variety which had a crop of sufficient size for any type of spray experiment. However, distribution of the good sample trees of this variety would not permit a satisfactory arrangement of plots for any type of treatment except the color spray. For this spray each tree served as a unit.
One or more branches on a sprayed tree were covered with a canvas to serve as an unsprayed check. Two sprays of .1 per cent sodium thiocyanate were applied at 15-day intervals before harvest. There was no noticeable effect from the spray. This result differs from that of 1940 when a definite response was reported for Jonathans. These conflicting results are similar to those reported by E. L. Overholser (et al) of Washington State Experiment Station. The future value of sodium thiocyanate for increasing the red color of Jonathan apples is therefore uncertain.

Some trees were also covered with “stopdrop” spray. In the main they showed some effect, but there was much variation in the percentage of drops from both sprayed and unsprayed trees. Possibly the excellent growing conditions of temperature and moisture during the summer and fall had something to do with the better than usual holding of the unsprayed fruit.

Codling moth damage in 1942 was very high in spite of the regular schedule of applications which was followed. Unusually cool weather in May and June delayed materially the emergence of the over-wintering larva and many of them became active at the time when the fruit was not well protected with poison. This large early infestation naturally gave a greater concentration later which resulted in an unduly large percentage of infested fruit at harvest time. This condition was general throughout the Missouri Valley orchard areas.

In charge of this work are R. E. Baker and E. H. Hoppert.

Orchards Show Promise

Grapes under cultivation, even though injured more severely above ground by the 1940 freeze, have renewed themselves better than the plants under continuous mulch and now look more promising for 1943 production. Subsoil moisture in the mulched area remains high while there has been much depletion in the cultivated rows.

Fruits on the mulched block of Jonathan trees continue to color less than is the case with adjoining trees growing under sod.

The supervisors are C. C. Wiggans and R. E. Baker.

Vegetable Experiments

Carrots. Selection of lines producing high specific gravity roots is being continued.

Asparagus. Up to the present time, length of cutting season and manuring or irrigation have exerted practically no measurable effect on the succeeding crop of asparagus from the present experimental block.

Soil management with vegetables. Irrigation and straw mulching continue to be the two methods most vital for the production of vegetables.

Tomato plant production methods. Replicated yield tests with various plant production methods were conducted at Lincoln and Scottsbluff. The production of plants in flats in greenhouse or hotbed gave better results than southern-grown plants or field seeding, when early tomatoes were desired at either Lincoln or Scottsbluff. At Lincoln, field seeding of an early variety was a good way to get good yields of good quality tomatoes in September. At Scottsbluff, greenhouse-grown plants were far superior to any others and this was the only method that appeared to be a practical or dependable way of assuring a commercially profitable yield. Field seeding at Scottsbluff gave yields entirely too low for consideration.

H. O. Werner conducted the experiments.
The never-ending battle for healthier plants is a part of the battle for increased production.

**Plant Diseases**
Department of Plant Pathology

**Bacterial Blights of Beans**

The breeding program to develop common and halo blight resistant bean varieties continues. Briefly it consists of crossing resistant varieties, all of which are unsuitable for use because of undesirable horticultural characteristics, with varieties possessing desirable characteristics but which lack resistance to blight. Because of the nature of bean hybrids to continue segregation for at least five generations after hybridization, it is necessary to continue selections in a number of generations to insure reasonably fixed plant characters. Progenies of crosses are grown successively in field and greenhouse where they are subjected to repeated artificial epidemics of blight. Selections are made on the basis of resistance to blight in the early generations and on resistance and desirable characteristics in the later generations.

**Breeding for halo blight resistance.** This program, which has been carried on for several years, has resulted in the selection of several green bean lines that are physiologically resistant to halo blight and which have vigor, acceptable plant type, and straight stringless pods. Yields of these lines are not sufficiently high for satisfactory garden use and back crosses to the green bean parents are being made in an attempt to increase yields without sacrificing resistance.

In the greenhouse tests 7,251 F3 individuals representing nine different parent combinations were inoculated and of this number 1,119 were saved because of freedom from infection after repeated inoculation or because of showing resistant type symptoms. Because some of the plants matured too late in the spring to be included in the field tests, only seed from 660 selected plants was planted in the field. The field stand of F1 field plants numbered 3,831 plants of which 59 were selected as being reasonably acceptable plant types and showing either freedom from infection or resistant type symptoms. Seed from these plants will be planted for further tests.

Bean plants 15 days after stem-inoculation with the halo-blight organism in the laboratory. A and B are resistant bean varieties—Schwert No. 27 and Red Mexican. C and D are susceptible varieties—Red Kidney and Bountiful.
Greenhouse and field inoculation tests were carried out with 38 F₁ lines. On the basis of horticultural type and resistance to halo blight, 12 F₁ lines and four plants from F₁ lines were selected as either worthy of further test or for use in back crosses.


Breeding for common blight resistance. Greenhouse and field inoculation tests were carried out with 59 F₁ lines from which, on the basis of field bean type and freedom from blight, 25 lines were selected for further test. From a field stand of 420 F₁ plants representing seed of 95 previous greenhouse plant selections, nine single plants, free from infection, were selected for further test.

A replicated field-yield test was conducted with five lines in the F₁ and seven lines in the F₂ generation representing four parent combinations compared with Great Northern U.I. 59, 123, and commercial pinto varieties. Three white bean selections were found to have yields superior to the standard white commercial varieties, and two pinto selections yielded more and were earlier than the commercial pinto variety.

These projects have been directed by J. H. Jensen, R. W. Goss, M. W. Felton and J. E. Livingston.

Potato Diseases

Fusarium wilt. Tests for resistance to this disease were continued in the greenhouse and in the inoculated field plot at the Scotts Bluff Station. The field tests included (1) 111 lines consisting of 78 untested lines and 33 survivors of the 134 lines tested in 1941; (2) 137 selections from 26 crosses saved out of the 506 seedling lines tested in the greenhouse for two years; (3) six lines out of 70 tested in the field in 1941 which had survived two years' greenhouse tests; (4) 42 lines out of 52 tested in the field in 1941 which had survived one year's greenhouse test and (5) 1,970 survivors of the 4,554 first-year seedlings tested in the greenhouse.

A new variety named Kasota is being described jointly by the Minnesota and Nebraska Experiment Stations and is being released for commercial production. In five years of tests in the Scotts Bluff fusarium plot it has shown only about one-third as much infection as the Triumph and Cobbler checks.

Scab. Tests for resistance were continued in the scab plots at Morrill, Nebraska. From 107 lines tested the previous year, 28 were selected for retesting and 75 new lines were included. Many hybrid lines have shown a high degree of resistance but none has combined resistance to scab and fusarium wilt.

Spindle-tuber. Eighteen seedling lines that had shown some resistance to either scab or fusarium wilt were tested for resistance to spindle-tuber by planting alternately in the rows with infected Triumphs. Only one line has been discovered that holds any promise of resistance. This line has survived two successive years without showing tuber symptoms and is now being used as parent material for new crosses.

Ring rot. Preliminary experiments have shown that soil temperature affects the rate of development of foliage and tuber symptoms. It was found that infected plants harboring the organism in the stolons and tubers sometimes failed to produce any detectable foliage symptoms when the organism had not migrated upwards in the stem. The organism was found to occur in the roots as well as in the other vegetative tissues of the
plant. Best area from which to obtain diagnostic smears was found to be the underground stem about one inch below the soil line. A much higher percentage of infection and a more rapid development of symptoms occurred when sprouts were hypodermically injected with pure cultures than when other methods of inoculation were used.


**Tomato Diseases**

**Bacterial spot.** The reaction of 17 tomato varieties, introductions, and selections was tested (in seedling and fruit stages) by inoculation with cultures obtained from three widely separated areas. No significant differences were noted in seedling tests but wide variations in symptoms and amount of infection were apparent from fruit inoculations. Isolations from the various lesion types were found to be alike morphologically and no differences in type of lesion development were noted in leaf and stem inoculations. Isolations during the summer from field material gave further evidence of a wide range in symptoms not usually associated with bacterial spot. Much of the damage in canning areas which has been mistakenly termed “nailhead” is undoubtedly caused by bacterial spot. Sixty selections of Lycopersicon spp. and related weeds have been obtained and increased to provide material for tests relating to host range and resistance.

**Bacterial speck.** A study of bacterial speck of tomato revealed that field infection under natural conditions may be strongly dependent on driving wind and rain and on the stage of plant development. An examination of 15 varieties, randomized and replicated in a yield plot, indicated that the wide variations in amounts of infection between varieties were due largely to differences in stage of fruit development during periods of weather favorable for infection.

**Bacterial canker.** This serious disease of tomatoes was found to be common in eastern Nebraska for the first time and was present in several other areas. Fields which were a total loss from the commercial standpoint were found in four areas of tomato production. The source of infection in one case was traced to improper methods of seed extraction. In another canning district all fields planted with non-certified stock from a southern grower showed from a trace to a high percentage of bacterial-canker plants.

**Fusarium wilt.** The same 17 varieties used in the bacterial spot tests were tested for wilt resistance, in the greenhouse and in the field. While conditions for disease development in the field were unfavorable this season, results from the two tests were essentially in agreement. Two varieties, Pan American and a Missouri selection, were practically immune, but not adapted to the growing conditions of Nebraska. With one exception, all the early varieties recommended for Nebraska were highly susceptible. Victor, an early variety, and the later varieties Marglobe, Pritchard, and Pearson exhibited considerable tolerance to the wilt disease. A comparison between Nebraska isolates of the wilt fungus and two highly pathogenic strains from Missouri showed some to be lower and others to be equal to the Missouri cultures in pathogenicity.

M. W. Felton was in charge of experiments.
Lodging of Early Kalo sorghum caused by charcoal rot of the stalk.

**Miscellaneous Diseases**

**Barley.** Discoloration of barley in Nebraska is caused primarily by two groups of organisms, *Helminthosporium* sp. and *Alternaria* sp. Comparative inoculations demonstrated that while *Helminthosporium sativum* could attack seedlings, leaves, and floral parts at practically any stage of development, *Alternaria* developed on leaves, glumes, lemma and palea only when these parts began to yellow on approach of senescence or maturity. While the extensive development of *Alternaria* which occurs in wet seasons was not reflected in lower germinability, it did obscure the symptoms of *Helminthosporium* blight and interfered with laboratory isolations. It was found that under such conditions a count of blighted seedlings in greenhouse flats provided more accurate information.

Using samples of known blight percentage, increases in healthy stands resulting from seed treatment with a commercial organic mercurial ranged from 18 per cent for a slightly blighted sample to 47 per cent for a heavily blighted barley.

**Charcoal rot of corn and sorghum.** Studies have shown that it is difficult to obtain infection of grain sorghum plants in the greenhouse following artificial inoculation below 35° C. The organism is able to utilize a wide range of carbon and nitrogen sources in synthetic media and grows well over a fairly wide pH range with a tendency for more rapid growth on an acid medium.

Observations on the appearance of charcoal rot in Nebraska were reported by J. E. Livingston in the Plant Disease Reporter, 26:50–51.

**Corn ear rots.** A survey in eastern Nebraska revealed wide variation in susceptibility of hybrid corn varieties to ear rot damage. *Diplodia zeae*, *Nigrospora sphaerica*, and *Fusarium moniliforme* were the principal
organisms involved and in many cases up to 20 per cent of the ears were
diseased. Loss to the farmer will not be that high as many diseased ears
still have marketable corn. The most serious damage will be from poor
germination of kernels with diseased embryos. Many ears show no evi-
dence of mold on the surface but have a rotted cob with the tips of the
kernels and the germ damaged. Single crosses between inbred lines of
corn showed a great variation in the percentage of rotted ears, thus it
may be possible to select single-cross combinations that will produce
hybrids having resistance to ear-rot organisms.

**Eggplant.** Two organisms, *Phomopsis vexans* and *Colletotrichum*
species, were isolated from badly damaged fields of eggplant near Omaha.
Defoliation, stem cankering, and fruit spotting caused by *Phomopsis* blight
have been troublesome during the last two seasons. *Colletotrichum* oc-
curred largely on marketed produce and over-mature fruits in the field.

**Peppers.** Cultures obtained from diseased material and a study of
symptoms revealed that serious mid-season defoliation and fruit spotting of
peppers in eastern Nebraska the past several seasons resulted from
bacterial spot infection, similar to the disease of the same name on
tomatoes. Severity of the disease in truck-garden areas may be in part
explained by general use of varieties very susceptible to bacterial spot.

**Potato late blight.** First reported potato late blight (*Phytophthora in-
festans*) in Nebraska was observed in the early potato regions of the
central part of the state this year. Very little tuber infection but severe
foliage infection was found. Favorable weather for the disease, above-
normal rainfall and below-normal temperatures, prevailed throughout
most of the growing season in central and south-central Nebraska. The
disease was not detected in the commercial table and seed stock pro-
ducing areas in western Nebraska.

**Seed treatments.** A definite increase in the number of sorghum and pea
plants emerging from the soil resulted from treating the seed before
planting with certain chemicals. Several materials which contain no
metals essential in the war effort were as good, or better than the com-
monly used mercury and copper fungicides. Field corn, sweet corn, and
spinach gave very little response to seed treatments. The control of seed-
borne rhizoctonia and scab on potatoes in the Central Platte Valley was
best with acid-mercury treatments. Semesan Bel gave fairly good control
of rhizoctonia.

**Sugar beet diseases.** Careful examination of sugar beet stands in the
Scotts Bluff rotation plots throughout the season failed to reveal any
serious losses in stand due to disease, except in the continuous beet plots
where fusarium and rhizoctonia reduced the stands 25 per cent. There
was no serious loss due to crown rot in the harvested beets. Sand-culture
studies in the greenhouse showed that rhizoctonia infection of seedlings
was favored by a high concentration of nutrients while the reverse was
true with fusarium infection.

**Wheat bunt or covered smut.** Preliminary studies of the effect of differ-
ent nutrients on the development of *Tilletia levis* in wheat plants follow-
ing infection showed that the type of nutrition affected the percentage
of smutted heads that appeared. Seeds were inoculated by the rag-doll
method, then transplanted to sand cultures after infection had occurred.
Research was conducted by M. W. Felton, J. E. Livingston, Eric Kneen
and C. E. Dallimore.
War needs have turned attention and new problems toward chemistry in agriculture.

Chemical Studies With Plant Materials
Department of Agricultural Chemistry

Leoti Sorghum is a Tapioca Starch Substitute

ANNUAL U. S. tapioca starch imports had amounted to as much as 350 million pounds because this starch is essential for certain adhesives and food manufacturing purposes. Then the war cut off importation, and it became necessary to find a domestic starch substitute. For some time it has been known that the so-called "waxy" starches have properties similar to tapioca starch. Since Nebraska grows 100 to 200 thousand acres of Leoti sorghum, a sorghum which has "waxy" type grain, investigations were started concerning the possibility of the use of Leoti grain for the manufacture of a tapioca starch substitute. Methods were developed for manufacturing from this grain a pure white "waxy" starch which had the desired tapioca starch properties. Accordingly, the tapioca starch importers and users were informed of the possibilities, and one company is now in the market for Leoti grain for starch manufacturing purposes.

In charge of this project have been R. M. Sandstedt and B. D. Hites.

Sorghum Malt May Fill a War Need

Studies of the influence of various factors on the development of starch-splitting enzymes in germinating cereals have been continued and expanded. The influence of variety and of seed source were investigated with wheat, barley, and sorghum. Both factors had pronounced effects on the resulting "malts" and must be considered in any program for the production of malts of high amylase activity.

Confirmation was obtained for the previous finding that the amylase of germinated sorghum essentially is limited to the alpha form. Though somewhat unlike barley or wheat malts, it should have equal utility in many procedures. Experimentally, sorghum malt has been found equal in value to other malts in flour supplementation as well as applicable to the production of industrial alcohol from grain.

Several features of the production of sorghum malt were investigated. A modified rotary-drum technique proved applicable, thus indicating the industrial feasibility of the process. The low cost of grain, short malting time (two to three days), and lowered refrigeration costs all contribute to the economy of production. This economy, especially the increase in plant capacity by shortening of malting time, assumes added significance in light of the present malt shortage occasioned by the demands of plants producing industrial alcohol. A single large alcohol plant would use daily the malt from some 1,000 to 2,000 bushels of grain. If this were sorghum malt, the resultant cash market for high-grade grain sorghums would have a pronounced influence on midwestern agriculture.

Investigations of the properties of amylases have been continued with particular regard to the manner in which such properties influence utilization. This data, in addition to increasing our knowledge of an important group of biocatalysts, should facilitate intelligent industrial use of the amylases.


It has been discovered that, in certain cereal grains, there are substances which inhibit the action of amylases. Such a substance is present
in wheat, rye, and certain of the sorghums. This appears to be the first instance on record of the isolation of a naturally occurring amylase inhibitor from such materials. Apparently this particular inhibitor is specific for animal and bacterial amylases. There are indications that the action involved is of pronounced biological significance.

These studies have been conducted by Eric Kneen and R. M. Sandstedt.

**Industrial Amylases from Bacteria**

Investigations dealt with the isolation of promising strains of bacteria and studies of the production of amylases by these organisms. Methods for the evaluation of the amylolytic activity were developed and applied. Preliminary studies of the properties of one of the amylase products indicate that it has industrially desirable thermo-stability and adequate starch liquefying, dextrinizing, and saccharifying powers. Experimentally it has been used with success as a pre-cooking mash liquefier in processes simulating those used in the production of industrial alcohol.

In charge of this work have been Eric Kneen; K. H. Lewis, Department of Bacteriology; and L. M. Christensen, Chemurgy Project.

