5-1944

57th Annual Report of the Agricultural Experiment Station May 1944

W.W. Burr

University of Nebraska at Lincoln

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Letter of Transmittal

The University of Nebraska—Agricultural Experiment Station

To His Excellency, Dwight Griswold, Governor of Nebraska:

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

W. W. Burr, Director

February 1, 1944.

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

Dwight Griswold, Governor

February 1, 1944.

Introduction

The outstanding contribution to Nebraska agriculture in 1943 was the unanimous and energetic response of farmers, their families, farm laborers, and volunteer farm laborers to the urgent call for increased food production. Never before has the agriculture of the state and nation been under greater pressure to furnish much needed food materials. Never before has Nebraska agriculture been confronted by such deficiencies of equipment and labor as it faced in 1943 and which carry forward into the new year. When all factors are considered, the accomplishments of Nebraska agriculture in 1943 were quite satisfactory.

The Nebraska Agricultural Experiment Station, in common with Agricultural Extension and the entire College, gave every assistance within
their means to the program of maximum production. There has never been more need nor greater demand for exact and helpful information than during this war period. It is fortunate that a great deal of valuable information was available to meet this need. That the current program of the Agricultural Experiment Station is making further contribution of valuable information is clearly evidenced in this report.

During the past year the Experiment Station, in common with farmers and all industry, has been handicapped by a shortage of labor. The insufficient labor supply was used first to carry those long-time projects where interruption in the program would be most serious and, second, to carry projects that offered greatest immediate return. A number of projects, at least temporarily, had to be discontinued.

The Experiment Station was able to carry the fairly satisfactory 1943 program because of help procured from the National Service Board for Religious Objectors. These men were experienced and made valuable contributions in getting the work done.

Weather conditions in 1943 were less favorable than in the previous year. The total amount of rainfall was less and the crops produced were made possible largely because of the fairly satisfactory distribution of the rain that did come and the relatively low temperatures that prevailed. From August to December, inclusive, there was a decided shortage of moisture over most of the state and this shortage is carrying into the new year. It has created a serious situation over a considerable area for winter wheat, fall rye and fall-seeded grasses and legumes.

As the prospects for military victory brighten, more attention is being paid to post-war planning. Members of the Experiment Station staff have contributed to such planning and are continuing with certain studies. Members of the staff have also contributed much time and information in the preparation of agricultural production goals. Several staff members have also assisted in the field program to meet these production goals.

The fifty-seventh annual report encompasses the research program and its progress during 1943. It covers the work done at the main station at Lincoln, the substations at North Platte, Mitchell, and Valentine, the experimental farm at Alliance, the fruit farm at Union, and the cooperative research with farmers in all sections of the state. A considerable part of the research carried on at the Station continues to be cooperative with some other agency. This cooperation includes the Bureaus of Plant Industry, Animal Industry, Entomology and Plant Quarantine, Agricultural Chemistry and Engineering, and Agricultural Economics, also the Soil Conservation Service, the regional laboratories authorized by the Bankhead-Jones Act, and with various state experiment stations. Our relations with the Agricultural Extension Service and with the Chemurgy Division of the College of Agriculture remain close and profitably cooperative.

Following the report on progress there is given the list of bulletins, circulars and articles published by the Experiment Station staff during the past year and also the financial report for the fiscal year July 1, 1942, to June 30, 1943. The financial report, it should be observed, does not coincide with the progress report which is made for the calendar year 1943.
In years of accelerated agricultural production, the conservation and improvement of soil resources is of paramount importance. Nebraska’s wealth derives ultimately from her good earth.

Soils Research
Department of Agronomy
Erosion Control and Moisture Conservation

The experimental work on erosion control and moisture conservation conducted cooperatively with the U. S. Department of Agriculture, Soil Conservation Service, is being confined largely to the use of crop residues as protective surface cover. Runoff and erosion losses were much less in 1943 than in previous years due to a fewer number of torrential rains. During the one most notable rain of the season (1.94 inches on June 15), residues on the surface gave advantages as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Treatment</th>
<th>Runoff</th>
<th>Soil loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inches</td>
<td>Tons</td>
<td>per acre</td>
</tr>
<tr>
<td>Wheat in</td>
<td>Residues on surface, subtilled</td>
<td>0.59</td>
<td>0.12</td>
</tr>
<tr>
<td>head</td>
<td>No residues, plowed</td>
<td>0.96</td>
<td>0.27</td>
</tr>
<tr>
<td>Oats in</td>
<td>Residues on surface, subtilled</td>
<td>0.39</td>
<td>0.12</td>
</tr>
<tr>
<td>head</td>
<td>No residues, disked</td>
<td>1.08</td>
<td>0.42</td>
</tr>
<tr>
<td>Weed-free</td>
<td>2 t. straw on surface, subtilled</td>
<td>0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>summer</td>
<td>2 t. straw, disked in</td>
<td>0.89</td>
<td>2.25</td>
</tr>
<tr>
<td>fallow</td>
<td>No residues, disked</td>
<td>1.11</td>
<td>5.87</td>
</tr>
</tbody>
</table>

Relatively large fall and winter precipitation, together with favorable rains in May and June produced a plentiful supply of early season moisture in all experimental plots to depths of 4 to 6 feet. As a consequence, residues on the surface were not notably advantageous with respect to yields of oats or wheat, or to the early growth of corn, but they were an advantage to the later growth of corn during the hot, dry summer.

The eradication of weeds where residues were kept on the surface presented unusual difficulties during 1943. In the spring the soil frequently was too wet at the time of subsurface tillage for weeds to die rapidly, and after harvest weeds in stubble developed so luxuriantly that the soil was soon dried beyond all possibility of effective tillage. Two practices were employed that showed considerable promise in weed control. One of these was subsurface tillage and treading in tandem immediately behind the binder. The other was two treading in tandem chained together as one and so that each would pull slightly askew. A third practice employed in preparation of land for corn was light disking with treader in tandem, followed later by customary subsurface tillage.

In the cultivation of corn much difficulty was encountered with weeds in the row. This was surmounted, where planting was done in furrows, by the use of rolling coulters as shields. At the first cultivation these were locked to crowd soil out, and were locked to crowd soil in at the second cultivation. Planting on the surface through residues without making furrows was effective in erosion control and prevention of surface gullies while the corn was small, but weeds were much more difficult to control than where the corn was planted in furrows.
1. Late fall subsurface tillage through standing cornstalks. 2. Subsurface tillage immediately behind a harvester. 3. A heavy combine wheat stubble in a western Nebraska county. 4. Wheat seedbed prepared by subsurface tillage with oats straw residue.
Studies are in progress on practices of fall subsurface tillage. Several different makes of subsurface tillers have been operated successfully through corn or sorghum stalks in late fall at depths of 5 or 6 inches.


### Soil Microbiology and Crop Residue Management

Comparative studies are being made of the soil environment of microorganisms under a straw mulch and in soil farmed by conventional methods. During May 1943 the soil temperature was found to be 12 degrees cooler under a mulch of two tons of straw per acre than under bare soil. In general, when the air temperature was rising, the mulch caused the soil to be cooler. When the temperature was falling (as in autumn) the soil temperature was warmer under a protective mulch than where the soil was bare.

Soil population studies under plant residue mulches indicate that the zone of most intense microbial activity is at the point of soil and residue contact, especially during moist weather. Immediately after adding straw residues to the soil, the total number of microorganisms increased more rapidly where the residues were mixed with the soil than where they were left at the surface.

In studies on residue decay, the microorganisms constantly reduced the quantity and altered the character of the protective cover. Subtiling prolonged the life of the cover as compared with plowing. The mulching material, as decay progressed, became more brittle, was broken into shorter pieces, and became darker. The change in color modified the soil environment by increasing heat absorption.

It now appears possible by the use of subtill揽 practices, supplemented with plowing where necessary, to exercise a considerable degree of control over the decomposition processes in the field. The decomposition rate of plant residues apparently can be increased to hasten the release of mineral nutrients to the growing crop, or decreased to prolong the life of the protective covering.

Nitrate production in general has been slightly less under straw mulch than with conventional methods of residue disposal. More significantly, however, in the presence of a residue cover, nitrates have been leached more extensively out of the surface soil and have penetrated deeper into the subsoil than is the general case where land is plowed or disked. Both of these findings are illustrated by data obtained during a period of fallow in 1943 at the Hastings, Nebraska, Hydrological Project:

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<th>Disposition of straw—</th>
<th>Nitrate-nitrogen in parts per million of soil</th>
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</thead>
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<tr>
<td>3 tons per acre</td>
<td>Depth of sampling (Feet)</td>
</tr>
<tr>
<td></td>
<td>0–0.5'</td>
</tr>
<tr>
<td><strong>INITIAL SAMPLING, MAY 14</strong></td>
<td></td>
</tr>
<tr>
<td>Subtilled</td>
<td>63.1</td>
</tr>
<tr>
<td>Plowed in</td>
<td>78.5</td>
</tr>
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| **TOTALS** | 19.2 | 8.8 | 5.0 | 12.3 | 3.5 | 1.6 | 1.3 | 14.0 | 31.3 | 37.7 |

| **FINAL SAMPLING, SEPTEMBER 8** | | | | | | | | | | |

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*Table data include nitrate-nitrogen in parts per million of soil at various depths.*
The decomposition of cornstalks and wheat straw applied in different amounts as a surface mulch.


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

Fertilizer for Wheat, Corn, Sugar Beets, and Field Beans

Seven tests using superphosphate (45% $P_2O_5$) at two rates (40 and 80 pounds per acre) were conducted in Richardson county. In two of the tests, wheat was planted and fertilizer applied at two different dates, one being the usual time for seeding and the other being approximately two weeks later. Increases in yield of wheat due to superphosphate applications ranged from 2.2 to 10.6 bushels per acre with mean increases of 4.9 and 6.6 bushels for the 40- and 80-pound rates, respectively. The date of planting had no effect on the response of wheat to superphosphate, but the yields were decreased approximately 6 bushels per acre as a result of the late planting. The late planted wheat with superphosphate yielded approximately the same as the untreated wheat planted earlier.
Commercial fertilizers increased the yield of corn significantly in four of five tests on irrigated lands in the North Platte valley. The increases were obtained on fields that yielded 16 to 50 bushels per acre without treatment; the one field showing no response to fertilizer yielded 56 bushels per acre. Each test included ten treatments replicated five times in a random block arrangement. The fertilizers were applied as a sidedressing when the plants were two to four inches high. In three fields the increased yields were due entirely to nitrogen applied as ammonium sulfate, the increases ranging from 4 to 24 bushels per acre. In one field significant increases were obtained from the use of both superphosphate and ammonium sulfate. No significant differences were obtained for different rates of application of ammonium sulfate or superphosphate. The potassium fertilizer did not increase yields significantly. No significant increases in yields of corn as a result of fertilizer application were obtained in three tests under irrigation in central Nebraska and in three tests on nonirrigated lands in southeastern Nebraska. Variations in stands and cultural practices appeared to influence the yield of corn in these tests more than did the use of commercial fertilizers.

Ten fertilizer tests on irrigated sugar beets were conducted in the Platte and North Loup valleys. The fertilizers included carriers of nitrogen, phosphorus, potassium, and boron; they were applied as side-dressings before blocking and thinning of the sugar beets. Each test contained five treatments arranged in a latin square. In general, the increases obtained from the use of the fertilizers were not sufficiently large to be significant. Variations in stand, irrigation, and cultural practices appeared to influence the yields of sugar beets more than did the use of fertilizers.

Five fertilizer tests on irrigated field beans were conducted in the North Platte valley. The fertilizer was applied as a side-dressing either immediately after planting or at the time the plants were about two inches high. None of the tests showed significant increases for the use of fertilizer although there was evidence to indicate that the small yields obtained from several fields were due largely to low fertility. Apparently the method used for applying the fertilizer was partly responsible for the failure to obtain significant increases in yield in these tests.

J. W. Fitts and H. F. Rhoades.

Reclamation of Sodium Alkali Soils

A study of the influence of sulfur, gypsum, and calcium chloride treatments on some physical and chemical properties of sodium alkali soils or “slick spots” was completed during the year. Progress reports on this study were made in the 54th and 55th Annual Reports. Here is a summary of the results.

All treatments increased the rate of water intake by slick spots. Sulfur was more effective than gypsum or calcium chloride except for a short time following the application.

All treatments reduced the percentage of clods larger than one-fourth inch. Sulfur was more effective than the other treatments. The sulfur treatments lowered the resistance of the large clods to crushing but neither gypsum nor calcium chloride had any effect.

Alfalfa roots did not penetrate below a depth of nine inches in the untreated, calcium, chloride, or gypsum treated plots although a vigor-
ous growth of lateral roots occurred in the treated plots. Roots in the sulfur treated plots penetrated to coarse sand at a depth of 40 inches.

Calcium chloride and gypsum had little effect upon the pH of the soil. Sulfur lowered the pH of the surface layer in direct proportion to the amount applied. None of the treatments had an appreciable effect upon the soil below a depth of 9 inches.

Little difference was found in the amount of soluble salts with the exception of the heavier sulfur treatments. The latter plots contained more soluble salts in the surface 9-inch depth than did the other plots.

All the treatments lowered the percentage saturation of sodium in the surface 9-inch depth; the order of decreasing effectiveness was sulfur, calcium chloride, and gypsum. None of the treatments had any measurable effect on saturation of the soil with sodium or potassium below a depth of 9 inches.


Nitrogen and Organic Matter Changes in Irrigated Soil

Total nitrogen and organic matter contents have been determined on soil samples taken to a depth of five feet from the rotation plots of Field K at the Scotts Bluff Field Station in 1941. These results were compared with similar determinations previously made on samples taken in 1912 soon after the plots were broken from sod.

The results point out the value of manure applications and the growing of alfalfa in a rotation on the maintenance of nitrogen and organic matter in the surface foot of Tripp very fine sandy loam. Cropping for 30 years with neither legumes in the rotation nor manure applications resulted in decreases of 30 to 35 per cent in nitrogen and organic matter contents. Compared with the original samples, an average annual application of 4 tons manure per acre resulted in a small decrease in nitrogen and organic matter contents whereas an average annual application of 6 tons of manure per acre resulted in a small increase in nitrogen and organic matter contents. Where alfalfa was grown three years in a six-year rotation, the nitrogen and organic matter contents were maintained at approximately the levels of the original samples. An average annual application of 2 tons of manure per acre to a similar six-year rotation resulted in nitrogen and organic matter contents almost identical with those obtained with an annual application of 6 tons of manure in rotations containing no legume.

Neither cropping nor manure applications had any measurable effect on the nitrogen and organic matter contents of the soil below a depth of one foot.

Chemical and Physical Properties of Soil

A study was made to characterize soils mapped as types of the Bur-
chard and Steinauer series. The parent material of these soils consists of calcareous Kansan drift. A part of the characterization of these soils was based upon observations made in the field in southeastern Nebraska, and the remainder upon laboratory data taken by horizons from nine profiles. Six profiles were taken from type locations of different types.
of Burchard and Steinauer series. The remaining three profiles were chosen to represent soils which might be mapped as types of the Burchard series, but which had some of the characteristics of the related series, viz., Carrington, Steinauer, and Pawnee.

Field observations and laboratory data indicate that typical Burchard soils differ from typical Steinauer soils in three important respects. First, the Burchard soils have a definite textural B horizon whereas the Steinauer soils do not have a textural B horizon. Second, the two soils differ markedly in total amount and distribution of organic matter. In the Burchard soils, the organic matter decreases gradually and with fair uniformity of rate to a depth of 35 inches. In the Steinauer soils, however, the amount decreases quite rapidly to a depth of about ten inches and then decreases very slowly into the lower B and C horizons. Third, the two soils differ in pH and carbonate content. In the Burchard profiles the pH values indicate slight acidity to a depth of 20 or more inches with carbonate being present at a depth of about 26 inches. In contrast, the Steinauer soils had pH values of 6.9 or above from the surface downward. There were noticeable amounts of carbonate throughout the profile with a marked concentration at a depth of 12 inches.


Henry W. Smith and H. F. Rhoades.
With the ultimate aim of greater yields through the adaptation of crops to Nebraska conditions, field crops research seeks to improve strains, to increase hardihood, and disease resistance, and to find new or better cultural practices.

Field Crops Research
Department of Agronomy

Protein from Pasture Grasses

THE value of pasture in supplying the protein needs of livestock on the farm has received increasing attention during recent periods of protein feed shortages. Pastures offer a cheap source of protein which may be harvested without high labor costs. Total yield and protein content of the most important pasture grasses adapted to eastern Nebraska conditions have been compared over a five-year period. The relative value of these grasses was determined under different frequencies of harvesting by mowing to simulate haying and pasturing conditions. A five-year study on the maintenance of stand and yield of bromegrass-alfalfa pastures under different systems of pasture management also was concluded in 1943.

Effect of Mowing Frequency.—The grasses studied included five cool-season grasses, bromegrass, crested wheatgrass, western wheatgrass, Russian wild-rye and Kentucky bluegrass, and five warm-season grasses, big bluestem, blue grama, side-oats grama, buffalo grass and switchgrass. The period of years in which the investigation was conducted included wet and dry years and years in which rainfall was distributed to favor the production of warm-season or of cool-season grasses.

Yields were secured by mowing replicated plots of each grass in two ways during the five-year period. One set of plots was mowed once each season as hay at the approximate time of maximum production and another set was mowed several times during the season to simulate grazing. Although the harvesting of grass by mowing may not be considered entirely comparable to harvesting by grazing, the responses of the grasses to the two frequencies of mowing may be taken as indicative of yields obtained as hay versus yields obtained under pasture conditions.

By 1943, the fifth year of the experiment, the cumulative effects of the previous years' mowing treatments had become pronounced. The pasture yields were lower than the hay yields for all of the grasses except buffalo grass, a grass which withstands close and frequent clipping. In 1943, April and early May as well as August, September, and October were especially dry. June was a month of high rainfall and July was above normal in precipitation. Accordingly, the yields of warm-season grasses were favored over those of the cool-season grasses. Hay yields relative to that of bromegrass taken as 100 were as follows: big bluestem 191, side-oats grama 132, blue grama 118, bluegrass 114, bromegrass 100, crested wheatgrass 90, switchgrass 77, western wheatgrass 75, Russian wild-rye 48, and buffalo grass 37. When harvested as pasture, bromegrass was exceeded in yield by four grasses. These yields relative to that of bromegrass taken as 100 were: big bluestem 184, blue grama 148, buffalo grass 138, and side-oats grama 111.

During the investigation each of the 10 grasses was outstanding in one or more years for one or more characteristics. Switchgrass was the
highest yielding grass in the first year in which the production was measured but was most severely damaged by the mowing treatments and weed invasion.

In the years of very limited moisture the two short grasses, blue grama and buffalo grass, showed to advantage in average yield. They withstood the frequent clipping treatments better than did the other grasses. Buffalo grass produced higher yields on the more frequently clipped plots than on plots cut once a season. Loss of stand occurred on plots of this grass cut only once a year.

During years of good rainfall bromegrass and big bluestem were highest in yield. Their relative production depended on the seasonal distribution of moisture. Bromegrass responded to adequate spring moisture and big bluestem to summer rainfall.

As an average for the most productive period, 1941–1943, the grasses were given the following ratings in relation to bromegrass as 100, the ratings being determined by the average yields of both hay and pasture plots: bromegrass 100, big bluestem 103, crested wheatgrass 82, blue grama 79, buffalo grass 78, bluegrass 75, western wheatgrass 70, side-oats grama 63, Russian wild-rye 57, and switchgrass 42. Somewhat similar ratings were obtained for the five-year period 1939–1943 with the exception of buffalo grass which rated 92 instead of 78 due to the relatively high production of the grass in 1939 and 1940. The cool-season grasses maintained the best stands and were less affected by weed invasion than were the warm-season grasses. Of the warm-season grasses, blue grama maintained the best stand and was least affected by weed invasion.

Samples of forage obtained from the grass plots harvested for hay and pasture yields were analyzed for nitrogen content. From these data crude protein (N x 6.25) was determined. Averages of plot determinations of a grass at a given clipping date were made to determine the seasonal trend of protein production in plots cut several times during the season as compared to those cut once for hay.

The crude protein content of grass during early stages of vegetative growth is relatively very high as compared with grass which is approaching maturity. The decrease in the percentage of protein is rapid after reaching the jointing stage as yield increases and the grass heads out. Accordingly, the stage of cutting is the most important factor in determining the protein content of hay. Greater differences could be found between different stages of cutting for hay than between different kinds of grasses. The protein of grasses normally may vary between 10 to 15 per cent when cut at an appropriate stage for hay. Such percentages may be considered adequate protein for normal maintenance and growth of animals. Higher percentages with certain grasses may be obtained by sacrificing some of the yield by early cutting. Much lower percentages than these will be obtained if the grass is allowed to mature before cutting. Accordingly, mixed grass hay frequently is relatively low in protein because of the more advanced stage of maturity of part of the grasses.

In general, the cool-season grasses attain higher percentages of protein than do warm-season grasses. Cool-season grasses such as bromegrass and wheatgrasses may contain a very high protein content during spring and fall months. If kept clipped so that jointing and heading do not occur this high protein content may extend through the summer months
as long as a green succulent growth is maintained. The percentage crude protein of cool-season grasses harvested as pasture may vary from 15 to 25 per cent. Variability is due to season and to soil and climatic factors. Protein content as high as 30 per cent or somewhat more may be found in grass on especially fertile soils in the spring or in the small amount of growth made late in the fall. The protein of the warm-season grasses harvested as pasture in young growth stages during their growing season commonly runs between 10 and 15 per cent which may be considered adequate for normal maintenance and growth of livestock, although not as high as in cool-season grasses. With this group protein rapidly declines below 10 per cent as the grass matures.

In the clipping experiment the crude protein content of all the grasses was maintained at a higher percentage level on the frequently cut plots than on the plots cut once for hay. As an average for two years the calculated yield per acre was higher for most of the grasses on the plots that were cut several times as pasture than on those cut once per year at the stage of maximum production. This higher yield of protein on the pasture plots was obtained in spite of a lower total yield due to the cumulative effect of more frequent clipping. From these data it would appear that the most economical use of grasses in conserving protein would be in their use as pasture.

Somewhat similar results as to protein content and yield were obtained in 1942 with the annual cool-season crops, winter wheat and rye, cut during the spring months as hay and also at younger stages to simulate pasture. On a very fertile soil the protein level was maintained at 24 per cent or above in each of two clippings simulating pasture conditions as compared with 18 per cent when these crops were cut for hay in the early bloom stage. Late fall and early spring growth of these annual crops may produce protein percentages in the upper 20's or lower 30's. The protein content of Sudan grass, an annual warm-season grass, has been found to be around 12 per cent when harvested in pasture growth stages.

The high level of protein in the cool-season grasses in early spring and late fall suggests that their most economical use as pasture would be in conjunction with carbohydrate feeds. It is well recognized that excesses of protein in the ration are consumed in the production of energy in the same way as carbohydrates. The use of other feeds in conjunction with high protein pastures would thus conserve valuable protein, provided a maximum of the pasture's production is utilized at its proper growth stage.

The high level of protein in the cool-season grasses such as bromegrass, crested wheatgrass, and the annual pasture crops, wheat and rye, suggests the possible utilization of these grasses as special protein crops for dehydration. Such a crop would necessarily need to be harvested before maximum production of the grass had occurred in order to obtain the highest percentage of protein. More than one clipping could be secured or fields could be pastured following the harvest of one crop.

Rotation Grazing.—An experiment evaluating the effect of three grazing practices with sheep on the maintenance of stand and yield of bromegrass-alfalfa pastures was completed in 1943 in cooperation with the Animal Husbandry Department. The three methods of grazing management studied were (1) early and continuous grazing, (2) deferred
(in the spring) and continuous grazing, and (3) deferred and rotational grazing. The experiment was designed to answer certain practical problems of livestock and pasture management. Yields of bromegrass and alfalfa in mixture were obtained over a five-year period by the “difference” method using pasture cages, and a record of sheep days of grazing was kept.

As a result of the grazing management, striking differences were obtained between the pastures grazed in rotation as compared to those grazed continuously during the parts of the season in which they were productive. Both the early continuous grazing and the deferred continuous grazing caused a loss of stand due to irregular selective grazing or “spot grazing.” Loss of stand of alfalfa was most serious throughout these pastures, its yield in relation to the total production being reduced to 6 per cent in 1943. In the pastures grazed rotationally at the same stocking rate each season as the continuously grazed pastures, alfalfa made up 28 per cent of the total production in 1943. As a consequence of the legume being maintained in the mixture a higher yield was obtained in the rotation pastures as contrasted to the continuously grazed pastures which showed evidence of becoming sodbound. By such a system of rotation grazing, it appears possible to maintain pastures in a higher state of productivity as measured by total yield and yield of protein.

These studies were carried out in cooperation with the Division of Forage Crops and Diseases, U. S. Department of Agriculture.


**Alfalfa Improvement**

The transfer of much of the breeding work from Scottsbluff, in the western part of the state, to Lincoln has proved advantageous in some respects. During the past year a rather severe infestation of leafhoppers (*Empoasca fabae*) in the Lincoln area made it possible to eliminate many susceptible strains from the breeding material. It is believed that continued selection under leafhopper infestations may make it possible to isolate types that are much more resistant to leafhopper yellowing than any commercial varieties now being grown. Resistance to leafhopper yellowing is an important factor in the eastern alfalfa producing areas where western seed of improved strains will find a ready market, especially if found adapted to their conditions.

The Lincoln area provides a favorable environment for alfalfa improvement. It is far enough east to experience occasional epidemics of foliar diseases and infestation of leafhoppers, yet conditions are usually sufficiently favorable to make seed production possible. Winters in the area are severe enough to eliminate non-hardy strains and yet not so severe but what moderately-hardy breeding material will survive. Final winter-hardiness determinations are made under controlled conditions.

Progress is being made in increasing the supply of seed of the new bacterial wilt-resistant variety, Ranger, which was released for commercial production in the fall of 1942. Approximately 1000 pounds of seed were produced in 1940, over 2000 pounds in 1941, 12,000 pounds in 1942, and available estimates indicate that the supply for spring planting in
1944 will be between 30 and 35 thousand pounds. Preliminary tests have shown no appreciable difference in the yielding ability of seed from various generations of this synthetic variety, i.e., Syn-0, Syn-1, and Syn-2; nor from different regions providing the quality of the seed is sufficiently good to provide comparable stands. This point is of special interest with regard to Ranger since at this time the demand for seed of improved forage crops is so great. As the seed supply is increased it is expected that Ranger with its high degree of wilt resistance will fill an important need until superior hybrids can be made commercially available.

The commercial utilization of hybrid vigor in alfalfa awaits only a few more years of testing and the establishment of clonal lines which will transmit superior germ plasm to their progeny. The principles involved have been determined, the breeding methods are well worked out, and considerable material is being tested in various combinations. The utilization of small isolated areas in city gardens has proved a very satisfactory method for obtaining natural single- and multiple-cross seed for testing purposes. This phase of the program must of necessity be quite extensive since the very nature of the hybrid program demands the comparison of a large number of combinations.

The evaluation of clonal lines for general combining ability through a comparison of the progenies from their outcrossed seed is proving valuable. Aside from the production of this outcrossed seed the replicated polycross nursery provides an excellent opportunity for determin-
ing the performance of individual clones. This performance is important not only as a basis for selection but also from the standpoint of obtaining a hybrid with satisfactory seed production. Seed setting conditions were unusually good in the nursery during the 1943 season, largely due to an abundance of tripping insects. Wide variation in seed-setting ability was apparent. Seed yields per plant varied from over 10 grams for one clonal line to less than 1 gram for several others. This indicates the improvement that might be expected from the standpoint of seed yields, a factor which is among the most important in forage crop improvement. An attempt is being made to develop a hybrid that rates high in seed and forage yield, wilt resistance, winterhardiness, seedling vigor, and resistance to leaf and stem diseases as well as resistance to insects. Since it is believed that high protein and carotene content are associated with dark green color, lines possessing this characteristic are being selected.

The opinion in the past has been that hybrid vigor in alfalfa would probably be made available through the commercial utilization of double-cross seed. This involves finding four lines that “nick” well which is considerably more difficult than finding an outstanding single cross involving only two lines in a single combination. With this in mind along with the desirability of meeting and solving the difficulties of vegetative propagation involved in hybrid seed production, it is believed advisable to investigate the feasibility of utilizing the single cross for commercial production.

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

Sweetclover

Production Practices. The cultural studies with sweetclover are now being directed toward seed production. Special plantings were made for this purpose in the spring of 1943 and the effects of various first- and second-year field management practices on seed yields and ease of harvesting will be apparent in 1944. Experiments and experiences concerning the management of sweetclover for pasture, hay, and soil improvement have been summarized in bulletin form.

The three new varieties, Madrid, Spanish, and Evergreen, have continued to be superior as to forage yield, rapid seedling growth, and ease of obtaining successful stands because of favorable competition against weeds. General use of these varieties, which are named above in order from early to late maturity, awaits increase of the seed supply by farmers. Such seed increase may be regarded as a real service to agriculture.

A better understanding of seedbed and seeding requirements has led to the recommendation and use of materially less seed per acre than was formerly believed necessary. With sound, scarified, hulless seed, 8 to 12 pounds per acre is sufficient under favorable seedbed conditions. A companion crop of oats or barley sown at half the normal amount of seed per acre usually does not reduce the chances of obtaining a stand of sweetclover in eastern Nebraska and yet contributes nearly a full yield of grain.

The maximum amount of pasturage is provided if the sweetclover is
not grazed excessively close. Pasturing precautions must be taken to prevent bloat in livestock. To obtain well-cured sweetclover hay without spoilage requires more favorable curing conditions and careful handling than do other hay crops. Spoiled sweetclover hay may cause "bleeding disease" and should not be fed to livestock.

Sweetclover is a valuable soil-improving legume, resulting in better texture and nitrogen content of the soil. This commonly leads to increased yields of succeeding crops where moisture is ample. Under conditions of moisture shortage excessive fertility may result in "burning" of the crop due to over-stimulation, and for this reason sweetclover should not occur too frequently in the rotation.

**Sweetclover Improvement.** Breeding work continued to be directed toward improvement with respect to such characters as lateness of maturity, palatability, coumarin content, leafiness, stem fineness, seed production, and general vigor.

