AGRICULTURAL RESEARCH in South Dakota

SIXTIETH ANNUAL STATION REPORT
JULY 1, 1946 TO JUNE 30, 1947

Agricultural Experiment Station
South Dakota State College of Agriculture and Mechanic Arts
BROOKINGS, SOUTH DAKOTA
Letter of Transmittal

Dean A. M. Eberle,
Division of Agriculture
South Dakota State College

Dear Dean Eberle:

With the presentation of this publication the South Dakota Agricultural Experiment Station has completed sixty years of research in behalf of the agriculture of South Dakota and the Northern Great Plains. During this period of service the Station’s research achievements have been made available through the publication of 392 bulletins, 208 articles in scientific journals, 68 circulars, and 60 annual reports.

The sixtieth year of activity is truly a bench mark in the acceptance of research findings by farmers and ranchers and in the support accorded research by the citizens of the state. This has been a real inspiration to the station staff members and will spur them to greater achievements. The research program is being expanded on those problems that are pertinent to the agriculture of the state.

Not only did the state provide additional funds for research, but industrial and trade organizations likewise made substantial contributions. The State Fish, Game and Parks Department set aside the Antelope Range, an enclosed area of approximately 8,200 acres, on which the Station could conduct research on range management problems involving beef cattle and sheep.

As heretofore, farm crops field days, field trips, livestock feeders’ days were held at different times and places during the year, where anyone interested could inspect the work of the Station. The radio stations, the daily and weekly press, and the agricultural press have assisted the Station in an effective way in publicizing the results of our research activities.

Respectfully submitted,

[Signature]

Director, Experiment Station
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Soils and Crops

South Dakota Soils Respond to Nitrogen, Phosphorus and Organic Matter. Research work in soils at the main experiment station and at substations consists of fertility studies, including methods of fertilizer application, tillage methods, crop residue management, and legume and grass rotations. The effects of crop rotations and return of crop residues to the soil on soil nitrogen changes were also studied.

Signs of declining soil fertility are appearing on many farms in South Dakota. One of the more noticeable soil changes caused by continuous cropping is a lack of enough available nitrogen for crop growth. This is indicated by a light green or yellow color of crops and causes lower crop yields. This lack of available nitrogen is the result of the depletion of soil organic matter containing the nitrogen used by crops. (By “available” nitrogen, we mean that part of nitrogen in the soil that can be utilized by the growing crops). The maintenance of nitrogen and organic matter thus becomes one of the important fertility problems in South Dakota farming. For this reason, special emphasis is being given this problem by determining the best methods of utilizing crop residues, legumes and grasses for improving soil fertility.

At the State Experiment Station, nitrogen fertilizer increased the yields of wheat by seven bushels. Nitrogen and phosphorus fertilizer together increased yields 11 bushels per acre in a three-year rotation of corn-oats-wheat. Corn yields were increased nine bushels per acre by nitrogen and phosphorus. In a three year rotation of corn-wheat-sweet clover, the average yield of wheat was 31 bushels per acre as compared to 18 bushels per acre for continuous wheat. In a wheat and sorghum rotation, the yield of wheat was increased three bushels per acre by application of nitrogen fertilizer.

The yields of corn on the tillage and residue plots were higher where the seedbed was prepared by plowing than where subsurface tillage was used. It has been difficult to get satisfactory stands of corn on plots where subsurface tillage is practiced.

Analysis of the soil from plots indicates that changes in soil nitrogen are greatly influenced by crop rotation and return of crop residues. In a three-year corn-wheat-sweet clover rotation, the nitrogen content of the soil was about maintained. In a corn-oats-wheat rotation, the nitrogen content of the soil decreased only slightly where all crop residues were returned to the soil during a five-year period.