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Wheat starch granules as they look through the microscope. At left are surface and edge views before enzyme action. Subjecting these sectioned granules to enzyme action brings out the structure, the one from the edge-wise cross section (center) and the one from the disk-like side (right).

**Study of Starch Granules**

In order to supplement the knowledge concerning structure of the wheat starch granule which was obtained through study of the action of enzymes on the granule, granules were sectioned by means of a freezing microtome. A study of the action of enzymes on these sectioned granules gives further insight into their structure. The wheat starch granule as seen from one surface is a disk. When viewed from the edge, the granule looks like the crease side of a grain of wheat.

R. M. Sandstedt is making this study.

**Sulfa Drugs and Growing Chicks**

This project concerned the effect of sulfa drugs upon the number and kinds of bacteria in the intestines of young, growing chicks. It was found that large dosages of the sulfa drugs (four per cent to five per cent live weight) were extremely toxic. Smaller amounts of the drugs caused decrease in growth rate but the majority of the chicks survived. The easily absorbed sulfa compounds were not effective in modifying the bacteria in the intestines of young, growing chicks since they were absorbed rapidly in the upper digestive tract. Sulfaguanidine, which is only slightly absorbed, was the most effective. Modification of intestinal flora by sulfa-
guanidine was most effective upon the coliform group of organisms and especially upon Escherechia coli, which is the chief coliform organism found in the intestines of young, growing chicks. However, the total count of organisms in the intestines remained about the same, even when the number of E. coli was greatly reduced by the use of sulfaguanidine.

Addition of thiamin, riboflavin, and p-amino benzoic acid to the diet of chicks receiving sulfaguanidine, inhibited the bacteriostatic effect of the sulfaguanidine. However, it increased the mortality from 25 per cent for the chicks receiving the drug alone to about 60 per cent for the birds receiving the drug plus supplements of 600 mg. thiamin, 800 mg. riboflavin per 100 g. of feed, and 12 mg. p-amino benzoic acid per day. Addition of pure cultures of E. coli to the diets of chicks receiving sulfaguanidine increased the mortality rate from 25 per cent for the chicks receiving the drug alone to 70 per cent for the chicks receiving the drug plus pure-culture E. coli.

In charge of this work has been W. E. Ham, in cooperation with K. H. Lewis, Department of Bacteriology.

**Vitamin D in Growing Chicks**

In order to determine the relative vitamin D potency of good fish oil and irradiation by an S-4 ultraviolet lamp, an assay method was tried using the total calcium content of groups of ten birds, partially dissolved in hydrochloric acid and defatted. Digests were made up to volume and aliquots used for perchloric acid digestion and calcium determinations.

Three groups of ten birds each were used. All groups received the same ration with the exception of the differences in the vitamin D supplement. The negative control lot received no vitamin D supplement and were rachitic at the end of the 14-day feeding period.

<table>
<thead>
<tr>
<th>Lot</th>
<th>Total live wt. grams</th>
<th>Total dry wt. grams</th>
<th>Total calcium</th>
<th>% Ca. live wt.</th>
<th>% Ca. dry wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish oil</td>
<td>1701</td>
<td>564.65</td>
<td>13.568</td>
<td>0.797</td>
<td>2.40</td>
</tr>
<tr>
<td>S-4 lamp</td>
<td>1621</td>
<td>523.08</td>
<td>13.152</td>
<td>0.809</td>
<td>2.51</td>
</tr>
<tr>
<td>Control (rachitic)</td>
<td>1284</td>
<td>349.89</td>
<td>4.056</td>
<td>0.316</td>
<td>1.16</td>
</tr>
</tbody>
</table>

On the basis of these results, the method would appear to have promise as a chick assay method for vitamin D.

The experiment was conducted by W. E. Ham, in cooperation with F. E. Mussehl of the Department of Poultry Husbandry.

**Cold Resistance in Crop Plants**

Studies dealing with the cold hardening response of winter wheat to differential nutrition in sand culture have been completed. The most striking responses were those relating to calcium and nitrogen nutrition. An adequate supply of the calcium ion is essential to the normal development of cold resistance. The kind and level of available nitrogen proved of similar importance; high nitrogen was detrimental to hardening and at any one level the kind of nitrogen (nitrate, ammonia, urea) had a pronounced influence, greatest hardening attending the use of nitrate.

The importance of nutrition is evidenced by the fact that hereditary differences in varietal cold resistance could be completely reversed. For instance, Cheyenne and Blackhull varieties of winter wheat were grown with adequate and identical nutrition. In addition Cheyenne, normally much more winter hardy, was subjected to a combination of nutritional
factors detrimental to the development of winter hardiness, and Blackhull to a combination of favorable factors. As a result, Blackhull with "good" nutrition became much more cold resistant than Cheyenne with "poor" nutrition.

Sufficient soil studies were conducted to demonstrate the practical significance of plant nutrition in the development of winter hardiness in wheat. However, with soils the problem is complex and more work must be done before agronomic recommendations can be made.


In the controlled freezing studies, investigations of the cold resistance and hardening characteristics of many varieties of winter wheat, barley, and rye were continued. This program has proved to be a successful means of evaluating the winter hardiness of cereals, thus assisting in the development of varieties with satisfactory agronomic characteristics.

Sufficient data are at hand to supply conclusive evidence that the date of seeding of winter wheat has a pronounced influence on winter hardiness. Planting dates either too early or too late were unfavorable. The influence of seed source on the winter hardiness of wheat again was found to be negligible.

Eric Kneen made these studies in cooperation with the Department of Plant Pathology. Controlled freezing studies were in cooperation with K. S. Quisenberry of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.

**Flour Enzymes as Related to Baking**

The view is held that the poor baking results obtained from unoxidized doughs (doughs made from unbleached flour without the addition of chemical improvers) are the consequences of proteolytic enzyme action. (Proteolytic enzymes are the enzymes which break down proteins into more simple compounds.) This theory states that the action of bleaching agents and chemical improvers is to decrease the activity of the proteolytic enzymes. However, if these properties are due to breakdown of the protein, the addition of oxidizing agents after a period of fermentation—after proteolytic action has supposedly taken place—should not cause a reversal of these characteristics. It is not probable that the proteins can be resynthesized after being disintegrated.

Experimental baking in this department has shown that the characteristics of reduction in doughs are completely reversible by oxidation. Quite surprisingly the action of proteolytic enzymes is also partially reversible, indicating that proteolytic action in doughs may be accompanied by the release of reducing substances. The reducing action may be reversed but the disintegration of the protein cannot be reversed. Accordingly, the similarity of the action of proteolytic enzymes and the action of reducing agents may be due to the release of reducing substances by the proteolysis. However, the evidence indicates that the characteristics of reduction in dough are not due to proteolysis but are due to the presence of reducing substances in the unoxidized flour, and that while oxidizing agents may inhibit proteolysis, the improving action of bleaching and other oxidizing agents is not due to this inhibition but to oxidation of other constituents of the flour.

R. M. Sandstedt and Karl Fortmann are in charge of this study.
Pests that cause destruction and waste must be destroyed as enemies of production.

Insects and Rodents
Department of Entomology

Methods of Chinch Bug Control

The fall chinch bug survey in 1941 showed one of the more serious potential threats of recent years, particularly in the east-central part of the state. But timely rains in the spring of 1942 reduced the bug population in the southeastern part of the infested territory to the point where only minor damage occurred. In the east-central areas there was rather severe damage to small grain and corn but here again losses were greatly reduced by the rains. The 1942 fall survey showed a light infestation in southeastern counties and a moderate to heavy infestation in east-central Nebraska.

Because of the threatening chinch bug situation at the beginning of 1942, the apparent shortage of creosote, and the restriction of transportation facilities, nine permanent storage tanks for creosote with a total capacity of 118,500 gallons were located at strategic points in the chinch bug territory. This, it is hoped, will permit the retention of an emergency stock and an adequate supply through the control season. These tanks

A chinch bug barrier made of 2-4 dinitro-ortho-cresol dust, applied as a small line in a shallow furrow, and easier to make than a creosote barrier.
were purchased by the federal government and set up in cooperation with this department.

Experiments were conducted to determine the relative value of 2-4 dinitro-ortho-cresol dust as a chinch bug barrier. To reduce blowing by the wind a dust containing a small amount of oil was used. The dust was applied as a small line (about one pound per rod) in a shallow, smooth furrow. The construction and maintenance of this type of barrier was found to require considerably less time than a creosote barrier; it also compared quite favorably with creosote in effectiveness. The results obtained by this department, together with the reports of favorable results from a number of other states, lead to the conclusion that dinitro dust offers promise of becoming an effective substitute for creosote in chinch bug control.

This work was supervised by H. D. Tate and Lewis T. Graham.

**Hessian Fly Infestations**

Although a relatively heavy infestation was present the previous fall, Hessian fly damage in the spring of 1942 was comparatively light. Observations indicate that this can be attributed largely to two factors: first, growers gave more attention to the recommended control measures, a reaction which no doubt was influenced by the heavy losses experienced in the spring of 1941; and second, weather unfavorable for egg deposition occurred at the time of adult emergence in the spring of 1942.

A stubble survey conducted in July (1942) in southeastern and east-central Nebraska showed an average stem infestation of about 12 per cent. A limited survey of volunteer wheat in the late fall showed that an average of about 40 per cent of the plants were infested.

In cooperation with the Department of Agronomy and the United States Bureau of Entomology and Plant Quarantine, the Hessian Fly Uniform Nursery plantings were continued. Counts made in the spring of 1942 on the 1941 fall plantings, which included 20 varieties, revealed that the checks, Tenmarq, Cheyenne, and Gladden, had an infestation of 63, 51 and 27 per cent, respectively, while Pawnee, a recently developed variety showing considerable promise in eastern Nebraska, showed an infestation of seven per cent and the remainder of the varieties from zero to four per cent. In the 1942 spring plantings, which included 26 varieties, the percentage of infestation in the test varieties ranged from zero to 48 per cent, and the check varieties, Hope and Thatcher, had 82 and 100 per cent infestation, respectively. The infestation in the 1942 fall plantings was so light that no comparisons could be made.

H. D. Tate and Lewis T. Graham conducted the research.

**Corn Earworm Control Methods**

*Insecticide treatments.* Experiments to determine the effectiveness and practicability of individual ear treatment to control the corn earworm on sweet corn were continued in 1942 in cooperation with the Department of Horticulture. The treatments used were: (1) mineral oil, (2) mineral oil plus two per cent dichloroethyl ether, (3) mineral oil plus 0.2 per cent pyrethrins and (4) clipping of silks immediately after pollination was completed.

The average percentages of worm-free ears at harvest were as follows: oil-pyrethrins, 85.75; oil-dichloroethyl ether, 80.65; oil alone, 72.69; clipping, 51.99; and check, 56.58.
The results obtained this season add support to the evidence obtained the previous year, namely that either the oil-pyrethrín or oil-dichloro-ethyl ether treatments are economically practical for sweet corn grown for the retail market or for home consumption, provided the percentage of infestation is high. Also, it seems that this treatment is practical for valuable hybrid seed corn. This is supported by the fact that hybrid seed corn producers treated several thousand acres of corn in Nebraska by this method in 1941.

A mimeographed circular, Nebr. E. C. 1523 was published by H. Douglas Tate, entitled “Corn earworm control on sweet corn.”

**Planting date.** Tests to determine the relationship of the date of planting sweet corn to corn earworm infestation were started at the Scotts Bluff Field Station. Results of the 1942 tests are as follows:

<table>
<thead>
<tr>
<th>Date of Planting</th>
<th>Per Cent of Ears Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 8</td>
<td>60.7</td>
</tr>
<tr>
<td>May 15</td>
<td>36.4</td>
</tr>
<tr>
<td>May 27</td>
<td>14.4</td>
</tr>
<tr>
<td>June 5</td>
<td>7.1</td>
</tr>
<tr>
<td>June 18</td>
<td>17.8</td>
</tr>
<tr>
<td>June 29</td>
<td>37.6</td>
</tr>
</tbody>
</table>

**Varietal resistance.** Records were obtained on the susceptibility to corn earworm injury of 18 varieties of sweet corn. As was anticipated, difficulty was encountered in evaluating resistance because of difference in maturity dates of the corn and variation in the abundance of the corn earworm at different periods. Considerable variation was evident among varieties harvested on different dates; for example, three varieties harvested on July 28 showed an average of 60.76 per cent worm-free ears, whereas two varieties harvested on August 7 showed an average of 81.72 per cent worm-free ears. Significant differences also were found in infestations among varieties harvested on the same date; for example, 70 per cent of the ears of Golden Cross Bantam were worm free as compared to 54.43 per cent for the variety Top Flight.

These studies were conducted by H. D. Tate, Roscoe E. Hill and Lewis T. Graham.

**Potato Insects and Their Control**

**Potato flea beetles.** An average of 17.4 per cent of the potato flea beetles confined in hibernation cages in the fall of 1941 survived the winter of 1941–42. The over-winter adults began emerging May 20 and continued to appear until June 29, the peak occurring June 9. During this period the beetles were more abundant than at the same time the two previous years. Unusually large numbers were found feeding on young tomato plants. First and second generations developed in the field at about the same dates as in 1940 and 1941. Evidence of larval development on the roots of tomatoes and in “cull” potato dumps was obtained. More than 700 first generation beetles developed in and emerged from a small portion (approximately 2,800 cubic inches) of “cull” dump which was naturally infested by over-winter beetles.

Field experiments for the purpose of developing more adequate control measures for the potato flea beetle were continued. A pyrethrum dust (Pyrocide No. 7½) proved to be less effective than either barium fluorosilicate dust (Dutox) or zinc arsenite spray for this pest. The reduction of zinc arsenite from a concentration of two pounds to one pound in 40
gallons of water resulted in 75.4 per cent of the tubers falling in the higher grades as compared with an average of 81.9 per cent where the stronger concentration was used.

**Potato psyllid.** The psyllid situation resembled the 1941 season in several respects. Large numbers again were found developing on volunteer growth on "cull" dumps during May, June and early July. As was true last season there was a reduction in the yield of early potatoes due to this insect. Because of the early abundance of this pest, control measures on the late crop again were considered advisable throughout the growing season. Although some damage was evident on late plantings which were not sprayed, the population failed to build up to expected proportions.

In field experiments lime-sulfur spray, 300-mesh dusting sulfur, and a pyrethrum-sulfur dust (Pyrocide) were tested as control measures against the potato psyllid. Increased yields were obtained in all cases where these materials were used. Although these increases slightly favored the sulfur dusts, definite conclusions as to the superiority of one treatment over the other cannot yet be made. The low psyllid population in the experimental plots and the abundance of certain secondary pests, the economic importance of which has not yet been ascertained, make it difficult to evaluate the effectiveness of insecticides in the control of psyllids in western Nebraska.

**Residual toxicity of sulfur.** Greenhouse experiments concerned with the residual toxicity of wettable sulfur, liquid lime-sulfur, and dusting sulfur to the potato psyllid, *Paratrioza cockerelli*, were completed. In eight series of experiments with wettable sulfur, involving several hundred nymphs having pre-caging intervals (time between application of insecticide and confinement of insects) of from one to 36 days, only one normal adult emerged; in 11 series with liquid lime-sulfur, having pre-caging intervals of from six to 39 days, only four normal adults developed; and in nine series with dusting sulfur, having pre-caging intervals of from six to 41 days, only a small number of normal adults developed. No evidence of translocation of toxicity from treated to untreated portions of the plant, or to foliage, developing following treatment was obtained in a series of experiments concerned with this problem.

**Aphids.** Additional evidence of aphid population increases following the use of zinc arsenite for flea beetle control was obtained in five field experiments. Significant increases occurred in every case where two or more applications were made. Much smaller increases, usually insignificant, followed the use of barium fluosilicate dust (Dutox). It seems likely that the control of virus diseases transmitted by aphids may become more difficult as a result of zinc arsenite applied to control flea beetles. In general, aphid populations were found to remain at a low level on both treated and untreated plants until late August or early September. Their late seasonal occurrence would tend to complicate direct control with insecticides. The use of barium fluosilicate dust, which is as effective as zinc arsenite for flea beetle control, may offer one solution of the problem.

**Potato tuber worm.** A special potato tuber worm survey was started in the spring of 1942 in cooperation with the U. S. Bureau of Entomology and Plant Quarantine. This pest previously had been collected in Cass and Lancaster counties, Nebraska. During the current survey it was found in three new localities: Buffalo, Lincoln and Box Butte counties. All
specimens collected were larvae which were feeding on the foliage. Relatively few specimens were found in any one area, in Box Butte County only two specimens were collected, and in Lincoln County a single individual was taken. Examinations of a large number of storage cellars in western Nebraska have been made with negative results.

**Other potato insects.** Collections and records on other potato insects were continued. Plant bugs (*Lygus* spp.) were less numerous than during the past two years. Another bug, the false flea hopper (*Chlamydatus associatus*), was abundant in certain fields and was observed to breed on potato plants in large numbers. A leafhopper (*Ceratagallia uhleri*) was reared on potato plants in the laboratory and nymphs were also found developing on plants in the field. The economic importance of these species is yet to be determined. It is possible that the reduction in numbers of secondary pests resulting from the use of sulfur sprays and dusts may be correlated to some extent with the increased yields which usually are attributed entirely to psyllid control.

Roscoe E. Hill and H. D. Tate were in charge of the experiments.

**Use of Wheat Flour in Sprays**

Laboratory studies on the tenacity of sprays showed that the addition of flour to a mixture of an insoluble copper sulfate in water increased the degree of retention slightly. When lime was mixed with the flour before it was added to the spray mixture, the degree of retention was increased markedly; in some cases the tenacity was doubled. This compared favorably with some commonly used non-oil spreader-stickers.