During the year a number of selections were made in segregating populations resulting from crosses between high-yielding Madrid and several aberrant, very late maturing but low-yielding yellow sweetclovers. These segregates appeared to possess gene combinations of high vigor and lateness. In 1944 the selections will be grown in isolation for recombination into a new variety. An isolated crossing block containing lines similarly but less carefully selected was started in the spring of 1943. Syn-1 seed of late maturing yellow-flowered sweetclover will be available in the coming year from this crossing block.

Investigations on the palatability of sweetclover and the toxicity relations of improperly cured hay were continued through the selection of plants low in coumarin and related compounds. During the year a rapid, quantitative method of coumarin determination based on the fluorescence principle was developed. By means of this new test approximately two thousand plants were analyzed and several plants were found with coumarin contents considerably lower than those normally contained in our commonly grown sweetclovers. No plants free or nearly free of coumarin were discovered in these investigations.

Several crosses between high-yielding, high coumarin *M. alba* plants and the low-yielding but coumarin-free *M. dentata* species were obtained. Hybrids between these two species lack chlorophyl and are unable to grow beyond the sprout stage. However, they can now be made to develop to maturity by using the grafting technique of Dr. W. K. Smith of Wisconsin. Studies to determine the possibility of obtaining coumarin-free yet high-yielding segregates from this hybrid are continuing.

A seed increase plot of a new fine-stemmed, very leafy synthetic variety was established during the year. About a bushel of seed is expected from this plot during the coming year to be used for further testing. This new variety made exceptionally good first year growth and if it continues to perform as well in its second year it should find a place in Nebraska agriculture as a hay-type sweetclover. A new synthetic variety similar in type to the one described was begun in 1943. The new synthetic variety is being developed from inbred lines selected on the basis of their "polycross" performance.

Efforts continue at developing a new strain of Evergreen sweetclover which will maintain its present high-yielding capacity and lateness of maturity but will possess improved seeding ability. With this in view, a part of the breeding nursery was devoted to the production and se-
lection of lines of Evergreen which possessed all these desirable characters. During 1943 several such lines were added to the number obtained in previous work. When a sufficient number of desirable lines have been obtained they will be recombined into a new strain of Evergreen which is expected to prove superior with regard to seed production.

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


**Improvement of Small Grains**

In the last report it was stated that more emphasis was being placed on the increase and preparation for distribution of superior strains of small grains. This same emphasis was continued during 1943. With the distribution of certain varieties it was possible to discard much similar but slightly inferior material, thus making room for other strains.

The 1942–43 season at Lincoln was rather favorable for small grains. Winter wheat did not make as much straw growth in the field plots as in 1942, but yields of grain were nearly as high. In the nursery growth was slow in the fall, heavy winterkilling occurred, and yields were low, but this made possible the elimination of tender material. Leaf and stem rust appeared late and failed to do any damage. The oat crop was characterized by high yields, but low test weights. The barley nursery was much better than in 1942 when chinch bugs caused so much damage.

At Alliance differential killing was recorded for winter wheats, but those varieties having the better survivals gave the highest yields. Spring grains looked very promising until hit by a severe hailstorm soon after heading. No attempt was made to harvest either barley or oats, and although injured the spring wheat was cut but yields and quality were very low.

The shift from field plots to nursery plots for small grain varietal tests at the Box Butte Experiment Farm at Alliance, was completed. The data obtained from nursery plots were satisfactory, the cost was greatly reduced, and the plan will be continued.

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

**Winter Wheat.** The seed increase of Pawnee winter wheat was continued in 1943 with considerable success. This variety, developed cooperatively by the Nebraska and Kansas Experiment Stations and the U. S. Department of Agriculture, possesses a number of highly desirable characteristics. Pawnee is early ripening, is resistant to Hessian fly in the hard red winter wheat region, is highly resistant to loose smut, and is moderately resistant to leaf and stem rust. It has a heavier test weight than Turkey, and is not greatly different from that variety in milling and baking characteristics. It is not as winter-hardy as Kharkof, may shatter under certain conditions, but in extensive tests has displayed an unusual capacity to yield over a rather wide area. It is recommended for southeastern Nebraska, south of the Platte river and west to Highway U.S. 81. Each of 24 selected farmers were sold two bushels of seed in
the fall of 1943. These men, all located in the recommended area, were asked to put their seed on approximately two acres of ground. Winter injury eliminated four of these tests, but from the remaining 20, approximately 1200 bushels of seed were harvested. The highest yield reported was 107 bushels from 2.4 acres, and the lowest was 30 bushels from 1.8 acres. On the Agronomy Farm 432 bushels of cleaned foundation seed was harvested from 11 acres, and on 4.5 acres grown under contract in southeastern Nebraska 182 bushels were harvested. All of this foundation seed was sold and there was a big demand for the seed raised by the farmers. All of this seed was planted in the fall of 1943 under relatively unfavorable soil moisture conditions.

In field plot tests at Lincoln in 1943, Pawnee ranked first with an average yield of 54.3 bushels per acre. A few of the other named varieties in the test ranked in the following order: Chiefkan, Comanche, Blackhull, Tenmarq, Cheyenne, Nebred, and Nebraska No. 60. For the 14-year period (1930-43), Cheyenne has ranked first for yield followed by Tenmarq, Nebred and Kharkof. For the period 1936-43, Pawnee has had an average yield of 31.6 bushels per acre compared to Cheyenne 25.5 bushels, Nebred 24.8 bushels, and Turkey 23.8 bushels.

Winterkilling was heavy in the nursery, being most severe in some yield tests, the head rows, and in the rust nursery. While this reduced the yields, it did make possible selection for cold resistance, and in the rust nursery under an artificial epidemic of stem rust, selection was also made for rust resistance. Considerable progress is being made in the development of stem-rust resistant winter wheats that are hardy enough for Nebraska.

Winter survival was an important factor determining yields of winter wheat varieties in the test at Alliance. The highest yield was for Nebred with 29.1 bushels and the lowest for Chiefkan with 17.8 bushels per acre. Between these extremes were found Cheyenne, Pawnee, Tenmarq, Nebraska No. 60, and Comanche yielding in the order named. For the period 1931-43 Cheyenne and Nebraska No. 60 have had the highest average yields, while for the period 1938-43, Cheyenne, Nebred, and Pawnee have had the best records.

**Spring Wheat.** The spring wheat variety test at Lincoln was grown in nursery plots using seven replications. The yields obtained were slightly higher than for previous years. Some leaf and stem rust developed on susceptible varieties and as usual test weights per bushel were low. Pilot yielded 18.7, Rival 18.0, Kearney 16.5, and Thatcher 15.4 bushels per acre. Newthatch, a leaf-rust resistant Thatcher, gave a yield of 13.0 bushels per acre. Over a period of years Kearney still has the highest average yield but its quality is not acceptable. Pilot and Rival should be considered along with Thatcher as being among the varieties best adapted to Lincoln, although the yields of this crop are much below those of winter wheat. At Alliance, spring wheat was very poor with Thatcher averaging 8.4 bushels per acre, while Rival, Kearney, Pilot, and Mindum all yielded less. No variety has exceeded Thatcher in average yield for a period of years although Mindum, Rival, and Pilot have had records nearly as good.

**Barley.** In the barley variety test at Lincoln, stands were thin, test weights low, but yields were slightly higher than in 1942. The highest ranking strain was Hybrid Composite (C.I. 7114) with a yield of 41.9 bushels per acre. This strain was selected at Nebraska from Hybrid
Composite (C.I. 5461) and has been advanced to field plots because of good nursery record. It was entered in tests in other states in 1943 and did very well in some of these. This strain may have some value as a malting variety. Some of the named varieties gave the following yields in bushels per acre: Velvon 35.5, Spartan 33.4, Beecher 33.0, Ezond 31.0, and Trebi 28.4. For the period 1935–43 Spartan ranked first for average yield, followed by Club Mariout, Ezond, and Trebi. For the period 1939–43, Spartan and Velvon have had averages that are nearly identical and are closely followed by Lico, Club Mariout, and Ezond.

The barley nursery included the usual yield tests as well as a Great Plains Uniform Nursery and an Upper Mississippi Valley Nursery. This latter test is grown in the area indicated with its chief purpose being to test material of possible value for malting. Several strains in this nursery gave indications of having some agronomic value in Nebraska, and these will be tested more thoroughly at Lincoln and possibly at one or two points in the northeastern part of the state.

**Oats.** The new oat selection, Victoria x Richland (C.I. 3314), was named Cedar and seed released to experienced growers in the spring of 1943. The variety was named in cooperation with the Iowa Experiment Station at Ames, since it was developed there. Cedar is a variety that is resistant to both crown and stem rust and to smut. In the spring of 1943 about 140 bushels of seed were sold to 13 selected growers in eastern Nebraska, and after harvest these men offered over 2300 bushels of seed for sale. In addition the Agronomy Department had about 500 bushels of Cedar for sale.

The oat variety test in field plots at Lincoln was characterized by high yields, but low test weights. In addition the straw was short, ranging from 28 to 34 inches in height. Two varieties, Ventura and Tama, each had average yields of 85.3 bushels per acre, which were the highest in the test. Ventura, in the variety test for the first time, is a selection from the cross Fulghum-Markton x Victoria-Richland that was named recently. Ventura is disease resistant like Cedar but seems to be a few days earlier in heading but no earlier in ripening. Tama is a sister selection of Cedar and the two strains are very similar. Some of the named varieties gave the following yields (in bushels per acre): Cedar 84.4, Marion 81.4, Boone 76.7, Trojan 69.1, Otoe 66.8, Kherson 65.1, Brunker 64.9, Kanota 58.5, and Fulton 55.8. It will be seen that the new, disease resistant, slightly later types gave yields well above the earlier and more common types for Nebraska. The presence of stem rust on the earlier, susceptible varieties may have reduced their yields, but it must be remembered that the season was rather favorable for late varieties. For the period 1930–43, Otoe and Trojan have had the highest average yields, while for the 1932–43 period the ranking strains were Brunker, Otoe, Columbia, and Trojan. Cedar was first tested in 1938 and for the period 1938–43 has had an average yield of 58.4 bushels, compared with 52.4 bushels for Otoe, and 44.9 bushels for Kherson. For this same period of years Marion, Brunker, and Columbia have had good yield records although not so good as Cedar.

The oat nursery at Lincoln was very good, with yields nearly as high as indicated for the field plots. Again the later types tended to yield above the earlier varieties. Several new strains that have disease resistance are being increased and will be entered in the field plot tests in 1944. In the nursery some selections are available that are slightly
earlier than Cedar and yet resistant to crown and stem rust. It is hoped that they will be adapted a little farther west in Nebraska than is Cedar.

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Corn Improvement

A late wet spring necessitated considerable replanting of corn in the state in 1943. Later, however, growing conditions became very favorable and the crop had lost its backwardness by tasseling time. In spite of some moisture deficiency in late summer the crop ranged from fair to excellent over the main corn growing areas of the state. The official estimate of yield was set at 26 bushels per acre as compared with 33.5 bushels in 1942.

The use of hybrid corn in Nebraska has not yet reached a maximum as is indicated by the following data supplied by the Nebraska State-Federal Division of Agricultural Statistics. Striking annual increases in the acreage planted to hybrids are shown, beginning with the year 1934.

Annual percentage of total corn acreage planted with hybrid corn in Nebraska:

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<th>Year</th>
<th>1934</th>
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<tr>
<td>Per cent hybrids</td>
<td>0.1</td>
<td>0.3</td>
<td>1.0</td>
<td>2.5</td>
<td>6.8</td>
<td>12.7</td>
<td>24.9</td>
<td>36.5</td>
<td>51.4</td>
<td>63.0</td>
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In many of the eastern counties and in extensive irrigated districts elsewhere as much as 90 to 95% of the acreage is planted to hybrids. Under dryland conditions in south-central, central, and western Nebraska where drouth hazards are somewhat greater in the absence of irrigation, progress in the testing, demonstration, and general acceptance of corn hybrids has been more retarded because of crop failures caused by drouth. In the south-central and central sections, hybrids are now, however, making their way. Corn breeders and seed producers understand better the adaptation requirements and have a more effective improvement program for those regions. During this transition period, conservatism in the use of hybrids would seem the wise policy except as local experiments and experiences may justify their more general adoption.

The hybrid corn testing program involving the testing of privately controlled as well as Experiment Station hybrids under the designation “Official Yield Tests” was discontinued this year. A reduced testing program consisting mainly of Experiment Station hybrids together with a few of the privately controlled hybrids that had maintained a high average performance over a period of years was carried out in the eastern corn districts and at the North Platte and Scotts Bluff substations.

Several experimental hybrids continued to demonstrate their superior performance, and will be eligible for certification in 1944. They include two yellow hybrids, Ia. 4316, a good early corn for northeastern Nebraska, and Nebr. 1001, a midseason corn for east-central and west-central irrigated areas, and a white hybrid, Kansas 2234, which is a late corn adapted to the southeastern parts of the state. During the last two years, 13 hybrids, including 9 Nebraska certified hybrids and 4 experimental hybrids, averaged 19 per cent higher yield on the Experiment Station farm at Lincoln than open-pollinated corn. Of these hybrids, the nine that are considered suitable types for this locality averaged 24 per cent higher yield than that of the standard open-pollinated variety.
A collection of 9 varieties and 36 hybrids was again tested in 1943 on the Box Butte Experimental Farm, with the objectives of establishing the type of corn best suited for the dry-farming conditions in that part of northwestern Nebraska and to find if possible some superior hybrids that might be recommended there. Most of these were chosen on the basis of previous performance at Alliance and included some of the most promising Experiment Station hybrids from Wisconsin, Minnesota, North and South Dakota, Michigan, and Ohio. Some of these hybrids closely resemble the best local open-pollinated varieties as to plant type, while some are smaller and earlier ripening and others are larger and later. No hybrid proved superior in grain yield to the best local open-pollinated varieties. Likewise, no newly introduced variety has proved superior. The highest yielding hybrid was surpassed 1.5 bushels by the highest yielding variety. Correspondingly, in 1942 the highest yielding hybrid surpassed the top variety by 1.3 bushels. These differences are not statistically significant. Since a number of the hybrids so far tested possess superior vegetative characteristics and have approximately equalled the yield and quality of grain of the best established varieties, it appears likely that satisfactory hybrids can be developed for this region that will add to the profits of corn production.

Since Nebraska has long been an important popcorn producing area, it was thought desirable to begin improvement work with this crop. Two common varieties, South American and Supergold, were compared with four Kansas popcorn hybrids at Lincoln this year. The hybrids averaged 47.0 bushels per acre against 28.8 bushels for the varieties, which is a superiority of 63%.

Approximately 23,000 bushels of the variety known as “Nebraska Waxy” was grown under contract by Nebraska farmers for the experimental use of the National Starch Products Inc. of New York. This type of corn is proving satisfactory to replace the cassava starch formerly imported for special food and industrial utilization. The possible industrial need for this type of grain has led to a special breeding program for the development of superior waxy corn hybrids. Favorable progress was made in 1943 in the production of both yellow and white waxy lines by both self-fertilization and back-crossing methods. A new open-pollinated yellow waxy variety (Nebr. Waxy No. 5) and a new white waxy variety (Nebr. Waxy No. 6) surpassed Nebr. Waxy by 3 bushels or 5 per cent in yield of grain per acre. In a comparative yield test involving 8 replications on the Experiment Station farm at Lincoln, the following yields were obtained: Nebr. Waxy 58.8 bu., Iowax 1 (formerly Waxy Iowa 939) F1, Waxy 60.6 bu., Iowa 939 F1 (non-waxy) 62.2 bu., and U. S. 35 (non-waxy) 72.9 bu. Iowax 1 is regarded as the most productive waxy corn now available. In vegetative characteristics this waxy hybrid is almost equal to the Iowa 939 non-waxy hybrid and evidently may be expected to yield within 5 per cent as much grain. In comparison with U. S. 35 which ripens a week later and is a more suitable hybrid in this locality, its yield was 17 per cent less. The extent to which waxy corn may be grown in Nebraska in the future will depend upon industrial demand and contract prices.

The Agronomy Department produced 500 bushels of waxy corn to be used in a continuation of feeding experiments by the Animal Husbandry and Poultry departments.
A rate-of-planting test was carried out at Lincoln in which Ia. 939, Nebr. 463, U. S. 13, and Ohio C92 were planted at the rates of 2, 3, 4, and 5 kernels per hill with no thinning. The final stands averaged 1.8, 2.6, 3.1, and 4.0 plants per hill, respectively, and the corresponding yields averaged 57.0, 64.2, 64.4, and 65.5 bushels per acre.


**J. H. Lonnquist and T. A. Kiesselbach.**

### Sorghums

The 1943 season was very favorable for sorghum production. Yields were the highest ever obtained on the Experiment Station farm. Chinchbug infestation was light. The moisture conditions early in the season were very favorable for the development of the crop and the low precipitation during August and September permitted the crop to mature uniformly without excessive tillering. Special emphasis was placed upon purification and seed increase of the certified varieties and of promising new ones developed by the Station.

**Sugar Sorghums.** For the second year a project was conducted in cooperation with the Sugar Division of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, to test the possibilities of using sweet sorghums for sugar production. Two tests were conducted in 1943. One test included four varieties which had previously given promise for use in sugar production. In this test the total acre yields based on 70 per cent moisture were: Red X 23.7 tons, Collier 20.7 tons, Early Folger 18.0 tons, and Rox 17.1 tons. The field yields of stripped and topped stalks of these were 16.0, 16.7, 12.6, and 11.2 tons, respectively. The Brix readings of the juice ranged from 19.2 per cent for Collier to 17.6 per cent for Early Folger. These readings indicate the per cent of solids in the expressed juice, and approximately 70 per cent of the solids is sucrose. Figured on a basis of 15 tons of stripped and topped stalks per acre, about 1800 pounds of sugar could be produced per acre.Unfortunately the laboratory analysis failed to show the accurate percentage of sucrose in the samples of juice and it was not possible to calculate the sugar yield of the different varieties.

The second test consisted of 10 varieties with a wide range of maturity dates. Yields per acre on a 70 per cent moisture basis ranged from 20.8 tons for a very late maturing variety, Saccaline, to 12.7 tons for the extra early variety, Ames Amber.

**Waxy Sorghums.** The interest in sorghums with the waxy type of endosperm has decreased in Nebraska during the past year mostly because of the increased acreage of waxy kafir in Texas and the increase of Waxy Club (Cody) in Kansas. These two varieties are much more satisfactory for use in the manufacture of industrial starch than is Leoti. A minor part of the present breeding program is the development of an adapted, “combine” waxy variety. In addition, extensive selections have been made in Leoti sorgo in an effort to produce a variety that is pure for the waxy character, and more uniform in plant type. Seed increase plantings of the more desirable selections will be made in 1944.

**Seed Treatment.** In cooperation with the Department of Plant Pathology and the Division of Cereal Crops and Diseases, U. S. Department of Agriculture, the reaction of nine different fungicides applied at
two rates to Sharon kafir and Leoti sorgo was studied. The two varieties were planted on two dates, May 22 and June 17. The results may be briefly summarized as follows: (1) The highest smut infection was in the early planted check plots. This shows the influence of soil temperature on the degree of smut infection. (2) The fungicides, Copper Carbonate, Ceresan, Spergon, Arasan, Dubay 1452-c, and Leystosan gave good control for smut. M.T.D.S. controlled smut on Sharon kafir but not on Leoti. The glumes which adhere to the Leoti seed reduce the effectiveness of some fungicides, particularly those which kill smut spores only by contact. Merc-o-dust gave very poor control. (3) All fungicides with the exception of sulfur gave significantly increased stands from the early planted Sharon kafir. There was very little increase in stands from the treatments on the seed when planted late. Similar results were observed from the seed treatment of Leoti, although the differences in stands were not so marked. In an unreplicated seed treatment test the commercial compound, Sanoseed, failed to control smut. The results of 1943 closely correlate with those obtained in 1942.

Selection of Early Kalo. The same 14 reselected strains of Early Kalo that were tested in 1942 along with Nebraska Certified Early Kalo were again compared in a yield test of balanced lattice design. This gave no increase in precision over the randomized block design. The highest yield, 57.1 bushels per acre, was produced by a Kansas selection. For the past two years the Kansas selection H.C. 48 has had the highest average yield. It is of very uniform type, yields as well or better than the present certified Early Kalo, and is somewhat more resistant to lodging. This improved selection will be increased to replace the Early Kalo now being certified.

Testing Varieties for Grain Yield. The grain yield test was divided into two sections. Section I included 36 entries, about half of which were standard varieties and the remainder advanced experimental varieties. The five highest yielding varieties were Hegari, Nebr. No. 44, Bonita, Club, and Early Hegari with acre yields of 100.0, 93.0, 92.8, 90.2, and 85.0 bushels, respectively. The comparable yield of corn (U.S. 35) was 77.4 bushels. Some of the experimental selections looked very promising. Section I was planted in a simple lattice design and there was no gain in precision over the use of randomized design.

Section II of the yield test included 28 varieties, mostly experimental and new introductions. The five high yielding varieties were Hegari T.S. 7317, Early Hegari S.A. 25248, Leoti x Atlas H.C. 40–17, Hegari S.A. 1547–1, and Kalo sel. H.C. 613 with acre yields of 90.0, 78.3, 74.6, 72.9, and 68.1 bushels, respectively. Although the Hegari varieties were high yielding they proved to be very susceptible to charcoal rot. In most years since 1932 Club has been the highest yielding variety. Pink kafir, Western Blackhull, Early Kalo, and Hegari have also given good yields.

Yields of Forage Varieties. Eleven forage varieties were compared with corn for yield of forage. The yields, calculated on a 15 per cent moisture basis, ranged from 7.09 tons per acre for Atlas to 4.08 tons per acre for Sudan grass. The yields of Kansas Orange, Rox, and Leoti were 6.95, 6.34, and 5.85 tons per acre, respectively. In most years Atlas has been the highest yielding variety grown.

Breeding Nursery. A large number of lines were grown in head rows for observation and selection. Several lines were selected to be included in the 1944 yield tests.

**Sudan Grass Nursery.** This nursery included several strains developed in Texas from a cross between Leoti and Sudan grass, and also several local selections from Common Sudan grass. There was considerable variation between selections as to their resistance to chinch bugs, type of growth, rate of recovery following clipping, and prussic acid content. The prussic acid content of the new variety, Tift, developed in Georgia was equal to that of Black Amber sorgo while most of the Leoti x Sudan selections were about equal to Common Sudan.

*O. J. Webster and T. A. Kiesselbach.*

Sweet Sudan-type selections (Sudan x Leoti sorghum) showing chinch bug resistance in comparison with Sudan grass in center row.

**Soybeans**

Increased interest in soybeans in Nebraska is reflected in the expansion of the soybean acreage to 100,000 acres in 1943. This acreage, the largest
in the state’s history, was mainly the result of an effort on the part of farmers to help meet the tremendous wartime demand for fats and oil and to increase the farm supply of high protein feed to be used in balancing grain rations. Soil moisture conditions during the early part of the growing season were generally favorable for the growth of soybeans. In spite of this, the yields on many farms suffered badly because the wet, rainy weather at this time interfered with successful weed control. Yields were further reduced by late summer and fall drouth which prevented the grain from filling out properly. The officially estimated yield for the state was 11.5 bushels per acre.

At Lincoln a test of 25 varieties was conducted in cooperation with the U. S. Regional Soybean Laboratory. Another cooperative test with 16 varieties of earlier maturity was located in the vicinity of Norfolk. Richland and Earlyana were outstanding varieties on the highly fertile soil of the northern test, while at Lincoln the new variety known as “Lincoln” again gave superior performance. The seed supply of the “Lincoln” is being increased for general distribution. A seed-increase field at Lincoln, irrigated once, yielded 36 bushels per acre compared with 28 bushels without irrigation. Dunfield and Illini continue to be standard varieties for Nebraska.

Breeding work was continued in an effort to produce new varieties better adapted to the soil and climatic conditions of Nebraska. For this purpose 52 hybrids in the fourth generation and 78 hybrids in the fifth generation were included in the 1943 breeding nursery. A total of 470 single plant selections were made from these and other strains for testing in 1944. Varietal crosses were made in the greenhouse during the winter for use in the selection of new varieties.

A seed-treatment and inoculation study carried on cooperatively with the Department of Plant Pathology and the U. S. Regional Soybean Laboratory showed that stands can be improved by the use of com-

Experiment Station soybean field in which varieties were tested in 1943.
commercial seed treatments. However, the improved stand did not significantly increase yields at the rate of seeding used in this experiment. The inoculation of seed with appropriate bacterial cultures failed to increase the yield.

Investigations with soybean varieties suitable for vegetable purposes were conducted during the year with a test of 15 varieties recognized as having merit for such use. In this test Bansei, Mendota, Kanro, and Jogun were selected as being most desirable from the standpoint of yield and general suitability for planting in gardens.


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

**Miscellaneous Crops**

Regional testing of a limited number of miscellaneous crops in Nebraska was continued in 1943 in cooperation with the University of Nebraska Chemurgy Project. The most extensive work was done with flax, safflower, sesame, and castor beans.

**Flax.** Yields in 1943 were good throughout the state wherever weeds were not the limiting factor. Averaging tests at Lincoln, Allen, and Tecumseh the yields were: Biwing 15.3 bu., Redwing 14.6 bu., and Bison 14.9 bu. per acre. The average of all varieties in the U.S.D.A. Uniform Nursery at Hay Springs on dry land was 12.5 bushels per acre. Biwing, a new variety developed by the Minnesota station, is now certified in this state.

In the western part of the state results in 1942 indicated that weeded 24-inch row spacing did not reduce yields in comparison with weed-free solid-drilled flax. In 1943 two varieties were seeded at Hay Springs in 6-, 24-, and 42-inch row spacings at the rate of 32 pounds per acre. The 6-inch row spacings were practically weed-free. The 42-inch spacings were seeded in twin rows 6 inches apart. The 24- and 42-inch rows were given shallow cultivations June 5 and 25. The average yields were: 6-inch spacing 11.4 bu., 24-inch spacing 13.8 bu., and 42-inch spacing 11.5 bu. per acre. This method of production may be commercially feasible where moisture is the limiting factor and in areas where weeds are troublesome.

Pasmo during the past two years has been a severe disease on flax in eastern Nebraska, especially when grown on bottom lands. The germination of seed produced in the eastern part of the state is often low, and is usually improved by seed treatment. On the other hand, the quality of seed produced in the western part of the state is good and the germination has not been improved by seed treatment.

**Safflower.** This crop has again shown possibilities of becoming a new crop in western Nebraska. Average yields of safflower at Scottsbluff under irrigation for the varieties Pusa No. 7, Ahmednager No. 1, Simla, Kardai, and Sholpur No. 1, were 2676 pounds per acre. For best results safflower should not be flood-irrigated. Ordinary beet machinery is well suited for growing this crop under irrigation. The average yield on dry land for the same five varieties at Hay Springs was 1043 pounds and at Dalton 395 pounds per acre. The Dalton nursery was badly hailed June 27. On dry land this crop will mature when seeded as late as June 10.
In the spring of 1943, 400 pounds of safflower seed of the above mentioned varieties was obtained from the Huntley, Montana, Substation through the U.S.D.A. This seed was increased by the University. Plans are now being developed for further increase, looking toward commercial production.

Most existing varieties are not pure. Sterility in some lines is common and considerable cross-pollination takes place. Purification of a few of the better varieties is now in progress. Many selections with varying degrees of spiny ness have been made and are being tested for their oil content and yielding ability. Crosses are also being made with the objective of combining spinelessness, high oil content, and high yield in one variety.

**Castor Beans.** This year all tests were not harvested until two weeks after a killing frost. Varieties such as Conner, Ky. No. 38, lost less than 2 per cent of seed through shattering. Individual plants in other varieties did shatter materially, some few plants losing all their seed, others none. A self-fertilization program to develop a shatter-resistant variety with short, fine stems is in progress.

Cooperative U.S.D.A. Uniform Castor Bean nurseries were grown at Lincoln and Falls City. Varietal seed-yields at Lincoln varied from 845 to 1089 pounds per acre. At Falls City on low-fertility upland soil the yields varied from 352 to 420 pounds per acre. In these tests the plants were spaced 3 feet apart in 42-inch rows. Test weights per bushel varied from 41.5 to 45.5 pounds. All varieties matured satisfactorily.

At Lincoln the Conner and U. S. No. 4 varieties were planted in 42-inch rows and thinned to 1, 2, and 3 feet between plants within the row. The yields of Conner in this test were: 1-foot spacing 1099 pounds, 2-foot spacing 1172 pounds, and 3-foot spacing 1011 pounds per acre. The yields of U. S. No. 4 were: 1-foot spacings 1032 pounds, 2-foot spacings 892 pounds, and 3-foot spacing 798 pounds per acre. The Conner variety has 1 to 3 large spikes per plant, whereas the U. S. No. 4 variety has many small spikes per plant. The shelling percentages were higher for the 1- and 2-foot spacings than they were for the 3-foot spacings. There were also fewer spikes per plant in the closer spacings.

**Sesame.** Two sesame varieties which matured satisfactorily in 1942 were seeded at Lincoln in 1943. Their average seed yields were 631 and 732 pounds per acre. Somewhat over an acre of sesame seeded at Brownville yielded 626 pounds per acre. This crop can be grown with regular row-crop equipment. In addition to ordinary expenses of cultivating row crops, it is usually necessary to thin sesame and to give it at least one hand weeding. Harvesting can be done with either a grain- or corn-binder. After proper curing in the shock, threshing can be done satisfactorily from the shock with an ordinary combine fitted with flax screens.

**Hemp.** Approximately ¼-acre hemp plots were grown at Falls City, Beatrice, Fremont, and Hartington, Nebraska, on the predominant bottomland and upland soil series at each location, and at Lincoln on upland only. The average green yield of the four bottomland plots was 30,720 pounds per acre and of the five upland plots 10,341 pounds per acre.

**Pyrethrum.** Flowers grown at Alliance contained 1.10 per cent pyrethrum.

**Rubber Crops.** Guayule plantings made in 1942 at Lincoln, North Platte, Scottsbluff, and Alliance were killed by winter temperatures early
in the winter even where protected by a heavy straw covering. All strains tested matured considerable seed during the summer of 1942. During the past two years seedings of Russian dandelion made in spring and fall have generally produced very poor stands. The 1943 average root yield of plots with good stands, obtained from seeding early in the previous September, was 2192 pounds per acre. All fall plantings which were beyond the 3-leaf stage survived the winter of 1943. All experiments on rubber crops at this station are being discontinued.