Fertilizer plots were established on 17 farms in order to evaluate the fertility of the soils in the major crop and soil areas of the state. Each location was a complete fertility test in which 204 fertilizer treatments were applied on small grain, corn, potatoes and grass. Nitrogen phosphorus and potassium fertilizer were applied singly and in various combinations. The yields of crops were markedly influenced by fertilizer treatment. The greatest yields being obtained from use of complete fertilizer. It was observed that a fertilizer containing nitrogen and phosphorus is most effective for increasing crop yields on South Dakota soils.
The tall spots of oats dotting this field came from cattle droppings, indicating nitrogen starvation. Manure is always rich in nitrogen.

Potato yields were increased approximately 60 bushels per acre by nitrogen-phosphorus-potash fertilizer. Fertility trials under irrigation showed that the most effective soil treatment for increasing corn yields was a combination of a complete fertilizer with manure.

The 1946 experiment results show that the efficiency of South Dakota soils for crop production may be greatly increased and, at the same time, the soil resources conserved through the application of sound soil management practices. These practices include legume and grass rotations, proper management of crop residues, and the use of fertilizers. (Project 46. Leaders: Leo F. Puhr and W. W. Worzella, Agronomy Department).

Results of Conservation Practices. Field trials were conducted in cooperation with the Soil Conservation Service to determine what effect vegetativeness and crop residues have on yield and control of wind and soil erosion. Three methods of soil preparation were used together with five rates of residue application in a two-year corn-wheat rotation. The average crop yields are given in the table.

In a two-year rotation, tillage has had little effect on crop yield. Wheat yields were increased only by manure treatment. Incorporating the manure and straw with the surface soil has produced the highest average wheat yield. On subsurface tilled plots corn yields were reduced by increasing the amount of straw. It has been difficult to get a good stand of corn on subtilled and one-way disked ground. Weeds are more numerous on subtilled land and are generally harder to control.
Results of Tillage and Rates of Straw on Yields, 1942-1946

<table>
<thead>
<tr>
<th>Wheat Stubble Left Every Other Year</th>
<th>Wheat Yields Bu./A. Subsurface One-way Plow</th>
<th>Corn Yields Bu./A. Subsurface One-way Plow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mowed stubble</td>
<td>28.9</td>
<td>30.0</td>
</tr>
<tr>
<td>6&quot; Stubble</td>
<td>29.8</td>
<td>29.9</td>
</tr>
<tr>
<td>6&quot; Stubble and Manure</td>
<td>30.9</td>
<td>32.3</td>
</tr>
<tr>
<td>12&quot; Stubble</td>
<td>29.4</td>
<td>29.5</td>
</tr>
<tr>
<td>Combined</td>
<td>29.0</td>
<td>29.3</td>
</tr>
</tbody>
</table>

Tillage trials conducted on a farm near Huron indicate that tillage had made little difference in the yield of wheat and oats. Highest corn yields have been obtained on plowed land. Corn on subsurface tilled and one-way disked land has been very weedy and the stand poor as compared to plowed land. Where crop residues have been left on or near the surface of the soil, there has been no evidence of wind or water erosion. (Project Nos. 15 and 16. Leader: R. A. Cline, Agronomy Department; Soil Conservation Service cooperating.)

Breeding Small Grain for Earliness and Disease Resistance. The use of adapted disease- and insect-resistant small grain varieties has become an important factor in stabilizing the agricultural production in South Dakota. Rust-resistant wheat and oat varieties have prevented heavy losses from rust during the past few years of above average rainfall. It is to be expected that early maturing varieties will aid in escaping or resisting the ravages of drought and grasshoppers in years of low rainfall.

Unfortunately we have no perfect small grain varieties, nor are we likely to have them. Rust resistance has been known to break down as new races of rust develop and increase. This has been well illustrated by the increasing amounts of leaf rust on Pilot and Rival wheat. New diseases such as the disease caused by Helminthosporium victoriae have become prevalent. This organism has reduced the yields of Vikota, Tama, Boone and Vicland oats in eastern South Dakota. Vigilance is necessary if we are to hold the advances that have been made. At the same time there is much room for improvement in the present varieties.