Lewis T. Graham and H. D. Tate conducted the study in cooperation with Agricultural Chemistry.

**Mosquito Survey**

Since no mosquito survey had been conducted in Nebraska and because recent discoveries have placed renewed emphasis on the role of mosquitoes in dissemination of diseases of man and animals, a mosquito survey project was started in the spring of 1942. Objectives of the survey were to determine: (1) species of mosquitoes occurring in the state; (2) distribution of the various species; (3) seasonal abundance of the more important species; and (4) their principal breeding places.

Thirteen different light-trap collecting stations were established at representative localities in the state and these were operated three nights out of each week from about the middle of May until the middle of October. In addition to the adults taken in light traps, larvae were collected from various places in the state. Although determinations have been completed on only a small proportion of the material, certain general trends have been observed.

Generally speaking, 1942 was exceptionally favorable for mosquito development, and the population attained an unusually high nuisance level, particularly during the spring and fall. Frequently during periods of greater abundance from 2,000 to 3,000 mosquitoes were collected in a single night in some of the traps. It is generally assumed that a nuisance level is attained when a night's catch reaches about 24 specimens. Conditions in the irrigated sections of the North Platte Valley were found to be especially favorable for mosquito breeding. In this area *Aedes* spp. constituted a predominant proportion of the total population and were observed to be breeding almost entirely in puddles and in temporary and
Mosquitoes would find this roadside ditch (left) a favorable egg-laying site. When it is flooded the eggs will hatch. Drainage ditches with pools resulting from irrigation (right) make favorable mosquito breeding places.

semi-permanent pools formed by irrigation water. *Anopheles* spp., principally *maculipennis* and *punctipennis*, were found to be present in all areas, being especially abundant during the fall in eastern Nebraska. Occasionally in September *Anopheles* spp. comprised as much as 25 per cent of a night's collection at Lincoln. Generally speaking, *Aedes vexans* and *Culex tarsalis*, both of which are known to be carriers of encephalitis, were the dominant species over the state. *Aedes dorsalis* often became abundant, particularly in western Nebraska. Several other species were found in appreciable numbers.

The survey was conducted by H. D. Tate, Raymond Roberts and Roscoe E. Hill.

**Grasshoppers and Their Enemies**

The grasshopper outbreak in 1942 was only about half as serious as that of 1941. Approximately 1,100 tons of dry bait materials were used as compared to 2,200 tons for the previous year. Frequent rains combined with relatively cool weather retarded grasshopper development about two weeks. As a result of an abundant growth of vegetation, grasshopper feeding was confined for the most part to fence rows, ditch banks, roadsides, waste areas and other weedy places, although some marginal damage to cultivated crops did occur.

Weather conditions were also favorable for the development of grasshopper parasites. The fungus disease, *Empusa grylli*, was found to have caused as much as 15 per cent mortality of *Melanoplus bivittatus* and *M.*


differentialis in some counties of eastern Nebraska in early July. At the same time nematodes (Gordius sp.) were found to be attacking grasshoppers in large numbers in western Nebraska.

Because of cool, moist weather during the late summer and early fall (1942) conditions were unfavorable for egg laying. A high degree of parasitism was evident at the time of the fall egg survey, principally by blister beetle, ground beetle, and bee-fly larvae. In some localized areas the egg parasite, Scelio calopteni Riley, was of considerable importance. Following are some examples of the extent to which parasites were found at the time of the fall egg survey: Adams County, about 55 per cent of egg pods were parasitized, 40 per cent by ground beetles, 10 per cent by blister beetles and five per cent by bee-flies; Boone County, 40 per cent of the egg pods parasitized, practically all by blister beetle larvae; Franklin County, 50 per cent of egg pods parasitized, principally by carabid larvae. In numerous other counties from 10 to 25 per cent were affected.

These studies were in charge of H. D. Tate and Lewis T. Graham.

Cockroach Control

Investigations regarding the relative effectiveness of various dusts used for cockroach control have been completed. Sodium fluoride, sodium fluosilicate, and borax were found to be about equally toxic to the German cockroach (Blattella germanica) when readings were based on the number dead at the end of ten days. Pyrethrum was comparatively low in toxicity. The addition of pyrethrum increased the toxicity of sodium fluoride but not of sodium fluosilicate and borax.

The dusts tested in the order of their rate of lethal action were: mixtures of sodium fluoride and pyrethrum, sodium fluoride, mixtures of sodium fluoride and pyrophyllite, mixtures of sodium fluosilicate and pyrethrum, sodium fluosilicate, pyrethrum, mixtures of pyrethrum and borax, and borax.

H. D. Tate and Edward C. Klostermeyer conducted the investigation.

Rodent Control

Activities concerned with rodents have been principally in the form of field control operations, including surveys. The work has been conducted largely by extension entomologists in cooperation with Experiment Station personnel and personnel of the rodent control division of the Fish and Wildlife Service, who have had office space in the Department of Entomology since the spring of 1942. Activities have been as follows:

1. A state-wide rat control campaign in which 65 counties actively cooperated.
2. A prairie dog control campaign in western Nebraska, and a survey to determine areas infested in certain other parts of the state.
3. Organized coyote control started in a number of counties of western Nebraska.
4. A pocket gopher control project in cooperation with Indian Service in northeastern Nebraska.
5. A pocket gopher control project at Fort Robinson, Nebraska.

H. D. Tate, Lewis T. Graham and Roscoe E. Hill were in charge of work for the department.
Livestock production is as important as airplane production in winning a war.

Feeding Cattle, Hogs and Sheep
Department of Animal Husbandry

Cattle Feeding Investigations

**HEIFER calves thrive on barley.** Six lots of heifer calves with an average initial weight of 440 pounds per head were fed for 200 days on a basal ration of corn silage, linseed cake, and ground limestone. In addition, grain was fed to the six lots as follows: ground shelled corn, equal parts by weight of ground shelled corn and coarsely ground barley, coarsely ground barley mixed with silage as fed, coarsely ground barley, finely ground barley, and whole barley. The barley fed was Spartan with a crude protein content of 13.25 per cent and a test weight of 48.2 pounds. The corn graded No. 3 with a crude protein content of 10.5 per cent.

The heifers were brought up to a full feed of grain rather slowly and consumed an average of approximately 9.00 pounds of grain per head daily. All of the barley-fed calves except those in lot 6, which were fed whole barley, made slightly larger gains, made more economical gains, dressed higher, and produced carcasses which graded higher than the heifers fed corn. The heifers fed whole barley required approximately 13 per cent more grain, linseed cake and silage per unit of gain than the heifers fed ground barley and made 0.25 pound less average daily gain. They made the lowest carcass yield and produced the lowest grading carcasses of any lot in the trial.

There was no appreciable difference in results from feeding barley ground to different degrees of fineness, nor was there any advantage in mixing the barley with the silage when fed. No difficulties which could be ascribed to the feed were encountered in the trial.

**Brome grass pasture for heifers.** One lot of yearling heifers with an average initial weight of 566 pounds was fed for 140 days on brome and alfalfa pasture and for 32 days on dry lot. A second lot was fed for the entire 172 days in dry lot. Feeds given the two lots were similar except the pasture heifers were fed no roughage while on pasture and the dry lot heifers were fed more linseed pellets. Roughage for the heifers in dry lot was corn silage in the early part of the feeding period and alfalfa hay later. For the entire period the dry-lot heifers made larger average daily gains by 0.19 pound per head. Each month's pasture for one heifer replaced 22 pounds of linseed pellets, 179 pounds of silage, and 154 pounds of alfalfa hay, but required 14 pounds more corn per hundred pounds of gain. The heifers sold at the same price ($14.75) but the dry-lot heifers yielded slightly more and their carcasses graded higher than those from the pasture-fed cattle. To reflect differences in carcass yields and grades when sold, the pasture heifers should have sold at $14.25 with the dry-lot heifers at $14.75.

M. L. Baker conducted these experiments.

Hog Feeding Investigations

**Substitutes for alfalfa meal for fattening pigs.** This is the third of a series of trials designed to find a suitable substitute for alfalfa meal in dry-lot rations for pigs. As in the previous trials reported last year,
artificially dried Sudan grass meal was compared with artificially dried alfalfa meal in a ration of white corn, tankage and soybean meal. The alfalfa meal and Sudan grass meal were fed at the same levels as reported earlier. Two additional lots of pigs were added to this trial. They were fed the same mixtures as the other four lots, except that one lot received ground field-cured Sudan grass hay, and the other received ground field-cured prairie hay as the forage in the ration, and at a level of 25 per cent of the protein supplement mixture.

The Sudan grass meal used in this mixture was purchased and, therefore, no specific information is available as to the stage of maturity when cut, etc. However, it contained 16.2 per cent of crude protein and it was higher in carotene than the meal used in the previous trial, so apparently it was harvested and handled much as was the meal used in the other two trials.

The following table shows the carotene content of the various roughages used (air-dry basis).

<table>
<thead>
<tr>
<th>Roughage</th>
<th>Carotene content in mgs. per 100 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dec. 29, 1941</td>
</tr>
<tr>
<td>Alfalfa meal</td>
<td>7.16</td>
</tr>
<tr>
<td>Sudan grass meal</td>
<td>17.69</td>
</tr>
<tr>
<td>Sudan grass hay (ground)</td>
<td>3.63</td>
</tr>
<tr>
<td>Prairie hay (ground)</td>
<td>3.65</td>
</tr>
</tbody>
</table>

Nine pigs were used in each lot and they had an average initial weight of about 59 pounds. None of the lots of pigs gained as rapidly as in the previous trials. One of the reasons for the poor results in this trial was an affliction which affected some individuals and which appeared to be of nutritional origin. This affliction was a form of locomotor incoordination and appeared first in a pig in the control lot (alfalfa meal). Soon one pig in the lot receiving 25 per cent of Sudan grass meal was also affected and in a short time pigs in all the lots were affected except the lot which received ground Sudan grass hay. Only one individual was affected in the prairie hay lot and he but mildly. Some of the pigs were affected more seriously than the others. The most seriously affected pigs developed a typical "goose-step" and almost stopped gaining in weight. There were some variations in the type of incoordination exhibited.

Cause of the trouble was not ascertained. One moderately affected pig from the alfalfa meal lot and one moderately affected pig from the lot receiving Sudan grass meal were removed and fed a mixture of 85 per cent yellow corn, five per cent tankage, five per cent soybean meal, and five per cent alfalfa meal to which was added a high potency cod-liver oil at the rate of 0.3 pound per 100 pounds of feed. The protein supplements and the alfalfa meal were out of the same supply which was used in the test rations. These pigs improved considerably in their rate of gain as well as in their gait. However, they never did resume a normal gait.

One pig in the lot which received Sudan grass meal as 20 per cent of the protein supplement was the most severely affected. This pig gained only two pounds during the 14-day period preceding the "special" treatment and his hind legs became so crooked that he could barely move about on a wet surface. They curved under him to the extent that he very nearly walked on the back of his metatarsals. On wet surfaces his legs would keep sliding under him so that he would sit down on his buttocks. This pig was left on the same ration as his lot-mates but was given a supple-
ment of 0.3 pound of non-irradiated dry yeast daily. The first few days his appetite was very poor, but it soon improved and within three weeks he was gaining about 1.5 pounds daily and his gait noticeably improved. This pig was slaughtered when he reached a weight of 226 pounds and the sciatic nerve and the spinal cord were removed and preserved for microscopic study.

Several moderately affected pigs were left on the same rations. Some appeared to improve, some to get worse. That the deficiency is a heritable trait is very unlikely as it appeared in crossbred pigs as well as in pure-bred pigs.

**Protein needs of growing pigs.** This was the first of a series of trials designed to obtain data on the protein requirements of pigs in dry lot.

Four lots of 11 pigs each were fed a concentrate mixture composed of ground yellow corn, five per cent artificially dried alfalfa meal, 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 in the mixture was varied to get the desired protein level.

The feeding test was carried through two weight periods as follows:

<table>
<thead>
<tr>
<th>From an average initial weight of</th>
<th>Per cent protein in ration</th>
</tr>
</thead>
<tbody>
<tr>
<td>58 pounds to an average weight of 125 pounds</td>
<td>Lot 1</td>
</tr>
<tr>
<td>From an average weight of 125 pounds to an average weight of 200 pounds</td>
<td>18</td>
</tr>
</tbody>
</table>

None of the lots of pigs gained as well as was expected. One or more pigs in each lot developed a locomotor incoordination which appeared to be the same affliction that caused trouble in the trial mentioned previously.

One Poland China barrow from lot 2 was given a supplement of 50 mg. of nicotinic acid daily for 23 days. He continued to make fair gains, as he had before the supplement feeding began. However, his gait became worse and treatment was discontinued. One Hampshire-Berkshire crossbred barrow in this same lot was given a supplement of 50 mg. of calcium pantothenate daily for 42 days. This pig did not improve or get worse, either in rate of gain or in gait. At no time was his incoordination as great as that of the Poland China barrow. This pig was slaughtered when he had reached a weight of 146 pounds and the sciatic nerve and spinal cord preserved for future study.

**Protein for weanling pigs on pasture.** This was the first of a series of trials for formulating an improved protein supplementary mixture for weanling pigs. Four lots of ten pigs each were self-fed shelled yellow corn and a protein supplement, free-choice. Each lot had access to one-half acre of oats and sweet clover (first year) pasture, and a simple mineral mixture.

The trial was divided into two periods. The first period was begun when the pigs averaged nine weeks of age and was concluded when the lightest lot averaged about 75 pounds per pig. The second period followed immediately and was concluded when three of the lots had reached an average weight of about 200 pounds per pig.

The control group of pigs was fed a protein supplement of 50 per cent tankage and 50 per cent expeller-process soybean meal. In the other three lots 15 per cent of the tankage was replaced with fish meal, "liver and
Pigs in the lot getting their protein from a self-feeder. Experiments with varying protein rations had a large part in 1942 research.

glandular meal," and dried whey, respectively, during the first period. In the second period all lots were fed the same protein supplement as the control group.

During the first period the pigs fed fish meal and the pigs fed "liver and glandular" meal made the most rapid gains. They retained this advantage in early gains over the control group during the second period so that at the conclusion of the trial the pigs in each of these groups had a higher average weight than those in the control group. In the first period the pigs which were fed dried whey made no more rapid gains than the controls. However, during the second period this group gained at a more rapid rate than any of the other groups and this increase in rate of gain was sufficiently large so that the average rate of gain for both periods was slightly greater for this group than for any of the other three.

The pigs which were fed dried whey consumed a greater proportion of supplement than any of the other groups. This was expected as the inclusion of whey lowered the percentage of protein in the supplement mixture from about 50 to 42 per cent. In the second period this group retained its "appetite habits" and consumed nearly one-third pound more protein supplement daily than the control group. The "liver and glandular meal" group also consumed more protein supplement than the controls or the group fed fish meal.

**Protein for weanling pigs in dry lot.** This trial is a replication of the trial just mentioned, except that it was conducted in dry lot and therefore the supplement included 25 per cent of alfalfa meal as a pasture substitute.

The pigs used in this trial averaged nearly two weeks older and somewhat heavier at the beginning than the pigs which were used in the pasture trial. Because of this difference in age and size, pigs in this trial were fed the first period rations until they reached an average weight per head of about 90 pounds.

The control group and the "liver and glandular meal" group made the most rapid and the most efficient gains during the first period. The group which was fed fish meal and that which was fed dried whey made about the same rate of gain. As in the pasture trial, the pigs fed dried whey consumed more supplement than any of the other lots.
During the second period all groups made excellent gains, the "liver and glandular meal" group gaining somewhat faster than any of the other groups. As in the pasture trial the whey-fed pigs retained their "appetite habits" and consumed a higher proportion of protein than any of the other lots, even though all groups were receiving the same supplement during this period. Because of this difference in protein consumption the pigs fed dried whey during the first period were the least efficient in reaching market weight. There were only very small differences in efficiency among the other three groups.

**Protein for pigs on sudan grass pasture.** This is the second of a series of trials planned to test the relative value of different protein supplements when fed singly and in combination as supplements to corn for pigs on Sudan grass pasture, and when fed in rations which are standardized as to protein content. During the summer of 1942 eight lots of ten pigs each were fed.

The trial was begun shortly after the pigs were weaned and was concluded when the pigs reached an average weight of 135-150 pounds per head. The plan was to conclude the trial when the pigs reached an average weight of 200 pounds per head, but destruction of the pasture by chinch bugs prevented this.

Results of this trial were very similar to the results of the first trial, reported last year. Pigs fed fish meal, and fish meal in combination with either expeller-processed or solvent-processed soybean meal made the most rapid gains and the most efficient gains. The mixtures were slightly more efficient than fish meal alone. Pigs fed tankage made about the same rate of gain as those fed either of the types of soybean meal as the only supplement. The mixtures of tankage with each of the two types of soybean meal were more efficient and produced more rapid gains than any of the single supplements, except fish meal.

**Spartan barley for fattening pigs.** Numerous trials have been conducted to study the feeding value of barley. During the past few years a new variety of 2-row barley, known as Spartan, has become of considerable importance in Nebraska. Chemical analyses of Spartan and older 6-row varieties, grown under comparable conditions, have shown that in most cases Spartan barley contains more protein and less fiber than the prominent 6-row varieties. Spartan barley also has had a considerably higher test weight. In view of these facts it was considered desirable to study the feeding value of this barley, and to compare different methods of feeding it.