C. E. Claassen and T. A. Kiesseflich.

Time of Planting Small Grains

Winter Wheat. Because of the excessively dry seedbeds, a high percentage of the winter wheat in Nebraska was planted two to three weeks later (October 15–20) than normal, and even much of that planted at the usual time was two to three weeks late in emergence in the fall of 1943. In some large areas the wheat failed to germinate in the fall. Experiment Station data are of value in anticipating the effects of such a situation on the crop yield of 1944. Throughout the last 23 years, a standard strain of Turkey Red winter wheat has been sown annually at Lincoln at six different dates, ranging from September 15 to October 22. The average yields per acre for the various dates have been September 15, 24.5 bu.; September 22, 27.5 bu.; October 1, 28.5 bu.; October 8, 24.7 bu.; October 15, 21.7 bu.; and October 22, 17.1 bu. Thus October 1, or slightly earlier in the absence of Hessian fly has proved optimum at Lincoln. A delay of two weeks resulted in a yield loss of 23 per cent compared with a reduction of 40 per cent for three weeks' delay in planting. An added disadvantage under current conditions is the comparatively loose, dry seedbed which has been found conducive to greater loss of stand from winter injury.

With respect to wheat that failed to germinate in the fall, the situation is similar to that in the fall and winter of 1939 when much wheat had not germinated by January 1. A favorable snow covering brought about germination during late winter and reasonably good yields followed. Based on vernalization studies and on 14 years of winter and early spring planting tests, it has been concluded that half a crop is possible in eastern Nebraska, and somewhat more in the west, following such delayed germination provided the seed germinates by about February 15 and moisture conditions thereafter are favorable. The winter wheat plants usually fail to joint and head normally if germination is delayed till after March 15, and the resulting crop is likely to be a near-failure.

Oats and Barley. In these days of labor shortage on farms, there may be a tendency for undue delay in getting the spring small grains planted. Late planting should be avoided if at all possible, as shown by the date-of-planting tests with oats and barley on the Experiment Station farm at Lincoln. Two-years data (1942 and 1943) are available for three varieties of oats that differ as to type, and for Spartan barley.

Yield per acre of oats and barley planted at three dates, 2-year averages, 1942–43:
Date of planting & Date of Oats Fulghum & Date of Oats Cedar Otoe & Date of Oats Spartan
bu. & bu. & bu. & bu.
April 1 & 64.2 & 76.1 & 66.8 & 40.5
April 11 & 51.2 & 66.7 & 60.5 & 35.1
April 21 & 35.1 & 49.2 & 54.7 & 22.3

The great gain in yield from early spring planting and the differential response of varieties to time of planting are readily apparent. A delay of 10 days after April 1 reduced the yield of Otoe 9 per cent, Cedar 12 per cent, and Kanota 20 per cent. Corresponding reductions for a delay of 21 days were 18, 35, and 46 per cent. In 1943 the Trojan variety was also tested and gave results similar to those of Otoe, both varieties being equally early. In general, early maturing varieties endure delayed planting materially better than do medium late and late varieties.

The new "Cedar" variety, being resistant to both stem and crown rust, yields exceptionally well at both early and medium planting dates. Seed of this variety is not yet available in commercial quantity, but will be by 1945. With the problem facing many farmers this spring of replanting abandoned winter wheat fields at a rather late date after the loss of the wheat can be definitely ascertained, choice of an early maturing variety as Otoe oats or Spartan barley is expected to be advantageous. When winter-type oats such as Kanota or Fulghum are planted early they react as an early variety and when planting is delayed they become relatively late ripening. Similar tests over a longer period of years, with other varieties in part, are substantiated by these data.


Noxious Weed Eradication

The experimental work with noxious weeds was transferred from York to Lincoln, Nebraska, in the fall of 1942. At that time an 80-acre tract of land in Denton precinct about 11 miles southwest from the College was rented for the continuation of studies with bindweed. Infestations with several other species of noxious and pernicious weeds are located in the same general vicinity. Cooperative agreements with the owners and tenants of various infested areas permit investigations concerning hoary cress, leafy spurge, Russian knapweed, and dogbane in addition to bindweed. The present project is cooperative between the Departments of Agronomy and Agricultural Engineering. Through this cooperation, machine attachments are being developed that can be used for noxious weed eradication.

Since most of these experiments were begun within the last year, no definite results or conclusions can be presented at this time. A few indications may be mentioned.

Bindweed. Eradication of bindweed through various tillage practices, combined tillage and cropping, fall and summer competitive crops, and chemical treatments are being studied in an attempt to discover the most efficient methods for destroying established stands and for preventing re-infestation from seed carried in the soil. Studies are included concerning rates and dates of application, and machines for applying sodium chlorate, Atlacide, borax, salt, sodium arsenite in liquid form, and several less important chemicals.

Since a large percentage of the bindweed-infested land in Nebraska is subject to erosion by water or wind, special attention is being given
Agronomy and Agricultural Engineering staffs cooperate in bindweed control experiment. Corn rows are spaced three times normal distance. When corn becomes too tall for cultivation in regular manner, it can be cultivated as in the picture. Field is well-terraced by season's end.

to acceptable erosion-control practices. Contouring, terracing, sub-surface tillage with crop residues, strip cropping, cover cropping, mulching, and blanket listing are means of reducing erosion that are employed singly and in combination wherever they can be fitted into the eradication method under investigation.

Hoary Cress. Similar cultural and chemical experiments are under way for hoary cress as for bindweed. Indications are that this weed is considerably more resistant to chemicals than is bindweed and the rate of application must be increased accordingly.

Subsurface tillage on contour. Bindweed cut off underground leaves residue on the surface for erosion control.
Leafy Spurge. Tillage- and chemical-treatment plots have been laid out on land infested with leafy spurge. Thus far no conclusions can be drawn on results obtained. Indications are that leafy spurge is more resistant to chemicals than is bindweed.

Russian Knapweed. Since the Russian knapweed infestations in Nebraska are still small in size, eradication by the use of chemicals is most important. Indications from one year’s results are that this weed is much more susceptible to chemicals than is bindweed, and, therefore, good kills may be obtained with smaller doses.

Dogbane. Dogbane is not classified as noxious in Nebraska, but it has destructive potentialities that are becoming apparent in the eastern part of the state. The destructiveness is especially severe in small grain fields where the crop may be completely lost from the infested patches. Row crops are affected but little when they are properly cultivated to destroy annual weeds. This is especially true where duckfoot shovels are used on the corn cultivator. Dogbane is susceptible to chemicals, but because of the nature of its growth, chemical eradication is impractical except on small, heavily-infested areas. Cultural and chemical experiments have been conducted on dogbane-infested land for only one year and no definite conclusions can be drawn.

Dandelion. Dandelions are neither noxious nor destructive to agricultural crops, but they are unsightly in lawns, and, therefore, are undesirable. This weed has been treated on separate plots with kerosene, MEO-181, ammonium sulphate, ammonium sulfamate, iron sulphate, tractor fuel, and Zotox. Of these substances the two first-named have given the best results. Ordinary kerosene is the cheapest of all and when applied at the rate of 2.5 gallons per square rod, a 98 per cent kill was effected without appreciable injury to a Kentucky bluegrass lawn.


N. S. Hanson, C. W. Smith, and F. D. Keim.
Varietal and cultural improvement of Nebraska fruit and vegetable crops continues to be the important contribution of horticultural research to the wartime demand for more food.

Horticultural Crops
Department of Horticulture
Storage of Seed Potatoes

Storage and Shipping Temperature. In recent years Southern potato growers have been planting potatoes earlier in the season than formerly. As a result, they sometimes encounter difficulty in getting Nebraska seed potatoes to grow as promptly as desired. To solve this problem two experiments were conducted. In one, small quantities of western Nebraska-grown seed potatoes that had been stored under a wide variety and combination of conditions were planted in trial plots in southern Texas in early January, in southern Alabama in February, and at North Platte, Nebraska, in April. In these tests the most prompt emergence and greatest and most uniform plant growth were attained by warming the potatoes which had been in cool storage for several weeks to a temperature of about 60°F. The potatoes were held at this temperature for a period of several weeks. The next most effective procedure was continued warm storage. With plantings made at North Platte in April, results were of the same order as those in the south.
In the second experiment, 18 carloads of seed potatoes were used to determine the effect of both warm and cold storage conditions on seed potatoes subjected to either high or low temperatures during transit. Nine cars were shipped to southern Texas in December, the other nine to southern Alabama in January. These cars were also used to test the relative merits of different styles of car heaters, and of cars equipped with fans to circulate the air in the car. Temperatures in twelve places in each car were determined at frequent intervals throughout the entire time the cars were en route. Potatoes taken from sacks located at six distinct positions in each car were planted in trial plots in the South.

In this experiment it was learned that: (1) cars equipped with fans and thermostatically controlled heaters are most satisfactory for maintaining high temperatures (55° to 70° F.) en route; (2) cars equipped with fans vary much less in temperature throughout the various parts of the load; (3) any amount of warming of seed potatoes, whether before or during transit, hastened the rate of growth and increased the uniformity of plant size.

Plantings of large commercial fields made from these cars of seed potatoes exhibited the same response to different treatments as were observed in the small scale experimental plots. In December, 1943, another storage and transit test was made with ten cars of seed potatoes between western Nebraska and southern Texas. The transit phases of the work are conducted by the U. S. Department of Agriculture specialists. O. H. Werner; Robert Pahl, Box Butte Experiment Farm; L. L. Zook, North Platte Substation; The Nebraska Certified Potato Growers Cooper-
ative; D. F. Fisher, A. L. Ryal, J. Lutz of the Fruit and Vegetable Division, U. S. Department of Agriculture; J. F. Wood of the Texan Branch Experiment Station at Weslaco, Texas; Alfred Edgar, Potato Storage Engineer, U. S. Department of Agriculture; and numerous railroads and refrigerator car companies cooperated in this study.

**Types of Storage Bins.** Uniform lots of seed potatoes were placed in crates at numerous positions in several types of large storage bins, each bin containing 1000 to 1500 bushels of potatoes. Thermocouples placed adjacent to the crates in each of these bins were read at weekly intervals. The temperature control of these large bins was greatly enhanced by having a false floor under the bin, this in order that the air might circulate under the floor and through the air space between the false rear wall and the outside wall. With bins thus equipped with false floors the temperature was fairly constant at the same level in the bin from front to rear; there was less thermal variation throughout the bin, and as compared to the bin with a ground floor, the temperature was several degrees lower. In the ground-floor type of bin the upper level of the bin was never cooled to the desired temperature until mid-February. When brought into constant high temperature, potatoes from the crates in each position in the bin varied in time of sprouting. A correlation between time of sprouting and bin temperatures was observed. Those from the high temperature position sprouted two or three weeks earlier than those from the low temperature position of each bin. In response to these findings, bin construction is being altered in some western Nebraska potato cellars.

A detailed study was made with thermocouples of the temperature in a shell-cooled bin used for storing seed potatoes until June planting time. The Agricultural Engineering Department cooperated by designing and constructing a low-priced thermostat that can be used to operate the fan that cools the bin. Definite progress is being made with this distinctive type of bin structure. During the winter of 1943–44 two types of bins utilizing the new principle are being studied.

During the winter of 1943–44 also, analyses are being made to determine the changes after various periods of time in the reducing sugar and sucrose content of Triumph potatoes stored at various temperatures. This study is undertaken to determine the probable relation between sugar content of seed potatoes and the rate of sprout growth. The great undesirability of having a high sugar content in potatoes that are to be dehydrated or to be used for potato chips gives particular significance to this study.

Results derived from this study are being given consideration in the sale and shipping of seed potatoes to the South in December and January, and in the construction of facilities for holding seed potatoes until June. Another direct application has been the construction of special features into storage bins built to store potatoes for a large dehydration plant. This storage provides for the circulation of warm air in order that the sugar content will not be increased to the point where it will impair the quality of the final product. The Triumph variety accumulates large quantities of reducing sugar at low temperatures. Since reducing sugar darkens the potatoes and disqualifies them for government purchase, the presence of it complicates dehydration. **H. O. Werner and Alfred Edgar.**

Assistance has been given the State Board of Control in designing and constructing several very large permanent fruit, vegetable, and potato
storage cellars. These will be of great value to state institutions in conserving their food supply.

**Potato Cultural Experiments on Dry Land**

A study at the Box Butte Experiment Farm to determine the relative feasibility of summer fallowing by litter mulching with and without spring plowing in comparison with other methods of fallowing is being conducted in cooperation with J. C. Russel and F. L. Duley. The 1943 data are not available at this date, however, field observations indicated that the method of fallowing resulted in less difference in yield than did plowing or not-plowing the land in the spring. Litter mulching presents many practical difficulties. Working dry small grain stubble sufficiently early in the season in order to destroy Russian thistles and other fall weeds and the problem presented by the deterioration of the straw during the long period (about 22 months) of exposure to drying weather before the potato crop is planted are examples of such difficulties.

A long-time test is being conducted to determine the time and rate of tuber development by harvesting at regular intervals and also by planting on different dates.

In 1943 a method of subsurface tillage used by some growers for the purpose of facilitating tuber development was tested, but was found to be not very promising because of the extent to which the soil surface is left loose and open.

**Crop Rotation on Dry Land at the Box Butte Experimental Farm**

This long-time crop rotation project is being conducted as in former years. Best yields of potatoes continue to be produced on summer-fallowed land. Yields after beans and corn are greater than after small grain. A shortage of soil moisture is the most common factor limiting crop yields. The 1943 spring rainfall was so great that differences in soil moisture due to previous methods of culture were largely eliminated, and the yields of potatoes were much the same from all methods of preparation. Time between the potato crops in the rotation is the greatest single factor affecting disease content of tubers.

A manuscript summarizing the results of the first years of cropping at this farm is practically ready for submission as a station bulletin. H. O. Werner; Robert Pahl; J. H. Jensen, Plant Pathology; and T. A. Kiesselbach, Agronomy.

**Potato Breeding**

Production of seed, growing of seedlings and increase and testing of seedling selections has been conducted on the same basis as in former years.

Definite progress has been made in locating pollen-producing parents that can be used in crosses to procure large numbers of seedlings producing red tubers. These seedlings are being combined with varieties and other seedlings. Several very promising red and white skin lines have been isolated and are being increased for yield and commercial tests. The Kasota,¹ a medium red-skinned variety that produces large

yields of excellent type tubers and which has considerable resistance to fusarium, was introduced commercially in February, 1943, by this station in conjunction with the University of Minnesota where the original cross was made.

Further studies concerning the relation of calcium content to the sloughing of potatoes have been conducted.

A complete series of cooking tests were made with 25 varieties and selections grown at Lincoln in 1943. Another series of the same varieties as grown at Scottsbluff and Alliance is being conducted at this time. H. O. Werner, Horticulture; J. H. Jensen, Plant Pathology; and Mrs. Edna B. Snyder, Home Economics.

**Vitamin C Content of Vegetables**

A thorough study is being made of the vitamin C content of tomatoes and potatoes to determine the extent to which that content is affected by various factors. Factors being considered with either or both crops are variety, place where grown (Lincoln, North Platte, Alliance, Scottsbluff, Banner county), methods of culture, time of day harvested, temperature and duration of storage. With tomatoes, the losses under different methods of canning and making juice, the effect of different storage temperatures, and the influence of time of storage are being studied.

Some distinct differences in vitamin C content between varieties of both vegetables as well as the effect of location where grown, degree of maturity, method of culture and storage temperature are indicated, and
it may be tentatively concluded that the manner of growing and storing these vegetables exerts a great influence on the vitamin C content.

_H. O. Werner, Horticulture, and Ruth Levertan, Home Economics._

**Tomato Breeding**

Several of the selections of early tomatoes with determinate vines have produced high yields of very early good quality tomatoes in all parts of the state. Very good crops were produced at altitudes of 5300 feet in Nebraska and numerous ripe fruits were produced at 6000 feet and 7500 feet in Wyoming (Cheyenne and Laramie). Some serious damage occurred to the fruits of some of these selections of early tomatoes as a result of the scant foliage, and their extensive exposure to the direct sunlight. Damage from this source was much greater than in former years. It is hoped to determine what environmental factor contributes to this damage. However, in spite of this defect several fields planted with these strains produced excellent yields of very early tomatoes that netted the growers good returns. These strains are promising for use in the portions of the state having a relatively short growing season. One of these varieties is being introduced in 1944 under the name Red Cloud, after the famous Sioux Indian Chief. This line was selected from a cross between All Red and Stokesdale.

Another selection of great promise is an indeterminate variety selected from the same cross as was Red Cloud. It is being named Sioux. It is a “late-early” or midseason line that produces a large crop of very uniform, round to slightly flattened fruit of good red color. It has outyielded under test all varieties of similar growth-season in comparative trials at Lincoln, Scottsbluff and North Platte. Two large commercial canneries

(Field run Sioux tomatoes as picked September 10, 1943, at Scotts Bluff Substation.)
A plant of Sioux tomatoes. This variety yielded 16.5 tons of U. S. No. 1 grade fruit by September 24 and 24.5 tons per acre by October 5, 1943.

plan to grow at least 300 acres of this variety in 1944. The fruit of both of these varieties has a vitamin C content equal to or somewhat above that of fruits of most other varieties.

Several selections with distinctive characteristics are being increased and tested with a view to introductions within a year or so. Careful observation of these varieties, over a wide range of conditions during several years, indicates that with the general adoption of these varieties throughout Nebraska, tomatoes can be grown with greater assurance of success than in former years.

Distribution of all available seed of Sioux and Red Cloud in 1944 through commercial seedsmen is being arranged.


Vegetable Crops

In a test of garden peas the Cleveland, a strain of Alaska, was the earliest variety. Resistant Surprise and Early Harvest were good and but little later. Among the intermediate varieties Little Marvel, American Wonder and Laxton's Progress were at the top of a number of good varieties. The peas of the latter variety were unusually large. Among the late, midseason varieties some strains of Perfection and Canner King were excellent producers of peas of large size and good quality. At this season the Climax produced more peas than any other variety in the entire test, but the peas were smaller than most late peas, being only a trifle larger than Alaska peas.

The three varieties of lima beans introduced by the Illinois Experiment Station, Early Baby Potato, Baby Potato and Illinois Large Poded Lima, all gave good yields. Other good varieties were Henderson Bush, Clark's Bush, and an introduction by the U. S. Department of Agriculture known by the name of U. S. No. 2. All of these are small podded, bush lima beans producing small beans and did well at Lincoln in 1943. The larger podded varieties have not produced well in our hot dry summers.
The cultural study of asparagus to determine the effect of length of cutting period, the annual applications of manure, and the annual use of irrigation water is being continued. Up to the present time none of these factors has had a noticeable effect upon yield.

The carrot breeding project to develop lines with high specific gravity, good color, and small cores has been temporarily discontinued because of insufficient help to carry the project satisfactorily. A number of lines of several types had been isolated. These have been conserved by sending the supply of seeds and roots to the Regional Research Vegetable Breeding Laboratory at Charleston, South Carolina, where they will be used in the vegetable breeding program of that institution.

The test of sweet corn hybrids was carried in conjunction with entomology for observing differences in ear worm damage. H. O. Werner.

**Fruit Culture and Improvement**

A study of the use and value of supplemental water for orchards in eastern Nebraska. The apple trees surviving the freeze of November 11, 1940, at Union were given several irrigations during the summer. The leveled experimental area, which had been well soaked the previous season, was replanted with Red Delicious trees at a spacing of 15 x 16.5 feet. This thick planting was for the purpose of more quickly reducing the available subsoil moisture, thereby bringing the permanent trees more rapidly to the maintenance level insofar as subsoil water is concerned.

Soil samples down to ten feet were taken at monthly intervals in this block at eight different plats. Four samples were taken near trees and four at the intersection. Data as yet are not conclusive as to the consumption of water, but it has not been great for the first orchard season of these trees.

Rainfall was less adequately distributed in 1943 than in 1942, and the total for the season will be appreciably less. In only one month, June, when 6.32 inches fell, was precipitation really adequate for a mature orchard's needs. During the active growing season, April to September inclusive, only 17.70 inches of rainfall was recorded. This amount of moisture is far less than the requirements of mature trees when planted at the customary spacing.


**Orchard Culture**

Because of the 1940 freeze, production of grapes at Union was still much retarded for both the cultivated and mulched rows. The cultivated plants, however, present a better appearance than the mulched and seem to be recovering more rapidly from the effects of the freeze. Soil samples, as heretofore, show better moisture conditions under the mulched area. The scarcity of mulching material has made it difficult to maintain a good mulch; hence some difficulty has been encountered with weeds in these rows.

C. C. Wiggans.

**Fruit Breeding**

Blossoms produced on several of the Latham raspberry canes reported last year as being affected by the colchicine treatment were self-pollinated. On four shoots good fruits developed and formed what
appeared to be normal seeds. These seeds were collected at the proper time, were cleaned and then stratified in damp sphagnum moss. They are now being held in a cool cellar and in due time will be removed to the greenhouse to test their germination ability. Any plants developing therefrom will be transplanted and later set in the field for further observation.  

C. C. Wiggans.

Fruit Stocks Investigation

The Virginia crab apple trees at Lincoln were top-budded during the past summer with desired varieties and with an apparently high degree of success. Some rebudding will be necessary in 1944 in order to complete this investigation.

Both at Lincoln and at Union, Hibernal trees and additional Virginia Crab apple stock were planted, both to be topworked to standard varieties. The Union planting occupies ground from which winter-injured trees had been removed. The new trees were set on the contour and were given one good irrigation during the summer. Growth on these trees was much better than that secured in the Lincoln planting, probably because of the greater moisture supply.

Growth and yield data from the scion-rooted orchard are still being assembled, but the very light 1943 crop did not give much information.  

C. C. Wiggans.

Water Relations of the Potato Plant

With the arrival of Mr. Frankford, active research on this project has been resumed. During the fall further aspects of factors influencing cracking of potato tubers at harvest time were investigated. Recently, work to determine the difference in transpiration rates and water requirements of distinctive varieties with a view to determining basic facts that govern the differences in heat and drought tolerance of several varieties has been initiated.  

H. O. Werner.
There are many means by which yields are increased. The control of plant diseases is of major importance in this respect, and research in plant pathology, in 1943 as in the past, was directed toward the diseases that affect beans, potatoes, sugar beets and other Nebraska crops.

**Plant Diseases**

Department of Plant Pathology

**Bean Diseases**

**Breeding for Resistance to Halo and Common Blight.** The bean breeding program, a general outline of which was presented in last year’s annual report, was continued. Additional crosses were made between varieties resistant to either halo or common blight or both and varieties possessing desirable field or garden qualities. Back crosses were also made of selected halo-blight resistant lines which were low in yield. Progenies from crosses made in previous years were tested in artificially produced epidemics in the field and greenhouse. The general practice was to discard plants exhibiting susceptibility to either halo or common blight or plants having undesirable characters.

A study was conducted on the differences in virulence of halo-blight-producing bacterial isolates. Thirteen isolates were compared by means of leaf, stem, pod and germinated-seed inoculations, and the results have been prepared for publication.

**Dry Bean Yield Tests.** A replicated yield test was conducted with 15 hybrid lines and varieties. Ten selections comprising both pinto and white dry bean lines in the F₁ generation and two selections in the F₂ generation were compared with U.I. 59 and U.I. 123, standard commercial white dry bean varieties, and with the commercial pinto variety. The two selections in the F₂ generation were selected from the previous year’s yield test on the basis of disease resistance, superior yield, quality and type. One pinto selection again produced appreciably higher yields due to being 7 to 10 days earlier than the commercial pinto. While the white bean selection of the previous year again yielded satisfactorily, its record was not notably greater than the standard commercial varieties of the Great Northern type. Several selections included for the first time in a yield test showed sufficient promise to justify additional field trials next season.

**Preliminary Spray Test for the Control of Halo Blight.** A preliminary field test designed to test the efficacy of Bordeaux, lime sulphur and an experimental spray material for the control of halo blight and bean leafhoppers on Giant Stringless Green Pod beans was conducted at Lincoln during the spring and early summer months. Each plot to be sprayed was bordered by a row of susceptible Red Kidney beans inoculated with halo blight. Spraying began soon after the border rows were inoculated. Several applications of each spray were made. Some indications were obtained that Bordeaux sprays tended to decrease both leaf and pod infection. The leafhopper infestation was negligible in all plots including the controls.

**Bean Disease Survey.** Common blight infection was relatively light during the past season in the commercial dry bean producing areas.
Although fields in some areas showed leaf and pod damage, only a few fields showed severe damage. Bean rust appeared late in the season in scattered fields, but little or no damage resulted. The lack of severe common blight infection in most irrigated areas was probably accounted for by the relatively disease-free seed used and by the unusually dry growing season. Halo blight on snap beans was severe throughout the state with the exception of a few late planted fields in the North Platte Valley. J. H. Jensen, R. W. Goss, and J. E. Livingston; the spray tests were cooperative with the Entomology Department.

Cereal. Diseases

Charcoal Rot of Corn and Sorghum. Greenhouse studies of the effect of soil temperature and soil moisture on infection of grain sorghum have shown that seedling blight produced by the charcoal rot organism is greatest with high temperatures and low soil moisture. These same conditions favor the development of charcoal rot in mature plants. Several selections of grain sorghum showing some resistance are being studied.

Field records disclose that five of the inbred corn lines observed impart resistance to charcoal rot in the single cross. Studies of the effect of these lines on the resistance of double crosses are being made.

Stalk Rots of Corn and Sorghum. Two fungi, *Rhizoctonia bataticola* causing charcoal rot, and *Diplodia zeae*, were responsible for most of the stalk rots of corn and were major factors in producing severe lodging in many fields throughout the corn producing area. *Diplodia* was most abundant in the two tiers of counties bordering the Missouri River, averaging 29% of the stalks infected per field, and was of minor importance elsewhere, with an average of 8.5% of the stalks diseased. Charcoal rot, on the other hand, was of minor importance in the eastern counties, with an average of 2% of the stalks per field infected, but was abundant in the south-central counties where the corn was injured by drought, averaging 29% of the stalks per field infected.

Lodging was present in every field examined, varying from 2 to 79% of the stalks. Some of this was due to disease and some to other causes.

Seed Treatments. Treated seed of Leoti sorgo and Sharon kafir sorghum were planted at Lincoln on May 22 and June 17. The effect of nine commercial fungicides and nine experimental fungicides on stand and control of smut was studied. Stand improvement was greatest with the early date of planting and with the Sharon kafir variety. The stand increases from seed treatment were not as great as in the 1942 tests.

Only four of the commercial fungicides, New Improved Ceresan, Spergon, Arasan, and Sulphur gave complete control of kernel smut with both varieties; however, only one failed to reduce the incidence of the disease. Four of the experimental fungicides, Fermate and the related mercury, zinc and lead dimethyl dithio carbamates, showed promise both in the control of kernel smut and in stand improvement.

Soybean seed of the Lincoln variety was treated with five commercial fungicides. Several produced significant increases in stand but there were no differences in yield between the treatments and the untreated checks.

Bunt of wheat. A technique devised for the inoculation of wheat with bunt consists of germinating the bunt spores at 10°C in a moist roll of cloth until primary sporidia are produced (7 to 10 days). Soaked wheat seed then is added and germinated at the same temperature until the sprouts approximate 30 mm. This procedure resulted in a higher percentage of infection than other methods used in greenhouse studies. There was a high correlation between the chlorotic mottling of the leaves, even in the seedling stage, and the percentage of plants showing bunted heads.


(Cereal projects were directed by J. E. Livingston with cooperation from O. J. Webster and R. W. Cushing on the sorghum seed treatment and from Eric Kneen on bunt of wheat.)

Potato Diseases

Fusarium wilt. Only 39 seedling lines have survived out of over 14,000 tested for two or more years in inoculated soil in the greenhouse and field. Inoculations of first-year seedlings in the greenhouse have been discontinued and resistance tests in the field are being confined to those lines which have been selected as having desirable horticultural characteristics.

Scab. Tests for scab resistance have been continued at the Scotts Bluff Substation with all lines having either desirable horticultural characters or fusarium resistance.

Spindle Tuber. Tests for resistance in the field have been continued. Two lines which failed to contract the disease when exposed to infection in the field were further tested by seed-piece plug inoculations and were found to be susceptible to spindle tuber when inoculated in this manner. However, these lines appear to have a high degree of field resistance and are being used as parents in the breeding program.

Late Blight. This disease which was reported for the first time in Nebraska in 1942 again occurred in the central area of Nebraska. The infection resulted from planting infected seed tubers from northern states. Surveys of commercial fields and tests conducted with inoculated seed showed that while the disease developed on the foliage, its spread was checked by the high temperature of July and no damage was caused by infection of the new tubers.

Leak. During 1943 this disease appeared in serious amounts for the first time in Nebraska. Considerable loss was caused in the field as well as in storage and transit. Experiments are under way to determine the specific causal organism.

Seed Treatments. Tests were conducted at Wood River on Irish Cobbler potatoes with Thiosan, Fermate, Semesan Bel, yellow oxide of mercury, and acidulated bi-chloride of mercury. Rhizoctonia lesions on stems were recorded on three different dates and scab records were made of the harvested tubers. All of the treatments reduced rhizoctonia infection on the stems as compared with the untreated checks but there were no significant effects on yield due to the control measures. None of the treatments reduced scab, but twice as much scab occurred on the tubers from the yellow oxide of mercury treatment as from the checks
and other treatments. The use of the Semesan Bel and acid mercury treatments on cut seed caused damage to seed pieces and resulted in reduced yields, as compared with the same treatments on whole seed. The other treatments were not tested on cut seed pieces.

R. W. Goss, J. H. Jensen, M. W. Felton, and J. E. Livingston; the breeding phases were cooperative with the Department of Horticulture.

Tomato Diseases

Fusarium Wilt. The effectiveness of the tests for resistance to this soil-borne disease was greatly increased by the use of electrically heated soil beds with thermostatic control. Twenty-eight Nebraska lines in later stages of selection for quality and productivity and representing fourteen crosses involving 16 different parent varieties were tested. While none of these lines possessed a high degree of resistance, they did demonstrate a wide range in reaction, some showing early and severe symptoms, others being quite tolerant to the disease. Such tolerance could mean the difference between profit and loss on a disease-infested soil. The highly resistant variety now available is unfortunately not adapted to Nebraska conditions.