As in the past, the small grain breeding and testing program in South Dakota is coordinated with the programs of surrounding states and the United States Department of Agriculture. Superior lines from other stations are grown in competition with our own at Brookings, Highmore, Cottonwood, and Eureka. Through such a cooperative program South Dakota has benefited by its early recognition of the value of new varieties. The value of Dakota flax and Minter winter wheat was recognized at an early date, and through the use of cooperative nurseries increases were started so that seed would be available to South Dakota farmers at the earliest possible moment.

Barley. Feebar barley was released to the members of the South Dakota Crop Improvement Association during the winter of 1946-47. This variety was developed at this experiment station. It is resistant to stem rust, possesses stiff straw, and has some resistance to grasshoppers. On the debit side, it is susceptible to leaf rust, spot blotch, smut, and bacterial blade blight. It is a high protein feed barley and yield tests indicate that it will perform well under a wide range of South Dakota conditions.
A field of Feebar barley. In the spring of 1947, 4,600 bushels of this barley was released to farmers throughout the state.

Another new variety of barley, P x D 252, is being increased for release during the winter of 1947-48. This variety is very early, stiff strawed, and has a high test weight. It has yielded very well under South Dakota conditions. It is resistant to stem rust but like Feebar it is susceptible to leaf rust (*Puccinia anomala*), spot blotch (*Helminthosporium sativum*), loose smut (*Ustilago nuda*) and bacterial blade blight (*Pseudomonas spp.*). About 3000 acres of Feebar and 80 of P x D 252 have been seeded this year.

**Oats.** A new hulless oat, resistant to smut, stem rust and leaf rust, is being increased for possible release to the South Dakota Crop Improvement Association in 1948-49. This variety is the result of a cross of (D69-Bond) x Nakota, made at the Iowa Experiment Station in cooperation with the United States Department of Agriculture. Early generation seed was sent to the South Dakota Experiment Station and selections were made under South Dakota conditions from which an adapted variety was developed.

**Wheat.** Sixty acres of Rival x Thatcher 2280 have been seeded for increase. This variety is early, beardless, stiff strawed, and resistant to stem rust. Small scale milling tests have been favorable but larger tests in commercial mills are needed before release will be possible.

**Winter Wheat.** Minter, a new stem rust-resistant winter wheat developed by the United States Department of Agriculture in cooperation with the Minnesota Experiment Station, is being increased for joint release by the South Dakota and Minnesota stations. (Project 25. Leaders: J. E. Grafius and W. L. Nelson, Agronomy Department).
Breeding Superior Field Corn Hybrids. Much of the hybrid corn now being raised in South Dakota is not too well adapted, especially in regard to maturity. In the breeding program we are attempting to develop hybrids which will be equal or superior in yield to those now grown in South Dakota, and which will be better adapted in other characteristics, such as their time of maturity and resistance to drought. This involves development of new inbred lines and the testing of new material, old lines, and inbreds from other states in single, double and top-crosses. Tests of such materials were made in Brookings, Grant, Hyde, Davison, Minnehaha, Clay, and Union counties.

No double crosses involving early inbreds were found superior to the Sokota hybrids which have already been put out by the Experiment Station.

One of our greatest needs is the development of hybrids adapted to areas having a growing season too long for existing Sokota hybrids and too short for most hybrids from the corn belt. Double crosses composed of two South Dakota inbreds and two later maturing out-of-state inbreds again proved one of the best means of rapidly obtaining such hybrids. One such hybrid, Sokota 400, was given to the Foundation Seed Stock division for seed increase and distribution.

Prediction of yields from single and top-cross results indicated some new combinations which may be desirable. These will be made and tested. (Project No. 66. Leaders: D. B. Shank and K. F. Manke, Agronomy Department).