Six lots of 10 pigs each were used. The test was begun when the pigs had an average weight of about 69 pounds and concluded when they reached an average weight of about 200 pounds. The pigs were fed as follows:

- Lot 1—Shelled yellow corn and supplement, free choice.
- Lot 2—Ground Spartan barley and supplement, free choice.
- Lot 3—Ground 6-row barley and supplement, free choice.
- Lot 4—Ground Spartan barley and supplement, mixed.
- Lot 5—Ground 6-row barley and supplement, mixed.
- Lot 6—Whole Spartan barley and supplement, free choice.

All lots of pigs were fed the same protein supplement, that is, 50 per cent tankage, 25 per cent soybean meal, 25 per cent alfalfa meal. All lots had free access to a simple mineral mixture.
The Spartan barley fed contained 16.5 per cent crude protein and the 6-row barley 15.7 per cent crude protein on a moisture-free basis. The test weights were approximately 49 pounds and 41 pounds for the Spartan and 6-row variety respectively.

The pigs in lots 1 and 2 made the most rapid gains. The pigs in lots 2 and 3 consumed more grain but less supplement than the pigs fed corn. When the barley was mixed with the supplement so that both lots received the same percentage of crude protein in their rations (lots 4 and 5) the results deviated considerably from the expected. In this comparison the pigs fed ground 6-row barley gained more rapidly than those fed ground Spartan barley. Part of this difference is probably due to variation in the pigs, but it is possible that one factor in the poorer results obtained with lot 4 was the amount of carotene in this ration. In order to keep the protein levels the same in lots 4 and 5, it was necessary to limit the pigs in lot 4 to only one pound of supplement in each 100 pounds of feed mixture. Since the supplement contained only 25 per cent of alfalfa meal and the alfalfa meal was the only significant source of carotene in the diet, it is likely that carotene was the limiting factor.

Pigs which were fed whole Spartan barley (lot 6) made good gains until they reached a weight of about 125 pounds. After that their gains were not nearly as rapid as those which received the ground Spartan barley (lot 2). The efficiency with which the pigs in lot 6 balanced their own rations decreased as the trial progressed and during the last few weeks this group consumed a much higher proportion of supplement than they needed, or than any of the other lots. Because of this, lot 6 made very expensive gains, consuming 104 pounds of supplement per 100 pounds of gain, nearly three times as much as the pigs in lot 2.

Results of this trial clearly demonstrate that the feeding of whole Spartan barley to pigs weighing more than 125 pounds, with a supplement (such as was used) free-choice is a wasteful and uneconomical practice. In this case, grinding the barley (lot 2) saved about 65 pounds of protein supplement per 100 pounds of live weight gain.

**Protein rations for suckling pigs.** This was the first of a series of trials planned to study the value of various creep rations for suckling pigs. Two lots of six sows each were used in this trial. They were selected by pairs so that sows of comparable breeding, age, farrowing date and potential productive ability were used in each lot.

The sows in both lots were hand-fed the same ration. This was a mixture of ground yellow corn, tankage, and soybean meal and contained about 15.1 per cent crude protein. They were fed and housed on a Sudan grass pasture, but the Sudan grass was destroyed by chinch bugs shortly after the trial started. To compensate for lack of pasture, fresh alfalfa and weeds were cut and fed to both lots, *ad libitum*. The pigs produced by the sows in lot 1 were self-fed the same mixture in a creep as was fed to the sows. The pigs in lot 2 were also self-fed a mixture of ground yellow corn, tankage and soybean meal, in a creep, but the proportion of tankage and soybean meal was increased to that the mixture contained 22.1 per cent crude protein. All of the sows and pigs had free access to a simple mineral mixture. Each of the litters was weighed when the pigs were 14 days old and they and their dams turned out of the farrowing pen. Feed records were kept from the time the pigs were 14 days old until they were 56 days old, when sow and pigs were removed from the test lot and weighed.
The sows in lot 1 farrowed 45 pigs and raised 41 pigs. The sows in lot 2 farrowed 41 pigs and raised 37 pigs. While the differences in gain between the pigs fed the 15 per cent protein ration and those fed the 22 per cent protein ration were not great, they were slightly higher for the pigs fed the higher level of protein. The dams of the pigs fed the higher level of protein lost an average of 57.5 pounds per sow from pre-farrowing to weaning, while the sows in lot 1 lost an average of 81.3 pounds per sow during this same period. Deducting the weight lost by the sows from the weight gained by the pigs, the net increase in weight of pigs and sows was definitely higher for lot 2, the high protein level creep ration. This resulted in more efficient gains on the 22 per cent mixture than on the 15 per cent mixture, at present feed prices.

The experiment on alfalfa meal substitute was conducted by L. E. Hanson and Wm. J. Loeffel, the other investigations by L. E. Hanson.

**Feeding Sorghums to Lambs**

Eight lots of 30 western Colorado feeder lambs each were used to determine the influence of grain sorghums and sorghum silage on the development of urinary calculi in feeder lambs, and to determine the influence of grouping the lambs into lots with small variations in individual weights within a lot.

A ration of shelled corn and alfalfa was used as a check lot for all rations. When one-half pound of alfalfa hay per lamb daily was added to a ration of shelled corn, cottonseed meal, bone meal and Atlas silage, the daily gain was increased 50 per cent or from .21 pound to .32 pound. The check lot of corn and alfalfa produced .30 pound daily gain. No symptoms of urinary calculi were noticed in these three lots.

When Early Kalo replaced the shelled corn in the two silage rations two lambs in the lot receiving Early Kalo, cottonseed meal, bone meal, Atlas silage and alfalfa hay showed symptoms of urinary calculi and were removed. One lamb showed the same symptoms in the lot receiving Early Kalo, cottonseed meal, bone meal, Atlas silage, but no alfalfa hay. The lot with the alfalfa hay produced a daily gain per lamb of .27 pound compared with .20 pound for the lot without alfalfa hay.

The three lots of lambs used in the uniform grouping study were fed a ration of shelled corn, cottonseed meal, bone meal, Atlas silage and alfalfa hay. The lots were designated heavy-weight, medium-weight, and light-weight lambs and showed an average initial weight of 74.75, 68.58 and 62.72 pounds respectively. Three lambs died in the heavy-weight lot, two showing urinary calculi and the other one pneumonia. There were no losses in the medium-weight and light-weight lots. The economy of gains was practically the same for all three lots although the days on feed were different. The two calculi lambs in the heavy-weight lot cannot be accounted for at this time.

Results this year with Early Kalo and the effects of adding a limited amount of alfalfa hay to a silage ration are in agreement with results of previous trials.

M. A. Alexander was in charge of this study.
Dairy products rank high among those foods that "will win the war and write the peace."

**Dairy Production and Manufacture**
Department of Dairy Husbandry

**Dairy Cattle Weight is Important**

STUDIES continuing during the year suggested again the importance of weight in the consideration of the production of dairy cows, and indicated that in proving sires, weight may be a much more important factor to consider than age, in order that records may be comparable. For such purposes the obtaining of weights of cows within the first 30 days after calving, either by weighing or by means of tape, would appear to offer means of improving the methods of evaluating records.

In connection with this study a tape was devised for the measurement of dairy cows which is believed more accurate than any previously suggested, and which has correction factors for breed and age. With this tape it is believed possible for cow testers and farmers to determine weight of dairy cows with reasonable accuracy, though a scale is not available.

The study on weight and production was based upon 747 lactations of 334 Ayrshire, Guernsey, Holstein and Jersey cows in the Nebraska Station dairy herd. The live weight of each cow at each lactation was considered at 10 stages within 31 days after calving (one month) and for each month thereafter including the tenth. Principal attention was given to the yield for the first eight months of lactation expressed as milk-energy yield in terms of pounds of four per cent milk per day designated FCM. The FCM is more closely related to the live weight of the cow at the first month after calving than at any later stage of the same lactation, and a single live weight determination in each lactation appears to be sufficient for many purposes. Exclusive use of live weight as measured within 31 days after calving is recommended in the interests of uniformity and biological significance.

FCM as related to weight was studied with reference to age correction but the effect of age when weight was considered was of such minor importance that for practical purposes it could be disregarded. This direct proportional relationship becomes more manifest the more the lactation function is developed, that is, the higher the level of the relationship of FCM to weight at the first month. Correlation between live weight at the first month and milk-energy yield in the present records is greatest when all breeds are put together and equaled .83.


H. P. Davis and R. F. Morgan were in charge of this research.

**Factors Affecting Reproduction in a Dairy Herd**

In a study to determine the best period during the estral cycle to breed or inseminate cows, best results were obtained from inseminating at the middle of estrus, and the middle of estrus plus rebreeding in 24 hours. Almost equally good results were obtained by breeding at the end of estrus and substantially satisfactory results were obtained by inseminating six hours after estrus ended.

A total of 295 inseminations divided into 10 groups were tabulated. Inseminating cows 12 and 18 hours after the end of estrus gave approximately 30 per cent conception whereas 24 hours after the end of
estrus resulted in only 12 per cent conception. Two animals out of 25 conceived when inseminated 36 hours after the end of estrus while no animals conceived when inseminated 48 hours after the end of estrus. This study confirms observations by many farmers that breeding towards the end of estrus is more satisfactory than at the start of estrus. It also indicates that with artificial insemination it is possible to breed with a reasonable degree of success animals within six hours after the end of estrus. All inseminations were made artificially with semen placed at the mouth of the cervix.

Over a period of more than three years 24 bulls representing the Holstein, Guernsey, Jersey and Ayrshire breeds have been studied at monthly intervals with reference to their semen production. Stained slides have been prepared for each bull and observations made as to the number of normal and abnormal spermatozoa per thousand. An attempt was made to correlate these data with the breeding efficiency of the several bulls. Most of the bulls showed a range of 70 to 90 per cent of normal spermatozoa but the percentage of conception did not show a high correlation with this factor.


Artificial Insemination with Dairy Cattle

Data on artificial insemination indicate that a substance or substances present in autoclaved milk can prolong the life and maintain the fertility of spermatozoa. Semen diluted with autoclaved milk gives apparently the same conception results as semen diluted with buffered egg yolk. Each of these however shows a decline in fecundity of the sperm under storage conditions. Certain dyes in weak dilutions of isotonic or buffered solutions have no apparent effect on the motility of spermatozoa. A simple staining technique has been developed to differentiate dead and live spermatozoa which gives promise of being a more reliable guide for determining motility of spermatozoa, though results are not available.


Studies were under general supervision of G. K. L. Underbjerg, assisted by G. W. Trimberger and H. P. Davis.

Some Causes of Variation in Milk Quality

Results so far have indicated that abnormalities in milk vary greatly from milking to milking and from day to day with the individual cow, the extent and continuance depending upon the kind of infection and the individual characteristics of the cow. By the removal of animals infected with long chain streptococci the incidence of new cases of mastitis has been kept at the minimum.

Further field studies indicate that peppergrass does not give objectionable flavor to milk but that penny cress does produce such flavors. Feed-
ing trials have failed to show any difference in flavor in milk from animals pastured on different types of rye.

As a result of these and other studies P. A. Downs has published an article entitled "A proposed score-card method of determining the quality of milk," Journal of Dairy Science, 25:103-110.

**This Cow's Sorghum Diet Was Not Adequate**

The Guernsey cow fed solely on a diet of products from the sorghum plant was slaughtered during the year because it appeared likely that death would soon occur. At the time of slaughter she had lost completely the sight of one eye and at times had difficulty seeing from the other one. At the time of slaughter the animal had developed several abnormalities in internal organs and these showed evidences of general infection. She was somewhat emaciated, and walked with considerable difficulty and with a wobbling gait, showing a lack of muscle coordination. It is believed that her condition was due largely to the lack of vitamin A.

This demonstration indicated that a cow could survive for a period of two years on a sorghum diet and that her reproduction was not affected since she dropped two normal calves during that period. Milk production was very greatly curtailed. Results showed that there is a cumulative effect from such a diet and also that the animal becomes more susceptible to various types of disease infection.

This work was carried on by H. P. Davis, I. L. Hathaway and G. W. Trimberger.

**How Much Milk do Calves Need?**

A group of grade Holstein heifer calves was fed during a five-month period varying amounts of dried whey, as possible substitutes for milk in the early stages of calf growth. Efforts are being made to determine the practical minimum amount of milk needed for starting calves and the age at which animals can be placed on an all-dry diet.

This experiment is being conducted by I. L. Hathaway, G. W. Trimberger and H. P. Davis.

**Pituitary Glands and Milk Secretion**

An experiment was carried on to determine the influence of the number of nursing young on the lactogen content of the pituitary gland of the rat. Thirty females were allotted at parturition into three groups. The females were allowed respectively two, six, and ten pups each. Litters were weighed daily and destroyed on the fifteenth day. Fifteen hours later the females were sacrificed and the pituitary glands were weighed and stored at 0° F. A portion of the mammary glands of each female was preserved in Bouins fluid for histological study. The assays and histological results are not yet available.

This work was under supervision of I. L. Hathaway, in cooperation with R. P. Reece of the New Jersey Experiment Station.

**A New Cornhusker Cheese**

A new type of cheese has been developed and named "Cornhusker Cheese." It is a blend between ordinary Cheddar Cheese and Brick Cheese and has met with a very good public response. It is of rather soft texture and possesses a distinctive flavor.

One step in the process of making Cornhusker Cheese as shown in a Nebraska Station bulletin. Curd must be kept stirred at this stage of manufacture.

Their studies have continued on comparison of the influence of paraffin and wax coverings on five-pound prints. A considerable amount of difficulty has been encountered with the double-dip waxes due to rind rot and mold growth between the layers of wax and the cheese.

**New Method for Making Cream Cheese**

A standardized method of making cream cheese has been developed which yields a finished cheese of good quality both in flavor and body, and in keeping characteristics. The advantages of the new procedure are that the time of manufacture is shortened appreciably and that a more uniform quality is obtained.

E. L. Reichart was project supervisor.

**Vitamin Analysis of Cheese**

The vitamin B\textsubscript{1} assays and the chemical analysis of 46 cheeses have been completed. Preliminary studies have been made on the methods for determination of the riboflavin content of cheese. It might be mentioned that the results indicate that cheese is not a rich source of vitamin B\textsubscript{1} since all of the 46 cheeses studied proved to be low in that vitamin.

This work was carried on by I. L. Hathaway.

**Sugar for Ice Cream**

Studies have been carried on in the use of hydrochloric, sulfuric and citric acids as compared with tartaric acid in the production of a satisfactory type of invert sugar. They are in charge of L. K. Crowe.

**Vitamin Content of Various Grasses**

Determinations and chemical analyses have been made at various growth intervals on a number of native Nebraska grasses. There was a very wide variation in the carotene content of the dried grasses and also in the protein values.

This work is under supervision of I. L. Hathaway, cooperating with the Department of Agronomy.
Nebraska poultry raisers produced in 1942 more than $60,000,000 worth of eggs and poultry.

Poultry Nutrition and Management
Department of Poultry Husbandry

Cooked Soybeans Are Better for Chicks

It has been recognized for some time that the nutritive value of soybean proteins was altered by heat treatment. The nature of the changes which occur and the exact degree of heat treatment which promotes the most desirable changes are not yet fully understood.

Experiments conducted during 1942 showed that cooking soybeans for 30 minutes at 250°F. very significantly improves the growth-promoting value. Cooking at the same temperature for 60 minutes does not result in further improvement. In fact, there is a decline in growth-promoting value for chicks with this degree of heat treatment.

The depression of growth with raw soybean rations is not due to the fat content, since experimental work with a ration containing the same amount of fat added to a soybean meal ration gave excellent results.

In the expeller method of soybean processing, the by-product is subjected to heat treatment in a tempering bin at 270°F. for about 13 minutes. It is then exposed in a rather thin layer to heat treatment at about 290°F. for three minutes. This degree of heat treatment produces a by-product of good nutritional quality. In the solvent method, which is more efficient from the standpoint of fat removal, the heat treatment or toasting process is not incidental, but must be introduced as a specific phase of the manufacturing process.

Experiments to determine the most desirable degree of heat treatment were carried out in 1942. Thirty minutes of heat treatment at 250°F. of solvent process soybean meal apparently produces a product of highest growth-promoting value. There is a suggestion from these experiments that heating for 90 or 120 minutes reduces its nutritive value for chicks.

Two hypotheses have been advanced to explain the changes which occur in soybeans as a result of heat treatment. First, the destruction of certain toxic materials or enzymes. Second, denaturation of soybean proteins with an increase in the ratio of essential sulphur containing amino acids, which in a raw condition are bound in an unavailable state.

Research work to determine which hypothesis is correct was carried on in 1942. It was found that two outstanding changes occur when soybean proteins are autoclaved. First, there is a significant reduction in the solubility of protein in salt solution, and an increase in the number of active sulphhydryl groups. Second, there is a factor present in the raw residue, but lacking in the cooked residue, that destroys sulphhydryl groups.

Rollin Thayer, F. E. Mussehl, R. M. Sandstedt and Wendell Ham conducted the research on cooked soybeans.

Protein for Turkeys

The limited supply of animal protein concentrates has made desirable the use of as much plant-derived protein in turkey rations as possible without reduction of utilization efficiency. The three plant protein concentrates in greatest supply are soybean meal, cottonseed meal, and corn gluten meal. Experimental work was carried on with 615 poults to determine the most efficient combinations of these concentrates with a limited amount of animal protein.
It was found that an additional 10 per cent of soybean meal, cottonseed meal, and corn gluten meal can be used to replace animal protein concentrates in a standard ration without loss of efficiency. A combination of 3½ per cent each of soybean meal, cottonseed meal, and corn gluten meal was, however, more efficiently used than the same amount of protein from any one of these products.