Bacterial Diseases. Seed disinfection is of paramount importance in successful control of bacterial diseases of tomato. The precise nature of the treatment periods and solutions as well as the frequently experienced reduction or retardation in germination following treatment with mercurials tends to discourage widespread and continued use of these materials.

In testing various methods of carrying out seed disinfection it was found that thorough washing immediately following treatment effectively reduced the amount of injury resulting from a variety of over-treatments with mercurial solutions. Markedly decreased germination resulted when treated seed was permitted to stand wet for some time without rinsing. Thorough rinsing thus acts as a partial safeguard against injury. While the mercurial treatments gave little protection against damping-off, non-mercurial seed protectants applied as dusts on dry seed following the mercurial disinfection gave excellent results.

An organic sulfur seed protectant gave indications in laboratory tests of having strong disinfectant properties accompanied by a wide range of tolerance from the standpoint of seed injury. This material will be tested further.

M. W. Felton.

Miscellaneous Diseases

Seed Treatments. Several commercial seed protectants were tested on sweet corn, peas, lima beans, snap beans, and garden beets. Arasan, Spergon and Semesan Jr. in order of effectiveness significantly increased stands and yields of early-planted sweet corn and wrinkle-seeded peas. The same materials improved the stands but not always the yields of smooth-seeded peas and later plantings of both types. The use of seed protectants also significantly increased the stands in lima beans and beets but failed to more than slightly improve stands of garden snap beans.

M. W. Felton.
Sugar Beets. Rhizoctonia was found to be the dominant parasite in seedling sugar beets in rotation plots of the Scotts Bluff Substation. Fusarium wilt infection occurred late in smaller amounts. The continuous beet plots had the most disease but there was no significant difference between a 2- and a 5-year interval between beet crops. Less disease occurred when beets were planted after potatoes than after oats.

The effect of nutrition on susceptibility was studied with sand cultures in the greenhouse. Increasing the concentration of nutrients was found to increase the susceptibility of sugar beet seedlings to damping-off caused by rhizoctonia, whereas the reverse held true for fusarium infection with low concentrations of nutrients increasing susceptibility.

C. E. Dallimore and R. W. Goss.
Both the rural and urban economy of Nebraska have benefited by the research work of agricultural chemistry.

**Chemical Studies With Plant Materials**

Department of Agricultural Chemistry

**Digestive Enzyme Inhibitors**

The discovery of substances in some of the cereal grains which inhibit the action of salivary amylase (also bacterial amylases) was reported in the 56th Annual Report of this station and in a publication, “An amylase inhibitor from certain cereals,” by Eric Kneen and R. M. Sandstedt. Amer. Chem. Soc. Jour. 65: 1247. It was suggested that naturally-occurring enzyme inhibitors may be of pronounced physiological significance.

An inhibitor for pancreatic protein digestion, a *trypsin* inhibitor, has been found in uncooked soybeans. This factor can be extracted from raw soybean meal with dilute salt or acid (pH 4.2) solutions. It is destroyed by treating the raw meal with alcohol solutions, especially at moderately elevated temperatures (70°–90°C.) or by treatment of the moistened raw meal (at 70°–90°C.) with 95% ethyl alcohol. It is destroyed by autoclaving and is lost by dialysis. These properties correspond to those of the factor which causes the depression of growth rate when raw soybean meal is included in the diet of growing chicks. Accordingly, it seems probable that these factors are identical.

This research is being done by Wendell Ham, R. M. Sandstedt and F. E. Musschel.

**Cold Resistance in Crop Plants**

Further investigations were made of the influence of bunt on winter-hardiness of wheat. Winter wheat was inoculated with the organism, grown and hardened under controlled conditions, then frozen. The bunt infection resulted in a considerable reduction in cold resistance.

Controlled freezing studies with numerous varieties of winter wheat and barley were continued. Excellent correlations with field response to winter temperatures were obtained.

In a comparison of the hardiness of winter wheat and rye the hardy varieties of ryes, such as Dakold, were found to be much more cold resistant than a very hardy wheat such as Minhardi. Balbo rye proved to be less cold resistant than Minhardi wheat but more resistant than wheats of intermediate hardiness such as Cheyenne. This demonstration of relative winterhardiness is of considerable practical significance.

*Eric Kneen and K. S. Quisenberry.*

**Cereal Amylases**

Studies directed toward establishing optimum conditions for the production and utilization of sorghum malt were continued. Drum malting at high temperatures and high moisture levels proved satisfactory. When used in experimental alcohol production, sorghum malt proved to be somewhat less efficient than barley malt. At the present time it appears inadvisable to use sorghum malt as the sole source of amylase in the
production of alcohol from grain. However, it offers definite possibilities as a substitute for part of the barley malt, and its use in such combination could do much to alleviate the current shortage of malt. Eric Kneen.

A number of articles dealing with the cereal amylases have been prepared. One titled, "The differential stability of the malt amylases—separation of the alpha and beta components," by Eric Kneen, R. M. Sandstedt, and C. M. Hollenbeck appeared in Cereal Chemistry 20:399–423. This article illustrates many of the factors which must be considered in the utilization of malts. Two articles illustrate many of the factors which must be considered in the utilization of malts. Two articles designed to provide information for industry were released by Eric Kneen, "Diastatic agents for the saccharification of starchy mashes in the alcohol fermentation industry," distributed to members of the Wheat-Alcohol Conference, and "The cereal amylases—significance of the component concept," in Wallerstein Laboratories Communications, August, 1943. A chapter on amylases for a monograph on starch and its derivatives was prepared by Eric Kneen and another for a monograph on enzymes in milling and baking technology was submitted by Eric Kneen and R. M. Sandstedt. Both of these will be published in the near future. Also in press in Cereal Chemistry is an article by Eric Kneen, "A comparative study of the development of amylases in germinating cereals."

**Amylases from Bacteria and Fungi**

The necessary details have been obtained for the production of bacterial amylase both in semi-solid medium (wheat bran) and in liquid medium (thin stillage). A patent application covering the latter of these processes has been prepared and submitted by K. H. Lewis, L. D. Beckord and Eric Kneen.

Extensive data relating to the properties of bacterial and fungal amylases and their industrial utility are being accumulated. These deal with the activity of the enzymes on various types of carbohydrates and under various conditions. Likewise, methods of concentrating and purifying the enzymes are being investigated.

The production phase of this work is under the direction of George L. Peltier of the Department of Bacteriology and the enzyme investigations are under R. M. Sandstedt and Eric Kneen. L. D. Beckord is assisting with the project work.

**Cereal Hays as Sources of Proteins and Vitamins**

The present shortage of protein for feeding purposes together with the well-known fact that protein, minerals, and vitamins are higher in young plants than in older suggests the possibility of obtaining a high protein, high nutritive value feed without too much sacrifice of total digestible nutrient yield by cutting cereal crops at some early stage of growth. Accordingly, a preliminary survey was made by harvesting samples of hay at different stages of growth from plots of oats and barley. The percentage of protein and carotene decreased progressively with the maturity of the plants. In the case of Cedar oats, the change in protein content was from 29% when the plants were three to four inches tall, to 23% at the early bloom stage and to 11% at the late dough stage (all figures based on the dry hay). The carotene varied from 250
micrograms per gram at the three to four inch stage to 30 micrograms in the late dough stage.

These results seem quite encouraging. However, a relatively high nitrate content was found in the young grasses: 2% to 3% in the oats from the early milk and late dough stages and about 1% in plants nearing maturity. The nitrate content of barley hays was somewhat lower; varying from 1.6% at the early dough stage to 0.4% when nearly mature. The nitrate content varies with the season, stage of growth, soil fertility, and available moisture. These high nitrate levels in the young plants, especially in oats, suggest that they should be fed with considerable caution.

Wendell Ham, R. M. Sandstedt, and T. A. Kiesselbach.

Studies of Flour Baking Quality Factors

One of the major problems in the wheat and bread industry is that of baking quality. A paper, "Effect of environment during growth and development of wheat on its flour baking properties," by R. M. Sandstedt and Karl Fortmann (Cereal Chemistry) shows that such flour baking properties as water absorption, mixing requirements, handling properties of the doughs, and the characteristics of the bread were markedly affected by the locality in which the wheats were grown. In any one locality the baking properties of the different varieties of wheats placed them in the same order of preference as in any other locality; i.e., Chiefkan was the poorest baking variety in each locality and Turkey, Nebred, and Tenmarq were the best. However, because of the great effect of environment on baking properties, Chiefkan from a locality in which conditions were most favorable for the production of good baking properties gave better baking results than the other varieties from the least favorable locality. The different varieties tended to respond in a similar manner to changes in environment; all varieties had better baking properties when grown in one particular locality than they did when grown in a certain other location. However, the degree of baking response to environment was much greater for the better baking varieties than for the poorer; Chiefkan was improved little by a change from an unfavorable to a favorable environment whereas Turkey, Nebred and Tenmarq were remarkably improved by such a change in environment. In localities in which conditions were unfavorable for the production of good baking properties, all varieties produced rather poor bread, with Chiefkan much poorer than the others; in localities favorable for the production of good baking properties, Chiefkan was somewhat improved but still did not produce good bread whereas the better baking varieties produced exceptionally good bread.

One of the baking properties of flour which is of considerable importance to the milling and baking industry is the response of the flour to oxidizing and reducing agents. All flours are subjected to oxidation by bleaching during milling, by natural aging during storage and by flour improvers during baking. The response of the flour to these treatments is important in determining its value. One phase of the study of oxidation in doughs was discussed in the 56th Annual Report and in a paper, "The relation of proteolysis to the characteristics of oxidation and reduction in doughs," by R. M. Sandstedt and Karl Fortmann, Cereal Chemistry 20: 517–528.
Mr. B. D. Hites, who has recently developed new methods for determining the state of oxidation or reduction of flours and doughs, is making a fundamental study of oxidation in flour and in doughs. It has been known for some time that ascorbic acid (vitamin C), though it is a reducing agent, may be used as an oxidizing agent in doughs. This is due to the enzymatic oxidation of the ascorbic acid to dehydro-ascorbic acid which then acts as the oxidizing agent. However, the analogs of ascorbic acid, d-iso ascorbic acid and d-gluco ascorbic acid, are not so active as oxidizing agents in dough as ascorbic acid. They are oxidized to the dehydro compounds, but these oxidized compounds are not active oxidizing agents in doughs—the d-iso compound is more active than the d-gluco.

R. M. Sandstedt and B. D. Hites.
The control of insects and rodents in Nebraska bears directly upon the wartime need for increased food supplies. Entomological research in 1943 continued to provide new or improved means to carry on the war against destructive pests, and hence reduced costly waste.

Insects and Rodents
Department of Entomology

Potato Insects and Their Control

POTATO Flea Beetles. Field surveys and bin inspections have shown a steady spread of larval injury to new localities, both in western and central Nebraska, during the past three seasons. In Box Butte county more flea beetles were taken in the 1943 sweeping samples than in any previous year. Although more widespread, tuber injury in late fields was less severe than in 1942. The long dry summer and more favorable conditions for applying insecticides were important factors in holding flea beetle injury below that anticipated early in July. Overwintered flea beetles began to appear at about the usual time, but a cool dry May and early June prolonged the emergence period, the peak being reached around June 20, or from a week to ten days later than the three previous seasons. A warm period immediately following several days of precipitation near mid-June provided very favorable conditions for emergence. Peak abundance in early potato fields occurred in late June. In late July, adult beetles were present in greater numbers and over a wider territory in late plantings than at any time since the present project was started in 1940.

Additional information was secured on larval host plants. Flea beetles were found to breed on buffalo bur (Solanum rostratum), black nightshade (Solanum nigrum), tomato and potato. In laboratory tests it was found that the kind of host plant had a marked effect upon oviposition.
Although adult beetles fed readily on marsh elder (*Iva xanthifolia*) and kochia (*Kochia scoparia*) no eggs were laid. Immediately following a change to potato foliage, however, egg laying began; also, a change from buffalo bur or bean to potato resulted in a considerable increase in the number of eggs deposited.

Field control experiments were continued. Cryolite and barium fluosilicate-sulfur dusts proved about equally effective; both were more effective than zinc arsenite dust. A second test included cryolite, barium fluosilicate, rotenone, rotenone-cryolite—all with sulfur—as dusts and zinc arsenite-lime-sulfur spray. On the basis of flea beetle populations and leaf injury, the rotenone-cryolite-sulfur dust proved slightly superior; the other combinations were about equally effective.

In a test involving three different planting dates, namely May 22, June 3 and June 24, it was found that the “worm track” type of injury was more prevalent on tubers from the earlier plantings and the “pimply” type more common on the later plantings. Apparently “worm track” results from injury during earlier growth stages of individual tubers, and “pimples” from larval injury during the later growth period. A large percentage of the “pimples” formed on the tubers in late plantings after about September 10.

**Potato Psyllid.** In 1943 the psyllid population was lower than at any time during the past five years; even early plantings escaped injury. Unfavorable weather, specifically, a cool, dry May and early June followed by a warm, dry July and August, probably was a major factor in preventing a serious increase of the psyllid population.

**Application of Insecticides**

During the last few years considerable change has taken place in the control of potato insects in western Nebraska, especially in methods of insecticide application. There were very few spray machines in the North Platte valley previous to the serious psyllid infestation of 1938, but immediately thereafter large numbers were secured. Better potato growers began to include potato insect control in their regular farm operations and spraying became common. In 1940 three dusting machines were purchased by growers and tried on a small scale. Since then, dusting has become increasingly popular, and during the 1943 season dusts were used on approximately 60% of the acreage treated for potato insects in Scotts Bluff county. Evidence indicates that this trend toward dusting will continue. In experiments conducted by this department during the past four years, dusts have proved to be as effective as sprays for the control of potato flea beetles and psyllids.

**Aphids.** Additional evidence was secured showing that zinc arsenite sprays increase the aphid population on potatoes. Because of less favorable weather, however, the aphid population in general did not reach so high a level in 1943 as in 1942. Because of their importance as disease vectors, a survey on aphid populations was made in representative potato fields in Scotts Bluff and Box Butte counties for the purpose of obtaining further information.

**Other Potato Insects.** Collections and observations of other potato insects were continued. The false fleahopper (*Chlamydatus associatus*), which was very abundant in some fields, was found to be responsible for a stippling of potato foliage; incidental to flea beetle and psyllid con-
control experiments, it was discovered that this insect could be controlled rather effectively with sulfur dusts or lime-sulfur sprays. The aster leafhopper (*Macrosteles divisus*) was collected in considerable numbers on potatoes; grasshoppers caused some damage in dry land fields in Box Butte county and were more numerous in irrigated fields of the North Platte valley than at any time during the past four years. Several other insects were taken in significant numbers. The following table shows average numbers per 100 sweeps with an insect net of species taken in representative potato fields of western Nebraska during August, 1943:

<table>
<thead>
<tr>
<th>Species</th>
<th>Field Number—Locality</th>
</tr>
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<tbody>
<tr>
<td><strong>Species</strong></td>
<td><strong>Mitchell</strong></td>
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<tr>
<td>Potato flea beetle</td>
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<td>Potato psyllid</td>
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<td><em>Chlamydiscus associatus</em></td>
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<td><em>Aceratagallia uhleri</em></td>
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<td><em>Macrosteles divisus</em></td>
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<tr>
<td><em>Agelus neglectus</em></td>
<td>27.0</td>
</tr>
<tr>
<td><em>Empoasca fabae</em></td>
<td>4.5</td>
</tr>
<tr>
<td>Aphids</td>
<td>2.5</td>
</tr>
</tbody>
</table>


**Hessian Fly**

Although favorable moisture conditions prevailed in the fall of 1942 and the succeeding spring, the Hessian fly population remained at a low level and caused only minor losses in 1943, except for isolated fields in some of the southeastern counties. An average of approximately 12% of the stems were infested. A potentially destructive population was checked in part by rainy, windy weather during and immediately following adult emergence and undoubtedly, in part, by the fact that a majority of the growers practiced the recommended preventive measures.

The percentage of infestation of Pawnee wheat, records on which were obtained from plantings in various parts of southeast Nebraska, continued to be consistently low. Hessian fly uniform nursery plantings were continued in cooperation with the Agronomy Department. Infestations in spring plantings were too low for critical tests. In fall plantings, which included 28 varieties, a susceptible check variety, Tenmarq, showed a plant infestation of 27% whereas zero infestation was recorded in Pawnee as well as a large proportion of the test varieties.

Increasing interest in subsurface tillage as a moisture and soil conservation practice has raised a number of questions regarding its possible influence on insect pests, among them the Hessian fly. Consequently, some tests were conducted in cooperation with the Soil Conservation Service and the Agronomy Department to determine the effect of sub-
The adult Hessian fly (much enlarged) on a wheat leaf. Control of this pest by the late sowing of winter wheat, plowing under of wheat stubble and cultivation to prevent the growth of volunteer wheat has long been recommended by the Station.

surface tillage in late summer and fall on survival of flax seeds in volunteer wheat. Infested volunteer plants were subtilled in the fall (1942) and the samples of plants examined, first in December and again the succeeding March. There was no significant difference between fly survival in the checks and treated plants. However, exceptionally abundant moisture in the fall of 1942 resulted in a survival of practically all plants in the treated plots which would not occur in more normal years.

Lewis T. Graham and O. S. Bare.

**Corn Earworm Control**

**Insecticide Treatments.** Tests concerned with the practicability of individual ear treatment to control earworm on market sweet corn were continued in 1943. Results were as follows:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Av. % commercially clean ears</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>55</td>
</tr>
<tr>
<td>Desilking</td>
<td>63</td>
</tr>
<tr>
<td>Oil, alone</td>
<td>71</td>
</tr>
<tr>
<td>Oil + 0.2% pyrethrins</td>
<td>72</td>
</tr>
<tr>
<td>Oil + 2.0% dichloroethyl ether</td>
<td>72</td>
</tr>
<tr>
<td>Cryolite dust (33%)</td>
<td>73</td>
</tr>
</tbody>
</table>

Controls were less effective than during the two previous years, probably due largely to the comparatively low earworm infestation. Obviously there is a point of infestation below which treatment would be impractical, apparently about the 30% level in this area. Because of wide annual and seasonal fluctuations in earworm infestation in Nebraska, the grower should be able to determine the degree of infestation. This, together with the necessity of deciding when pollination is com-
plete, and accurately measuring dosages in order to avoid injury, tends to limit somewhat practicability of oil treatments for the home gardener.

**Varietal Resistance.** Records were obtained on percentage infestation of 30 varieties of sweet corn at Lincoln. On the basis of harvest date, these varieties represent six groups within which there were marked variations in infestation: for example, in group 1, harvest date July 20, the variety Patrick Henry was 100% infested, and Golden Mammoth XC87, 11%; in group 4, which included seven varieties harvested July 29, the range was from 18 to 47%; and in group 5, including 6 varieties, harvested August 30, the range was from 45 to 86%.

*H. Douglas Tate and Doris Gates.*

**Chinch Bugs**

The open winter of 1942–43 with its radical temperature and moisture changes greatly reduced chinch bug populations in counties north of the Platte river; mortality averaged 75 to 80% in some counties and as much as 90 per cent in others. South of the Platte mortality ranged from 25 to 75%. Weather favorable for spring migration occurred early, but immediately following, abnormally cool wet conditions prevailed for some time. This delayed and greatly reduced egg laying, and a two weeks' rainy period in early June destroyed many of the newly hatched nymphs. As a result of these conditions, a serious potential threat was reduced to the point where only light damage occurred in the state. In no cases was barrier construction regarded as necessary. Weather favorable for development of the second generation increased the chinch bug population. A fall survey (1943) showed heavy populations in parts of seven counties and moderate to light in about 15 others.

Greatly increased plantings of bromegrass for various purposes in the chinch bug territory of Nebraska has raised a question among farmers and others regarding the suitability of this plant for overwintering chinch bus. Samples of bromegrass and little bluestem, a highly favorable overwintering host, were collected from the same vicinity on March 29, 1943, and examined to determine the number of bugs present and percentage of mortality in the two types of winter cover. Results were as follows:

<table>
<thead>
<tr>
<th>Sample Media</th>
<th>Bugs per sq. ft.</th>
<th>Live bugs per sq. ft.</th>
<th>Dead bugs per sq. ft.</th>
<th>Per cent mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromegrass</td>
<td>16</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>90</td>
<td>34</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>5,472</td>
<td>1,872</td>
<td>3,600</td>
<td>66</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>1,780</td>
<td>1,073</td>
<td>707</td>
<td>40</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>216</td>
<td>0</td>
<td>216</td>
<td>100</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>29</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>6,806</td>
<td>3,650</td>
<td>3,156</td>
<td>46</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>4,416</td>
<td>816</td>
<td>3,600</td>
<td>82</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>2,808</td>
<td>828</td>
<td>1,980</td>
<td>71</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>4,512</td>
<td>3,744</td>
<td>768</td>
<td>17</td>
</tr>
</tbody>
</table>

*H. D. Tate, Lewis T. Graham and O. S. Bare.*
Grasshoppers

Grasshoppers caused relatively minor damage to Nebraska crops in 1943 except in a few local areas and, late in the season, on new alfalfa plantings, dryland potatoes, and fall-sown grain. A period of warm weather in early spring, during which about 20% of the eggs hatched in the Panhandle counties, followed by cool weather resulted in a high mortality of the nymphs. Later in the spring, intermittent periods of warm and cool weather, including snow in a few instances, destroyed large numbers of nymphs as they hatched. Heavy beating rains, particularly in the eastern counties, killed many of the young nymphs directly and encouraged the development of fungus disease. Also, abundant moisture produced a plentiful food supply in the form of weeds along ditch banks, roadsides and other waste areas. These combined influences reduced a threatening grasshopper population to non-economic proportions in some areas.

A total of 2997 farmers used approximately 450 tons of dry bait on approximately 160,000 acres of crops and 6,000 acres of pasture and range lands.

To compensate partly for the labor shortages during the growing season, bait materials are being mixed in a dry condition during the winter months. The bait can then be issued directly to the farmer, ready to use except for the addition of water. At present threatening grasshopper populations are confined to small areas in a few sections of the state. Federal and state agencies are planning a concentrated control program in these areas in an effort both to prevent increase and spread from these foci of infestation and to demonstrate the value of the preventive measures in grasshopper control.


Corn Rootworm

Records on this pest were obtained in cooperation with the Soil Conservation Service and the Agronomy Department. In a series of replicated plots, on land planted in corn for the third successive year, the percentage of stalks affected by the northern corn rootworm, *Diabrotica longicornis*, was found to be significantly less on fall cultivated plots (either subtilled or disked) than on spring cultivated plots. A marked difference in varietal susceptibility to *D. longicornis* was evident. Measured in terms of lodging, approximately 100% more of the plants of the hybrid “Ohio 38” were seriously affected (inclined 30° or more) than of the hybrid “Ohio 92.”

Damage by the southern corn rootworm, *Diabrotica duodecimpunctata*, varied markedly in fields planted on different dates. In a field of “early corn,” only 0.4% of the plants were seriously affected as compared to 47% in an adjoining field of “late corn.”

Heavy infestations of the corn rootworm *Diabrotica filicornis* developed in irrigated sections in the vicinity of Lexington (Dawson county). In early July, a large percentage of the stalks in some corn fields were affected. Timely irrigation appeared to overcome most of the damage except for the difficulties of harvesting lodged corn with mechanical pickers. In this region growers have developed a practice of planting
corn for several years in succession in the same field. During recent years corn rootworms have greatly increased and, as a result, it seems likely that some change in rotations may become necessary.

Lewis T. Graham and H. Douglas Tate.

Mosquito Survey

A mosquito survey started in 1942 was completed during the current year. Thirteen New Jersey type mosquito light traps located in various parts of the state were operated three to five nights each week from May to October, 1942, and 11 traps in 1943, 6 of them in new locations. The traps were operated a total of 1152 trap-nights during the 2-year period, and approximately 250,000 specimens of mosquitoes collected and identified. Included among these were 8 genera and 33 species, 15 of which were new records for the state. Of the 9 major species, *Aedes vexans* ranked first in abundance, followed in order by *Culex tarsalis*, *Theobaldia inornata*, *A. nigromaculis*, *A. dorsalis*, *Psorophora signipennis*, *C. salinarius*, *C. pipiens* and *A. trivittatus*.

Mosquitoes in Nebraska often increase to a degree highly annoying both to man and animals, and the situation will be aggravated as irrigation projects expand. The greatest importance of the mosquito, however, is as a potential vector of disease, particularly encephalitis. *Culex tarsalis*, second most abundant species in the state, has been repeatedly shown to be infected in nature with the virus of St. Louis and western equine types of encephalitis and to be capable of transmitting the infection; this mosquito appears to be particularly worthy of emphasis since it readily feeds on wild animals, both birds and mammals which may serve as natural reservoirs for the virus, on horses, and, to a limited extent, on man. *Aedes vexans*, dominant species in Nebraska, *Theobaldia inornata*, third in abundance, *A. nigromaculis*, *A. dorsalis*, fourth and fifth in abundance, respectively, and *Culex pipiens*, one of the 9 major species, have been shown to be capable of transmitting one or the other of the encephalitis viruses under experimental conditions. *Anopheles quadrimaculatus*, one of the two major malaria vectors in the United States, was collected in considerable numbers in one location. The records indicate, however, that it does not occur in sufficient numbers over a long enough period of time to be of serious consequence as a malaria vector in Nebraska.

H. D. Tate and Doris Gates.

Cattle Grubs

When a control program was being organized in 1942–43, it became evident that few data on the actual extent of cattle grub infestation in Nebraska-produced cattle were available. Therefore, more definite information was desirable in order to present an accurate and convincing account of the problem to the cattle growers. With the cooperation of the National Livestock Loss Prevention Board, Cudahy Packing Company, Swift and Company, Wilson and Company, Armour and Company and various commission firms, records were obtained on 826 lots of cattle representing 26,776 animals at the time of slaughter in Omaha packing plants. Eighty-five per cent of these were infested, i.e., harbored at least one grub, and 61% were grubby, i.e., harbored five or more grubs; no lots were free from infestation. Of the 826 lots 60, or 1,843 animals,

were directly from Nebraska farms and ranges. Among these, 92 per cent were infested and 64 per cent were grubby.


Lewis T. Graham and H. Douglas Tate.

Miscellaneous Insects

Bean Insects. A study of insect pests of beans, particularly the potato leafhopper (*Empoasca fabae*) in eastern Nebraska, was continued. Limited exploratory control tests, in cooperation with the Department of Plant Pathology, were conducted in garden plots at Lincoln.

Stored Grain Insects. Publication: H. Douglas Tate and Don B. Whelan, “Controlling stored grain pests on Nebraska farms,” Exp. Sta. Cir. 74.

Cockroach Control. Investigations concerned with the development of an effective bait for controlling the German cockroach were initiated.


External parasites of poultry. Publication: O. S. Bare, “External parasites of poultry and methods for their control,” Exp. Sta. Cir. 75.

Rodent Control

Rodent control work in 1943 consisted principally of demonstrations, organized control programs and surveys by extension entomologists and personnel of the Fish and Wildlife Service assigned to this state, along with limited assistance by Experiment Station personnel.

The menace of coyotes as predators has increased during the past year to the point where in some instances livestock and poultry producers
have been forced to liquidate their flocks. Coyotes, for example, de­
stroyed the entire lamb crop from 70 ewes on a farm near Ellsworth. At a meeting at Benkelman, 20 farmers reported the loss of 786 chickens, 174 turkeys, 64 sheep, 5 ducks and 9 calves. Predator control areas have been organized in Banner, Dawes and Sioux counties with an estimated 60% reduction in losses. Eight other counties have requested assistance in an effort to set up control areas.

Field observations and reports from various sources indicate that pocket gopher damage has increased during recent years. There is evidence that the range of prairie dogs has been extended; jack rabbits have become an increasing menace, partly because of insufficient ammuni­
tion; and rats appear to be more numerous both in the country and in urban communities, probably because under emergency conditions lack of customary sanitation measures and other normal checks has created favorable situations for increase.

Field control activities during 1943 were: (1) A state-wide rat control program was given general supervision. Thirty-five meetings and demon­strations were conducted and extensive publicity issued. (2) Two prairie dog control programs were organized, one in Sioux and one in Dawes county. Twenty-seven demonstrations were given. (3) Fifteen pocket gopher control demonstrations were held in ten counties. (4) Three organized predator control areas were supervised in Banner, Dawes and Sioux counties where several hundred coyotes were killed.

In the campaign for greater food production in 1943 animal products were highlighted. Animal husbandry research continued to find answers to the problems of animal nutrition and well-being encountered by Nebraska livestock growers.

Feeding Cattle, Hogs and Sheep
Department of Animal Husbandry

The Relation of Grain and Forage Sorghums to the Incidence of Lithiasis, Anasarca and Pathological Liver Conditions in Cattle

Further investigations of grain and forage sorghums and the occurrence of pathological responses were conducted in 1943. Six lots of 12 steer calves with an average initial weight of approximately 460 pounds were fed for 326 days. All lots were fed sorgo silage. Lot 1 was fed ground shelled yellow corn, approximately 1.5 pounds cottonseed cake and .08 pound ground limestone per head daily; Lot 2 was fed the same as Lot 1 except ground Early Kalo was substituted for ground corn; Lot 3 was fed the same as Lot 2 with the addition of Type 20 Provato1, a commercial carotene concentrate with vitamin A value of 3330 USP units per gram, fed at a level to provide an average of approximately 4200 units per 100 pounds live weight daily. In addition to sorgo silage and ground Early Kalo, Lots 4, 5, and 6 were fed 1.0 pound of cottonseed cake and 2.0 pounds of alfalfa per head daily. Lot 4 was fed green U. S. No. 1 leafy alfalfa and Lots 5 and 6 brown U. S. No. 3 leafy alfalfa. Lot 6 also was fed Provato1 at the same level as that fed to Lot 4.

No very clean-cut differences between lots were secured. In general, the lots fed alfalfa made slightly larger gains than the three lots which were not fed alfalfa. Lots 1 and 2 were the least attractive of the six lots in general appearance and the three alfalfa-fed lots slightly superior. All of the steers in Lots 1 and 2 showed discharge from the eyes, and 6 steers from Lot 1 and 3 from Lot 2 showed enlarged hocks near the close of the feeding period. The other lots were free of discharge from the eyes and practically free from enlarged hocks. One steer was removed from Lot 1 because of urinary calculi and one because of excessive loss of weight. This steer showed thick mucus in the nostrils and continuous copious dripping of saliva. Postmortem showed a corneal abscess in each eye in the middle anterior portion of the eyeball. The lymph glands were enlarged and edematous. There was a fibrinous exudate in the abdominal cavity. There were extensive adhesions in the middle portion of the small intestine. There was an extensive growth around the intestine, which with the adhesions, prevented the passage of solid food through the digestive tract. The corn fed to Lot 1 was very low in carotene.