Testing Corn Hybrids for Yield and Adaptation. In 1946 12 tests of commercial hybrids and varieties were conducted in eight different districts of the state. In all, 90 hybrids and 19 open pollinated varieties were included. The results of the work were published in South Dakota Agricultural Experiment Station Circular 66, "Corn Performance Tests, 1946."

From this work we obtained performance results on the most important hybrids being planted in South Dakota. Such information can serve as an aid in selecting hybrids adapted for various areas of the state. (Project No. 151. Leaders: D. B. Shank and K. F. Manke, Agronomy Department.)

Rates and Dates of Planting Corn. In a continuation of the study to determine the best rates and dates of planting corn, the corn was planted thick and thinned to two, three, and four plants per hill on May 6 and May 22. Hills were 42 inches apart in each direction. Early, medium and full-season corn was used. Higher yields were obtained from the May 22 planting than from corn planted May 6. (Project No. 4. Leader: A. N. Hume, Agronomy Department).

Sorghum Breeding. The sorghum breeding nursery contains 472 strains and segregating populations of grain and forage sorghums and sudan grass. These combinations are being evaluated for earliness, grain and forage quality, yield, standability, adaptability, and resistance to disease, drought, and insects. Re-combinations of the earlier types are being made for future study.

Variety tests are being conducted on 95 strains of grain and forage sorghum. A comprehensive variety test is being conducted on several new promising grain sorghums. These tests are located at the main station, three substations, one federal station and one farm. In addition to the variety test, there is an observational test located at the main station. In this test 147 strains of grain and forage sorghums are being evaluated before being placed in the variety test.
Alfalfa variety test plots. Argentine alfalfa (2) winter killed last year, whereas adapted varieties like Cossack (1) and Grimm (3) survived and produced a good crop.

Results of the variety test last year indicated that experimental grain sorghums No. 1 and No. 2 were about ten days to two weeks earlier than any of the commercial grain sorghums tested. Their yielding ability was more than double those of the commercials tested. The development of an extremely early strain of grain sorghums will aid considerably in stabilizing grain production in South Dakota where corn is a risk crop. (Project No. 61. Leader: C. J. Franzke, Agronomy Department).

Forage Crop Breeding and Testing Continued.

Legumes. Hay yields, growth characteristics, disease and adaptation notes were recorded on established stands of alfalfa, sweet clover, and red clover, recently developed by the United States Department of Agriculture and state experiment stations. This study includes 63 duplicated strains of alfalfa, 12 duplicated strains of sweet clover, and nine duplicated strains of red clover.

Thirty new strains of alfalfa introduced from the United States Department of Agriculture were seeded in duplicate for additional testing and study.

Argentine alfalfa, an unadapted variety, maintained equal stand and yield for one season, but was winter-killed nearly 100 percent last winter.

The study of factors affecting seed set in alfalfa was continued. Results from study based on one season's experience did not produce significant differences.
The study includes insect control through the use of insecticides, differential dates of cutting, and differential densities of stand.

**Grasses.** Hay was harvested on 12 species of grass and nine strains of brome-grass planted alone and in combination with alfalfa. In all the trials where the grass species and brome-grass strains were seeded in combination with alfalfa, except where the bluegrass was used, the hay yields were from 15 to 35 percent higher than where alfalfa was seeded alone. The recovery after the hay crop was removed was more rapid on all grass species and brome-grass strains in combination with alfalfa than where they were seeded alone.

South Dakota selected species produced a higher yield of hay than similar species introduced from other sources. It appears fairly certain that the region of best adaptation of a grass species is restricted. The introduced strains were not as drought resistant and hardy to withstand the adverse climatic conditions as those strains grown in the state for several years.