F. E. Mussehl, Rollin Thayer, R. M. Sandstedt and Wendell Ham conducted this project.

Studies in Poultry Hematology

Research work has been started with turkeys for information on the changes which occur in various types of body tissue as a result of nutritional variations. The first phase of this work has consisted of a determination of the normal cellular constituents of turkey blood.

Esther Wolla, Rollin Thayer and F. E. Mussehl are supervising.

Milk Substitutes in Poultr Rations

A standard protein-vitamin-mineral concentrate formula, designated as No. 2, and which previous research work indicated had a very high biological value, calls for 10 per cent of dried buttermilk. The growing scarcity of dried milk products makes it desirable to find other sources of the B-complex factors, for which milk products are highly valuable.

An experiment was carried on in which the dried buttermilk in the control ration was replaced with dried whey and fermentation by-product. Conclusion was that five per cent each of dried whey and fermentation by-product can be used to replace ten per cent of dried buttermilk in a concentrate formula. It has proved to be very efficiently utilized with a typical wheat, corn and oats basal ration.

F. E. Mussehl, Rollin Thayer, R. M. Sandstedt and Wendell Ham were in charge of the experiment.

Antirachitic Value of S-4 Lamp

Growing poults have a relatively high requirement for the antirachitic factor. The scarcity of fish oils makes it desirable to provide this factor in the most economical manner. Certain types of lamps have been developed to produce a blend of energy very comparable to May sunshine, and one of these lamps (Type S-4) was used in experiments with growing poults.

The work has shown that normal calcification and adequate antirachitic factor can be provided for growing poults by exposure to sunlight type-4 lamp irradiation for two hours daily from 36 inches above the feeders.

F. E. Mussehl, Rollin Thayer and Wendell Ham supervised this study.

Further research work was conducted with type S-4 sunlight lamps to determine adequacy of its energy as a source of the antirachitic factor for hens. Leghorn hens, it was found, can be kept in good laying condition during winter and early spring months when the antirachitic factor is provided with S-4 type sun-lamp irradiation for two hours daily from October 15 to March 15. Suspending the lamps at a distance of 60 inches from the floor above the feeders and waterers, and operating them from 5:00 to 7:00 a.m. seems to be the most practical method.

Sun lamps used in the manner suggested provide a longer working day as well as adequate antirachitic factor, and the additional cost over that of ordinary lighting equipment is, therefore, very slight.

Bulletin No. 344, summarizing three years' results with two types of sunlight lamps, has been made available to poultry producers.

This phase of research was supervised by F. E. Mussehl and F. D. Yung.
Animal disease research in Nebraska helps keep and improve resources for food production.

Animal Diseases
Department of Animal Pathology and Hygiene

Preserving Swine Erysipelas Serum

Tests were made during the year to determine the value of merthiolate as a preservative for swine erysipelas serum, and whether or not the use of merthiolate did in any way detract from the potency value of sera thus preserved.

It was found that the addition of 10 mg. (10 per cent) of merthiolate makes an excellent way of preserving anti-swine erysipelas serum. The 16 merthiolate-preserved serum samples, with one exception, proved to be sterile after a period of storage ranging from 11 to 31 months. The exception was provided by the development of a colony of mould on the culture medium used in the tests.

Average potency of the 16 samples in the quintuple parallel test series amounted to a numerical potency of 42.67 as compared with the average horizontal potency of 50.66 of the same group of sera revealed at an earlier date. Differences in the test methods applied, however, as well as the slight differences in the sera may somewhat vitiate this comparison.

In the initial trials for the use of merthiolate as a serum preservative, it was found that addition of merthiolate at the rate of 100 mg.-per cent apparently impaired serum potency. This, however, was not the case when the amount of merthiolate was reduced to 25 mg.-per cent. In the course of further trials the addition of merthiolate in the proportion of 10 mg.-per cent proved to be quite satisfactory.

As part of the activities under this project, a study was made of swine erysipelas culture vaccines, commercially produced, in an effort to determine their capacity for growths, and their disease-producing qualities.

In 1942 the Serum-Virus Control Division of the B. A. I. issued limited permits for manufacture and distribution of culture vaccine to be used in the vaccination of swine against swine erysipelas. A considerable volume of empirically-obtained evidence shows that if a culture of E. Rhusio-pathiae is to be effective in the sero-vaccination of swine, it must not only be capable of rugged and voluminous growth, but must also manifest a maximum degree of virulence.

At present there seems to be an understanding that cultures for vaccination purposes may be issued for a period of 60 days after the date of preparation. Although immediate use is always recommended on the labels of containers, there can be no doubt that a certain proportion of the cultures is used up to the tentative expiration date of 60 days and possibly even later. It seemed possible that such older cultures might no longer be capable of bringing about the most desirable vaccination results. With the cooperation of the Nebraska State Bureau of Animal Industry, monthly tests for growth capacity and virulence were made of all culture vaccines used in vaccination practice in the state.

Results indicate that 59.32 per cent of a total of 59 culture samples examined after a storage of 60 days could be classified as acceptable for use in sero-vaccination. Concerning the products of individual producers, the proportion of tentatively acceptable cultures ranged between 0 and 100 per cent. Loss of virulence appeared to be the principal evidence of culture-vaccine deterioration, although in a few cases rejection could be based upon contamination. Results of some preliminary tests made by
this department seem to indicate that loss of virulence can be attributed to a decline of the hydrogen ion concentration of the fluid culture vaccine. In 1942 a large volume of data pertaining to numerical potency variations of anti-swine erysipelas serum was collected. Its analysis will constitute part of the work during the ensuing year.

This project was supervised by L. Van Es, J. F. Olney and Ida Blore.

**Studies of Hog Cholera Vaccine**

During 1942 these studies consisted of trials with one of the more recently developed hog cholera vaccines, and a continuation of experiments concerning the influence of anti-hog cholera serum doses on the immunity developed after vaccination against the disease.

Vaccine studies were exclusively concerned with a vaccine designated as “Hog Cholera Vaccine (Tissue Vaccine) (B. T. V.).” Trials with this substance consisted of a series of pen experiments and one more extensive yard experiment.

In the pen experiments five different serial numbers of the vaccine were used. Three pigs were devoted to each separate experiment. Two of the pigs were vaccinated and one pig, occupying the same pen, was left untreated in order to serve as control. Thirty days later all three pigs in each pen were inoculated with hog cholera virus. This was to challenge the immunity of the pigs treated as well as the virulence of the virus used in the tests.

As a result of the virus injections all 15 pigs in the experiment showed rather severe reactions as expressed by pyrexia, anorexia and depression. These reactions in the vaccinated pigs, although of alarming aspect, subsided in the course of about a week, the animals fully recovering. On the other hand, all the control pigs contracted hog cholera, terminating in death either spontaneously or by killing when the pigs had reached a moribund condition.

Results of the pen experiments tend to show that the vaccine engendered a resistance to the disease, but that a complete immunity had not been attained within 30 days after the initial vaccination.

The yard experiment was carried out with 27 pigs of an average weight of about 40 pounds. Each pig received a subcutaneous injection of 5 cc. Hog Cholera Vaccine (Tissue origin) (B. T. V.) on April 29, 1942. There were no visible reactions to the vaccine injections and the pigs made a satisfactory growth.

No evidence of sickness developed among these pigs and they were all in good health on October 26, 1942, the day they were exposed to hog cholera infection. For the purpose of exposure, four small pigs were introduced into the lot, two of which had received subcutaneous inoculations of hog cholera virus. The other two pigs served as exposure controls.

First death from hog cholera among the B. T. V.-injected pigs occurred three days before the first one of the exposure pigs died of the same cause. Between November 14 and 30, 1942, twenty-three of the experimental pigs (about 85 per cent of the total) either had died of hog cholera or had been killed when in a moribund state arising from the same cause.

Results of the experiment showed conclusively that pigs vaccinated with B. T. V. in accordance with the producer's directions had failed to acquire an immunity enduring for a period of nearly six months.

Under this project the experiments pertaining to the influence of varying anti-hog cholera serum doses on the immunity engendered by hog cholera simultaneous vaccination were continued during 1942.
Results obtained during the year seem to indicate that some influences have to be considered. They are summarized as follows:

**Results of Serum Dosage Experiments**

<table>
<thead>
<tr>
<th>Experimental groups</th>
<th>Died of hog cholera</th>
<th>Died of other causes</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>1</td>
<td>A number of these pigs apparently developed hog cholera but recovered. Some remained unthrifty for a considerable period.</td>
</tr>
<tr>
<td>$\frac{1}{2}$ x Normal serum dose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>2</td>
<td>This group excelled all others in gains and thriftiness.</td>
</tr>
<tr>
<td>1 x Normal serum dose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>This group, although in constant good health, failed to make the gains observed in Group B.</td>
</tr>
<tr>
<td>2 x Normal serum dose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>1</td>
<td>Pigs in this group showed a considerable variance in body weight. One pig died of hog cholera 42 days and the other 57 days after vaccination.</td>
</tr>
<tr>
<td>4 x Normal serum dose</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


L. Van Es and J. F. Olney were in charge of this project.

**11,020 Specimens**

In the course of the year 11,020 specimens were given bacteriologic, serologic and pathologic examinations. These were recorded and reported to the persons by whom such requests were made. The examinations were conducted by C. B. McGrath and other members of the department.
Increased Nebraska agricultural production requires the use of modern, well-tested equipment.

Agricultural Engineering
Department of Agricultural Engineering

Preserving Perishable Farm Products

Food dehydration. During the summer of 1942 a natural-draft dehydrator was developed for home use. It is simple in construction, is heated by Mazda lamps, and does not require a fan. It is so designed that the sulfuring of products is easily and inexpensively done within the cabinet without moving the products. Between drying seasons the dehydrator can be used as a storage cabinet. The 900-watt heating unit, consisting of nine 100-watt lamps, has proved ample for the most adverse conditions of relative humidity encountered during the summer. The lamp-type heating element was found to be safe and convenient for over-night use. It is a simple matter to remove some of the lamps to reduce the heat as desired during the unattended period.

The time requirement of the forced-draft dehydrator was approximately 75 per cent of that of the natural-draft unit. Otherwise they produced similar results. Both types were found to be safe and dependable for both day and night use.

Sun drying was attempted several times during the season but in each instance the outdoor weather conditions became so unfavorable that the product did not dry properly. The product was saved by placing it in one of the electrically-heated units.

Products dehydrated included peas, beans, peaches, apricots, red plums, apples, sweet corn, spinach and parsley.

A paper entitled "Nebraska type home-made driers" was presented at the mid-year meeting of the American Society of Agricultural Engineers at Chicago. Ext. circ. 709, "Home-made food driers," was published.

Egg Cooling. An egg cooling and storage cabinet is being developed in cooperation with the U. S. Department of Agriculture, Bureau of Agricultural Chemistry and Engineering, division of rural electrification research. The laboratory trial stage is nearly completed after which the cabinet is to be tried out under actual farm conditions.

The cabinet is insulated and is cooled by means of cold well water flowing through a tube and fin-type coil. An electric fan circulates the air within the cabinet. Provision is made for rapid cooling of eggs in wire baskets or mesh bottom pails and there is additional storage room for three 30-dozen cases of eggs after cooling.

Previous laboratory trials have shown that eggs cooled to below 65° F., maintained at 60°F. to 65° F., can be kept in good marketable condition for a week, if necessary, between marketing periods. With water at approximately 57° F. the interior of this cabinet can be maintained at 60° F. to 65° F. in ambient temperatures as high as 110° F. Well water at 55° F. to 60° F. is available during the summer on many Nebraska farms and its usefulness for watering livestock, garden irrigation, and many other applications is not at all impaired by the additional job of egg cooling.

Differential thermostat. An inexpensive thermostat which will start the ventilating fans in a potato storage whenever the outdoor temperature falls below that of the storage interior has been developed through the laboratory trial stage, and is now in actual use at the Experiment Farm near Alliance.
Two types of differential thermostats are being designed and studied. One depends on the action of thermostatic wafers for its operation; the other embodies the principle of thermostatic bimetal. Both types are relatively inexpensive and both have produced acceptable results in the laboratory. Field trials are expected to point out any imperfections or needed improvements.

This work was done in cooperation with the Departments of Dairy Husbandry and Poultry Husbandry. E. E. Brackett and F. D. Yung were in charge for engineering, H. P. Davis and P. A. Downs for dairy husbandry, and F. E. Mussehl for poultry husbandry.

**Heating Water for Livestock**

A low cost, immersion-type thermostat has been developed, primarily for use with electric tank heaters. The thermostat is simple in design and it can be used in liquids or in air. Temperature control is obtained by means of a wafer and a snap-action switch. The new thermostat performed well in the laboratory and has given trouble-free service in actual use on the farm. It is of higher sensitivity than many of the more expensive thermostats of the immersion type and is readily adjusted to maintain the desired temperature within its range. Due to its sensitivity
it provides uniform temperatures and lowers operating costs by preventing over-use of electricity.

E. E. Brackett and F. D. Yung were in charge of the project.

**Wartime Poultry House Equipment**

Lamp-heated electric brooders were studied during the late winter and early spring of 1942. These studies were made for the purpose of gaining information in advance of the normal brooding season as to the feasibility of substituting lamps for the more commonly used nichrome alloy heating units which were fast disappearing from the market. Results were very satisfactory and no detrimental effects were observed due to the rather intense illumination from the lamps.

Later in the season thermostats became scarce. A reasonably satisfactory solution of this problem was found in the use of reflector-spot lamps without thermostatic control. The lamps, by virtue of their built-in reflectors, concentrated their heat rays on the area occupied by the chicks and produced satisfactory conditions for chick comfort.

A "skeleton" brooder frame was built so that it could be covered with any available material, preferably half-inch insulation board. This very inexpensive construction was offered for those who felt they could not afford a more permanent brooder, to encourage them to raise chicks during the present emergency. It is suitable for lamp heating with or without thermostatic temperature control.

Agricultural Engineering Progress Report No. 9, "A lamp-heated electric brooder," was issued in 1942.

Experiments were carried out in cooperation with the Department of Poultry Husbandry. F. D. Yung was in charge for engineering, and F. E. Mussehl for poultry husbandry.

**Corn Production Practices**

To check on machinery requirements for the production of corn in Nebraska, with the aim of lessening costs, six cultures were compared and an analysis is being made of the results. While a complete report cannot be given at this time, the following points are evident:

(a) More contour farming should be done to lessen erosion for all types of culture.

(b) There is little or no promise in double listing in the spring for corn; work is increased and yields are usually decreased.

(c) Crop residues left undisturbed on the surface decrease erosion.

(d) Plowing in this region for corn is questionable. To date there have been no increases in yield comparable to the increase in work.

C. W. Smith was in charge of this project. Cooperation was received from the U. S. Department of Agriculture.

**Mechanical Equipment for Bindweed Eradication**

During the past year the 16-acre field on which corn had been grown for two years was clean tilled and cultivated to eradicate bindweed. This should make a clean field for 1943 with the exception of a few plants which can be chlorated.

Some preliminary work was done in 1942 to see if the lister could be used in the eradication of bindweed. Two small infested areas were secured for this work. Corn was put in on one and sorghum on the other. No conclusions have been reached regarding the efficiency of this work.

C. W. Smith supervised the research.
The aim of research in rural economics is to help make agricultural production profitable.

Rural Economics
Department of Rural Economics

Cost of Producing Farm Crops

Records were secured from 266 farmers in 1941 upon the cost of producing sugar beets in 286 fields. The average cost of producing beets, based upon a 1942 study of the records obtained, was $71.89 per acre or $5.45 per ton. The cost of hand work amounts to 27 per cent of the total cost; 21 per cent is for other man labor; 16 per cent is for the use of horses, tractors, trucks and equipment; 11 per cent is for miscellaneous costs, including seed, fertilizer, perquisites provided for beet laborers and other items; and 25 per cent is for the use of the land.

In this study the influence of quality of land and management upon the production or yield has been shown in relation to the cost of producing a ton of beets. Larger yields were obtained from the better grades of land, and costs up to harvest time were no greater than on the poorer land. The higher yields on the better land are reflected by lower costs per ton. The average cost up to harvest time, not including a land charge, was: Grade I land, $2.48; Grade II, $2.82; Grade III, $3.15; and Grade IV, $3.53.

Two management ratings were established. One of these was based primarily upon agronomic standards and emphasized the importance of proper soil and crop management in obtaining large yields. The second was based upon costs prior to harvest, or the in-puts of labor, power, equipment and other resources. This management rating emphasizes the importance of efficient use of labor and other in-puts. In 1941, growers who kept their costs low produced as many tons of beets per acre as those whose costs were high. The average cost of producing and harvesting a ton of beets was $4.26 when the best land was used in combination with good soil and crop management practices and with efficient use of labor and other resources. It was $9.81 under an unfavorable combination of poor soil and management.

In 1941 the average cost per ton varied from $4.44 for growers receiving 23 tons per acre to $9.00 for those obtaining 10-ton yields. The average yield for 266 growers was 17.58 tons per acre. As a rule, management is efficient if the labor requirements for various operations are approximately the same as those for producers whose costs prior to harvest were $25 to $39 an acre.

During the summer of 1942, data were obtained from 98 farmers upon the cost of operating various kinds of farm machinery. They include interest on investment, depreciation, shelter, repairs, lubricants, time spent in making repairs, and estimated annual use. Data were secured from 88 farmers upon the cost of water obtained from more than 100 wells for use in pump irrigation, including cost and estimated rate of depreciation of well and pump, and cost of power for operating pump. Records were obtained from 144 farmers on the cost of producing wheat, and from 189 farmers on the cost of producing corn. Yield per acre is the most important factor affecting cost per bushel.