The six lots of steers sold at the same price and did not show marked differences in yield or carcass grades. Eighty-two per cent of the livers showed abscesses or telangiectasis. Because of abscesses, 5.6 per cent of the livers were condemned and 2.8 per cent because of telangiectasis. As far as could be determined, differences in the rations fed were not reflected in the condition of the livers. Marvel L. Baker.

Feeding Barley to Heifer Calves. Four lots of 11 heifer calves were fed for 173 days beginning January 6, 1943. For the first 90 days corn and
sorgo silage, a limited amount of alfalfa hay, and approximately 1.0 pound of cottonseed cake comprised the basal ration. The silage was then dropped from the ration, the alfalfa hay increased, and the cottonseed cake reduced to 0.55 pound per head daily. The grain fed the four lots respectively was ground shelled yellow corn; a mixture of two parts ground shelled yellow corn and one part ground two-row barley; a mixture of one part ground shelled yellow corn and two parts ground two-row barley; and ground two-row barley. No digestive disturbances were encountered.

Gains and feed requirements per unit of gain for the first three lots were quite similar. Lot 4, fed ground barley, made a somewhat smaller average daily gain than the other three lots and required approximately five per cent more grain per unit of gain.

Market and slaughter data failed to show any appreciable difference between lots.

Marvel L. Baker.

**Bromegrass vs. Grama Grass Pasture for Yearling Heifers.** Two lots of 10 light yearling heifers were run on pasture from May 7, 1943 to September 23, 1943, a period of 139 days. They were then full-fed in dry lot for 84 days on corn silage, ground shelled corn, and soybean oil meal.

Lot 1 was grazed throughout the pasture season on bromegrass; Lot 2 was grazed for 27 days on bromegrass and for 112 days on grama grass. Both pastures were seeded the spring of 1942.

The pasture did not make much growth in early spring because of dry weather. Because of the rapid growth of the bromegrass in late May and June, much of it was not used until past its most palatable and nutritious stage of growth. The above-normal rainfall of June brought on a heavy weed crop, principally kochia, in the grama grass pasture. This was utilized about 50 per cent. Gains per head on grass by periods were:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1 Bromegrass Pounds gain</th>
<th>Lot 2 Grama grass 112 days Bromegrass 27 days Pounds gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st period, 27 days</td>
<td>55.5</td>
<td>56.7</td>
</tr>
<tr>
<td>2nd period, 28 days</td>
<td>35.0</td>
<td>61.0</td>
</tr>
<tr>
<td>3rd period, 28 days</td>
<td>19.5</td>
<td>28.5</td>
</tr>
<tr>
<td>4th period, 28 days</td>
<td>10.0</td>
<td>35.0</td>
</tr>
<tr>
<td>5th period, 28 days</td>
<td>1.0</td>
<td>10.5</td>
</tr>
</tbody>
</table>

The yields per acre and utilization of forage from the two pastures were as follows:

<table>
<thead>
<tr>
<th>Kinds of Vegetation</th>
<th>Yield Moisture-free basis Tons</th>
<th>Utilization Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromegrass</td>
<td>1.96</td>
<td>1.34</td>
</tr>
<tr>
<td>Sweetclover</td>
<td>0.27</td>
<td>0.19</td>
</tr>
<tr>
<td>Weeds</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>Total</td>
<td>2.46</td>
<td>1.76</td>
</tr>
</tbody>
</table>
Blue grama                     0.75  0.51  68
Side-oats grama               0.09  0.09 100
Weeds (principally kochia)    2.24  1.10  49

Total                        3.08  1.70  55

In the 84-day feeding period, Lot 1 made an average daily gain of 2.79 pounds per head daily and required 1079 pounds of corn silage, 507 pounds ground shelled corn, and 54 pounds of soybean oil meal per 100 pounds of gain. Lot 2 carried more finish at the beginning of the feeding period and made an average daily gain of 2.66 pounds per head daily. The heifers in this lot required 1180 pounds of corn silage, 531 pounds of ground shelled corn and 56 pounds of soybean oil meal per 100 pounds of gain.

Although Lot 2 appeared fatter than Lot 1 at the close of the feeding period, both lots sold at the same price. Lot 2 dressed 60.0 per cent and Lot 1, 60.8 per cent. They graded approximately the same in the carcass.

Combining both the pasture period and the dry-lot feeding period, the heifers in Lot 1, grazed on bromegrass for 139 days and fed in dry lot for 84 days, gained 355 pounds per head and required 711 pounds of corn silage, 334 pounds of ground shelled corn, 35 pounds of soybean oil meal and 39 days of bromegrass pasture for one heifer for each 100 pounds of gain.

The heifers in Lot 2 grazed on bromegrass for 27 days and on grama grass for 112 days and fed in dry lot for 84 days, gained 416 pounds per head. They required 636 pounds of corn silage, 286 pounds of ground shelled corn, 30 pounds of soybean oil meal and 33 days of pasture (6 bromegrass and 27 grama grass) for one heifer for each 100 pounds of gain. E. C. Conard of the Soil Conservation Service cooperated in establishing the grama grass pasture and L. C. Newell of the Agronomy Department, in supplying the yield and utilization data. Marvel L. Baker.

Feeding Distillers' Dried Wheat Grains to Fattening Yearling Heifers

Distillers' dried grains made from 53 per cent whole wheat, 33 per cent wheat grits or granular flour, 4.0 per cent corn and 10 per cent barley malt were used to replace soybean oil meal and/or ground shelled corn for fattening yearling heifers fed for 88 days. The distillers' dried grains analyzed 31.5 per cent protein.

Five lots of 10 head of good quality Hereford yearling heifers, averaging 680 pounds initial weight, were fed. The five lots respectively were fed 1.50 pounds soybean oil meal, 1.0 pound soybean oil meal and 0.80 pound distillers' dried wheat grains, 0.50 pound soybean oil meal and 1.50 pounds distillers' dried wheat grains; 2.30 pounds distillers' dried wheat grains, and 6.49 pounds distillers' dried wheat grains per head daily. In addition to the soybean oil meal and distillers' dried wheat grains, all five lots were fed corn silage, ground shelled corn, and 0.10 pound ground limestone per head daily.

The average daily consumption of concentrates per head for the five lots respectively was 13.90 pounds of ground shelled corn and 1.50 pounds of soybean oil meal or a total of 15.40 pounds; 14.65 pounds of ground
shelled corn, 1.0 pound of soybean oil meal and 0.80 pound of distillers' dried grains, or a total of 16.45 pounds; 14.59 pounds of ground shelled corn, 0.50 pound of soybean oil meal and 1.50 pounds of distillers' dried grains, a total of 16.59 pounds; 14.15 pounds of ground shelled corn and 2.30 pounds of distillers' dried grains, a total of 16.45 pounds; and 10.07 pounds of ground shelled corn and 6.49 pounds of distillers' dried grains, or a total of 16.56 pounds. The average daily gains for the five lots were respectively 2.08, 1.98, 2.05, 1.90, and 1.93 pounds per head. Concentrates required for 100 pounds of gain were 741, 829, 808, 867, and 859 in the five lots. In this trial distillers' dried wheat grain were palatable and apparently stimulated feed consumption. They were satisfactory as a protein supplement but was not as efficient as soybean oil meal in producing gain.

However, at the conclusion of the trial, Lots 2, 3, and 4 appeared to be the fattest lots of the five and commanded a slight premium in selling price. These three lots also dressed higher (59.3, 58.9, and 59.2 per cent) than Lot 1 fed soybean oil meal without distillers' dried grains (57.6 per cent) and more than Lot 5 fed an average of 6.49 pounds distillers' dried grains (57.9 per cent). There was little difference in carcass grades between lots.

Marvel L. Baker.

Hog Feeding Investigations

Substitutes for Alfalfa Meal in Rations for Pigs in Dry Lot. This was the fourth of a series of trials designed to find a suitable substitute for alfalfa meal in dry lot rations for pigs. As in previous trials, artificially dehydrated Sudan grass was compared with alfalfa in a ration of white corn, tankage, and soybean meal. The Sudan grass was cut at a height of about 18-20 inches, and dehydrated without exposure to sunshine. The alfalfa was fourth cutting and was baled from the windrow.

The alfalfa was fed at a level of 25% of the protein supplement mixture while the Sudan grass meal was fed at levels of 20, 25, and 33% of the protein supplement mixture. In addition one lot was fed ground, field-cured Sudan grass hay as 25% of the protein supplement. The Sudan grass hay was cut at a height of approximately 3 feet. All lots were self-fed a simple mineral mixture.

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

<table>
<thead>
<tr>
<th>Roughage</th>
<th>Carotene content in mgs. per 100 gr.</th>
<th>Crude protein %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa (ground)</td>
<td>20.4 11.3 6.1</td>
<td>Jan. 15, 1943</td>
</tr>
<tr>
<td>Sudan grass meal</td>
<td>14.7 5.1</td>
<td>April 26, 1943</td>
</tr>
<tr>
<td>Sudan grass hay (ground)</td>
<td>14.5 4.1 2.4</td>
<td></td>
</tr>
</tbody>
</table>

As in the trial reported last year, none of the rations was entirely adequate under the conditions imposed. The gains were poor, being but slightly over one pound daily per pig, and the trial was concluded after 108 days of feeding. At that time the pigs fed alfalfa were easily the best-appearing group and averaged 192 pounds. The pigs fed Sudan grass meal as 25% of the supplement also had reached an average weight of 192 pounds, but they were not so sleek as the alfalfa-fed pigs. The pigs fed Sudan grass meal as 33% of the supplement weighed 188 pounds,
and the pigs fed Sudan grass meal as 20% of the supplement weighed 171 pounds. These latter two groups had the poorest appearance. The pigs fed the Sudan grass hay weighed an average of 187 pounds and were a decidedly better-looking group than the two preceding ones.

When the trial had been in progress for approximately 8 weeks, locomotor incoordination was noted in one pig in the 20% Sudan grass meal lot. Later one or more pigs in all of the lots except the one which received ground Sudan grass hay were affected. As in last winter's trial, the pigs were affected to varied degrees of severity. Some individuals ceased growing while others continued to make approximately normal gains. Some pigs merely became very unthrifty without losing their coordination. In addition, an abnormal skin condition was present in most of the pigs. The animals would rub on the fences with such vigor that several rubbed off big patches of hair. The animals were carefully checked for external parasites with negative results.

Several of the most seriously affected pigs were divided into three groups and fed a basal ration of the same ingredients as produced the condition. One group was used as controls, one group was fed a supplement of 0.2 pound of brewers' type yeast per pig daily, and one group was fed a supplement of 0.4 pound of liver and glandular meal per pig daily. The most striking improvement was in the group fed yeast, especially in the case of one pig.

Our experience with these rations the past two winters indicates that the nutritive deficiency has a "border-line" status. In the first two trials of this series, in which highly satisfactory results were obtained, the pigs used had access to excellent pasture for about one month before they were placed in the concrete lots. The pigs used in the last two trials had access to little or no pasture before they were placed on concrete floors. One hundred head of pigs farrowed under the same conditions as the pigs used in the past winter's trial were left in a large dirt lot and were fed similar rations except that nearly twice as much alfalfa was fed. These pigs were carefully examined several times during the winter and at no time was there any clinical evidence of nutritional inadequacy in their ration. They made excellent gains and were marketed at approximately six months of age. L. E. Hanson and William J. Loeffel.

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

<table>
<thead>
<tr>
<th>Average weight of pigs</th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
<th>Lot 5</th>
<th>Lot 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 lbs. to 125 lbs.</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>125 lbs. to 200 lbs.</td>
<td>15</td>
<td>13</td>
<td>11.3</td>
<td>15</td>
<td>13</td>
<td>11.3</td>
</tr>
</tbody>
</table>

During the first period the ration fed to each lot contained 5% of ground alfalfa. During the second period the alfalfa was fed at a level of 10% of the ration. All lots were self-fed a simple mineral mixture.

The 30 pigs fed the 18% protein ration made somewhat faster gains on a smaller daily feed intake than the 30 pigs fed the 15% ration. At present feed prices this resulted in more economical gains on the higher protein ration.
During the second period, the pigs fed the 13% ration made nearly the same gains as the pigs fed the 15% ration, and because they consumed considerably less protein, their gains were made at a lower cost per pound. Both lots consumed approximately an equal amount of feed daily. The ration containing 11.3% protein was composed of corn and alfalfa, and although reasonably good results were obtained, it was the least efficient ration fed. 

_L. E. Hanson._

**Waxy Corn vs. Non-waxy Corn for Pigs in Dry Lot.** The recent industrial interest in waxy corn containing a special type of starch raised the question as to the feeding value of this cereal. The answer to this question would be important if a surplus were produced and it should become necessary to dispose of this surplus by feeding it to swine.

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

The response of the pigs fed the waxy corn was fully equal to that of the control group (Lot 1). The pigs in Lot 2 consumed 6.3 pounds less supplement per 100 pounds of live weight gain than the pigs in Lot 1; whereas the corn requirements were nearly identical. On analysis by the station chemist, it was found that the non-waxy corn contained 11.7% crude protein and the waxy contained 14.0% crude protein on a moisture-free basis. This would account for the difference in protein consumption. On the other hand, the extra protein contained in the waxy corn did not replace the protein provided in the protein supplements, unit for unit. As an average for the entire feeding period of 113 days, the pigs in Lot 1 consumed a 15.5% crude protein ration in their self-balanced diet; whereas the pigs in Lot 2 consumed a 16.9% crude protein ration.

That the pigs preferred non-waxy corn to waxy corn when given a choice was clearly demonstrated by Lot 3. During the first 2 weeks of the feeding period this group consumed approximately equal amounts of each kind of corn. Thereafter their preference was very marked and during one four-week period the ratio of non-waxy corn to waxy corn eaten was nearly 8:1. The ratio for the entire feeding period was 3.3:1. The two kinds of corn were alternated in location each four weeks to eliminate any location habits the pigs may have developed. _L. E. Hanson._

**Rations for Weanling Pigs on Pasture—Special Supplements**

This trial was a duplication of the trial reported last year for formulating an improved protein supplementary mixture for weanling pigs. Four lots of ten pigs each were self-fed shelled yellow corn and a mixed protein supplement, free-choice. Each lot had access to one-half acre of oats, followed by sweetclover (first year) pasture, and a simple mineral mixture.

The controls were fed a supplement of equal parts, by weight, of tankage and soybean meal. In the other three lots the tankage was reduced to 35%, and 15% of fish meal, liver and glandular meal, or dried whey was added. The pigs were fed these mixtures from an initial weight of approximately 40 pounds to a final weight per lot of 75 to 83 pounds per pig (35 days). They were then continued on the same protein mixture as the controls until they reached an average weight of approximately 200 pounds.
During the first period the pigs fed fish meal and the pigs fed dried whey made more rapid gains than the controls. They retained this advantage during the second period and at the conclusion of the trial were the heaviest group in the trial. For some unknown reason the pigs fed liver and glandular meal failed to gain as well as the control group, although the difference was slight. They did make somewhat more efficient gains than the controls.

During the second period, when all groups were fed the same ration, the pigs of the liver- and glandular-meal-fed group gained more rapidly than any of the other lots, and also made the most efficient gains. The fish-meal-fed pigs ranked second in efficiency of gains.

As occurred in the trial last year, the gains made by the pigs fed whey were the most expensive. During the first period these pigs consumed from 12 to 29 per cent more supplement than any of the other lots and when they were changed to the control mixture they continued to consume more supplement per unit of gain.

L. E. Hanson.

Protein Requirements of Pigs on Sudan Grass Pasture. This is the first of a series of trials designed to obtain data on the protein requirements of pigs on pasture when soybean oil meal is used as the primary source of protein.

Four lots of 10 pigs each were self-fed a concentrate mixture composed of ground yellow corn, tankage and soybean meal. The percentage of tankage included in the rations was the same for all lots and was limited to 3.3% of the ration. The percentage of soybean meal was varied to obtain rations of 20, 18, 17, and 15% protein.

All lots were self-fed a mineral mixture composed of 50% ground limestone, 20% steamed bone meal and 10% salt. The mineral consumption varied from 2.1 pounds to 2.6 pounds per 100 pounds of gain.

From an average initial weight of 41 pounds to a final weight of 74 pounds, 20 pigs fed the 20% ration consumed 14.6 pounds more soybean meal but 29.7 pounds less corn and 0.5 pound less tankage per 100 pounds gain than 20 similar pigs fed an 18% ration. Both lots made about the same average daily gain, slightly more than 1 pound daily.

From an average weight of 74 pounds to a final weight of 125 pounds, 20 pigs fed a 17% ration consumed 16.7 pounds more soybean meal but 56 pounds less corn and 0.6 pound less tankage per 100 pounds gain than 20 similar pigs fed a 15% ration. Again the gains made by both lots were approximately the same, 1.5 pounds daily.
This study will be continued to determine whether or not the slight differences observed with different levels of protein are significant.

_L. E. Hanson._

**Spartan and Comfort Barley for Pigs in Dry Lot.** This trial was a duplication of a trial reported last year in which the feeding value of Spartan, a high-protein, 2-row variety of barley, and a 6-row variety of barley was studied, along with methods of feeding the barleys. Six lots of 9 pigs each were fed for 111 days. The average initial weight was 52 pounds and the average final weight per pig varied from 183 pounds to 210 pounds in the different lots. 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 Comfort barley and supplement, free-choice; Lot 4, ground Spartan barley and supplement, mixed; Lot 5, ground Comfort barley and supplement, mixed; Lot 6, whole Spartan barley for the first 70 days, ground Spartan barley for the last 41 days, and supplement, free-choice.

The supplement fed to Lots 1, 2, 3 and 6 was composed of equal parts, by weight, of tankage, soybean meal and alfalfa meal. The mixtures fed to Lots 4 and 5 included 5% alfalfa meal and sufficient supplement, of equal parts of tankage and soybean meal, added to obtain the desired protein level. All lots had free access to a simple mineral mixture.

The pigs in Lot 2 made the most rapid gains, 1.42 pounds daily, but were closely followed by Lot 3, 1.38 pounds daily. Lots 1, 5, and 6 made about the same gains, 1.25 to 1.29 pounds daily. Lot 4 made the least rapid gains, averaging 1.17 pounds daily. The pigs fed corn consumed more supplement but less grain than the pigs fed barley. However, the additional protein in barley will not replace the protein provided in the protein supplement, unit for unit. This is clearly shown by the percentage of protein in the rations consumed by the pigs, which were fed by the free-choice method.

The corn-fed pigs consumed an average of 16.0% protein for the entire feeding period. The figures for Lots 2, 3, and 6 were 18.4%, 17.7%, and 18.8%, respectively.

This fact was even more strikingly shown by the lots fed the mixed rations, Lots 4 and 5. These mixtures were changed 3 times during the feeding period. When both lots were fed the same quantity of protein supplement, the pigs fed Spartan barley gained more rapidly than those fed Comfort barley. When both lots were fed the same level of crude protein in the diet the daily rate of gain was reversed, since the pigs fed Comfort barley were then fed a greater proportion of tankage and soybean meal. The Spartan barley used in this test contained 17.9% crude protein on a moisture-free basis, whereas the Comfort barley contained 15.9%. Both varieties were grown on the station hog-breeding farm on comparable soils.

The reason for the difference in response is not necessarily due to protein *per se*. It is possible that the protein supplements used also contribute certain other essential nutrients which may be present in insufficient amounts in barley.

It is felt that this experiment emphasizes the point that the optimal level of crude protein in a ration based on corn is not the optimal level of crude protein in a ration based on barley, when the other ingredients of both rations are the same.
The pigs fed whole barley up to a weight of 135 pounds and ground barley thereafter (Lot 6) showed good results, but these results were not equal to those of Lot 2. Whether or not this method of feeding Spartan barley should be followed would depend on the price of barley and the cost of grinding. In this instance grinding 288 pounds of barley saved 5.8 pounds of live weight gain. 

**Creep Rations for Suckling Pigs—Protein Levels.** This is the second of a series of trials planned to study the value of various creep rations for suckling pigs. Two lots of 5 sows each were used in this trial. They were selected by pairs so that each of the sows in one lot had a littermate sister in the other lot. The sows in both lots were hand-fed the same ration, twice daily. The ration consisted of a mixture of ground yellow corn, tankage and soybean meal and contained 15.2% crude protein. They were fed and housed on a sweetclover pasture. The clover was seeded in the spring of 1943 with barley and thus was only fair in quantity.

The pigs produced by the sows in Lot 1 were self-fed in a creep the same mixture as the sows. The pigs in Lot 2 were also self-fed a creep mixture of corn, tankage and soybean meal, but the proportion of protein supplement was increased so that the mixture contained 22.2% crude protein. All of the sows and pigs had free access to a simple mineral mixture.

The sows and pigs were weighed individually on the day the pigs were 14 days old and when the pigs were 56 days old they were weighed again and removed from the lot. Feed records were kept for the sows and pigs during that 42-day period.

The sows in Lot 1 farrowed 48 pigs and raised 34. The sows in Lot 2 farrowed 40 pigs and raised 30. Both lots of pigs made exactly the same total gain and since there were fewer pigs in Lot 2 the average daily gain per pig was 0.56 pound as compared with 0.5 pound for the pigs in Lot 1. Both lots of sows maintained their weights very well. The sows in Lot 1 lost only 5.8 pounds per sow while those in Lot 2 lost 7.2 pounds per sow. The sows in Lot 1 consumed more feed than the sows in Lot 2, whereas the pigs in Lot 2 consumed more of the creep ration than the pigs in Lot 1. On the basis of total feed consumption by sows and pigs and net total gain of sows and pigs, it required 10.2 pounds more protein supplement and 16.5 pounds less corn to produce 100 pounds of gain on the high protein creep ration. Thus at present feed prices the cost of gains for the two groups was nearly identical.

**Lamb Feeding Investigations**

**Nutritive Studies of Alfalfa Hay, Sorgo and Corn Silage and Their Relationship to Urinary Calculi Formation in Lambs.** In previous lamb feeding experiments at the Nebraska Experiment Station, Lincoln, and the Scotts Bluff Substation at Mitchell, the development of urinary calculi in the wether lambs on certain rations has ranged from mild to severe outbreaks. Feeder lambs of the white-face, smooth-body type from the range near Gillette, Wyoming, were used in the fall of 1942 at the Nebraska Experiment Station, Lincoln, to determine the effects of adding a feed rich in vitamin A activity to alfalfa, sorgo silage, and corn silage with reference to urinary calculi formations in lambs. The results were as follows:
I. Green-colored alfalfa vs. brown-colored alfalfa. Alfalfa hay of green color was compared with brown-colored alfalfa hay. The results showed a saving of 14.37 pounds of corn and 20.39 pounds of hay for every 100 pounds of lamb gain in favor of the green-colored hay. With corn at 56 cents a bushel and hay $10 a ton, the green-colored hay was worth about $1 a ton more for lamb feeding. No lambs died in the green-colored hay lot, whereas two died in the brown-colored hay lot. One death was attributed to urinary calculi formations; the other to “feed-lot-death-loss” with no specific cause.

II. Adding vitamin A activity to brown alfalfa. A product rich in vitamin A activity, Provatol Type 20, was added to the brown alfalfa at the rate of 2.23 grams daily per lamb. The Provatol carried 3330 U.S.P. units of vitamin A activity per gram in the form of carotene. It was fed once daily mixed with the corn. The lambs produced an average daily gain of .30 pound compared with .28 pound for the lambs receiving brown hay but no Provatol. This extra gain produced a saving of 16.77 pounds of corn and 23.16 pounds of brown alfalfa hay for each 100 pounds of lamb gain. There were no deaths in the lot receiving Provatol. Two lambs in the lot not receiving it died.

III. Green-colored alfalfa vs. brown-colored alfalfa fortified with vitamin A activity. Brown alfalfa hay fortified with Provatol Type 20 produced practically the same gains as green-colored alfalfa hay when fed with corn to lambs. The feed required to produced 100 pounds of gain was practically the same with the small difference in favor of the brown hay and Provatol combination. No lambs died on either ration. Through the whole test the brown hay lot would have consumed more hay, but it was kept at the same intake as the green-colored hay.

IV. Adding vitamin A activity to corn silage. Provatol Type 20 was added to a basal ration of shelled corn, cottonseed meal, bone meal and corn silage made from frosted corn. It was difficult to keep both lots of lambs on feed. The daily gain per lambs was poor and about .06 of a pound less than could have been expected. The feeding of 978 grams of the Provatol product saved 39.73 pounds of shelled corn, 9.5 pounds of cottonseed meal, 1.53 pounds of bone meal and 79.68 pounds of corn silage in feed required to produce 100 pounds of gain. One lamb in the lot not receiving the vitamin A activity product died from the formation of urinary calculi. No lambs were lost in the lot receiving it.

V. Adding vitamin A activity to Leoti silage. When a basal ration of shelled corn, cottonseed meal, bone meal and sorgo silage made from frosted Leoti was supplemented with Provatol Type 20, the daily gains for both lots were poor and about .10 pound per lamb less than could have been expected. No lambs died in the lot receiving the supplement whereas two lambs died from pneumonia in the lot receiving the basal ration.

VI. Vitamin A activity vs. alfalfa hay for a supplement to Leoti silage. One-half pound of green-colored alfalfa hay was compared with Provatol Type 20 as a supplement to a basal ration of shelled corn, cottonseed meal, bone meal and Leoti silage. The concentrates were fed at the same level in both lots. The Provatol-fed lambs were allowed what silage they would clean up, which was 2.08 pounds per lamb daily. The alfalfa-fed lambs were limited to one-half pound alfalfa per lamb daily and what silage they would clean up as additional roughage, which was 1.42 pounds per lamb daily. The Provatol-fed lambs gained .18 pound
daily per lamb while the alfalfa-fed lambs gained .22 pound. Both gains were poor. The results seem to indicate that the alfalfa furnished something in addition to the nutrients classed as proteins and carbohydrates since the alfalfa-fed lambs gained .04 pound more daily per lamb than the lambs receiving the Provatol. No lambs died in the Provatol lot; whereas 2 died in the alfalfa lot, one from urinary calculi and the other from causes unknown.

Rations that in the past have produced urinary calculi in the wether lambs were not so effective this year. Whether the poor quality of the silage had some inhibiting effects is not known. M. A. Alexander.
Research in the field of dairy production and manufacture during 1943 carried forward studies designed to promote improvement in dairy herds, nutrition, herd management, dairy products, and dairy manufacture—vital contributions to the great need for dairy foods now and after the war.

Dairy Production and Manufacture
Department of Dairy Husbandry

Relationship of Weight of Cow to Milk Production

REFERENCE was made previously to a study of the relationship of the weight of milking cows to their milk production which included a study of 747 lactations of 334 Ayrshire, Guernsey, Holstein, and Jersey cows in the University of Nebraska dairy herd. The production records used included every normal lactation that was not less than 243 days in length. Most of the correlations were made on the milk-energy yield for 243 days which is expressed as fat-correlated-milk for eight months (FCMs). The weights of the cows each month from the first through the tenth month of the lactation were correlated with the FCM, for each of the breeds and for all the breeds combined. It was found that the milk-energy yield had the greatest correlation to weight the first month of the lactation (W<sub>1</sub>). Thus the correlations (r) between FCM<sub>s</sub> and W<sub>1</sub> were as follows: Guernsey 0.24; Ayrshire 0.45; Jersey 0.58; Holstein 0.60; and all breeds combined 0.83. As between the weight the first month (W<sub>1</sub>) and the weight the tenth month (W<sub>10</sub>), it is believed that the high yielding cow tends to gain less weight from W<sub>1</sub> to W<sub>10</sub> than does the low producing cow, and, accordingly, at W<sub>10</sub> there is some tendency for high weight and low yield or low weight and high yield to go together. Live weight is a combination of size, in the sense of skeletal dimensions, and of condition of flesh or fatness. In good dairy cows, fatness at W<sub>1</sub> is positively correlated with yield, while fatness at W<sub>10</sub> is likely to be negatively correlated with yield. In young cows, gain in weight due to growth behaves much the same as gain in weight due to fatness, so far as concerns the correlation at W<sub>10</sub> and yield. Thus if a single weight is to be for the study of milk energy as related to weight, W<sub>1</sub> serves the purpose from both the practical and biological standpoints. Why correlations between FCM<sub>s</sub>/W<sub>1</sub> for the different breeds vary is not entirely clear. It is suggested that in this herd the Holsteins (r = 0.60) are more highly developed genetically in the lactation function than are the Guernseys (r = 0.24). Correlation coefficients reflect not only the closeness of connection between FCM<sub>s</sub> and W<sub>1</sub>, but also the degree of regression. In the samples of the breeds studied, the breed of largest cows (Holstein) has the largest milk-energy yield in proportion to live weight so that when all four breeds are combined, the correlation is higher than for any individual breed as, for example, all breeds FCM<sub>s</sub>/W<sub>1</sub> = r =0.83. The regressions of milk-energy yield on live weight (FCM<sub>s</sub>/W<sub>1</sub>) are expressed in two forms: the customary linear form, b<sub>1</sub> in the equation FCM = a + bW; the curvilinear form b<sub>2</sub> in the versatile and somewhat elusive power equation FCM = aW<sup>b</sup>. The value of b in FCM = aW<sup>b</sup> = Guernsey 0.43; Ayrshire 0.84; Jersey 0.96; Holstein 1.01; and all breeds 1.27. While some authors have argued that “metabolic body size" of
cows and other animals is proportional to the \( \frac{3}{4} \) power of their live weight and consequently as between cows, milk-energy yield should be proportional to the \( \frac{3}{4} \) power of the live weight, or 0.75. Other authors suggest the \( \frac{2}{3} \) power (0.66), and still others give 0.70. As opposed to these concepts, it appears that our data would indicate a direct proportion. Holsteins and Jereys show direct proportion (1.01 and 0.96) while Ayrshires do not agree so well (0.86). Guernseys are quite different.

The effect of age at the commencement of the lactation was studied statistically and the conclusion reached that age had much less effect upon production than weight, and that weight tended to correct for age in young growing animals since their growth increased their weight. At present there are correction factors applied for adjusting the effect of age upon milk production for comparative purposes such as daughter-dam comparisons. This study indicates quite clearly that weight is a more important factor than age at calving as affecting milk production and suggests that dairy herd improvement association testers obtain weights of cows in dairy herd improvement associations so that further correlations may be made to test the accuracy of our conclusions.