Field data were taken and seed harvested from 166 lines of Festuca rubra, 66 lines of Agropyron desertorum, 38 lines of Agropyron trichophorum, and five alfalfa varieties. All these lines and eight new species introduced from Africa were tested for seedling blight resistance in the greenhouse on indexed soils from different cropping systems. Observations and readings were made on root rot and seedling blight resistance. Considerable progress has been made in raising the root rot and seedling blight resistance level. Several selected seedlings from each species line were planted in the breeding nursery for further study and observation. Field data will be taken and seed harvested from the most promising lines of the 42 brome-grass strains, 36 crested wheatgrass strains, 83 Ree wheatgrass strains and five alfalfa varieties.

Brome-grass, Ree wheatgrass and crested wheatgrass were planted in two polly-crossed increase seed plots each; Agropyron trichophorum in four plots; and Agropyron desertorum in two plots this spring. The seed produced from these increase seed plots will be used for future tests and observations. (Project 74. Leaders: C. J. Franzke, E. L. Erickson, M. W. Adams and John H. Miller, Agronomy Department).

**Soybean Improvement.** In cooperation with the United States Department of Agriculture, new and improved strains of soybeans grown uniformly were ap-

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Ree wheat grass subjected to various clipping treatments. Greater total forage yields are obtained when treated as hay (1) than when cut at one inch (2) or at four inches (3).

[9]
praised for oil content, maturity, growth characteristics, disease resistance, and yield at the main station and at Centerville, South Dakota.

This spring 13 promising strains were seeded at the main station, 18 strains at Centerville, and 18 strains near Peever. The seedings were made in quadruple.

A study of seeding methods is also being conducted at the main station. This study includes rates of seeding and differential row spacings. (Project No. 148. Leaders: M. W. Adams and E. L. Erickson, Agronomy Department; Bureau of Plant Industry, Soils and Agricultural Engineering cooperating).

Noxious Weed Control. The weed research farm at Scotland, South Dakota, has been maintained and enlarged. The study of weed control practices has been continued. These practices include (1) intervals of cultivation, (2) fall and spring planted competitive crops, (3) summer planted competitive crops, (4) corn culture for control of bindweed, (5) perennial forage crops, and (6) the use of selective herbicides.

New experiments have been established, involving the use of 2, 4-D in conjunction with (1) spring planted crops, (2) fall planted crops, (3) perennial forage crops, and (4) intensive cultivation. Preliminary studies on the varietal reaction of corn, oats, and barley to 2,4-D at different stages of growth have been started. A study that compares the results of dusting with those of spraying 2,4-D on field bindweed has been inaugurated.

Low volume trials on field bindweed and on annual weeds have been set up in an effort to determine the minimum amount of water that is needed to spray an acre of grain with 2,4-D and control these weeds.

Experiments have been started throughout the state on noxious weeds to determine the minimum requirement of each of the three general formulations of 2,4-D needed to give satisfactory control.

Agronomy pamphlet No. 10, “Chemical Control of Weeds,” and Agronomy pamphlet No. 12, “Approved Practices for Noxious Weed Control in 1947,” summarize the recommendations. 2,4-D was recommended for use in a weed control program that involves the control of field bindweed, perennial sow thistle, Canada thistle, and many of the common annual, winter annual, and biennial weeds. (Project No. 32. Leaders: L. A. Derscheid, L. M. Stahler and E. L. Erickson, Agronomy Department; United States Department of Agriculture and Bureau of Plant Industry, Soils and Agricultural Engineering cooperating).

Fruits and Vegetables

Tree Fruit Breeding. The major objective of this work has been the development of fruit varieties possessing greater winter hardiness. The use of hardy parents has made it necessary to sacrifice quality of fruit. By crossing and back-crossing, however, progress has been made in the development of apples, apricots, pears, plums, and cherries.

A varietal testing program has also been started. Several hundred fruit trees have been planted at Brookings and Watertown to test their performance under South Dakota conditions. For local conditions, the varieties developed at the local station have been equal to, or better than, those introduced from other stations.
Sapa and Opata and related plum-sandcherry hybrids adapted to state conditions have proven to be exceptionally good. (Project No. 1. Leader: N. E. Hansen, Horticulture Department).