Studies were directed by H. C. Filley, Frank Miller, Walter Ruden.
Farm Organization and Costs

Farm account books kept by 627 farmers were turned in to the department. The books were summarized by areas. Tabulation of data in a farm management survey of 63 farms in Buffalo County is nearly complete.

Summaries obtained from the books show quite clearly the factors which affect farm profits in various parts of the state. Irrigation and sub-irrigation have had an unusual influence on farm profits in recent years as a result of the prolonged drouth. The business management of the individual farmer has been an important factor in determining profits. Size of business, yields, and distribution of labor throughout the year are also important.

H. C. Filley and A. W. Peterson have been conducting the research.

Farmer Response to Hog Prices

Information concerning "The cost of marketing hogs shipped from points in Nebraska to the Omaha public stockyards market," was published as Nebr. Exp. Sta. Bulletin 340. This bulletin gives the farmer an opportunity to compare truck and rail costs, and to compare terminal market costs with local auction costs.

Average annual costs per head at the terminal market for the hogs shipped by all of the various methods of transportation were as follows: inspection 0.5 cent, yardage 13.3 cents, feed in yard 10.5 cents, insurance 1.9 cents, commission 25.4 cents, and other costs 1.0 cent. In 1930 when the average price paid for hogs in Omaha was $9.13 the shipper received 94.7 per cent of the gross price. In 1931 when the average price was $3.41 the shipper received only 87.9 per cent of the gross price.

Annual average cost of terminal market services, including commission, yardage, feed in yard, and all other items of expense was less on hogs shipped by rail than on those shipped by truck, with the exception of hogs shipped in 1934 and 1935 from counties within 50 miles of market.

Frank Miller and George Lambrecht conducted this study.

Farm Real Estate Tax Delinquencies

Maps were prepared showing tax delinquent farm real estate in three Nebraska counties. There is a greater per cent of tax delinquency on poor farms than on the best farms. L. B. Snyder supervised the research.

Farm Economics in a Soil Conservation District

Fairly complete farm records for 1941 were secured from 58 farmers in the Turkey Creek Soil Conservation District which is located largely in Pawnee County. The farmers kept not only business records, but a record of the labor required and the cost of raising corn, wheat and oats on different grades of land. These records have been summarized. Books to record the 1942 farm business were placed with cooperating farmers. Collecting of the books started December 28.

Returns per man and farm labor income varied in fairly direct proportion to the number of days of productive labor per farm. These increased as the size of the farm increased, but not in the same proportion. Acreage was only one of several factors influencing the number of days of productive labor.

The group of farms with 200 to 300 days of productive labor per farm varied in returns per man from approximately $200 to $1,700. The two extremes were on farms of similar land grade with approximately the
same number of crop acres. Crop yields were about the same on the two farms. Variation in returns on these two farms was due almost entirely to variation in the efficiency of handling livestock.

Nearly every farm in the Turkey Creek Soil Conservation District contains land of at least three or four grades of productivity. Some farmers are prospering who have relatively little land that is highly productive. These men crop their better land, keep their rough land in meadow and pasture, and market livestock and livestock products.

This study was made by H. C. Filley and Walter Ruden.

**Levels of Living of Nebraska Farmers**

Records were secured in 1941 from 200 Nebraska farm families and the data have been tabulated. Some relationships are shown between farm incomes, tenure, age of farmer, quality of land, size of farm, and the level of living of farm families.

This project is cooperative with the Department of Home Economics and the division of farm population and rural welfare of the Bureau of Agricultural Economics, U. S. Department of Agriculture. L. B. Snyder is in charge for rural economics, and L. H. Stott for home economics.

**Land Tenure Problems**

During the year two bulletins were published presenting land-tenure information previously secured. Experiment Station Bulletin 336 is based on 302 records obtained from farmers in Box Butte County and Bulletin 337 upon 556 records from Clay County.

Tenancy has increased in Box Butte County since the land was first homesteaded. Owner operators, in general, have a little better buildings and a little more livestock than tenant operators, but the difference is not great. Tenants and landlords agree that more livestock on farms is desirable. Over a period of years, farmers with limited savings have been able to obtain more income by renting land and investing their savings in working capital than they could have secured as owner operators with a small equity in the land.

A change from tenancy to ownership increases a tenant's security of occupancy, but it usually decreases the amount of income available for family living. Ownership is more desirable than tenancy, but tenancy enables men who have only a small amount of capital to begin farming. They may secure at least two-thirds of the capital required to establish a farm business by renting land. Information was secured on terms of leases in force on 104 irrigated farms in Buffalo and Hall counties.

The project was conducted by Frank Miller and George Lambrecht.

**Livestock Marketing from Farm to Processor**

Nebraska is one of 14 north-central states cooperating on a livestock marketing project. The information is being compiled by the Bureau of Agricultural Economics of the U. S. Department of Agriculture.

Data on livestock marketing were secured from farmers, local livestock buyers, auction markets, concentration yards, and local packing plants. Probably the most important achievement of the project is to assemble a great deal of information that has hitherto been widely scattered. The study gives fairly definite proof that active competition exists between the different types of marketing agencies and between agencies of each type.

H. C. Filley and Lawrence Gustafson were in charge of research for the department.
HOME ECONOMICS
Department of Home Economics

Youth and the Farm Home

A WELL-KEPT home and farmstead, and the attendant high social status of the family in the community are important in the life and development of farm youth. In a study of patterns of rural family life in Nebraska, standardized scales of personality and family adjustment were administered to a large portion of the high school population of Lancaster County outside the city of Lincoln. From these same youngsters were obtained data from which ratings on the economic, cultural, and social status of their families were derived. To supplement these data, “farm class” ratings for these families were made by farm management specialists in the Department of Rural Economics. These ratings were based on the outward appearance of the home and farmstead, farm equipment and other evidences of successful farm operation. Some significant relationships were found between these various indexes of farm success and the personality and adjustment of the youngsters.

Most of these same families were contacted by mail and by personal visits, and data were obtained regarding certain attitudes and adjustments of the parents. Scores on attitude toward farm life, farmer morale (attitude toward the present national crisis and world situation and their part in it), emotional habits and personality adjustments were derived from these data. Analysis of the relationships between these scores and the data obtained from the youngsters is not complete but the following conclusions seem to be warranted:

Of the personal qualities measured in the parents, “emotional maturity” and personality adjustment (healthy mindedness—freedom from excessive fears, worries and anxieties) have greatest influence upon the character of the parent-child relationship from the standpoint of the child.

Farm folks, on the average, have a “favorable” attitude toward farm life. In spite of the difficult times and the discouragements that many deplore, they still believe in farm life and appreciate the advantages of the farm as a place to rear a family.

“Citizen morale” of farm parents appeared, on the average, to be somewhat higher than that of college students at the time the data were collected (spring, 1942). Among the factors related to farmer morale were the relative success of the farm enterprise as shown in ratings of home and farmstead, and farm ownership.

At the present time analyses are being made of data concerning the effects of the war, with the increased work, obligations and adjustments which it entails, upon farm family life and the morale of farm folks. These data were collected from approximately 500 farm youth from all parts of the state. Leland H. Stott directed the project.

Studies in Human Nutrition

Mineral and nitrogen metabolism of college women. The study was undertaken to add to the data on the metabolism of calcium, phosphorus, iron and nitrogen of young women between 16 and 27 years on their customary self-chosen diets. This would help to evaluate the suitability of present adult dietary standards for the intermediate period of late adolescence and early adulthood.
One hundred metabolism studies which included the analysis for these nutrients of the food intake and fecal and urinary excretion for periods of one week were made on 70 healthy college women. In the case of each of the nutrients the least retention, or the largest negative balance, occurred on the lowest intake, and as the intake rose the occurrence of negative balances decreased and finally disappeared, and the size of retentions increased. When the figures were sorted into groups according to performance (those subjects in positive balance, those in negative, and those in equilibrium) the same trend of storing on higher intakes of the nutrient was demonstrated. Average daily intakes of the nutrients were: calcium 0.857 g., phosphorus 1.088 g., iron 10.44 mg., and nitrogen 9.46 g.; and the average daily retentions were respectively 0.013 g., 0.033 g., 1.37 mg., and 0.58 g.

On the basis of the percentage of each nutrient retained at different levels of intake a recommendation for “minimal requirement” and “optimal allowance” seemed justified. Figures for the latter are: calcium 1.08 g., phosphorus 1.43 g., nitrogen 11.34 g., or protein 70.87 g. These parallel closely the recommendations for this age group made by the committee on foods and nutrition of the National Research Council.

Findings have been reported in detail in Nebr. Agr. Exp. Sta. Res. Bulletin 125, “One hundred studies of the calcium, phosphorus, iron and nitrogen metabolism and requirement of young women.” General findings have been incorporated in “Calcium, phosphorus, and nitrogen metabolism of young college women,” Journ. of Nutr. 24, 4. Further publications: “The dietary habits of college students,” Jour. of Home Econ. 34, 6, and “Length of the observation period as a factor in variability in calcium retentions,” Journ. of Home Econ. 34, 9. Findings for iron have been published in “The iron metabolism and requirement of young women,” Journ. of Nutr. 23, 3.

Copper metabolism of young women. Copper determinations have been completed on the material collected in the hundred studies of the previously mentioned project. Apparently self-chosen diets of girls furnished enough copper to meet metabolic needs for there were few negative balances between intake and excretion.

Nutrition and a low-cost diet. A group of eight girls at Love Memorial Hall began the first of October to live on a well-planned low cost diet designed to meet their nutritional requirements. They plan to continue this for six months. Tests for nutritional status in regard to vitamin A and the hemoglobin and ascorbic acid content of the blood are made at monthly intervals. Similar groups of girls, but living on a self-planned and self-chosen diet, serve as control subjects. One result that can be reported now is that attractive, palatable, and satisfying meals can be served at low cost. For the month of October, such nutritious meals cost 22 cents a day; in November the cost was 24 cents. This, of course, does not include labor or fuel used.

Vitamin C for girls. A survey has been made of the nutritional status of 100 college girls at Wesleyan University. Results are being used to make plans for supplementing the diet in vitamin C, and testing the comparative efficacy of tomato juice and grapefruit juice as sources.

Food value of Nebraska potatoes and tomatoes. The mineral distribution between cortex, phloem, and pith has been determined in Irish Cobbler, Warba and Red Triumph potatoes. Individual variation in tubers
from different hills, different locations in the field, and with two cultural practices has been studied. Analyses are completed but the figures are not analyzed. Work on the vitamin C content of potatoes has been started. The effect of variety, stage of maturity and storage is being studied as well as the effect of different methods of cooking—peeled, left whole and boiled; peeled, diced and boiled; boiled in the skins; and peeled, boiled and mashed.

The vitamin C content of whole tomatoes canned by the open kettle, cold pack, and commercial methods is being determined following different periods of storage. There appears to be appreciable destruction during storage but only preliminary figures are available.

Publication: "Butter and margarine," Journ. of Home Econ. 34, 4.
Ruth M. Leverton supervised these research projects.

Cooking Quality of Potatoes

Work on the cooking quality of potatoes has been continued. Special emphasis has been placed on the sloughing of potatoes during cooking. A method for measuring the amount of sloughing was developed and a comparison of the tendency to slough was made on different varieties, different cultural conditions, and on the same variety stored for varying periods. Potatoes have been cooked in different solutions to determine the effect on sloughing. Calcium chloride solution appears to be effective in decreasing loss. There appears to be a slight tendency for a decrease in sloughing during storage, but with the potatoes used in this study the difference was slight.

Edna B. Snyder is in charge of the study.

Household Equipment Experiments


Briefly, the bulletin contains technical information regarding the performance of three typical pressure gasoline stoves and one pressure kerosene stove. Findings showed the efficiency of cooking top burners for both short and long-time heating, heat distribution from cooking top burners, preheating the oven, oven heat loss with special emphasis on flue loss, surface temperatures of the ovens, internal temperature distribution of the oven, operation of the safety thermostats, and the production of carbon monoxide during the operation of these stoves.

To provide information for the consumer, a pamphlet discussing factors of safety, facts of construction, and features of performance has been published as Nebr. Agr. Exp. Sta. Circular 70, "Pressure gasoline and pressure kerosene stoves."

Study of small electrical food mixers. Using two electric beaters, a method was developed to rotate the bowl by using an outside source. This completes Nebraska's part of the project. The data will be used in connection with foods tests performed at Iowa State College and Purdue University.

Lighting farm homes without electricity. A photometer room has been built and apparatus constructed for measuring the mean horizontal candle power of kerosene and gasoline lamps. Preliminary work has been done with the Macbeth Illuminometer.

Arnold E. Baragar conducted these projects.
Nebraska's substations—Box Butte, North Platte, Scotts Bluff, Valentine—all serve the state by doing experimental research with the aim of improving agricultural production in their respective sections.

Box Butte Experiment Farm

Work conducted on the farm during 1942 included a crop rotation experiment on dry land, with special emphasis on the potato crop, and projects planned and supervised by departments of the Experiment Station in Lincoln. Reports on project results are made by the separate departments.

Horticulture

A potato storage project concerned the study of temperature changes and tuber keeping in automatic fan-cooled shell bins. Also considered was the effect of various temperatures and humidities upon time and rate of mid-winter and spring sprouting of seed potatoes.

Present cultural experiments with potatoes involve the time of planting and harvesting in relation to tuber development, quality, scab prevalence, frost damage and seed value. Studies are being made on the rate of water loss and drought endurance of different types of potato varieties.

Potato and tomato breeding work provided dry-land variety yield tests.

Agronomy

Projects for agronomy included a hybrid corn yield test, winter wheat nursery, grass nursery, work on summer fallow tillage methods, and chemurgic crop tests.

Plant Pathology

Among plant disease projects for 1942 was the study of scab and fusarium content of tubers in crop rotations. A test was made of seedling lines for scab and fusarium resistance and maintenance of virus-disease free stocks of breeding lines.

General Farm Projects

1. Production of foundation quality seed potatoes in cooperation with the Nebraska Certified Potato Growers Cooperative.
2. Increase of new varieties of small grain.
3. Crop production in large fields to complete rotations in two series of fields providing land for other experiments.
4. Maintenance of an effective windbreak and an attractive lawn with plantings of ornamentals, many of which are new to the region.

The potato cellar was almost entirely rebuilt, according to most modern research findings. After rebuilding, it has a waterproof, insulated roof, and concrete end walls that provide cooling surfaces. These permit the cooling of the cellar without excessive ventilation which would reduce the humidity and cause excessive weight loss in the potatoes. The shell-cooled bins are provided with fans that automatically circulate air around the potatoes whenever the outside air is cooler than the inside air. Shell-cooled bins for all potatoes permit abundant air circulation "around" but not "through" the bins of potatoes. Facilities of the cellar provide for storing large quantities under at least five different types of conditions.

Sufficient rain fell between mid-April and June 28, 1942, to fill the soil with moisture to a depth of five or more feet in addition to providing for the current moisture needs of the crops throughout spring. From June 28
to October 12 there were only four showers of 0.25 to 0.32 inch but none at all of 0.5 inch. Temperature of each summer month was below the long-time average. A killing frost on September 18 and 19 damaged tomatoes severely and did some damage to potato plants. A very severe frost on September 26 killed all tender vegetation and froze many potatoes in the ground. Climatic conditions were excellent for small grain production. Yields of corn and potatoes were surprisingly good, probably due to generally low temperatures and the absence of hot, windy days. Wheat yields ranged from 12 to 58 bushels per acre. Potatoes yielded from 100 to almost 200 bushels per acre, a very unusual situation considering the complete absence of growing season rainfall.

Robert E. Pahl is supervisor of the Experiment Farm.

North Platte Substation

Crops Hurt by Heavy Rains

PRECIPITATION for the year was only slightly less than the all-time high in 1915. There was an unusual number of heavy dashing rains that caused much damage from soil washing. The climax of these was a rainfall of 7.35 inches in 24 hours on September 1. Corn and sorghum crops were ruined by hail in early August. Spring grains were damaged by root-rot diseases. The only crop that produced somewhat in proportion to rainfall possibilities was winter wheat. Yields of winter wheat from various seeding methods and soil preparations ranged from below 20 to over 50 bushels per acre. The average yield of 43 bushels was more than double the long-time average. Yields from fallowed land were relatively low because of rank straw growth and prolonged lodging.

Good stands were secured in the first year of grass seeding, whereas with less abundant rainfall several years are usually required before full stands are established.

L. L. Zook is superintendent of the Substation.

Unusual Weather Tests Crop Varieties

Conditions of the present season provided a severe test of stiffness of straw or lodge resistance of winter wheat. The previous year provided a similar test of winter hardiness. In the spring of 1942, stands of all varieties were uniformly good. Favorable moisture conditions stimulated a heavy vegetative growth. Varieties with weak straw began lodging early and lodging occurred in nearly all varieties, especially on fallow. Most notable exception was Pawnee. The previous year the winter survival of this variety was only 15 per cent and it occupied the lowest yield rank of the test. For the present season, it moved to the top of the list of 15 varieties with a yield of 50.8 bushels. On the other hand Cheyenne and Nebred, which have usually occupied high-yield rank, moved to mid-range with yields of 35.5 and 34.6 bushels respectively. For the five-year period 1938–42, Pawnee occupies third place of 13 varieties with a yield of 21.7 bushels. Cheyenne and Nebred respectively occupy second and fourth places with yields of 21.8 and 21.3 bushels.