**Factors Affecting Reproduction in a Dairy Herd**

During the year the effect of various hormone and vitamin treatments upon the breeding efficiency of bulls and upon the quantity and quality of semen produced was studied. A leased Ayrshire bull, five years of age, arrived in September 1942 in very thin condition and weighing 1036 pounds. He was active and energetic, but semen samples taken early in October revealed that while his semen was average in quantity and in numbers of sperm, only about one per cent of the latter were alive. Semen samples taken later during that month were watery in appearance and showed but few sperm with none motile. From the time of his arrival, the bull was fed on alfalfa hay of good quality and a mixture of various grains averaging 14% digestible protein. Beginning in October he was fed 20 cc. daily of vitamin A and D concentrate. He gained in weight and on December 15, 1942, weighed 1330 pounds. On February 15, 1943, he weighed 1420 pounds. During this period he was in good condition and very active.. On October 22, 1942, November 3, 1942, and November 12, 1942, this bull was treated with 30 cc. Gonadin serum (Cutter Laboratories) injected into the gluteal muscle. Six semen samples observed in November and December were similar to the ones observed the last of October. On January 23, 1943, and February 4, 1943, the bull was injected with 10 cc. of an anterior pituitary extract containing Antuitrin S (Fort Dodge Serum Company). This extract was recommended as a specific for oligospermia (few sperms) and azoospermia (absence of sperm). In March and April, 1943, the bull was given three additional injections of Gonadin serum and another injection of Antuitrin S and was also given subcutaneous injections of ascorbic acid, six grams weekly for five weeks. All of these treatments proved of no value. It is suspected that this bull suffered from a vitamin A deficiency which may have caused a degeneration in the seminiferous tubules which would prevent spermatogenesis.
The use of the Gonadin treatment for a young Jersey bull who produced semen of low motility proved successful. Another factor in reproduction that has been given additional study during the past two years is the treatment of the poor breeding cow by so recycling the individual that she will have a new estrus cycle for subsequent heat periods. This objective is accomplished by removing the corpus luteum or yellow body from the ovary by a gentle massage through the intestinal wall, performed about ten days following the previous heat period. A few days later the treated females usually will come into heat, and breeding at that time often results in pregnancy. A total of 24 females have been successfully treated during the years 1941 and 1942.


Artificial Insemination and Rate of Conception in Dairy Cows

A study was inaugurated to determine rate of conception when cows were inseminated artificially by the uterine method at various intervals before and after ovulation as indicated by the rupture of the follicle. The procedure followed is to test females for signs of estrus by the mounting and standing method at two-hour intervals until estrus has ended. This test determines the cessation of estrus within an average of one hour. The ovaries are palpated every two hours after the end of estrus until the follicle is ruptured in order that the time of ovulation may be determined within an average of one hour.

Cows are inseminated at intervals as follows:
1. Cows bred before ovulation—(a) over 24 hours before ovulation, (b) from 18 to 24 hours preceding ovulation, (c) from 12 to 18 hours prior to ovulation, (d) from 6 to 12 hours preceding ovulation, and (e) less than 6 hours before ovulation. 2. Cows bred after ovulation—(a) within two hours after rupture of the follicle, (b) six hours after ovulation, and (c) twelve hours following ovulation.

In every case one cc. of diluted semen (.25 cc. undiluted semen + .75 cc. of egg phosphate buffer) is deposited in the uterine horn. Thus far, 95 cows have started on the experiment. This study is a continuation of the one previously reported on the insemination of cows at various stages of estrus.


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

Variation in Milk Quality

Monthly examination of each quarter of the udder of individual cows has been discontinued, but examinations of all quarters showing abnormal conditions have been made. Through periodical examination of udder samples and sanitary practices in handling the milking machine, the University dairy herd has been kept practically free from streptococcic mastitis.
Flavor studies of the milk of cows pastured on balbo rye were made, and new pastures have been planted for further work. Studies thus far have failed to show that balbo rye has any advantage over regular rye when the question of milk flavor is considered.

Oxidized flavor appeared in bottled pasteurized milk from a local herd where no silage was fed. Various methods of prevention were tried until it was found that the particular milk could be protected by mixing it with milk from another herd which was being fed silage. Addition of starter before pasteurization did not correct the condition. The use of Avenex appeared to correct the condition partially and the retinning of a bronze agitator bearing in the bottom of the vat seemed to help.


Minimum Amount of Milk Necessary to Rear Calves

In an experiment to find out how little milk would be needed to rear calves to six months of age, 50 grade Holstein heifer calves, divided into 6 lots, were successfully raised from approximately three weeks to six months of age on alfalfa hay, a grain mixture, a vitamin concentrate, and various amounts of skim milk, supplemented by a mixture composed of 3.2 parts of dried whey to one part of blood meal. Six and eight-tenths pounds of this mixture (5.2 pounds of dried whey + 1.6 pounds of blood meal) were used to replace 50 pounds of skim milk. The skim milk was fed in total quantities of 50, 100, 150, 200, 250, and 300 pounds to the different groups. The calves in five of the lots made an average daily gain of approximately 1.5 pounds per head for 21 weeks, and there was no statistically significant difference among the average gains in weight made by five of the six lots of calves. The statistically significant difference which did exist between Lot 5 and the other lots, caused by the death of one calf from another cause, disappeared when the original weight of this lot was adjusted so that it was about equal to the mean original weight of the other lots. At the prices used, three hundred pounds of skim milk fed without substitutes produced cheaper gains than 50 pounds of skim milk supplemented by 34 pounds of the whey-blood meal mixture.

From the data obtained in this study, it was concluded that, under the conditions of these experiments, 6.8 pounds of a mixture composed of 3.2 parts of dried whey and one part of blood meal is a satisfactory substitute for 50 pounds of skim milk in the feeding of healthy dairy calves, which were approximately three weeks of age and which weighed not less than 104 pounds. Thirty-four pounds of this whey-blood meal mixture can be fed, without serious effects, in 30 days even though as much as 1.8 pounds is fed daily for a few days. Healthy, vigorous dairy calves can be raised satisfactorily from three weeks to six months of age on as little as 50 pounds of skim milk properly supplemented by dried whey, blood meal, alfalfa hay, a grain mixture, and a vitamin
concentrate. Labor can be saved in the raising of dairy calves by replacing the pail feeding of milk over a long period, with a few weeks of milk feeding followed by a suitable grain mixture, alfalfa hay, and a vitamin concentrate.

With the prices of feeds as quoted herein (corn $0.86 per bushel, oats $0.61 per bushel, wheat bran $1.80 per cwt., soybean meal $2.60 per cwt., bone meal $2.75 per cwt., linseed meal $2.60 per cwt., alfalfa hay $0.76 per cwt., salt $1.50 per cwt., skim milk $0.45 per cwt., dried whey $6.40 per cwt., and blood meal $4.70 per cwt.), the feed cost of raising calves on milk only may be less than when the milk is replaced by this whey-blood meal mixture. However, when the labor cost is considered in connection with the feed cost, the additional expense of using the substitute mixture will not be prohibitive. Dried whey and blood meal can be utilized as a means of diverting milk from calf feeding to human food and to other uses.


I. L. Hathaway, G. W. Trimberger, and H. P. Davis.

**New Sweetening Agents for Ice Cream**

A study has been made of the use of various acids in the making of a suitable invert sugar syrup for supplying sweetening in a commercial ice cream mix. Acids studied have included citric, tartaric, hydrochloric, sulphuric, lactic, and phosphoric. A procedure found satisfactory was to use 100 pounds sugar, 40 pounds water, and 1.25 fluid ounces of phosphoric acid (75%). The mixture was brought to boiling temperature in a steam-jacketed kettle and held at that temperature for 10 minutes, then cooled to 100°F., 1.3 ounces sodium bicarbonate added, and cooling completed.

National and state changes in butterfat and milk solids standards for ice cream have occasioned a preliminary study of proper balancing of mix formulae to produce a satisfactory ice cream of lower fat and serum solids content. In preliminary trials the effect of reduced butterfat and serum solids on the body of ice cream was most satisfactorily overcome by the addition of fresh whole egg. When butterfat was reduced from 14% to 11.5%, the use of one per cent fresh egg proved satisfactory. A further reduction of one per cent fat and a corresponding decrease in serum solids necessitated the use of two per cent fresh whole egg. More satisfactory results were obtained in improvement of body and maintenance of a satisfactory flavor when using egg than when using cereal flour products.

L. K. Crowe.

**Vitamins in Cheese**

Much work was done to develop a suitable method for the biological determination of riboflavin in cheese. A satisfactory method has now been matured and two experiments have been completed. A third experiment will be completed shortly, and another test group of 100 rats is about ready for the fourth experiment.

The sample of Wisconsin cheddar cheese studied in Experiment 1 contained approximately 2,326 micrograms of riboflavin per pound. In
Experiment 2, a sample of Wisconsin cheddar cheese contained approximately 2,421 micrograms. A sample of New York cheddar contained 1,517 micrograms of riboflavin per pound.  

_I. L. Hathaway._

**Studies of Nebraska Cheese**

Records of graded cheese in Nebraska in connection with Lend-Lease purchases have been available for study. The manufacturing records of some 2.25 million pounds of cheddar cheese made in one plant have been tabulated in an effort to determine possible relationship between the grade of cheese and manufacturing methods.

Detailed tabulation of over 1,600,000 pounds of cheddars or some 1600 vat batches have been made. From this, a month-by-month tabulation of the total quantity of cheese made in the plant, a separate tabulation of the total cheddars made, total cheddars graded, and total cheddars graded U. S. No. 1 has been made. More than 800 vat batches of cheese graded U. S. No. 1 have been studied to compare the time from setting to milling with the milling acidity. Although not yet completed, the study shows that No. 1 cheese was made under very widely different conditions. Tabulations showed that a considerable number of batches were graded differently over a period of nine months, thus indicating that not all cheese held its quality during aging and that the main fault was the development of flavor defects. Plant operation and methods seem to determine the quality of cheese made, and the survey indicates that pasteurization is necessary for the production of high grade cheese.

Although preliminary experimental batches made have not been extensive enough to furnish conclusions, they indicate that low milling acidities may develop sweet gas more often than higher acidities if the batches are held at room temperature.  

_P. A. Downs._

**Preserving Dairy Products**

Home pasteurization of cream in closed containers has been studied, and a process of pasteurizing cream in closed container has been found satisfactory. Cooling of cream to at least 70°F. and keeping it in covered container aided in preserving cream quality.

A wooden rectangular cooling tank that any farmer can make from available lumber has been developed. No. 10 tin cans, held in a pail of cold water by hooking them to a concrete disk which keeps the can partially submerged, cooled cream materially during separation.  

_P. A. Downs and F. D. Yung._

**Vitamin Content of Commercial Butter**

Equipment and supplies incident to this study have been assembled, arrangements have been made with commercial companies to supply the sample, and “points” have been obtained from the rationing board. The spectrophotometer has been calibrated with crystalline carotene and crystalline vitamin A, and some preliminary studies have been made of butter. This work has been retarded because of the scarcity of labor and the slow delivery of various items of laboratory equipment, occasioned by the war, but the study is now well under way.  

_I. L. Hathaway._
Research devoted to poultry nutrition and management continued through 1943 to help solve the problems of Nebraska poultrymen—the producers of a vital proportion of our food supply.

Poultry Nutrition and Management
Department of Poultry Husbandry

The Relative Value of Wheat, Wheat Milling By-products, and Oats in Rations for Growing Market Chickens

The release of large amounts of surplus wheat for livestock and poultry feeding raised many questions about the relative value of this feedstuff in comparison with other competitive ingredients. In a series of experiments for which the same combination of concentrates was used as a base, five different combinations of yellow cornmeal, ground wheat, shorts, bran and pulverized oats were compared. All rations gave satisfactory results, but a mixture of 28.8 per cent of yellow cornmeal, 10 per cent of shorts, 10 per cent of bran, and 10 per cent of pulverized oats, with 41.2 per cent of the basic concentrates, gave slightly better results than either of four other combinations of cereal products. It is concluded that with a good combination of concentrates a number of different combinations of cereal products can be used satisfactorily for growing market chickens. The relative price and availability is, therefore, the determining factor.

F. E. Mussehl and Rollin Thayer.

A Comparison of Four Concentrate Mixtures for Growing Chickens

A comparison of four combinations of concentrates, consisting of relatively high levels of soybean meal with only four per cent of meat scrap and chicken scrap, indicated that relatively high amounts of soybean meal can be used efficiently in rations for growing chickens, provided the mineral and vitamin limitations of soybean meal are satisfied. One combination of two parts of chicken scrap, three parts of soybean meal, two parts of corn gluten meal, two parts of alfalfa leaf meal, and one part of a standard salt mixture gave especially satisfactory results.

Data were obtained, indicating that chicken scrap, which is a by-product of poultry evisceration plants, supplemented soybean meal protein as effectively as does commercial meat scrap.

F. E. Mussehl and Rollin Thayer.

Supplements to High Soybean Meal Rations for Growing Pouls

Experiments to determine whether turkeys could be grown successfully with high soybean meal and relatively low animal protein rations indicated good possibilities when the soybean meal was fortified with vitamin B complex factors. With a ration containing three per cent of fermentation by-product, carrying 10,000 micrograms of riboflavin per pound, the growth rate was entirely satisfactory even with only four per cent of meat scrap in the ration. A comparison of chicken scrap and meat scrap, both fed at four per cent levels to growing turkeys, and used to supplement high soybean meal rations, indicates that the chicken scrap is equal in value to the meat scrap for growing turkeys.

F. E. Mussehl and Rollin Thayer.
Vitamin Supplements to High Soybean Meal Rations for Growing Poults

A typical fermentation by-product fed at a five per cent level was compared with dried buttermilk at the same level, and with another ration containing 2½ per cent each of fermentation by-product and dried buttermilk. The experiment indicated a very slight advantage for the dried buttermilk; but entirely satisfactory results were obtained with the fermentation by-products used as a source of the vitamin B complex factors necessary to supplement high soybean meal rations for growing poults.

F. E. Mussehl and Rollin Thayer.

The Effect of Superphosphate Additions to High Soybean Meal Rations for Chicks

Increased use of plant protein concentrates in poultry rations brings questions of possible mineral deficiencies, and under normal conditions this is met by supplying additional bone meal. The limited supply of bone meal, however, has made it necessary that other sources of phosphorus be investigated. Experiments with varying amounts of raw rock phosphate were therefore carried on.

The basal ration was adequate for all known vitamin essentials. Raw rock phosphate was included at levels respectively of .9 per cent, 1.8 per cent, and 2.7 per cent.

The growth rate was depressed proportionately as the amount of raw rock phosphate was increased. The growth rate on the control ration, without rock phosphate additions, was considered satisfactory. It is concluded, therefore, that with a basal ration similar to the one used in our experiments, the addition of raw rock phosphate is unnecessary and inadvisable. The chief sources of phosphorus in our basal ration were meat scraps 3%, alfalfa leaf meal 6%, ground wheat 20%, and wheat bran 10%.

F. E. Mussehl and Rollin Thayer.

The Effect of Dry Heating on the Nutritive Value of Soybeans for Growing Chicks

Previous research work has indicated definitely that moist heat treatment for 30 minutes at 15 pounds pressure in an autoclave very significantly improves the growth-promoting value of soybeans for chicks. To obtain information on the effect of dry heat treatment, four lots of chicks were fed rations that were, respectively: not heated, dry heated for 30 minutes at 250°F., dry heated for 60 minutes at 250°F., dry heated for 90 minutes at 250°F.

Dry heat treatment does not produce the same chemical changes in soybeans as is effected by moist heat treatment in the manner previously reported.

The growth rate of the chicks receiving soybeans—dry heat treated for 90 minutes at 250°F.—was significantly lower than that of the control lot receiving soybeans not heated. F. E. Mussehl and Rollin Thayer.

Growth-promoting Value of Waxy Corn for Chicks

An increase in the production of waxy corn has brought questions about the relative growth-promoting value of such corn compared with typical No. 2 yellow dent corn.

The first experiment carried on with 170 chicks in each one of two lots indicated a very slight advantage for the waxy type. The experi-
The Growth-promoting Value of Wheat Fermentation By-product for Chicks

Increased amounts of wheat fermentation by-product are available from alcohol production plants. The product used in our experiments was made by fermentation of 86% of wheat, 4% of corn, and 10% of barley malt. This by-product, as used, carried 34.67% protein, and this suggests its possible use as a source of supplemental protein to be used with other plant concentrates and a minimum amount of animal protein.

The first experiment was planned to determine whether there would be any marked unfavorable effect from the use of this type of fermentation by-product at relatively high levels. For a control ration, soybean meal and corn were blended to provide 34% protein. The basal ration, used at a 75% level, was adequate for all known vitamin and mineral requirements, these factors not being the object of experimentation in this particular project.

Chicks lived quite satisfactorily even on a ration with 25% of wheat fermentation by-product, but the growth rate was subnormal, probably because of the bulky nature of the ration and the sub-optimum energy value per unit of volume. The control ration, soybean meal and corn blended to provide the same amount of protein as was provided by 25% of wheat fermentation by-product, resulted in a growth rate 60% better than was obtained with the fermentation by-product ration.

A ration containing 12.5% each of wheat fermentation by-product and soybean meal, however, produced a growth rate within 5% of that of the soybean meal-corn mixture.

It is concluded that there is nothing particularly detrimental to the growth rate of chicks in the wheat fermentation by-product, but the bulky nature of the feedstuff will probably limit its practical use to a maximum of 8% of the total ration for growing chicks. Mature hens and turkeys may, however, be able to utilize more.

Improving the Efficiency of Turkey Breeding Flocks

One of the factors affecting the economic success of turkey production is the number of poults obtained annually per breeding bird retained. With the improvement of our turkey flocks from the market type standpoint, obtaining satisfactory hatchability has been increasingly more important.

Experimental work with certain crosses and with artificial insemination has been carried on during the year. From preliminary observations it appears that turkey males vary greatly in the number and activity of sperms produced. Rations, light treatment, and management factors may have a marked influence on the production of sperms. Some method by which impotent males can be identified early in the breeding season is needed.

A satisfactory method for collecting semen was developed through the use of a two cc. vial. A one cc. tuberculin syringe scaled to .01 of a cc. was satisfactorily used for insemination of the hens.
Eggs laid the second day after artificial insemination, by early maturing white hens which had been inseminated with sperms from bronze-colored males, produced bronze poults.

Fertile eggs were obtained 28 days after the males had been removed from the breeding hens. The breeding stock was sold on the 28th day, so it is possible that fertility may continue even longer than 28 days after mating.

Another approach to the fertility problem was undertaken by crossing early-maturing white males with broad-breasted bronze hens. Both the males and females used in the cross averaged about 20 pounds in weight at maturity. A comparison showed greater hatchability of eggs produced from this cross than from eggs produced by matings of male and female broad-breasted bronze turkeys. Even with this improvement, the eggs from the cross-bred hens were still lower in hatchability than eggs from purebred, early-maturing white flocks. Further work on this project is planned for the coming year.

J. H. Claybaugh and F. E. Mussehl.

The Relative Weights at Maturity of Strains of Early Maturing White Turkeys, Broad-breasted Bronze Turkeys and Cross-breds

The growth rate of a representative group of early-maturing whites, purebred broad-breasted bronze, and a cross of early-maturing white males with broad-breasted bronze females was observed. These were grown on relatively low protein rations in consideration of the protein conservation program, but the growth rate was adjudged very satisfactory for all lots. Sudan grass pasture of good average quality was provided throughout the growing season, together with a mash mixture, averaging about 17.5 per cent protein, and with a grain mixture of equal parts of oats, wheat, and barley, and with yellow corn available in a separate feeder as soon as the turkeys demonstrated an interest in it.

The early-maturing whites and the cross-bred stock matured faster than the pure bronze stock. Inspection of these birds indicated that they were ready for market at 24 weeks, and some of the white hens could have been marketed at 22 weeks.

The average weights of the birds at 27 weeks were as follows:

<table>
<thead>
<tr>
<th>Average weight</th>
<th>Feed consumption per bird</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 weeks</td>
<td>lbs.</td>
</tr>
<tr>
<td>Early-maturing whites</td>
<td>13.3</td>
</tr>
<tr>
<td>Cross-breds (white ♂ x bronze ♀)</td>
<td>16.1</td>
</tr>
<tr>
<td>Broad-breasted bronze</td>
<td>18.4</td>
</tr>
</tbody>
</table>

The cross-bred birds are, therefore, intermediate in size and have the advantage of somewhat earlier maturity and more rapid feather development. A further study of this cross is contemplated.

F. E. Mussehl and J. H. Claybaugh.
Research in animal pathology and hygiene in 1943 helped to reduce the hazards attendant on livestock raising. The important studies in swine diseases and their prevention were carried forward.

Animal Diseases
Department of Animal Pathology and Hygiene

The Bacteriologic, Serologic and Pathologic Examinations of Specimens Submitted by Private Individuals and Others

In the course of the year closing December 31, 1943, a total of 8485 specimens were examined, recorded and results reported to the persons interested. These included 6392 blood samples submitted for the agglutination test for brucellosis. The remainder of the specimens examined pertained largely to post mortem material submitted for a laboratory diagnosis. They also included 172 tests of commercial culture-vaccine against swine erysipelas.

The specimens received represented all Nebraska counties. The counties of Lancaster, Cass, Seward, Saline, Butler, Gage and Saunders sent the largest numbers averaging about 425 specimens each. Lancaster County alone supplied 1693 specimens, 780 originating in the Station herd. The remaining counties of the state averaged 64 specimens each.

The Department of Poultry Husbandry applied the agglutination test for Pullorum disease to its flock itself, which accounts for the difference in total specimens examined as between 1942 and 1943. F. R. Woodring.

A Study of the Nature of Swine Erysipelas

During the course of 1943 the work carried on in connection with this study consisted principally in the following.

A. A study of the growth capacity and virulence of culture-vaccines prepared by the Department and kept in storage for a period of three months. The object of this phase of our efforts is the collection data, which may be helpful to explain and to prevent the premature loss of quality of commercial culture-vaccines used in the field. This work is as yet far from being completed and must therefore be continued.

B. The current challenge of the quality of anti-swine erysipelas culture-vaccines obtained from commercial sources. The results of the tests of 172 specimens of culture-vaccine indicate that on the whole there are as yet too many cultures of inferior value being sold.

C. Orientation tests of the potency of anti-swine erysipelas serum. Of these only a few are being tested just in order to have information available pertaining to prevailing serum values.

D. An attempt to determine the nature of a presumably contributing factor in the etiology of swine erysipelas. This work has been undertaken only recently and hence nothing of a definite nature can be reported at this time.

L. Van Es and J. F. Olney.

Immunity Study of Hog Cholera

The activities under this project can now be regarded as concluded. A full account of results will be submitted in the near future in the form of a manuscript for station publication. The results of this year's work may, however, be stated briefly.

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The results obtained in the experiments with hog cholera tissue vaccine (B. T. V.) do not differ greatly from those recorded in a previous attempt.

On April 26, 1943, twenty pigs about ten weeks of age were inoculated with 5 cc. each of B.T.V. and twenty-one pigs of similar age were inoculated with 10 cc. each of B.T.V. These groups were kept separate and left undisturbed until October 25, 1943, when they were subjected to a natural exposure of hog cholera.

After about two weeks cholera broke out with the result that of the twenty pigs which were inoculated with 5 cc. B.T.V. fourteen, or seventy per cent, succumbed to hog cholera. Of the twenty-one pigs which were inoculated with 10 cc. of B.T.V. seventeen, or about eighty-one per cent, died from the same cause. Of the pigs which survived in the experiment a number also contracted the disease but recovered.

In that part of this study which is concerned with the influence of excessive doses of anti-hog cholera serum against a stable dose of hog cholera virus, the results simulated the ones of the previous year with this difference, in the three pigs which contracted hog cholera following vaccination the disease appeared much earlier after the serum-virus inoculations. These pigs had received a quadruple dose of serum whereas the other group which received a double dose sustained no losses from hog cholera.

From these experiments it appears that excessive doses of serum may interfere with the development of a substantial immunity. It is believed, however, that excessive serum doses do not constitute a very important factor in the causation of so-called "vaccination breaks."

*L. Van Es and J. F. Olney.*
In a period of labor shortages the importance of farm tools and equipment is greatly increased. Agricultural Engineering investigations in 1943 provided direct and indirect aid in maintaining farm machinery and equipment at peak efficiency.

**Agricultural Engineering**  
Department of Agricultural Engineering

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

HEATING water for livestock (Sub-Project E). This sub-project has been kept active to a limited extent through the development of a low-cost, immersion-type thermostat for the control of electric stock tank heaters and continued study of the use of lead-sheathed electric soil heating cable in heating drinking water for livestock. One new electric tank heater installation is being studied during the 1943–44 season on a farm near Lincoln. Expansion of the project has been retarded because of restrictions on materials. *E. E. Brackett and F. D. Yung.*

**Study of the Adaptation of Insulated Electric Brooders in Uninsulated Poultry Houses**

Cooperative between the Departments of Agricultural Engineering and Poultry Husbandry. The lamp-heated insulated electric brooders built and studied during the 1942 season were used again for the 1943 season. In addition to these, an insulated outdoor electric brooder was designed and constructed in the Agricultural Engineering laboratories and operated at the poultry plant. The small structure is a complete brooding unit in itself and is suitable for use by suburban as well as rural families who have no brooder house or other facilities for raising chicks. It is...

![An outdoor brooder and sun pen.](image)
heated by electric lamps and accommodates 50 chicks. A removable sun pen is also provided. The unit was intended for late season brooding, but trials by the Poultry Husbandry Department have indicated that early season brooding is feasible if the brooder is well insulated and is carefully operated in a sheltered location. Instructions for building and operating the brooder are given in Extension Circular 729, "Outdoor Electric Chick Brooders for Small Flocks," issued in April, 1943. F. D. Yung, Agricultural Engineering, F. E. Mussehl, Poultry Husbandry.

A Study of Methods and Equipment for Curing and Preserving Perishable Farm Products Under Conditions of Controlled Temperature and Humidity Adaptable to Use on the Farm

Home dehydration of food. Home food dehydration studies were continued throughout the summer of 1943. Lamp-heated, home-size electric dehydrators of both natural-draft and forced-draft types were operated, but special attention was given to the natural-draft type since its simplicity favored home construction. Products tested included asparagus, peas, string beans, corn, rhubarb and Wealthy, Jonathan and Winesap apples. Ascorbic acid (vitamin C) determinations were made in the Home Economics experimental laboratories on all of the products before and after drying. No other vitamin assays were made because of insufficient help. Investigations based on refreshing and cooking of the dehydrated products, together with further vitamin and storage studies are being carried on during the winter of 1943-44. A photograph is available to show natural-draft and forced-draft dehydrators in operation.

Recording temperatures (center) for natural draft dehydrators (left) and forced draft dehydrators (right).
Cooling and storing eggs on the farm. An egg cooling and storage cabinet has been developed in cooperation with the U. S. Department of Agriculture. It is now through the laboratory test stage and ready for trial under actual farm conditions. The cabinet is designed for rapid cooling of eggs and for storage of eggs on the farm for short carry-over periods between trips to market. It is insulated and is cooled by cold well water which flows through a tube-and-fin type radiator. An inexpensive electric fan circulates the air within the cabinet which has storage room for three 30-dozen egg cases in addition to the cooling compartment. High relative humidity is maintained by means of wet sand in a flat tank on the floor of the cabinet.

A general-purpose farm refrigerator. A 3-zone, reach-in, side-opening refrigerator of approximately 80 cubic feet capacity has been constructed and is now ready for the installation of refrigerating equipment. The three temperature zones are provided in 3 compartments, one for freezing, one for frozen storage, and the third for above-freezing storage. The above-freezing compartment is designed to accommodate a whole hog or two quarters of beef for chilling. The refrigerator is built in sections to facilitate moving.

An inexpensive differential thermostat for potato storage. Two inexpensive differential thermostats have been developed for starting the ventilating fans in a potato storage whenever the outdoor temperature falls below that of the storage interior. One of these depends on the action of thermostatic wafers for its operation; the other embodies the principle of thermostatic bimetal. The wafer type was in service during the fall and winter of 1942-43 at the Experimental Farm near Alliance. It was amply sensitive over much of the seasonal temperature range but was not satisfactory at the extremes of high and low temperatures encountered. The bimetal type performed uniformly well over the entire temperature range needed but was not quite so sensitive as the wafer type. It has been installed at Alliance in place of the wafer thermostat and is giving more satisfactory service. Work on design is being continued with increased sensitivity and simplification of construction in view.

E. E. Brackett and F. D. Yung, Agricultural Engineering; H. P. Davis and P. A. Downs, Dairy Husbandry; F. E. Mussehl, Poultry Husbandry; Ruth Leverton, Home Economics.

Investigation of the Power, Labor and Machinery Requirements for the Production of Corn in Nebraska

Work on this project was done on approximately 15 acres of land on the Animal Husbandry Burlington Farm, 10 miles southwest of the Agricultural College. Although the investigation was carried on in much the same manner as in previous years, one significant change was made. Since it was evident from the map that by dividing the field into two tracts and making the plots on one of them lie north and south while those on the other made a 60° angle with the east and west line, most work could be done on the contour, the field was surveyed and contour lines staked. Although this change increased the labor, it was considered justifiable in view of conservational values and will be followed again this coming season.