**Greenhouse Fruit Breeding by “Tub Orchard.”** High quality varieties of fruit plants are planted in tubs so they can be moved into storage cellars during severe winter weather. After a long enough rest period these can be forced into blossom by moving them into the fruit breeding greenhouse. Many crosses have been made by this method. Seeds collected from these crosses are planted in seed frames and transplanted to the orchard for further observation. Many seedlings are now growing under orchard conditions and selections will be made from these. (Project No. 59. Leader: N. E. Hansen, Horticulture Department).

Crossing cherries in the greenhouse is an aid to the fruit breeding program.

**Strawberries, a Dependable Fruit Crop.** Tests have indicated that Senator Dunlop, Burgundy, and Premier are dependable strawberry varieties for growing in South Dakota. Evermore and Gem have been outstanding performers of the everbearing type.

Mulching studies show that for consistent yields winter covering is essential. Two inches of straw mulch affords ample protection. One inch of covering during some winters is not enough. The time to apply the mulch is after the plants have matured, but before severe freezing weather occurs. Varieties have shown a great difference as to the best date for mulching. Senator Dunlop has consistently given a greater yield when mulched late in November, while Premier does better if mulched earlier. (Project No. 145. Leaders: S. A. McCrory and L. A. Yager, Horticulture Department).

**Yellow Foliage or Chlorotic Condition in Fruit.** This condition is especially prevalent when fruit plants are grown on low sites where water accumulates. Attempts have been made to correct this condition on strawberries and raspber-
ries. Replicated plantings of Latham raspberries and Senator Dunlop strawberries have been given various soil treatments. No treatment used to date has corrected the trouble. However, when one-half bushel of acid peat or a like amount or manure was added to 25 feet of row, some improvement resulted. Spraying the foliage with ferrous sulfate (one ounce per gallon of water) gave marked improvement in color of foliage. (Project No. 145. Leaders: S. A. McCrory and L. A. Yager, Horticulture Department).

Straw mulch applied at different dates provides winter protection for strawberries.

Tomato Yields Increasing Through Use of Hybrids. Some garden vegetables lend themselves to the use of hybrid plants. Tomatoes are one of these vegetables. The best hybrid used in the test plots in 1946 produced one-fourth more fruit than did the best yielding standard variety. Not all hybrids performed well, however. (Project No. 49. Leader: S. A. McCrory, Horticulture Department).

Sweet Corn Season May Be Extended by Planting Varieties with Different Maturity Dates. Most of the sweet corn hybrids have been developed for commercial uses. Uniform maturity is generally a desirable feature. For the home garden, however, if only one planting is made and only one variety used, the family may have sweet corn for a very short period. Hybrids are being developed for the purpose of making a long season of corn for the home garden. Other hybrids are being developed to supply the commercial producer. (Project No. 68. Leader: S. A. McCrory, Horticulture Department).

Vegetable Yields Increase When Protected from Insects. Benzene hexachloride and DDT show promise for insect control of potatoes in experiments conducted at Spearfish. Although little insect damage was noticed in 1946, yields increased when plots were sprayed with these insecticides. Late planting is the general rule for potato growing in the area in order to avoid psyllid infestation. Early planting and the use of these newer insecticides may lead the way to production of earlier potatoes and higher yields.

Sabadilla dust appeared promising in the control of squash bug on vine crops. Magnesium arsenate as a spray gave excellent control of Mexican Bean beetle on
beans. Tomato plants treated with starter solutions at the time of setting out gave the greatest yield of early fruit as well as total yield. The experiments, conducted at Spearfish, showed that the application of fertilizers in the liquid form proved superior to dry application. (Project No. 144. Leader: L. A. Yager, Horticulture Department).