The 1942 yield of all varieties of winter wheat was 28.4 bushels after fallow and 44.0 bushels on corn stubble.

The yields of spring wheat and barley were reduced by root rot, a disease prevalent in most of the state. Average yield of spring wheat was
6.9 bushels per acre. The quality of grain was very poor. Mercury was the most promising variety grown, averaging 9.5 bushels. Ceres has been the leading spring wheat variety grown since 1925. For the years grown, Marquis has averaged 79 per cent of Ceres, Thatcher 96 per cent, and Pilot 92 per cent.

The average barley yield of 15 varieties was 24.1 bushels. McClymont, Common 6-row, and Trebi made the highest yields of 31.8, 30.6, and 30.5 bushels per acre. Most years these varieties are average or below in yield. Spartan, most popular variety now grown in the state, averaged 1.3 bushels less than McClymont, and excelled all varieties in weight per bushel. For the 12-year period of 1931-42, the highest yielding varieties are Ezond, North Platte No. 1, Sandrel, Spartan, and Short Comfort. Velvon, a new smooth-awned variety, has given the best average yield for the past four years. Several barley selections are now being grown in the nursery and appear promising.

Stands of oats were poor as a result of a three-inch dashing rain at about the time of emergence. The average yield per acre of 15 varieties was 40.5 bushels. A new selection, Richland x Fulghum (Ks. 32178) was outstanding with a yield of 54.2 bushels. This was 7.3 bushels above the next best-yielding variety. This new selection appears to be well adapted, is resistant to stem rust, and the grain is of high quality. Brunker and Trojan, the two leading varieties in the past few years, were lowest in yield in the 1942 test. In comparison with Brunker for the years grown, Trojan has been equal in yield, Nebraska No. 21 ninety per cent, Iogold 93 per cent, and Otoe 92 per cent.

The hail storm on August 6 ruined the corn and sorghum projects, resulting in loss of seed of several pure selections of foundation stock of waxy-type Leoti. Previous to the hail a few of the Substation experimental corn hybrids appeared very promising in comparison with the commercial hybrids in the tests.

For the first time since 1933, a flax test was planted. One test of five varieties on valley land averaged 24.5 bushels. A second test of the same varieties on table land on less fertile soil averaged 13.5 bushels. Neither test was irrigated and the difference in yield is apparently due to differences in soil fertility. Biwing was the most promising variety in the tests.

O. J. Webster was in charge of crop projects.

**Trees and Gardens Hurt**

The main plantings of trees and shrubs made in the spring of 1942 were replacements of losses resulting from the November freeze of 1940.

Wind and hail on August 11 did extensive damage to the garden shade and fruit trees. Tree tops were almost a complete loss in the new dry-land orchard. It is possible that there can be considerable renewal from sprouts that may be developed from areas above the root grafts.

The heavy garden crop losses were tomatoes, cabbage and late sweet corn. Root crops recovered and made good yields.

H. A. McComb was in charge of this work.

**Little Irrigation Required**

The water table rise has continued. With 1938 as the base line, the readings at the end of successive years have been 41, 56, 76, and 106 inches. The high point of the 1942 season was 110 inches in June. Although there was a drop of about four inches between June and December
at the irrigation well and in the valley, wells farther south continued to rise through the season.

On account of the high rainfall and the loss of crops by hail, the amount of irrigation was the least of any year since the pumps were installed. The main station pump was not started until July 14. It was operated for 117 hours between that date and the destruction of crops by hail on August 6 after which there was no further irrigation from this pump. The pump discharge was high as a result of the high water table, averaging 1,200 gallons per minute or 2.65 acre-inches per hour. Water pumped was 310.05 acre-inches. Of this, 302.10 acre-inches were used on 17 acres of corn, at an average per acre application of 17.77 inches. Electric current usage was 2,720 kwhrs., the cost of which was $74.80. Labor costs at 30 cents per hour amounted to $35.10. Total operating cost was $109.90 or approximately $6.00 per acre. With fixed costs computed on a constant level of $300, the total cost per acre irrigated reached an all-time high of $23.94. Ensilage yields on the hailed corn were 9.9 tons per acre, so that the cost of irrigation per ton of yield was approximately $2.42.

The pump on leased land was operated 342 hours. A total of 739 acre-inches was pumped. Of this, 475 acre-inches were delivered to the 80-acre unit operated by the Soil Conservation Service. Fuel and oil costs were about 7.5 cents per acre-inch. Pumping and distribution cost of the 264 acre-inches of water used on Substation crops was 22.1 cents per acre-inch. The water was used on 25.4 acres of miscellaneous crops, making the average application 10.4 inches and the average per acre cost approximately $2.30. The crops were so completely destroyed by hail that no data were obtainable on the irrigation cost of unit yields.

H. E. Weakly supervised the irrigation work.

**Steers Fattened on Dried Beet Pulp**

This was the second year of a three-year trial. As in the first year, three lots of 12 steers each were used. The initial weights were lighter, being 567 instead of 684, and the time on feed was 238 instead of 224 days. In the first trial, identical gains of 2.11 pounds per head per day were made by the lot fed corn and the lot fed two-thirds corn and one-third dried beet pulp. In the second trial, the respective daily gains for these lots were 2.07 and 2.30 pounds. The lot fed equal parts by weight of dried beet pulp and corn made average daily gains of 2.13 and 2.24 pounds respectively in the first and second trials. The two-year averages are slightly in favor of the lots fed dried beet pulp. From the first trial all lots sold for the same price. From the second trial the lots finished on corn and dried beet pulp sold for $15.25 per hundred in comparison with $14.75 for the lot finished on corn.

M. L. Baker and C. F. Reinmiller are conducting the trial.

**Steers Fed Alfalfa and Soybeans**

Three lots of 570-pound steer calves were fed for 226 days beginning January 30, 1942 on a basal ration of sorgo silage, prairie hay, and ground shelled corn. Lot 1 was fed 1.35 pounds of soybean pellets per head daily. Lot 2 received .85 pound soybean pellets and 2.45 pounds of ground alfalfa hay per head daily. Lot 3 was fed .36 pound soybean pellets and 4.04 pounds ground alfalfa per head daily. A fourth lot was fed ground shelled corn, alfalfa hay ad lib and .35 pound of soybean pellets. In addition the steers had access to salt, a mineral mixture, and water.
The average daily gains for the four lots respectively were 2.01, 2.23, 2.17, and 2.05 pounds per head. Average daily gains for lots fed similar rations the previous year were respectively 2.06, 2.07, 2.20, and 2.38 pounds per head. The relatively lower gains in the second year for the lot fed alfalfa hay without grinding were apparently due to poorer quality of hay in that year resulting in lower consumption. The consumption in the first and second trials was respectively 461 and 336 pounds per 100 pounds of gain. In the first trial, all lots sold for the same price. In the second trial, the four lots shrunk 3.38, 3.63, 3.77, and 2.86 per cent and sold for $14.70, $14.85, $14.80, and $14.90 per hundred weight.

M. L. Baker and C. F. Reinmiller are in charge of this project.

**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. Two of the inbred lines as originally set up were discontinued. One was used as the basis for a new line. The other was dropped because of its close relationship to another line and the belief that available facilities could be used to better advantage for a non-related line. Stock for this line was secured from the University herd at Lincoln and pigs farrowed in this line in 1943 will have an inbreeding coefficient of approximately .20.

Considerable data from top-cross and line-cross matings were accumulated but have not been analyzed.

M. L. Baker and C. F. Reinmiller are conducting this project.

**Scotts Bluff Field Station**

The inauguration of a new series of rotation experiments during 1942 represented the major project at the Station. This new series of rotation experiments has been designed to cover new fields of study, and new problems arising out of the tests which have been conducted at the Station during the thirty-year period 1912 to 1941.

Other tests conducted at the Station included both official and experimental corn hybrid tests, sheep feeding tests, and a steer feeding test involving Holstein cattle.

Additional experimental work conducted during 1942 included cooperative projects with the Departments of Horticulture, Pathology, Entomology, and the Chemurgy Project at the University of Nebraska, and with the Office of Sugar Plants of the U. S. Dept. of Agriculture.

**Weather and Crops**

Total precipitation at the Scotts Bluff Field Station during 1942 amounted to 17.62 inches, compared with a 33-year mean of 13.75 inches. Heavy spring precipitation caused a rapid and vigorous growth of legume crops planted with barley as a nurse crop. In some instances, particularly with sweet clover, the legume outgrew the nurse crop, resulting in rather poor yields of barley. New seedings of alfalfa and sweet clover were not damaged by grasshoppers, and with abundant precipitation this resulted in establishment of very good stands of these crops. Adequate irrigation water was available at all times during the growing season.
Unusually cold temperatures during the last part of September caused some field frost damage in the potato crop. The short, cool growing season was unfavorable for crops such as corn and tomatoes, but satisfactory for potatoes, sugar beets, and alfalfa. Unusually cold temperatures during the first part of May killed about 75 per cent of the sugar beet acreage that had been planted about the middle of April. Sugar beets which were replanted were low in sugar at digging time.

**Crop Rotation Experiments**

In 1912 an extensive series of rotation experiments was inaugurated at the Scotts Bluff Field Station. Dealing with various methods of utilizing irrigated land, these were carried out as originally planned from 1912 to 1941, or a period of 30 years. Objectives included the most satisfactory methods of maintaining or improving productivity of the soil under a long-time cropping program. At the end of the 30-year period, definite results were obtained concerning methods of handling irrigated land, and new problems were encountered. In 1942, therefore, the original plan of rotation experiments was revised to include studies of the new problems.

**Results from the old rotation program.** Included in the first 30 years' work were the following types of rotations: continuous rotations, two-year and three-year untreated, two-year and three-year treated with applications of farm manure, alfalfa added to two-year and three-year, alfalfa and manure added to a three-year, and pastured sweet clover.

During the 30-year period, unsatisfactory results occurred on all of the continuously-cropped plots except alfalfa. Sugar beets grown continuously on the same ground suffered severely from various plant diseases, including rhizoctonia, fusarium wilt, nutritional deficiency diseases, and root nematode. During the last six-year period, the yield declined to approximately six tons per acre, which is considerably below the amount necessary to cover the high production costs encountered in irrigation farming.

Potatoes grown on the same ground continuously suffered severely from potato scab, which primarily affected the quality of the crop, and also produced low yields.

Corn and small grain on these continuously-cropped plots declined steadily in yield during the 30-year period.

Alfalfa grown on the same ground continuously produced a 30-year mean yield of 4.6 tons per acre, which is sufficient to cover production costs, and return a small profit. The continuous alfalfa plot was reseeded once during the 30-year period.

Unsatisfactory results were obtained in the untreated two-year and three-year rotations. Sugar beets, potatoes, oats and corn produced unprofitable yields when grown in various combinations of two-year and three-year rotations. When grown in short rotations, these crops produced slightly higher yields than when grown continuously on the same ground, but yields produced were not satisfactory or profitable. Considerable disease occurred in potatoes and sugar beets, and the test weight per bushel on the small grains was lower than average. Little value resulted from changing the crop sequence in these short, untreated rotations. For example, sugar beets in a three-year rotation of potatoes and oats produced essentially the same as in a three-year rotation of corn and oats, the yields in each instance being unprofitable.

Addition of farm manure to short rotations produced significant increases in the yields of all crops involved. During the last six years of
the 30-year period, sugar beets in three manured rotations yielded at the rate of 17.5 tons per acre, compared to 8.0 tons in four unmanured rotations. While manure increased the yield of potatoes approximately 69 bushels per acre, it resulted at the same time in a considerable amount of scab on the potato tubers, which caused them to be graded as number two. Manure increased the yield of oats 24 bushels per acre.

Manure in the short rotations produced yields sufficient in most instances to more than cover production costs.

During the 30-year period the addition of either two years or three years of alfalfa to short rotations resulted in significant increases in the yields of all crops involved. During the last six years of the 30-year period, sugar beets in alfalfa rotations yielded at the rate of 14.4 tons per acre, 6.4 tons more than in the rotations without alfalfa. The most significant benefits of alfalfa in the rotation occurred in the potato crop, where yields were increased 151 bushels over rotations without alfalfa. A notable improvement in quality of potatoes occurred in the alfalfa rotations. Whether this improvement in quality resulted from the inclusion of alfalfa in the rotation, or to the increased length of alfalfa rotations has not yet been ascertained. Oats grown in alfalfa rotations yielded 24 bushels per acre more than when grown in short rotations without alfalfa.

Both alfalfa and manure added to a three-year rotation of potatoes, oats, and beets produced significant increases in the yields of these crops. In the alfalfa and manure rotation, sugar beets produced a yield of 18.4 tons per acre, 10.4 tons more than in rotations without these treatments. The yield of potatoes was 308 bushels, an increase of 176 bushels, and the yield of oats was 65 bushels, an increase of 29 bushels per acre. The combination treatment, alfalfa and manure in the rotation, produced the most satisfactory results of all the various methods employed in utilizing irrigated land.

Pasturing sweet clover with sheep during a 22-year period produced a mean yield of sugar beets of 15.6 tons per acre, 6.3 tons more than were produced during a 30-year period in four unmanured rotations. In the pastured rotation, sugar beets occupied 50 per cent of the land each year.

The new rotation program. During 1942 the rotation program was revised to continue studies of the value of farm manure, alfalfa and sweet clover, and in addition studies of the value of mineral fertilizers.

In the new rotation program, barley has replaced oats in rotations where a small grain crop is involved. This action was taken in view of the increasing importance of barley as a livestock feed in the North Platte valley. Other principal crops involved include alfalfa, sugar beets, potatoes, beans and corn.

In the new rotation program the in-put and run-off of irrigation water will be determined on each plot in order to determine the water requirements of the various crops under different treatments.

Hybrid Corn Experiments

Tests with hybrid corn included an experimental hybrid test, involving 18 experimental hybrids, 11 commercial hybrids, and one open-pollinated variety; and the official corn hybrid test for western Nebraska, involving 29 commercial hybrids, supplied by various concerns, and one open-pollinated variety. The experimental hybrid test has been conducted at the Station for the past five years, in cooperation with the Agronomy De-
partment of the University of Nebraska, in an effort to obtain a field corn hybrid highly adapted to the irrigated section of the high plains area, where frequently short growing seasons are encountered. During the past five years some progress has been made in isolating in-breds, which when combined in double crosses, produce an early and otherwise satisfactory hybrid for this area. Several commercial hybrids are early enough, but proved unsatisfactory in other characteristics such as yield, resistance to smut and lodging, and stock type.

The official corn hybrid test involved a comparison of commercial hybrids furnished by various companies, which selected the hybrids on their possible merits for this territory and paid the costs of testing them. This program has been under supervision of the Agronomy Department of the University.

**Experimental Work with Livestock**

**Sheep feeding.** During the winter of 1941–42 a lamb-feeding project, involving a study of the relationship of lamb-feeding practices to feed lot death losses, was inaugurated. The test consisted of 15 lots with 30 lambs per lot. Features included the heavy feeding of corn compared with moderate feeding; feeding whole corn in comparison with cracked corn; feeding whole corn in comparison with whole corn and dried pulp; feeding of silage as the only roughage in comparison with silage and alfalfa hay; feeding the concentrates mixed with the silage in comparison with feeding the concentrates in a separate trough; comparing three different kinds of silage, including cane silage, rye silage, and beet top silage; and a study of the value of grading lambs on the basis of weight, and feeding the light, medium, and heavy lambs the same ration, but in separate pens.

A heavy outbreak of urinary calculi developed in the lot fed beet-top silage as the only roughage. A heavy death loss occurred in this lot, and several lambs were condemned at the packing house, even though they had attained a satisfactory weight. Alfalfa hay was added to the ration near the end of the test, and the affected lambs improved somewhat.

The addition of a small amount of alfalfa hay to a roughage ration of cane silage proved highly valuable. In the grading study it was found that the light lambs made the most efficient use of their feed, although a longer time was required to finish them for market.

**Steer feeding.** During the winter of 1941–42 a feeding test was conducted with five Holstein steers, to determine the gains which could be obtained in feeding such an assorted lot. At the start of the test the steers weighed respectively 898, 790, 620, 530, and 497 pounds, with a mean weight of 667 pounds. Average daily ration per steer was 13.1 pounds of molasses-rolled barley, 15 pounds of beet top silage, four pounds of cut alfalfa hay, and 0.5 pound of cottonseed meal. The steers had free access to a mineral mixture. The test was conducted for 91 days. Total gains amounted to 1,235 pounds, 247 pounds per steer. The mean daily gain per steer was 2.71 pounds.

**Cooperative Projects**

Several projects have been carried on each year at the Scotts Bluff Station in cooperation with various departments of the College of Agriculture and the U. S. Department of Agriculture.

In cooperation with the Office of Sugar Plants, U. S. Department of Agriculture, variety and time of planting tests have been conducted with
sugar beets. Also, the Station has provided facilities for storing a considerable number of mother beets used in experimental breeding work. Various isolated areas are also supplied for producing seed of this breeding material. Breeding objectives include improvement of size and quality of beets.

In cooperation with the Horticultural Department of the College of Agriculture, variety tests and breeding work with tomatoes and potatoes have been conducted. Facilities for storing special breeding material have been provided by the Station. Breeding objectives include improvement in earliness and yield of tomatoes, and improvement of horticultural qualities of potatoes.

In cooperation with the Pathology Department of the College of Agriculture, breeding experiments with potatoes and beans have been conducted at the Station, with a view to selecting disease-resistant strains of these crops. To facilitate this work, housing facilities for the pathology laboratory have been provided.

In cooperation with the Entomology Department, various tests involving the control of insects on potatoes have been carried out. Housing facilities for an entomology laboratory have been provided.