Five types of seed bed preparation, each replicated 5 times, were used. These were (a) plowed, double-disked, rotary-hoed, planted; (b) double-
disked, planted; (c) listed; (d) under-cover planted with 921 cultivator and two 30” sweeps with a special planting attachment; (e) under-cover planted with a two-row lister with 18” sweeps substituted for the lister bottoms. Weed control was unusually difficult this season. A period of rainy weather at the time the corn was coming through the ground permitted weed growth to reach a stage where the harrow and rotary hoe were not effective. Weed control was greatest on the listed plots. It was next best on the under-cover plots planted with the modified lister. Weed control was poorest on the plowed ground, a condition not true in the previous seasons. But because of the season and the foul ground the seed bed preparation was as conducive to the growth of weed seed as corn. The weeds were just as thick in the rows as between them and were practically the same size as the corn. This condition made it impossible to cover little weeds without covering corn and a ribbon of weeds was evident all season. The next poorest weed control was on the disked plots. The lister cleans weed seed out of the furrow where the corn is planted, and during this season it was possible to cover the few weeds in the lister rows without covering the corn. The modified lister had strips of galvanized iron wrapped about the shanks just above the 18” sweeps, making a small furrow 4” wide. This procedure seemed to have cleaned weed seed out of the rows and made weed control more effective than on those plots where the 921 cultivator had been used, much better, also, than on the plowed and disked plots. The average yields for the 5 procedures were (a) 51.96, (b) 53.48, (c) 54.76, (d) 48.74, and (e) 53.50 bushels per acre. These figures, of course, do not give a complete picture. The field was a tract made up of several previous treatments. Some portions had been permitted to become very foul, and these portions did not respond as well to corn as that portion which had been in wheat in 1942. One replica of the plowed treatment was definitely an inferior spot. For these and other reasons, given more in detail in the complete report, too much emphasis should not be placed on differences shown by the average yields. Part of the work spent on this project this year was constructive in the fact that the tract of land will be in more nearly uniform condition for future work. There is some assurance that the same tract can be used without interruption for several years, or as long as it might seem desirable to follow corn with corn for this project. Heavy rains changed the contour of the listed furrows by causing soil to collect on the down-hill side, a condition that caused the lister-cultivator (go-dig) to follow the furrows poorly and to cover with symmetrical furrows. In previous years it has been more difficult as a rule to get a good stand with listed corn than by other methods. This year it was observed that the stand at time of emergence was nearly the same for all treatments, but the stand on the listed plots at the close of the season was poorest, due partially to conditions as described above. Of the procedures used, plowing is most likely to leave the soil in a cloddy condition; listing is next in order. The under-cover seed bed preparation and the disking are very much less liable to leave the ground in a cloddy condition. These latter methods all give promise of cutting costs without cutting yields. They definitely lessen erosion. They can be accomplished with minor or no changes in standard equipment owned in this region.

E. E. Brackett and C. W. Smith.
Research in rural economics in 1943 was devoted to investigations of farm organization and costs, marketing costs, the agricultural productivity capacity of Nebraska, and kindred subjects, the objective being, as in previous years, to point the way to profitable production for the Nebraska farmer.

**Investigations In Rural Economics**

**Department of Rural Economics**

**Cost of Producing Farm Crops**

In 1942 records were obtained from 132 farmers in 8 counties giving information necessary for calculating the cost of producing corn. Records on the cost of producing wheat were obtained from 115 farmers in 6 counties. These records, which have been collected annually since 1930, are of frequent service in answering inquiries that come to this station. Furthermore, they are basic to the setting of price floors and ceilings for feed and bread grains.

Data obtained in the wheat cost study during the twelve years, 1931 to 1942, show that an average of 6.66 man hours have been required to grow and harvest an acre of wheat in eastern Nebraska. In central Nebraska the average labor requirement has been 4.53 hours. The labor requirement on summer-fallowed land in western Nebraska has averaged 2.25 man hours per acre of wheat, and six-tenths of one man hour on non-fallowed land. These man hours include only the time actually spent in the field. An allowance of perhaps 20 per cent should be added to cover the time used in getting farm equipment ready for use, caring for fences, mowing roadside weeds, and performing other work actually a part of the cost of producing crops.

The practice of summer-fallowing land for wheat in western Nebraska increases the annual yield and decreases production costs materially. In Cheyenne county during the ten-year period, 1933 to 1942, 48.3 per cent of the wheat planted on non-fallowed land was not harvested. Only 18.2 per cent of the fallowed acreage was abandoned. Yields per harvested acre on fallowed land averaged 19.6 bushels and only 8.8 bushels on non-fallowed land.

Machinery cost records previously obtained from more than 200 farmers in the state have been analyzed during the year. This study shows that the most important variable in the unit cost of operating a machine is the amount of annual use. In order to get low operating cost, the size of equipment should be adjusted to the farm unit so each machine will be used at its seasonal capacity. The results of the study will be submitted for publication. _Frank Miller and Walter Ruden._

**Cost of Marketing Corn and Wheat by Different Methods**

Audit records of 72 cooperative elevators for 1942 were obtained. Records have been secured from most of these elevators over a period of several years. It is not planned to publish the data until records for ten years are available. _H. C. Filley._

**Farm Organization and Farm Costs**

Considerable work was done during the year in summarizing by areas the records collected over a period of years. Account books for 1942
were submitted by 290 farmers. The books were summarized by the Department of Rural Economics and were returned to the cooperating farmers by the Agricultural Extension Service. A summary of each book was retained by the department for future use.


The summaries obtained from the farm account books and published as Bulletin 346 and the Buffalo county farm survey records show quite clearly the factors which affect farm profits in south-eastern and south-central Nebraska. The business management of the individual farmer, size of business, crop yields, productivity of livestock, distribution of labor throughout the year, the amount of water available have been important factors determining profits. Irrigation and sub-irrigation have had an unusual influence on farm profits during the past ten years as a result of the prolonged drouth.

H. C. Filley, Frank Miller, and Walter Ruden.

**Economic and Social Effects on Farms of a Definitely Designed Program of Soil Conservation.** Complete business records for 1942 were obtained from 42 farm operators in southeastern Nebraska soil conservation districts. Size of business, rates of production, the combination of enterprises and efficiency in the use of feed, labor, and equipment are important factors influencing net returns to the operator. Because of good crop yields and fairly satisfactory prices, net returns in 1942 were materially higher than they have been in recent years. Returns per man and labor income varied directly with the size of business and the efficiency of operation.

In 1942 records for calculating the cost of producing corn on land of different use capabilities were obtained in Pawnee county. Corn records were secured on 116 fields. The data were tabulated by type of seed used and land capability class. Fields on Classes I and II included land with 0 to 6 per cent slope, slight to moderate erosion, and regular topography. Class III fields had slopes varying from 3 to 9 per cent, moderate to severe erosion or irregular topography. There was no material difference in the acre cost of growing corn on the different land classes. Yields were the same on all classes of land for open-pollinated varieties, but yields of hybrid varieties were higher on the I and II land than on land having a lower classification. The cost per bushel varied inversely with the yields.

A new procedure for checking the effects of soil conservation practices was used in 1943. Yields of corn on the various classes of land were obtained by harvesting 35 foot sections of rows, weighing the grain and reducing it to a 14 per cent moisture basis. A total of 180 samples were obtained from 26 fields in Nemaha and Richardson counties. The data were tabulated by land capability class and the type of tillage practice. The records showed a definite relationship between land class and yield. The yields averaged 78 bushels per acre in fields on Land Classes I and II where rotations recommended by the Soil Conservation Service had been followed the past five years and only 64 bushels on Land Class IIIA.
There was no evidence that contouring increased the yield of corn in Nemaha and Richardson counties in 1943, but there was much less erosion in the contoured fields than in those farmed in straight rows. H. C. Filley and Walter Ruden.

Levels of Living and Social Status of Farmers in Selected Counties of Nebraska. This project is carried on in cooperation with the Department of Home Economics and the Bureau of Agricultural Economics. A survey was made in Lancaster county and the data tabulated. A manuscript was prepared by L. B. Snyder and submitted to the cooperating agencies for criticism. The manuscript has been revised and is now ready to submit for publication as an Experiment Station bulletin.

Farm income, size of farm, age of operator, and quality of farm, are compared with the following five indexes of level of living: material possessions, cultural possessions, cash expenditures, total living value per family and social participation. Farm income has the greatest effect on levels of living. Tenure of operator, size of farm, and age of farm operator affect the levels of living to the extent that they influence farm income. L. B. Snyder, Rural Economics and Leland Stott, Home Economics.

Agricultural Productive Capacity of Nebraska

During the summer of 1943 a report on the maximum wartime productive capacity of agriculture was prepared in cooperation with the U. S. Department of Agriculture. Basic information was obtained from the State-Federal Division of Agricultural Statistics and the Soil Conservation Service. The Departments of Agronomy and Agricultural Engineering and the Agricultural Extension Service of the University of Nebraska, the Agricultural Adjustment Agency, the Bureau of Plant Industry, the Farm Security Administration, and the Soil Conservation Service assisted in assembling and interpreting the data.

The inventory of Nebraska's land resources recently completed by the Soil Conservation Service was used as the basis for planning the cropping system. Long-time desirable land use recommendations were developed by placing the best adapted crops on the different capability classes of land. The wartime capacity acreage for each crop was obtained by making such adjustments in the long-time desirable land use recommendations as would tend to maximize production of the adapted food and feed crops that are most needed. Livestock numbers were then adjusted to feed supplies after giving consideration to the national needs and the class of animals best suited to utilize the feed. An effort was made to keep the following considerations in mind: (1) The national need for crops and livestock that can be produced in the state, (2) Maintenance of the present acreage of tilled land in a well diversified and balanced cropping system, but with emphasis directed toward the most productive and essential crops, (3) Expansion of the acreage under irrigation, (4) Maintenance of adequate feed supplies and reserves, (5) The use of varieties and the extension of cultural practices that will maintain or increase the present level of production, (6) Effective management and use of grazing land.

The acreage of each crop was allotted to the area or areas of the state where soil and climate are best adapted to its production. For example, soybeans were allotted only to the eastern counties and the irrigated land along the Platte river. Dry edible beans were restricted to the western counties, and preferably to the irrigated land in that part of the
state. Commercial production of potatoes was recommended only in those counties where experience has shown that they can be grown successfully.

As a means of meeting wartime needs, the acreage of soybeans and dry edible beans has been expanded beyond the area that is adapted to these crops. The report reveals that the average yield in the state has been about 12 bushels per acre. In 1942, 560,000 bushels were harvested from 40,000 acres. With yields of 12 bushels per acre 2,867,556 bushels can be produced on 223,963 harvested acres. This amount would be obtained at the possible sacrifice of 7,480,364 bushels of corn and other feed grains. Dry edible beans can be obtained by sacrificing sugar beets and potatoes on the irrigated land and wheat on the dry land.

The expansion of irrigation offers one of the major opportunities for increasing production and stabilizing agriculture in Nebraska. In 1942 the irrigated area reached 723,712 acres, as reported by the State Agricultural Statistician. Careful analysis of the water resources indicates that this area can be expanded to 1,465,000 acres at a comparatively low development cost. Frank Miller.

Agricultural Credit

Most farm operators use some form of credit. Money is secured from a local bank, a Production Credit Association, or the Farm Security Administration to meet operating expenses or to enlarge the farm business. A note is often given in payment for the purchase of a farm implement and even groceries are bought “on account.” A note secured by a mortgage enters into the financing of nearly every farm purchased. When agricultural prices are comparatively stable or are rising, most of these obligations are paid when due, but periods of price decline often bring heavy losses to both the borrower and the lender.

The ability of a farmer to carry debt successfully depends upon his net income. In 1943 an effort was made to determine the average amount of credit that can safely be extended to farm operators on different grades of land in southeastern Nebraska. Net farm incomes on 968 farm records have been analyzed. The results will be compared with loan experience in the area to determine the relationships between income and successful liquidation of debt. Frank Miller.

Land Tenure

Information was secured upon the terms of leases now in force on 104 irrigated farms in Buffalo and Hall counties. Data have also been secured upon the cost of pumping water used in irrigation and the dividing of these pumping costs between landowner and tenant.

The data when published will provide landowners and tenants with information upon current lease practice on pump irrigated farms. H. C. Filley and Frank Miller.

Land Use Planning in County and Agricultural Production Areas

The Soil Conservation Service has completed an inventory which divides the state into ten areas with similar land resources. In developing these areas the land was classified according to its use capability. During 1943 the Rural Economics Department, in cooperation with the Soil Conservation Service assembled this information to obtain the
acreage of land in each capability class in the ten generalized land areas. This inventory can be made the basis for land use adjustment. Research in agronomy and farm management can determine the most profitable crops and combinations of enterprises on the different capability classes under conservation farming. Adjustments in our land use to these crops and enterprises will stabilize farm income and save the soil. Frank Miller.

Livestock Marketing from Farm to Processor

This project is cooperative between the Department of Rural Economics and the Bureau of Agricultural Economics of the U. S. Department of Agriculture. In addition to Nebraska, thirteen other states in the Corn Belt are working with the Bureau of Agricultural Economics on this project.

The information obtained thus cooperatively under this project in the fourteen states has been combined and published as "Marketing Livestock in the Corn Belt Region," Bulletin 365, South Dakota Experiment Station. This 200 page bulletin furnishes definite information upon the marketing agencies which handle stock from the farm or ranch until the animals are slaughtered. The data presented show that on the whole livestock are marketed efficiently, and that competition between the marketing agencies is keen. H. C. Filley.
Research in the fields of home economics during 1943 was directed toward the health, mental and physical, of the family—with special emphasis on nutrition. The value of good family health and morale in Nebraska and elsewhere in wartime is inestimable.

**Home Economics**
Department of Home Economics

**Family Relationships**

The responses of approximately 650 young folks to a question schedule furnished the data for a study of some of the effects of the first year of war upon the family life and the morale of rural Nebraskans. The study was undertaken with three main purposes in mind: (1) To describe certain problems and difficulties being faced by farm families at the end of the first year of war and to determine the work adjustments being made, particularly by the women, to meet these difficulties. (2) To determine changes taking place with respect to family life and the welfare of family members as a result of the war situation and the extent to which these changes were related to the specific difficulties and work adjustments investigated. (3) To make a further study of aspects of civilian morale in rural communities.

The results indicated that during the first year of the war a much reduced family personnel harvested more acres and handled heavier yields with less hired help and poorer equipment than did similar units during the last pre-war year. This was accomplished by working longer hours and by a greater participation of farm women in the field work and outside chores. The change during the war year in family life, as seen and reported by adolescent family members, was more often in the "good" direction than in the "bad." In general, they reported more recreation or "good times" in the home and less irritability and conflict in the family group. Less family recreation outside the home was also noted. On the other hand, they reported an increase in worry and nervousness in their parents.

Special study was made of the relation between such factors as the mother working in the field, the mother doing outside chores, and the loss of family personnel to the war effort upon the quality of family life. Only one, namely the loss of personnel and some of the work adjustments made necessary by that loss, were found to have affected adversely farm family life.


The "morale" data consisted of self ratings and ratings of fathers and mothers of the respondents as to strength of feeling regarding the following nine generalized attitudes, hopes and beliefs: (1) belief in the cause for which we are fighting, (2) interest in and concern about the progress of the war, (3) interest and concern regarding the management of our own national war effort, (4) sympathy and accord with what is being done by our own government to win the war, (5) faith and confidence in the leadership of the civil authorities of the nation, (6) faith and confidence in our military leaders, (7) faith and confidence in the national farm program and its administrators, (8) hope for the future,
and (9) willingness and readiness to do own part to help win the war. The level of morale as judged in terms of these items varied considerably. For example, 94% of all the ratings on "willingness and readiness to work and sacrifice" were either "a great deal of" or "much" but less than 47% of the respondents expressed similarly strong "faith and confidence in the national farm program and its administrators."

Other results of this study were as follows: (1) The respondents tended to rate themselves and their parents similarly. The coefficients of correlation ranged from +.70 to +.82. However, there was a tendency, among the girls especially, to rate their father higher than themselves in interest in the progress of the war, concern about its management, and confidence in the farm program; on the other hand they had a tendency to rate themselves higher in hope for the future. (2) In general, with respect to these aspects of morale, the small-town group rated both themselves and their parents higher on the average than did the farm group.

The study emphasized the fact that morale is extremely complex and that within a given population the "level of morale" indicated will depend upon the particular aspect of morale under consideration.

Leland H. Stott.


During the past year a corps of "participant observers" has been organized for the study of rural family life in Nebraska. This group consists of former women graduates of the College of Agriculture who are at present homemakers and mothers in representative rural communities of the state. Reports are made periodically by means of carefully constructed information schedules and standardized rating scales sent out to the field observers. The method promises to be very useful in wartime research.

**Human Nutrition Studies**

A study has been made of the food consumption and food costs during the school year 1941–42 for a group of home economics students who lived in a cooperative residence hall and followed a self-chosen diet. Records of the food consumption of these girls have been analyzed to determine the quantities and kinds of foods purchased, the nutritive value of the diet, and the distribution of cost among the various food groups.

At Love Memorial Hall on the campus of the College of Agriculture, University of Nebraska, 48 girls are divided into units of six or eight students to a group; each unit is responsible for a part of the general housekeeping and for planning, purchasing, and preparing all of the food for its members.

The accounts kept by the girls during October and November, 1941, and February, March and April, 1942, have been used for this report. These accounts represent the food consumption of 36 students.

Although the girls had a generally good diet at an average cost of 22.5 cents per person per day, or $1.58 per week, an appraisal of the choices which were made within each food group suggests that the same amount of money might have brought greater nutritive returns and yet provided an unquestionably excellent diet. Wiser choices, however, might have
meant meals less acceptable to some individuals and meals which would have taken more time for preparation. For example, the purchase of uncooked cereal instead of the more popular ready-to-eat variety would have increased the nutritive value and decreased the cost. The small percentage of the food money spent for cereals resulted from the purchase of limited amounts of cereals rather than from extremely inexpensive choices.

Wiser choices within the fruit and vegetable group would have brought greater nutritive return for the money spent. Although 30% of the food money was spent for fruits and vegetables, the choice was such that only two-thirds of the recommended amount of the leafy, green, or yellow vegetables, one-half of the legumes, and one-half of the potatoes were used, whereas more than the recommended amounts of other fruits and vegetables and tomatoes and citrus fruits were purchased. Some of the money spent for fruits and vegetables other than leafy, green, or yellow ones would have brought greater returns if used for the less expensive and equally nutritious potato. Larger quantities of dried beans could have been bought for the money spent for canned beans.

The results of this study of the food choices made by home economics students suggest that in order for a self-chosen diet to be adequate at low cost, more emphasis must be placed upon the use of potatoes, legumes, and whole-grain cereals. Unfortunately, these foods are not popularly considered to be choice, especially when served in quantity. It has been found, however, in a long-time study now in progress with a group in the same residence hall, that careful planning, creative interest, and judicious seasoning of food can make a diet that contains four pounds of potatoes, one pound of legumes and two and a half pounds of cereal per person per week not only acceptable but enjoyable.

Perhaps the most important and gratifying feature of the study has been the realization that these home economics students, though limited in both time and money, planned, prepared, and enjoyed a far more adequate diet than did the national average. Ruth M. Leverton.


The Nutritional Status of Young Women Living on a Low-Cost Diet

For six months, from October, 1942, to April, 1943, the investigators planned the menus, selected the recipes, and did the marketing for Unit G of Love Memorial Hall; the girls themselves prepared the meals.

Certain measurements of nutritional status were made on the subjects to check the adequacy of the diets. Each month the hemoglobin and ascorbic acid in the blood were determined and a biophotometer test made, and at the end of the study the thiamin content of the blood and the thiamin and riboflavin excretion were determined.

The results of this study demonstrate that foods in the quantity suggested for the sedentary woman in Plan A of the low-cost adequate diets recommended by the Bureau of Home Economics can be chosen so it will furnish the amount of all of the protective nutrients recommended for 16 to 20 year old girls by the National Research Council. The study further demonstrates that even a low-cost diet with as few as 1800 to 2000 calories can furnish the liberal amounts of protein, calcium, and vitamins needed by an adolescent girl.
Important to the family or institution using a low-cost diet is the fact that the greatest saving in food cost came from the use of (a) unprepared cereals rather than prepared ones, (b) potatoes in generous quantities, (c) inexpensive table and cooking fats, and (d) minimum expenditure for miscellaneous items such as prepared desserts, salad dressings, condiments and relishes.

The results have been reported in detail in a paper by Ruth M. Leverton and Thelma J. McMillan, entitled, "Planned and self-chosen low-cost diets," Journal of Home Economics, April, 1944.

Recent research has altered our concept of the body's management of iron whether this dietary essential is administered orally or by injection. It was formerly believed that catabolized iron, and iron in excess of that used for hemoglobin formation and maintenance of normal body stores, was excreted by way of the intestine. It has now been established that the body does not have the ability to excrete iron, but that the iron in the feces is that which has passed through the intestine unabsorbed.

The present study was undertaken in an effort to answer several questions which arise when iron absorption and excretion are viewed from the standpoint that the body controls the metabolism of iron by regulation of the amount absorbed rather than the amount excreted.

Fifty studies of the absorption and excretion of iron from a daily supplement of 126 mg. of iron, given in the form of six grains of ferrous sulfate, were made on 46 healthy college women. The daily absorption of iron by all the subjects averaged slightly more than fifty per cent of the daily iron intake, whether the ferrous sulfate was given for only one week or for several weeks. This daily absorption for five or six weeks led to a total average storage of 3,225 mg. of iron, which practically doubled the amount of iron calculated to be present normally in the adult female body. Despite the retention of the large amounts of iron there were no significant changes in the hemoglobin values.

Twenty-one subjects infected with E. histolytica or with other non-pathogenic amoebae and various flagellates, absorbed the same amount of iron before and after the administration of a protozoacide. These twenty-one subjects also absorbed the same amount of iron as the controls who were not infected with the microorganisms.

The average amount of iron absorbed, 76.79 mg. per day, by the subjects who received the supplement for five or six weeks was as great as that reported in the literature for subjects who received eight times this amount of iron, or the usual medicinal dose.

During the thirty days that followed a week of iron supplementation the body did not release or excrete the iron that had been absorbed from the supplement. There was no indication that the body has any ability to control the iron content of the body by excretion or absorption.

Ruth M. Leverton.


The Copper Metabolism of Young Women

Data on the copper metabolism of young women are reported from two sources: 95 one-week studies of 65 young women on a self-chosen diet, and a long-time study of four young women on an adequate constant
diet. The average daily intake by the subjects on the self-chosen diets was 2.65 mg. of copper and their average daily retention was 0.85 mg. For the subjects on the constant diet the average daily intake and retention of copper were 2.14 mg. and 0.23 mg. respectively. As the copper intakes increased, a large proportion of each increase was retained. The copper content of 16 menses of four subjects varied greatly from one period to another.

Considerable evidence is advanced in support of the theory that the body does not excrete copper and that the intestinal tract may handle copper as it does iron.

A daily allowance of 2.0—2.5 mg. of copper is suggested for young women together with evidence that this amount can be obtained from diets of otherwise mediocre nutritive value.


There is now in progress an important study of the relation of dietary factors to blood regeneration in women blood donors.

Information regarding the most effective means of promoting regeneration whether following hemorrhage or in combatting simple anemia is needed. The role played by dietary factors other than iron or the potentialities of such factors has not been thoroughly investigated. The war effort makes this investigation both possible and urgent, for both professional and non-professional persons are acutely aware of the need for blood donors and subsequently of the importance of information regarding blood regeneration in the donors. That there will be a continuing need for blood donors, the war experience has demonstrated; moreover, the many new advantages and possibilities of the use of human blood in medical practice emphasize anew the importance of blood regeneration in the donor, whether a professional or a volunteer one. Regeneration of the blood has assumed, consequently, a new significance.

During the course of the school year each of 30 college girls gave approximately a pint of blood to the local blood bank in the fall and again in the spring and the regeneration of her blood was followed closely.

Two weeks prior to blood donation, subjects were fed an adequate diet and blood tests made. Determinations that were made on the blood at frequent intervals included: hemoglobin, red, reticulocyte, and differential cell counts, cell volume, ascorbic acid, thiamin, plasma protein, non-protein nitrogen and albumin tests.

At the time of the first blood donation the girls were placed on an adequate diet and received in addition a 25-gram protein supplement; one-third of the group received this from meat, one-third from dairy products, and one-third of the group received this from egg.

After seven weeks the subjects were on their customary self-chosen diets, which they followed until two weeks before the second donation.

For the second study the same procedure will be used except that following the donation the subjects will receive an adequate diet with no supplements. The results will form a basis of comparison of protein supplement versus no supplement. 

Ruth M. Leverton.
**Nutritive Value of Some Nebraska Food Products**

**A. Potatoes.** The effect of location, cultural practice, storage and cooking on the ascorbic acid content of potatoes is being investigated for five varieties of Nebraska potatoes: Cobbler, Kasota, SCIA 27, Triumph and Warba. Interesting and significant differences are suggested by the results to date but the data will not be complete for another year. Loss of ascorbic acid during cooking has been very small where the potatoes were cooked in about one-third of a cup of water and covered tightly rather than cooked in a large amount of water.

**B. Tomatoes.** The effect of location, degree of ripeness, commercial and home canning and storage practices on the ascorbic acid of tomatoes and tomato juice is being investigated for seven varieties of tomatoes. Conclusive results are not yet available. This work has been carried in cooperation with the Horticulture Department.
Agricultural research applied to representative regions of Nebraska constitutes the purpose of Nebraska's substations. Each of the substations—Box Butte, North Platte, Scottsbluff, and Valentine—provides a testing ground of specific value to its respective section.

Box Butte Experiment Farm

The land and buildings at the Box Butte Experiment Farm are owned by Box Butte county. They are assigned for this research work by the County Commissioners.

This farm is representative of a large amount of high tableland in western Nebraska. It provides an excellent opportunity for testing the regional adaptation of crops and varieties to this section and the determination of suitable dry land crop rotations and production practices.

Seasonal variation in the weather conditions, especially the amount and distribution of the precipitation, has been found the most influential factor affecting crop yields. The amount of subsoil moisture carried over from one season to the next is also important. Cultural practices planned to conserve soil moisture have given highest yields. A year of fallow before potatoes or winter wheat has increased the yields of these crops materially and profitably.

In varietal tests with winter wheat, Cheyenne and Nebred have given best results, while Thatcher and Ceres have proved most suitable among the spring wheats. Ezond, Spartan, and Trebi are the highest ranking barleys. Brunker, Trojan, and Fulton are superior varieties of oats. The Coes and Alliance varieties of grain sorghum and the Leoti and Black Amber forage sorghum varieties are recommended. Annual tests with corn hybrids and varieties have as yet failed to find any hybrids that can be depended upon to outyield the best standard local open-pollinated varieties in this region without irrigation.

The investigations on this experiment farm are conducted by the Departments of Horticulture, Plant Pathology, and Agronomy of the College of Agriculture. Important studies carried in 1943 include dry-land crop rotations; breeding, culture and storage of potatoes and tomatoes; breeding, varietal testing and cultural studies with grain and forage crops; disease investigations with various crops, especially potatoes and field beans; seed increase of foundation seed potato stocks in cooperation with the Nebraska Certified Potato Growers Cooperative; seed increase for farm distribution of superior certified small grain varieties; and maintenance of an effective windbreak and attractive lawn plantings containing many ornamentals new to the region.

In 1943 the rainfall during the spring and early summer was above average and prospects for all crops were relatively good. The yields of potatoes and corn were seriously curtailed, however, by late summer drought and by severe frost early in September. Three hundred bushels each of Ezond barley and Trojan oats were grown for distribution as certified seed for western Nebraska. This is the first seed of these superior new crops made available for farm use.

A manuscript summarizing several years' cropping experience at this farm has been completed and is being submitted for publication.

R. E. Pahl, Supervisor.
North Platte Substation

Grain Crops Damaged by Hail

The year as a whole was dry. All months except April and October were deficient in precipitation. The 20% below average rainfall for the crop season would have resulted in considerable drouth injury to crops except for the favorable carry-over of subsoil moisture from the heavy rainfall of the previous year. The major crop hazard of the year was hail. An unusual feature of hail this year and last was that heavy damage to Substation crops occurred in consecutive years. Hail this year was in June instead of August, and the damage was chiefly to early season instead of late season crops. All small grains in nursery, varietal trials and tillage projects were completely ruined for experimental use. A small amount of winter wheat was salvaged for seed. Corn and sorghums suffered reduction in stands, but recovery was sufficient to permit production of above normal yields. Hail damage this year was confined to the dry-land project while that of last year included both dry-land and irrigated areas. The early date of hail this year permitted use of catch crops. Highland sorgo seeded after hail damaged crops reached full maturity. Its yields were excellent on land fallowed the previous year, and fair on cropped land.

Corn yields in crop rotations were outstandingly good and the grain of high quality. The average of 34.1 bushels per acre is the highest dry land yield produced since 1927, and has been exceeded only four times in 36 years of Substation cropping history. Yield differences between the various crop sequences and cultural treatments were, for the most part, not significant. The lowest corn yield, 23.5 bushels per acre, was that on land fallowed the previous year.

Early Kalo was outyielded by corn on cropped land, but in contrast to corn it showed a favorable instead of an unfavorable response to summer fallow. The average yield on cropped land was 28.7 bushels and that on fallow, 39.8 bushels per acre.

Dry land potato vines made a second growth after injury by hail. The delay and development under higher temperatures reduced yields and quality. Yields were 88.9 bushels on cropped land and 103.3 bushels after fallow. As an average, 76% of the tubers graded No. 1.

L. L. Zook and H. E. Weakly.

Hybrid Corn and Sorghum Varietal Tests

Under irrigation, the yields of three commercial and 25 experimental corn hybrids ranged from 81.7 to 142.5 bushels and averaged 121.2 bushels per acre. The average yield of two adapted open-pollinated varieties was 97.6 bushels per acre. The average gain of all hybrids over varieties was 19%, and of the 10 best hybrids over varieties 27%.

On dry land, three commercial and 25 experimental corn hybrids ranged from 38.2 to 51.0 and averaged 44.2 bushels per acre. The yield of Substation White, an open-pollinated variety grown on the Substation dry land crop rotation fields for 37 years, was 48.3 bushels. This yield is only .3 bushel less than that of the average of the 10 best hybrids and only 2.4 bushels, or not significantly less, than the highest yielding hybrid.

The yields of 11 grain sorghums on upland fallowed land ranged from 39.4 to 60.0 bushels per acre and averaged 49.5 bushels. Day Milo and
Early Kalo were intermediate in yield. A long growing season favored later maturing varieties, with Club and Wheatland producing highest yields. For the 10-year period 1934-43, the yield of corn was only 49% of the yield of Early Kalo.

The yields of six forage sorghums ranged from 3.5 to 4.0 tons and averaged 3.74 tons per acre. Highest yields were made by Atlas and Leoti. These tests were conducted in cooperation with the Agronomy Department of the College of Agriculture.