**Plant Diseases**

**Potato Disease Control Investigations.** In 1946 the potato scab nursery was continued and 34 additional new lines were included in the tests for selection of a commercially desirable scab-resistant potato. As a result of the data obtained from these tests during the past several years, 27 of the most promising scab-resistant seedlings and named potato varieties were grown in the major potato growing section of the state in 1946 for further observation and to test their yielding ability.

Conditions for scab development on tubers was not as favorable as in previous years. Therefore, it was difficult to obtain reliable measurements on scab resistance to the lines under investigation in 1946. All lines will be tested again in 1947. Of the 27 seedlings and named varieties grown in Codington county, yields were generally lower except for a few lines which were virtually equal to an elite seed stock of Bliss Triumph.

Experiments on the control of the two major foliage diseases, early and late blight, were conducted at Brookings. The evaluation of the new fungicides for control of these diseases provided little data in 1946 because, due to the prolonged dry period during July and August, these diseases did not develop in the plots in quantities sufficient to make a difference in yield.

Data collected during the past three years indicate that Yellow Cuprocide and Phygon are the most promising as foliage protectants for potatoes in South Dakota. Spraying is superior to dusting. A Yellow Cuprocide spray formula was recommended to growers in 1945. This material is now being used in increasing amounts. (Project No. 107. Leader: C. M. Nagel, Plant Pathology Department).

**Seedling Blight and Root Rots of Forage and Cereal Diseases in Relation to Stand, Vigor, and Yield.** A new root-rot disease of oats was observed and identified as being present in South Dakota in June of 1946. A limited survey was made in eastern South Dakota to determine its distribution and severity of damage to the oat crop. Laboratory and greenhouse experiments were conducted to isolate the pathogen and to prove that it did cause the disease.

Isolation of the fungus and pathogenicity experiments demonstrated that this destructive disease was being caused by *Helminthosporium victoriae*. This organism had recently been reported in other states. The symptoms produced were blighting of the above ground parts and severe necrosis to all underground parts of the plant.

Experiments thus far indicate that only those varieties having Victoria oats in their parentage are susceptible. These findings are similar to those reported from the Iowa station. The susceptible varieties include such varieties as Vikota, Boone, Vicland, Tama, etc. Clinton, Bonda, Mindo, Benton, Eaton and Marion, etc., are highly resistant. Greenhouse experiments demonstrated that New Improved
Ceresan may increase the stand as much as 33 percent when used as a seed treatment. (Project No. 115. Leader: C. M. Nagel, Plant Pathology Department).

Effect of Irrigation, Rotation, and Other Cultural Practices on Seedling and Root Pathogens on Sugar Beets. Data were collected and observations made on the sugar beet rotation plots at the Newell station. The effects of the sugar beet root-rot disease was again the most serious disease of sugar beets grown under irrigation in western South Dakota.

Continuous cropping to sugar beets and including legumes in the rotation both result in poor stands. Manure applied each year afforded control, whereas if applications are made every other year the control is less effective.

Causes of stand failures in sugar beet fields have been determined, and by proper rotations and the application of manure each year better stands are attained. (Project No. 126. Leader: C. M. Nagel, Plant Pathology Department).

Selection of Adapted Species and Strains of Trees and Shrubs; The Control of the Diseases That Attack Them. The disease reaction of approximately 45 clonal lines of Populus have been observed for resistance to cottonwood leaf rust (*Melampsora medusae*).

Through selection, highly resistant lines of Populus have resulted. Marked differences in their reaction to leaf rust was again recorded in 1946, similar to their reaction during the previous season. Under epiphytotic conditions in the field, this disease defoliated the ordinary commercial strains about 97 percent in contrast to approximately five percent in the case of the most resistant selection.

Important benefits to growers appear promising at such time as these selections may be released pending adequate testing. This is based on the evidence which indicates that leaf rust is probably a limiting factor in maintaining cottonwood stands in farm and shelterbelt plantings in South Dakota.