Various drug, spice, oil, fiber, and rubber-producing plants were tested at the Station during 1942, in connection with efforts of the U. S. Department of Agriculture to obtain local sources of these substances.

Lionel Harris is superintendent of the Scotts Bluff Station.

Valentine Substation

Crop Production

**CORN.** Twenty hybrids were grown in comparison with 10 local open-pollinated varieties. Unfavorable weather prevented planting until the first of June and most of the hybrids were too immature when killed by frost to make good feed. The short-season hybrids yielded less than the local varieties.

**Sorghums.** With the return of normal rainfall and cooler nights, grain sorghums have lost the popularity gained during the drouth. This year none of the varieties was worth harvesting. Farmers let their fields stand to be pastured when cured after frost.

**Small grain.** In the oat variety test, nine varieties were grown in four replications. Brunker yielded 48.9 bushels, followed by Kanota and Victoria x Richland. There was no great range in yield between the other varieties except in the case of Hancock which was 11.3 bushels under Brunker.

In the barley variety tests, Velvon yielded 556 pounds more grain per acre than the high oat variety. Vance and Beecher were relatively low in yield. There was no significant difference in yield of the other six varieties.

The 10 varieties of spring wheat averaged 16.1 bushels per acre. This was three bushels less than the yield of Pilot-13, top-yielding variety.

The 10 winter wheat varieties averaged only half as much as the spring varieties. Plants had stooled very little, which accounts for the low yield.
Supplements to Prairie Hay for Wintering Calves

The project on supplements for wintering calves was expanded last winter by increasing the number of lots from six to eight in order that more work could be done with minerals in addition to proteins.

More favorable grazing seasons the past two years have lessened the increase in gain obtained by adding mineral to soybean oil meal. The feeding of one pound of soybean oil meal to which had been added four per cent of steamed bone meal, produced four pounds less gain than feeding soybean oil meal alone. Feeding 0.1 pound of ground limestone was even more depressing, the difference here being 38 pounds. Three-quarters of a pound of soybean oil meal produced 88 per cent as much gain as one pound. Linseed was fed for the first time as a winter supplement. The gain was about the same as from cottonseed cake but neither was as high as from soybean oil meal. Results from one year's test on mixing equal parts of the three proteins showed no significant advantage of the mixture over soybean oil meal or cottonseed cake fed alone.

Sub-irrigated Meadow Project

The March reading of 20 wells in sub-irrigated meadows showed a rise of 10.3 inches over the previous March. The seasonal drop was less than normal and the water stage this fall stands at approximately the pre-drouth level.

Meadows on which clover had died out during the drouth are now in favorable condition for reseeding. Dormant seed was found to have germinated on meadows where no clover had been seen for several seasons.

Cattle Investigation

The herd of milking Shorthorn cattle has increased to the maximum number which can be maintained with present facilities. Average production per cow year was 5,237 pounds of milk and 223 pounds of butterfat. Amount of feed consumed per 100 pounds of milk produced was as follows: 31.4 pounds grain, 125 pounds hay, 109.9 pounds silage. Amount of feed per pound of butterfat was 7.4 pounds of grain, 29.3 pounds hay, and 25.8 pounds silage. The feed requirement per unit of production was a little higher than last year.

Five head of steer calves were fed out by the Department of Animal Husbandry at Lincoln. The initial weight of the steers was 442 pounds and the average daily gain was 2.51 pounds for a feeding period of 227 days. Feed required per 100 pounds of gain was as follows: corn 558 pounds, alfalfa 32 pounds, prairie hay 136 pounds, silage 158 pounds, linseed oil meal 54 pounds, and ground limestone three pounds. The steers sold for $14.50 which was one dollar under the practical top. Dressing percentage ranged from 60 to 62 and the carcasses graded A.

E. M. Brouse is superintendent of the Valentine Station.
Experiment Station Publications During 1942

Annual Report

Fifty-fifth Annual Report, presented to the Governor February 1, 1942. 1,500 copies.

Bulletins

No. 338. The Nebraska Tractor Tests, 1920–1941. Board of Tractor Test Engineers. January, 1942. 6,000 copies.
No. 341. Sugar Beet Costs and Management in Irrigated Sections of Western Nebraska. George H. Lambrecht and Walter L. Ruden. May, 1942. 3,000 copies.
No. 344. Sunlight Lamps for Laying Hens. F. E. Mussehl and F. D. Yung. September, 1942. 5,000 copies.

Research Bulletins

No. 130. Swine Erysipelas Infection in Man. L. Van Es. August, 1942. 5,000 copies.

Circulars

No. 70. Pressure Gasoline and Pressure Kerosene Stoves. Arnold E. Baragar. August, 1942. 5,000 copies.
No. 71. Use Milk—An Essential Food. P. A. Downs. September, 1942. 5,000 copies.
1942 Experiment Station Administration and Staff

The Regents of the University

ROBERT W. DEVOE, Lincoln
WILL E. REED, Omaha
STANLEY D. LONG, Grand Island

FRANK M. JOHNSON, Lexington, President
CHARLES Y. THOMPSON, West Point
MARION A. SHAW, David City

C. S. BOUCHER, Ph.D., LL.D., Chancellor of the University
JOHN K. SELLECK,1 B.Sc., Comptroller of the University

LORING ELLIS GUNDERSON, Lincoln, Corporation Secretary

W. W. BURRE, B.Sc., Director
W. H. BROKAW, Director of Agricultural Extension
W. W. MARSHALL, Executive Clerk
R. T. PRESCOTT,2 A.M., Agricultural Editor
RALPH L. REEDER, A.B., Agricultural Editor

The Station Officers

W. W. BURRE, B.Sc., Director
W. H. BROKAW, Director of Agricultural Extension
W. W. MARSHALL, Executive Clerk
R. T. PRESCOTT,2 A.M., Agricultural Editor
RALPH L. REEDER, A.B., Agricultural Editor

The Technical Staff

C. W. ACKERSON,3 Ph.D., Agricultural Chemist (Acting Chairman)
M. A. ALEXANDER, M.Sc., Associate Animal Husbandman

ARTHUR ANDERSON,4 Ph.D., Conservationist

GUY M. BAKER, B.Sc., Animal Husbandman, North Platte Substation

MARVEL L. BAKER, M.Sc., Animal Husbandman
R. E. BAKER, Ph.D., Assistant Horticulturist
Arnold E. BARAGAR,5 M.Sc., Assistant Home Economist

ORLANDO S. BARE, M.Sc., Associate Entomologist

E. E. BRACKETT, B.Sc., Agricultural Engineer (Chairman)
E. M. BROUSE, B.Sc., Superintendent, Valentine Substation
M. P. BRUNIC,6 A.M., Assistant Agricultural Engineer

L. M. CAMP, B.Sc., Assistant Agronomist
E. C. CONARD,4 M.Sc., Associate Agronomist
L. K. CROWE, M.Sc., Associate Dairy Husbandman
R. L. CUSHING,4 M.Sc., Assistant Agronomist
H. P. DAVIS, M.Sc., Dairy Husbandman (Chairman)
P. A. DOWNS, Ph.D., Dairy Husbandman
F. L. DULEY,4 Ph.D., Senior Soil Conservationist
MARGARET FEDDE, M.A., Home Economist (Chairman)
M. W. FELTON, Ph.D., Assistant Plant Pathologist
H. C. FILLEY, Ph.D., Rural Economist (Chairman)
J. W. FITTS, M.Sc., Assistant Agronomist
SAMUEL GARVER,4 B.Sc., Associate Agronomist
R. W. GOSS, Ph.D., Plant Pathologist (Chairman)
LEWIS T. GRAHAM, M.Sc., Assistant Entomologist
W. E. HAM, M.Sc., Analyst
L. E. HANSON, Ph.D., Assistant Animal Husbandman
N. S. HANSON, M.Sc., Assistant Agronomist
LIONEL HARRIS,4 M.Sc., Assistant Agronomist and Superintendent, Scotts Bluff Substation, Mitchell

I. L. HATHAWAY, M.Sc., Associate Dairy Husbandman
LANOY HAZEL,7 Junior Animal Husbandman, North Platte Substation

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 fund on and after July 1, 1899.
2 Resigned, effective August 31, 1942.
3 On leave, effective January 1, 1942.
4 Detailed from the U. S. Department of Agriculture, Washington, D. C.
5 On leave, effective July 1, 1942.
6 On leave, effective September 16, 1942.
7 Resigned, effective August 31, 1942.
R. E. Hill, M.Sc., Assistant in Entomology
B. D. Hites, M.Sc., Assistant Agricultural Chemist
L. W. Hurlbut, M.Sc., A.E., Assistant Agricultural Engineer
J. H. Jensen, Ph.D., Associate Plant Pathologist
F. D. Keim, Ph.D., Agronomist (Chairman)
T. A. Kresselbach, Ph.D., Agronomist
G. C. Klingman, M.Sc., Assistant in Agronomy
Eric Kneen, Ph.D., Assistant Agricultural Chemist and Assistant Plant Pathologist
Ruth M. Leerton, Ph.D., Associate Home Economist
George Lambecht, M.Sc., Assistant in Rural Economics
J. E. Livingston, Ph.D., Assistant Plant Pathologist
W. J. Loeffel, M.Sc., Animal Husbandman (Chairman)
W. E. Lyness, M.Sc., Associate Agronomist
H. A. McComb, B.Sc., Horticulturist, North Platte Substation
C. B. McGrath, B.Sc., D.V.M., Assistant Animal Pathologist
Thehla J. McMillan, M.Sc., Research Assistant in Nutrition
R. A. Mapes, Manager, Union Fruit Farm
Frank Miller, M.A., Assistant Rural Economist
R. F. Morgan, M.Sc., Assistant Dairy Husbandman
F. E. Mussehl, B.Sc., Poultry Husbandman (Chairman)
L. C. Newell, Ph.D., Associate Agronomist
J. F. Olney, D.V.M., M.Sc., Associate Animal Pathologist
R. E. Pahl, B.Sc., Supervisor, Box Butte Experimental Farm
A. W. Peterson, Ph.D., Assistant Rural Economist
K. S. Quisenberry, Ph.D., Senior Agronomist
E. L. Reichart, M.Sc., Associate Dairy Husbandman
C. F. Reinmiller, M.Sc., Junior Animal Husbandman
H. F. Roaides, Ph.D., Associate Agronomist
Raymond Roberts, M.Sc., Associate Entomologist
Walter Ruden, M.Sc., Assistant in Rural Economics
J. C. Russell, M.Sc., Agronomist
R. M. Sandstedt, M.Sc., Agricultural Chemist (Acting Chairman)
C. W. Smith, M.Sc., M.E., Agricultural Engineer
Henry Smith, Ph.D., Assistant in Agronomy
L. B. Snyder, Ph.D., Associate Rural Economist
Leland Spott, Ph.D., Associate Home Economist
H. D. Tate, Ph.D., Entomologist (Chairman)
G. W. Trimberger, M.Sc., Assistant in Dairy Husbandry
H. M. Tysdal, Ph.D., Agronomist
G. K. L. Underbjerg, Ph.D., Assistant Dairy Husbandman
L. Van Es, M.D., V.S., D.Sc., Animal Pathologist (Chairman)
H. E. Weakley, M.Sc., Assistant Agronomist, North Platte Substation
O. J. Webster, B.Sc., Junior Agronomist, North Platte Substation
M. D. Weldon, Ph.D., Associate Agronomist
H. O. Werner, Ph.D., Horticulturist
C. C. Wiggans, Ph.D., Horticulturist (Chairman)
F. D. Yung, M.Sc., A.E., Assistant Agricultural Engineer
L. L. Zook, B.Sc., Agronomist and Superintendent, North Platte Substation

1 Resigned, effective October 17, 1942.
2 Resigned, effective November 9, 1942.
3 Detailed from the U. S. Department of Agriculture, Washington, D. C.
4 Resigned, effective January 15, 1943.
5 On leave, effective November 1, 1942.
6 On leave, effective September 12, 1942.
7 On leave, effective August 15, 1942.
8 Resigned, effective July 31, 1942.
9 On leave, effective January 20, 1942.
Nebraska Experiment Station Financial Statement

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, 1942, under act of Congress approved March 2, 1887. Total $15,000.00

**Expenditures**

For Salaries ................................................................. $15,000.00

Total ............................................................................. $15,000.00

**Bankhead-Jones Fund**

**Receipts**

Received by the State Treasurer, who is also the treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1942, under act of Congress approved June 29, 1935. Total $38,779.40

**Expenditures**

Salaries and Wages
- Regular employees .............................................. $26,342.61
- Temporary employees ........................................... 3,113.39
  Total .................................................................. $29,456.00

**Supplies**

- Office supplies ........................................................................ $ 83.53
- Laboratory supplies ........................................................... 1,005.09
- Feedingstuffs ........................................................................ 392.01
- Agricultural supplies .......................................................... 277.96
  Total ........................................................................... $1,758.59

**Expense**

- Office expense and postage .............................................. $ 10.04
- Freight, express and dray ................................................. 16.37
- Public printing, advertising and photo supplies ............. 656.60
- Traveling expense ............................................................. 845.46
- Special and temporary services ..................................... 2,647.41
  Total ............................................................................ $4,175.88

**Repairs**

- Building ................................................................. $ 270.89
- Equipment ................................................................. 180.38
  Total ........................................................................... $ 451.27

**Equipment**

- Furniture and fixtures .................................................. $ 427.61
- Apparatus, labor and equipment ................................... 548.89
- Livestock ........................................................................ 1,074.50
- Machinery ....................................................................... 359.43
- Books, magazines and maps .......................................... 20.38
  Total ............................................................................ $2,430.81

**Lands and Buildings**

- Land improvement ....................................................... $ 43.25
- Original construction .................................................... 129.06
- Addition and improvements ......................................... 334.54
  Total .......................................................................... $ 506.85
  Grand Total ...................................................................... $38,779.40

Dated at Lincoln, Nebraska .................................................

JOHN K. SELLICK,

Comptroller.
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, 1942, under act of Congress approved March 16, 1906. Total................................. $15,000.00

Expenditures

For Salaries ............................................................... $15,000.00
Total ............................................................................. $15,000.00

Purnell Fund

Receipts

Received by the State Treasurer, who is also the treasurer of the University of Nebraska, installment for the fiscal year ended June 30, 1942, under act of Congress approved February 24, 1925. Total................... $80,000.00

Expenditures

Salaries and wages
Regular employees ......................................................................................... $37,262.19
Temporary employees ................................................................................. 4,628.81
Total ........................................................................................................... $41,891.00

Supplies
Office supplies ........................................................................................................... $228.07
Laboratory supplies ............................................................................................... 3,976.05
Foodstuffs .............................................................................................................. 33.00
Educational supplies ............................................................................................. 17.72
Janitor and barn supplies ..................................................................................... .84
Feedingstuffs ......................................................................................................... 2,590.58
Agricultural supplies ............................................................................................ .30
Total .................................................................................................................... $ 6,846.56

Expense
Office expenses and postage ............................................................................... $133.41
Freight, express and dray ................................................................................... 8.86
Heat, light and power ........................................................................................... 5.89
Public printing, advertising and photo supplies .............................................. 1,939.12
Traveling expense ............................................................................................... 1,265.63
Special and temporary services .......................................................................... 5,302.63
Miscellaneous ..................................................................................................... 106.26
Total ..................................................................................................................... $ 8,761.80

Repairs
Lands ...................................................................................................................... $ 10.52
Equipment .......................................................................................................... 372.18
Total .................................................................................................................... $ 382.70

Equipment
Furniture and fixtures ......................................................................................... $ 353.05
Apparatus, labor and equipment ...................................................................... 1,330.79
Livestock ............................................................................................................ 168.75
Machinery ........................................................................................................... 64.07
Books, magazines and maps ............................................................................ 40.22
Total .................................................................................................................... $ 1,956.88

Land and Buildings
Land improvements ............................................................................... $ 161.06
Total .................................................................................................................... $ 161.06
Grand Total ........................................................................................................ $60,000.00

Dated at Lincoln, Nebraska

JOHN K. SELLECK,
Comptroller.
## Financial Statement

**Financial Statement Exclusive of Federal Funds**

Statement of Expenditures for the Agricultural Experiment Station of the University of Nebraska for the year ended June 30, 1942 (exclusive of Federal funds), including expenditures for central station at Lincoln and substations at North Platte, Mitchell, Valentine, Union and Alliance.

### Salaries and Wages
- Regular employees: $63,659.03
- Temporary employees: 3,629.64
- Total: $67,288.67

### Supplies

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<th>Cost</th>
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<td>Laboratory supplies</td>
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<td>Fuel (coal)</td>
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<td>Foodstuffs</td>
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<td>Educational and recreational</td>
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<td>Janitor and barn supplies</td>
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<td>Feedingstuffs</td>
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<td>Agricultural supplies</td>
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### Expense

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<td>Office expense and postage</td>
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<td>Freight, express and drayage</td>
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<td>Water, heat, light and power</td>
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<td>Public printing, advertising and photo supplies</td>
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<td>Rentals</td>
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<td>Special and temporary services</td>
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### Repairs

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<td>Lands</td>
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<td>Apparatus, labor and equipment</td>
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<td>Livestock</td>
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<td>Machinery</td>
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### Lands and Buildings

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<td>Land improvements</td>
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<td>Additions and improvements</td>
<td>710.58</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,245.12</strong></td>
</tr>
</tbody>
</table>

### Fixed Charges

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refunds</td>
<td>$6.80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$6.80</strong></td>
</tr>
</tbody>
</table>

**Grand Total**: $216,329.94

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.