**Emphasis on Food Crops**

Garden and food crop plantings were expanded in keeping with wartime needs. Vegetables for seasonal use and for canning were grown for use of station personnel. Tomatoes, potatoes and dry beans were grown in commercial quantities. Great Northern beans on a nine-acre field under irrigation produced 1225 pounds per acre. Potatoes on 2.4 acres under irrigation produced 290 bushels per acre. *Glenn Viehmeyer.*

**Good Response from Pump Irrigation**

Cost accounting for pump irrigation, both electric-driven and fuel oil-powered, provides the following interesting data.

Water was applied to 46 acres of corn, pasture, and garden crops from the Substation electric-driven pump. The average application was 18.8 inches per acre. The pump was operated 350.5 hours, and the delivery was 1100 gallons per minute. Electric current use was 6020 kwhrs. Cost of current was 2.23 cents per kwhr., 15.5 cents per acre inch of water used, and $2.91 per acre of land irrigated. Total operating cost was 27.68 cents per acre inch or $5.20 per acre. Fixed costs of $6.52 per acre were high on account of the limited acreage watered. Total costs were 62.3 cents per acre inch of water used and $11.87 per acre irrigated.

The yield on 22 acres of corn cut for ensilage was 17 tons per acre. The cost of irrigation per ton of ensilage was 66.4 cents.

On land under lease, 24 acres of Atlas sorgo was irrigated from a pump driven by a fuel oil power unit. Water used was 13.5 inches per acre. Total operating and distribution costs were 21.7 cents per acre inch of water used and $2.93 per acre irrigated. Yield of ensilage was 19.7 tons per acre. Irrigation cost per ton of ensilage was 14.9 cents. Fixed costs are not included as the equipment is owned by the landlord. *H. E. Weakly.*

**Different Rations and Management Practices for Breeding Heifers**

Five lots of 20 heifer calves with an initial weight of approximately 445 pounds were carried on different rations through the winter of 1942-43 and grazed on native grass during the grazing season of 1943. Lot 1 was wintered on prairie hay; Lot 2 on prairie hay plus 1.0 pound protein supplement per head daily; Lots 3, 4, and 5 were wintered on approximately 6.0 pounds of alfalfa plus a full feed of either sorgo or poor quality corn silage. The heifers all had access to salt and steamed bone meal. The winter period extended from December 31, 1942, to May 6, 1943.

The heifers in the five lots respectively gained an average of 23, 61, 87, 79, and 81 pounds per head in the winter period. In the summer period the average gain per head was 173, 158, 131, 151 and 144 pounds. The total average gain per head from December 31, 1942, to November
17, 1943, for the five lots respectively was thus 196, 219, 218, 230 and 225 pounds. Lots 4 and 5 were bred in the summer of 1943 to calve beginning in March, 1944. All lots are to be fed approximately the same rations in the winter of 1943–44 as in the preceding winter, except Lot 5, which is to receive a limited amount of grain. Lots 1, 2, and 3 are to be bred to drop their first calves in 1945.  

*Guy N. Baker and Marvel L. Baker.*

### Feeding Dried Beet Pulp to Fattening Steers

This was the third trial in which ground shelled corn, a mixture of two-thirds ground shelled corn and one-third dried beet pulp by weight, and a mixture of equal parts by weight of ground shelled corn and dried beet pulp were compared for fattening steers. Three lots of 12 head of 550-pound steer calves were fed the foregoing rations for 235 days. Alfalfa hay, silage and linseed cake were fed in addition. The three lots made approximately the same gains and required approximately the same amount of concentrates for 100 pounds of gain. As the amount of dried beet pulp in the ration was increased, there was a slight saving of roughage. The three lots sold at the same price.  

*Guy N. Baker and Marvel L. Baker.*

### Swine Breeding

The breeding project in cooperation with the Regional Swine Breeding Laboratory of the Bureau of Animal Industry, U. S. Department of Agriculture, was continued during 1943 much the same as in the preceding year. Boars from two inbred lines at the Oklahoma station were secured and used in matings with inbred North Platte females with the objective of developing, if possible, a new line. Fall matings in 1943 also were planned, this in order to permit the eventual formation of a new line from four North Platte lines. Pigs from six inbred lines as well as pigs from various cross-line matings were included in the 1943 farrowings. Results of studies on the relative importance of heredity and environment in affecting the weight and growth rate of pigs at different ages, and on genetic and environmental correlations between the growth rates of pigs at different ages were published in 1943.  


### Fattening Steers at Different Levels of Grain and Linseed Meal

Six lots of 10 head each were fed an equal mixture of ground corn and rye at different levels. Lots 1 and 2 were fed 6 pounds per head per day, Lots 3 and 4 were fed 10 pounds per head per day and Lots 5 and 6 were brought to full feed and fed that way. Lots 1, 3, and 5 were fed one-half pound of linseed cake and 4 pounds of alfalfa hay, while 2, 4 and 6 ate 6 pounds of alfalfa hay. All lots had access to salt and a mineral mixture, and all lots had all the silage they would eat.

The test started May 7, 1943. On October 1, the grain for Lots 1, 2, 3 and 4 was increased, bringing these lots to full feed as quickly as possible.

Lots 5 and 6 were marketed November 12. Lots 3 and 4 were marketed December 4. Lots 1 and 2 will be marketed about January 15.

The four lots sold at the same price. Lots 3 and 4, which required less concentrates and more roughage per 100 pounds of gain, weighed slightly more than Lots 5 and 6. By December 31, 1943, Lots 1 and 2 had consumed less grain but weighed more than the other lots.  

*M. L. Baker and Guy N. Baker.*
Scotts Bluff Substation

Climatic Conditions

The total precipitation at the Scottsbluff Substation during 1943 amounted to 8.82 in. Of the total precipitation during 1943, 6.96 in. occurred during the growing season (April to September) compared with the 34-year mean of 11.06 in. The total precipitation during 1943 closely resembled the amounts recorded during the record drought years of 7.32 in. (1931), 8.32 in. (1936), and 7.81 in. (1939).

Despite the low total precipitation for the year, rainfall during the spring months of April, May and June was close to normal and therefore favorable for the germination of spring-planted crops, particularly alfalfa, sweetclover, sugar beets, and beans. Precipitation during July, August and September amounted to only 1.17 in. After the middle of June, 1943, no precipitation of value to agriculture occurred.

The low precipitation recorded at the Scottsbluff Substation during 1943 failed to represent that occurring over the North Platte River Valley as a whole, however, for on the south side of the river, in the eastern end of the valley, unusually heavy precipitation occurred. The precipitation at the station represented precipitation occurring on the north side of the river chiefly.

The light summer precipitation was favorable for beans and potatoes in particular. The beans grew unmolested by bacterial blight, and the usual amount of scab on potatoes failed to appear. In view of an adequate supply of irrigation water at all times during the summer, the low precipitation did not result in crop injury, and in some instances as noted proved beneficial.

Compared with the 33-year means, temperatures during April were higher than normal; those during May lower; and those during June, July and August, approximately normal. Relatively low temperatures during May, accompanied by fairly frequent, light precipitation combined to produce a cold, wet soil, particularly during the first part of the month. These conditions were not favorable to the germination and early growth of corn, and some fields had to be replanted.

Evaporation during the growing season of 1943 amounted to 40.26 in. (33-year mean, 36.37 in.) and resembled the total amounts recorded during previous years of unusually low precipitation. During 1943, the evaporation was above normal during all months except May, when it was approximately 1.4 in. below normal. The low evaporation during May was associated with relatively low temperatures and a fairly high relative humidity.

The mean hourly wind movement during the growing season of 1943 was 20 miles or over, i.e., below normal during April, May and June, and approximately normal during July, August and September. During one day in January, two days in March, and one day in April, high wind movement, particularly during March and April, caused considerable soil erosion on the lighter soils. Severe dust storms accompanied these high winds.

The last frost in the spring occurred on May 17 and the first in the fall, on October 8, leaving a frost-free period of 144 days (33-year mean, 136 days). The first frost in the fall at the Scottsbluff station failed to conform to early frosts in lower areas of the valley, where freezing tem-
temperatures occurred during at least two days, between the 6th and 9th of September, or approximately a month earlier than at the station. The early frosts in the lower portions of the valley caused light to mod­erate damage on potato and bean plants and reduced the yields of these crops. Corn was also damaged to some extent, but favorable weather following the early frosts caused most of the corn to mature satisfactorily.

**Crop Rotation Experiments**

The new rotation program inaugurated in 1942 and carried forward during 1943 includes: studies of the value of farm manure, commercial fertilizers including chiefly phosphate and nitrogen, alfalfa as green manure, and sweetclover as a pasture and green manure crop when used in various types of cropping programs. The rotation experiments comprise, in addition to continuous plots, rotations varying in length from 2 to 6 years.

The untreated, continuous plot of sugar beets yielded: .58 tons of sugar per acre compared with .77 tons of sugar for the plot treated with phosphate and nitrogen, 2.75 tons for the manured plot, 2.18 tons for the plot treated with phosphate and manure, and 2.51 tons for the plot treated with phosphate, nitrogen and manure. The untreated continuous plot of potatoes yielded 52.8 bushels per acre compared with 85.2 bushels for the continuous manured plot. Manure failed to increase the yield of barley on continuous plots, slightly increased the yield of beans, and produced a significant increase in the yield of corn. The untreated plot of corn yielded at the rate of 32 bushels per acre compared with 59.4 bushels on the manured plot. The yield of alfalfa on the untreated, continuous plot amounted to 4.62 tons compared with 5.06 tons on the plot treated with manure.

Four-year and six-year alfalfa rotations, treated with farm manure, produced the highest yield of gross sugar per acre, amounting to 2.74 tons. The lowest yield of 1.36 tons of sugar per acre occurred in the short, untreated rotations. Farm manure in rotations without alfalfa or sweetclover produced a yield of 2.64 tons of sugar per acre compared with 2.50 tons for phosphate and nitrogen in similar rotations. Alfalfa rotations treated with phosphate and nitrogen produced 2.3 tons of sugar per acre.

The highest yields of barley were obtained from alfalfa rotations treated with phosphate and nitrogen, where the mean yield amounted to 67.2 bushels per acre compared with 62.7 bushels for alfalfa and manure and 58.1 bushels for alfalfa alone. Manured rotations without alfalfa produced 43.2 bushels of barley per acre compared with 43.8 bushels for similar rotations treated with phosphate and nitrogen. The lowest yield of 18.5 bushels was obtained in the untreated rotation.

The highest yield of beans, 29.8 bushels per acre, was obtained in an alfalfa rotation treated with manure. Phosphate and nitrogen in a similar rotation produced 29.3 bushels per acre. Manured rotations without alfalfa produced 24.1 bushels compared with 25.9 bushels in similar rotations treated with phosphate and nitrogen.

Rotations treated with alfalfa and manure produced a mean yield of potatoes of 343.5 bushels compared with 324.3 bushels in similar rotations treated with phosphorus. Manured rotations without alfalfa produced 272.1 bushels of potatoes compared with 261.9 bushels on similar rotations treated with phosphate and nitrogen. The lowest yield of
152.2 bushels was obtained in the untreated rotations. The percentage of scab, severe enough to remove the potatoes from the No. 1 grade, amounted to 8.3 per cent in the rotations treated with alfalfa and manure, 10.4 per cent for alfalfa alone, 20.9 per cent for alfalfa and phosphorus, 44.1 per cent for phosphate and nitrogen in rotations without alfalfa, 52.1 per cent for manured rotations without alfalfa, and 64 per cent for the short untreated rotations.

During 1943 rotations treated with alfalfa and manure produced the highest yields of most crops. Alfalfa rotations treated with phosphate and nitrogen also produced good yields. The addition of either manure or commercial fertilizers to short rotations without alfalfa increased the yields of most crops considerably above the yields obtained where no treatment was applied. Good yields of most crops were obtained in various three-year and four-year rotations including the use of sweetclover as a pasture and green manure crop. Most of these rotations have not been well enough established at the present time to make significant comparisons with other treatments.

Sheep Feeding Experiments

Sheep feeding experiments at the Scottsbluff Substation during the feeding season of 1942–43 included a continuation of studies on the factors causing death losses and a special study of the value of molasses-steam-rolled-barley, which has become a popular feed in the North Platte Valley.

During the previous feeding season of 1941–42, a high death loss occurred with lambs on a ration consisting of corn, cottonseed meal, and bone meal as concentrates and beet top silage as the only roughage. This ration was again used during the current season and again a high death loss occurred. The lambs on this ration during both years died as a result of urinary calculi. During the current season, the urinary calculi-producing ration was fed to two additional lots of lambs. One of these lots received a supplement of alfalfa hay at the rate of three-fourths pound per lamb daily. The other lot received a concentrated vitamin A product commercially called Provato!. The lambs receiving a limited amount of alfalfa hay made excellent daily gains and failed to develop serious symptoms of urinary calculi. Although the vitamin A product appeared to delay the development of urinary calculi, it did not prevent a widespread and serious development of this ailment. Corn silage and cane silage were used as the only roughages in comparison with beet top silage. These silages failed to produce satisfactory gains and, consequently, thrifty, entirely healthy-appearing lambs; yet the death loss from urinary calculi was small and hence this ailment did not appear to be the main source of the trouble, as was true where beet top silage constituted the only roughage. The addition of alfalfa hay to beet top silage prevented the development of urinary calculi to a serious degree and improved the gains and general appearance of the lambs. The addition of alfalfa hay to corn silage and cane silage also improved the gains and general appearance of the lambs, but to a lesser degree.

Lambs consuming molasses-steam-rolled-barley required eight pounds less of this mixture and 32 pounds less alfalfa than those fed plain barley and alfalfa. The molasses-steam-rolled-barley appeared to hold a greater element of safety than plain barley when fed at a high daily
rate per lamb. The lambs fed molasses-steam-rolled-barley reached a maximum consumption of 1.75 pounds per lamb daily compared to 1.5 pounds for the lambs on whole barley.

**Sugar Beet Investigations**

In addition to the work with sugar beets in the irrigated rotations a number of sugar beet projects were carried on at the station during 1943, in cooperation with the Office of Sugar Plants, U.S.D.A. Projects in operation in 1943 included time-of-planting tests, variety tests, breeding work and a war emergency project designed to determine the feasibility and possibilities of utilizing the nitrogen of legume crops in the production of sugar beets.

Conforming with results obtained during previous years, the earliest plantings of sugar beets, or those made near the first of April, produced the highest yield. Variety tests included comparisons of selected strains with standard varieties. In the breeding work seed was produced from selected mother beets grown the previous year. The war emergency project involved planting of sugar beets after alfalfa, which was plowed (1) at various times ranging from July of the previous year to the latter part of March or (2) immediately before the planting of the crop. Manure was applied to part of the plots.

**Irrigation Investigations**

With the objective of determining the amount of irrigation water necessary under practical conditions in irrigation farming, the irrigation water applied to each plot in the irrigated rotations and the runoff from each plot were measured during 1943. In view of the fact that different types of rotations and several levels of soil productivity are included in

*Feeding sugar beet tops to dairy cattle, Scotts Bluff Substation.*
the rotation studies, the accumulation of information on the practical use of irrigation water should prove to be of great value in the efficient and economical use of water for maximum crop production.

**Tomato Investigations**

Work with tomatoes during 1943 comprised variety tests and breeding work for the development of an earlier maturing variety. This work has been carried on in cooperation with the Horticulture Department. During 1943 additional crosses and further detailed studies were made with tomatoes. One selection made by the Horticulture Department shows definite improvement over varieties now available for this area and next season this selection will be introduced for commercial production here as well as elsewhere throughout the state.

**Experimental Work with Safflower**

This project was started during 1942 in the form of a test to determine possibilities for growing various oil-, drug- and spice-producing plants in this area in view of the increased need for these products during war time. Of the various types of plants tested during 1942, safflower showed the greatest promise for this particular area. Consequently, during 1943 more intensive studies, embracing variety tests, spacing tests and breeding work, were made with this crop. In the breeding work efforts were directed toward the production of a spineless, high oil-producing strain of safflower. Since little information was available regarding the production of the crop here, tests were conducted. Some varieties in the variety test produced promising yields, indicating a future for the crop in this area, provided a good demand continues to develop for the oil obtained from safflower seed.

**Field Bean Investigations**

Work with field beans has been carried on in cooperation with the Plant Pathology Department and has comprised breeding and variety testing work principally, with a view to developing a blight-resistant variety for the irrigated areas on the Great Plains. The work has been in progress since 1936. At the present time consideration is being given to the introduction of a new pinto bean obtained from a cross between Great Northern and pinto. The new bean carries the Great Northern size and earliness of maturity together with the pinto color. During 1943 an increased block of ground was planted to this strain and a good quantity of seed obtained for more thorough and widespread tests. At the present time the bean shows considerable promise. It appears to be an unusually uniform and a vigorous growing variety. Some progress is being made in the isolation of disease resistance to bean blight in the Great Northern variety.

**Potato Improvement Work**

This work is a continuation of projects started in 1936, involving breeding work with potatoes to isolate strains that are disease-resistant, and that show improved yield and quality. The work is carried on in cooperation with the Horticulture and Plant Pathology Departments.

Since 1936 a plot of ground, infested with scab and fusarium wilt organisms, has been utilized for testing the resistance of numerous potato seedlings to these diseases. The ground is manured heavily each year.
and sprinkled with soil inoculated with the organisms to insure an ideal environment for testing disease resistance. Large number of seedlings have been tested annually on other areas of the farm for general horticultural qualities. When a seedling showing improved horticultural qualities has been isolated, it is subjected to tests on the disease-infested soil before it receives further consideration. At the present time, seedling potatoes showing great resistance to scab and fusarium wilt have been of unusually poor quality and horticultural type. Further efforts will be directed toward combining disease resistance with good horticultural qualities. In the tests with seedlings for improved horticultural qualities, progress has been made in the selection of seedlings with more desirable qualities than are found in the standard varieties and with equally good disease resistance.

**Potato Insect Investigations**

The insects affecting potatoes in this area most injuriously are psyllid and flea beetles. During 1943 measures to control flea beetles involved the use of sprays and dusts applied at different times; special attention was given to the importance of time of planting. During the time-of-planting tests it has been observed that the greatest infestation of flea beetles occurs on the early plantings with lesser infestations on later plantings. It appears probable that time of planting may prove more valuable in the control of this pest than the use of sprays and dusts. Further studies were made during 1943 on the life cycle and overwintering habits of the flea beetle. Frequent examinations of fields for possible damage by the psyllid insect were made during 1943, and growers were kept advised regarding the need or absence of need for control measures.

**Vegetable Seed Production Investigations**

In cooperation with the Cheyenne Horticultural Field Station, the possibilities of producing seed of carrots, parsnips, beets and rutabagas in this area were studied. This project was carried on in response to requests by the government for greater quantities of vegetable seeds. Also, in cooperation with the Cheyenne Horticultural Field Station, tests with varieties of apples and plums were carried forward with the objective of determining varieties that will survive the severe winter climates in this area.

**Hybrid Corn Tests**

Hybrid corn tests were made during 1943 in order to compare promising commercial hybrids with experimental hybrids prepared especially for this area where an early maturing corn is necessary. Lionel Harris.
Valentine Substation

On account of the war, activities have been somewhat curtailed at this substation, the superintendent having assumed additional duties as county agricultural agent. Major projects, however, have been continued and despite the fact that growing conditions were affected to some extent by the rainfall in 1943, which was three inches below normal, useful data have been obtained. The moisture deficit accumulated after July first.

Crop Variety Tests

Winter wheat yields were the highest during the 15-year period in which tests have been conducted on the tableland north of Valentine. Cheyenne x Tenmarq (CI 1972) yielded 29.3 bushels per acre, the highest yield of the eleven varieties tested. Cheyenne and Kharkof yielded 28.1 and 27.6 bushels per acre, respectively. Winterkilling, approximately 50% on Pawnee and Red Chief, accounted for the low yield (16.5 bushels per acre) of those varieties.

Fall rye yielded to within three-quarters of a bushel of the average for the five high wheat varieties.

Yields of spring wheat were reduced by drouth. The nine varieties averaged 10.9 bushels per acre. The four high varieties were Thatcher, Merit, Rival, and Ceres, yielding 14.3, 12.0, 11.8, and 11.4 bushels per acre, respectively.

The average oat yield of nine varieties was 32.9 bushels per acre. Fulton, Cedar, Iogold, Kanota, and Marion were the five high varieties, yielding respectively 38.2, 35.8, 34.9, 33.6, and 33.1 bushels per acre.

Corn was very uneven in yield, a response ascribable to drouth damage of certain plots. Grain sorghums again failed to mature a profitable crop of seed. Leoti ranked highest in the production of sorghum forage.

Subirrigated Meadow Investigation

On this project readings were taken in surface wells to determine the rise and fall of the water level. The March reading of 12 wells recorded a stage six inches lower than in March a year ago. The October reading was only 3.5 inches lower than October, 1942. Since the low period in 1937 the rise has been approximately 30 inches.

Supplements to Prairie Hay for Wintering Calves

Continuing the investigation of oil meal supplements to prairie hay, eight lots of Hereford heifer calves were wintered on the same rations as in last year's test. Cottonseed, linseed, and soybean oil meals were fed separately at the rate of one pound per head per day and also as a mixture of equal parts. Cottonseed and linseed oil meal produced approximately the same gains each year. Soybean oil meal gains were 17 pounds higher in 1942 and 12 pounds lower in 1943 than the other two proteins. The mixture of the three showed a few pounds advantage over cottonseed and linseed in each test but over soybean oil meal only in 1943. Three-quarters of a pound of soybean oil meal produced 82% as much winter gain as did one pound of the mixture. Total winter and summer gain was 98%. Feeding steamed bone meal with soybean oil meal resulted in a 15 pound advantage in total winter and summer gain. Three-quarters of a pound of soybean oil meal plus .06 pound of steamed bone meal produced 6 pounds less gain than feeding one pound of soybean
oil meal plus .04 pound of steamed bone meal. One-tenth of a pound of ground limestone fed with one pound of soybean oil meal depressed winter gains considerably but was compensated for on grass, the total winter and summer gain being 9 pounds greater than from soybean oil meal alone.

**Dual-purpose Cattle**

The Milking Shorthorn herd milk production was somewhat lower than a year ago. The average for 25 head, eight of which were heifers, was 5146.2 pounds of milk and 198.2 pounds of butterfat. Spring pasture was late, and summer pasture dried up in late July.    

_E. M. Brouse._
Experiment Station Publications During 1943

Annual Report

Fifty-sixth Annual Report, presented to the Governor February 1, 1943. 1,500 copies.

Bulletins

No. 353. Sugar Beet Tops as Feed for Dairy Cattle.  Lionel Harris, H. P. Davis, and Paul Swanson.  December, 1943. 3,000 copies.

Research Bulletins

No. 132. The Use of Dried Whey and Blood Meal in the Raising of Calves on Limited Amounts of Milk.  I. L. Hathaway, G. W. Trimberger, and H. P. Davis.  October, 1943. 2,000 copies.

Experiment Station Circulars

No. 72. Cockroach Control.  H. D. Tate and E. C. Klostermeyer.  February, 1943. 5,000 copies.
No. 73. The Outlook for Waxy Sorghum in Nebraska.  R. L. Cushing.  May, 1943. 5,000 copies.
No. 75. External Parasites of Poultry and Methods for Their Control.  O. S. Bare.  December, 1943. 10,000 copies.

Journal Series, Technical Articles and Papers


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


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MARION A. SHAW, David City
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JOHN K. SELLECK, B.Sc., Comptroller of the University

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W. H. BROKAW, Director of Agricultural Extension
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NOEL HANSON, M.Sc., Assistant Animal Husbandman

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 On leave effective January 1, 1942, for military service.
3 Resigned, October 1, 1943.
4 Resigned, March 10, 1943.
5 Resigned, March 3, 1943.
6 Resigned, September 1, 1943.
7 Resigned, June 30, 1943.
STATION ADMINISTRATION AND STAFF

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F. D. YUNG, M.Sc., A.E., Assistant Agricultural Engineer
L. L. ZOOK, B.Sc., Agronomist and Superintendent, North Platte Substation

1 Detailed from the U. S. Department of Agriculture, Washington, D. C.
2 On leave effective February 15, 1943, for military service.
3 On leave effective February 1, 1943, for military service.
4 On leave effective November 1, 1942.
5 On leave effective September 12, 1942, for military service.
6 On leave effective August 13, 1942, for military service.
7 Retired, May 1, 1943.
8 Retired, September 1, 1943.
9 Resigned, September 1, 1943.
10 On leave effective January 20, 1942, for military service.
Money Received from the United States Government

Hatch Fund

Receipts

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

Expenditures

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

Adams Fund

Receipts

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

Expenditures

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.

Purnell Fund

Receipts

For Salaries..........................................................$60,000.00
Total..........................................................$60,000.00

Expenditures

Salaries and wages

Regular employees..............................................$38,921.25
Temporary employees...........................................3,184.83
Total..........................................................$42,106.08

Supplies

Office supplies .......................................................$164.73
Laboratory supplies ..............................................3,834.15
Foodstuffs ............................................................44.35
Educational supplies .............................................22.85
Janitor and barn supplies ....................................5.25
Feedingstuffs .....................................................1,494.65
Agricultural supplies .........................................286.15
Total..........................................................$5,832.34

Expense

Postage ...............................................................$100.18
Freight, express and drayage ................................16.15
Public printing, advertising and photo supplies .....1,383.68
Traveling expense ................................................550.30
Rentals ...............................................................15.00
Special and temporary services ...........................6,722.53
Total..........................................................$8,787.84

Repairs

Building .............................................................$42.65
Equipment .........................................................349.29
Total..........................................................$391.94

Equipment

Furniture and fixtures ..........................................223.88
Apparatus, labor and equipment ...........................2,232.07
Machinery ..........................................................204.15
Books, magazines and maps ..................................23.20
Total..........................................................$2,685.30

Land and buildings

Land improvements ...............................................$196.50
Total..........................................................$196.50

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

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.

Bankhead-Jones Fund

Receipts

For Salaries..........................................................$38,776.60
Total..........................................................$38,776.60

Expenditures

Salaries and wages

Regular employees..............................................$26,675.94
Temporary employees ...........................................2,121.59
Total..........................................................$28,797.53

Supplies

Office supplies .......................................................$2.50
Laboratory supplies ..............................................224.36
Feedingstuffs .....................................................1,222.75
Agricultural supplies .........................................208.38
Total..........................................................$2,257.99
**Financial Statement**

**Expense**

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<td><strong>Total</strong></td>
<td><strong>$ 5,772.56</strong></td>
</tr>
</tbody>
</table>

**Repairs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>$ 289.58</td>
</tr>
<tr>
<td>Equipment</td>
<td>$ 319.31</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 608.89</strong></td>
</tr>
</tbody>
</table>

**Equipment**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture and fixtures</td>
<td>$ 58.03</td>
</tr>
<tr>
<td>Apparatus, labor and equipment</td>
<td>$ 1,016.20</td>
</tr>
<tr>
<td>Machinery</td>
<td>$ 254.20</td>
</tr>
<tr>
<td>Books, magazines and maps</td>
<td>$ 3.72</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 1,332.15</strong></td>
</tr>
</tbody>
</table>

**Lands and buildings**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land improvements</td>
<td>$ 7.48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 7.48</strong></td>
</tr>
</tbody>
</table>

**Grand Total**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>$38,776.60</strong></td>
</tr>
</tbody>
</table>

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.

**Financial Statement Exclusive of Federal Funds**

Statement of Expenditures for Agricultural Experiment Station, University of Nebraska, for year ended June 30, 1943, including expenditures for central station at Lincoln and substations at North Platte, Scottsbluff, Valentine, Union and Alliance.

**Salaries and wages**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular employees</td>
<td>$49,439.24</td>
</tr>
<tr>
<td>Temporary employees</td>
<td>$3,077.73</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$52,516.97</strong></td>
</tr>
</tbody>
</table>

**Supplies**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office supplies</td>
<td>$ 1,148.85</td>
</tr>
<tr>
<td>Laboratory supplies</td>
<td>$ 4,459.15</td>
</tr>
<tr>
<td>Fuel (coal)</td>
<td>$ 933.15</td>
</tr>
<tr>
<td>Foodstuffs</td>
<td>$ 1,906.19</td>
</tr>
<tr>
<td>Educational and recreational</td>
<td>$ 325.13</td>
</tr>
<tr>
<td>Janitor and barn supplies</td>
<td>$ 1,011.38</td>
</tr>
<tr>
<td>Feedingstuffs</td>
<td>$ 1,996.19</td>
</tr>
<tr>
<td>Agricultural supplies</td>
<td>$ 325.13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$68,179.32</strong></td>
</tr>
</tbody>
</table>

**Expense**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage</td>
<td>$ 1,925.07</td>
</tr>
<tr>
<td>Freight, express and drayage</td>
<td>$ 1,452.63</td>
</tr>
<tr>
<td>Water, heat, light and power</td>
<td>$ 4,394.25</td>
</tr>
<tr>
<td>Public printing, advertising and photo supplies</td>
<td>$ 3,032.16</td>
</tr>
<tr>
<td>Traveling expense</td>
<td>$ 4,637.41</td>
</tr>
<tr>
<td>Rentals</td>
<td>$ 1,561.18</td>
</tr>
<tr>
<td>Special and temporary services</td>
<td>$ 33,900.05</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$ 2,350.77</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$53,233.52</strong></td>
</tr>
</tbody>
</table>

**Repairs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>$ 2,943.13</td>
</tr>
<tr>
<td>Lands</td>
<td>$ 312.20</td>
</tr>
<tr>
<td>Equipment</td>
<td>$ 6,421.56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 9,676.89</strong></td>
</tr>
</tbody>
</table>

**Equipment**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture and fixtures</td>
<td>$ 893.25</td>
</tr>
<tr>
<td>Apparatus, labor and equipment</td>
<td>$ 2,691.53</td>
</tr>
<tr>
<td>Livestock</td>
<td>$ 34,088.29</td>
</tr>
<tr>
<td>Machinery</td>
<td>$ 5,894.28</td>
</tr>
<tr>
<td>Books, magazines and maps</td>
<td>$ 130.83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$43,688.18</strong></td>
</tr>
</tbody>
</table>

**Lands and buildings**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land improvements</td>
<td>$ 862.41</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 862.41</strong></td>
</tr>
</tbody>
</table>

**Fixed charges**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refunds</td>
<td>$ 1,226.73</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 1,226.73</strong></td>
</tr>
</tbody>
</table>

**Grand Total**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>$229,404.02</strong></td>
</tr>
</tbody>
</table>

Dated at Lincoln, Nebraska

John K. Selleck, Comptroller.