A 12-acre planting of cottonwood (*P. deltoides*) has been established to investigate other methods of control, especially the influence of spacing, weeds, and pruning in relation to environmental conditions as they relate to leaf rust control. The latter experiments are being conducted at Hecla in cooperation with the Brown-Marshall soil conservation district. (Project 142. Leader: C. M. Nagel, Plant Pathology Department).

Control of Tomato Foliage Diseases in South Dakota. Approximately 160 tomato selections resulting from wild disease-resistant sorts and commercial varieties were under field study for their reaction to Septoria leaf spot. In 1946 the disease developed early under field conditions, but a dry period during July and August hindered further development. Consequently, the disease intensity was insufficient to determine the relative resistance of these selections under field conditions to the Septoria leaf spot disease.

A second approach to the control of Septoria leaf spot on tomatoes during the past several years has been through the application of various fungicides. During the past three seasons a comparison of materials was made to select the most effective fungicide. In 1946, as a result of the previous year’s evaluations, two of the most effective materials were placed in an experiment using different dosages. These were Phygion and Yellow Cuprocide. These fungicides were applied at three different dosages in a randomized block experiment with four replications.
They were also applied in dust form. Because of the unfavorably dry weather conditions during July and August, extensive development of Septoria leaf spot did not occur, so no data were collected on disease control. (Project No. 146. Leader: C. M. Nagel, Plant Pathology Department).

**Crop Insects**

**Experiments in Grasshopper Control.** During the past year experiments were conducted to destroy grasshoppers invading grain fields or hatched in grain fields and working on the grain. Other experiments were conducted to destroy grasshoppers working in alfalfa fields. Chlordane and Toxaphene were used as our toxic agents.

Chlordane (1068) is soluble in organic solvents such as acetone, xylene and the fractions of petroleum oils, but insoluble in water. For use as an insecticide it may be prepared as a solution, as an emulsifiable liquid, as a wettable powder and as a dry non-wettable dust. In our experimental work the Chlordane was used as an emulsifiable liquid, as a wettable powder in a liquid spray, and as a wettable powder used as a dust. In our work with Chlordane we applied the sprays or dusts at the rate of one pound of the Chlordane per acre in one series of experiments, and at the rate of three-fourth pounds of the Chlordane per acre in another series.

Toxaphene was used both as a dust and a liquid spray in the experimental tests. This material was applied to the infested crops at the rate of two pounds per acre in all the experiments.

The experimental work was done on farms in Lyman, Butte, and Lawrence counties and at the Federal Dry Land Field Station at Newell, South Dakota.

Ground equipment was used for applying the dusts and the liquid sprays. No planes were used. In Lyman county a Bean power sprayer mounted on an army type 6 x 6 truck equipped with a 40-foot boom on the front end, was employed to apply the liquid sprays. The boom had 28 nozzles that were spaced about 14 inches apart. The tank had a capacity of 400 gallons and the pump was set to develop a pressure of about 60 pounds per square inch. A good working agitator kept the spray liquid well stirred. The spray was applied very thoroughly to the vegetation, and minute droplets of the liquid, very closely spaced, clung to all vegetation that was sprayed. The only disadvantage of using this equipment was the damage done to the grain, especially after it was headed, due to the large dual wheels of the truck.

In Lyman county, a Niagara power duster was used for dusting. This duster had a 40-foot boom with 24 nozzles and was drawn by a tractor. A canvas apron 20 feet long was attached the length of the boom and was drawn behind the duster in order to force the dust in contact with the plants as much as possible. Excellent coverage was obtained with this equipment.

In Lawrence and part of Butte counties, a power sprayer with a 20-foot boom and 14 nozzles was used. This sprayer likewise gave us excellent coverage. The operator used 400 pounds of pressure while operating the sprayer. This produced a driving mist that completely covered all foliage.
On the Federal Dry Land Field Station at Newell, a dusting experiment was conducted to control grasshoppers in alfalfa. The duster used was an old outmoded power duster with a 10-foot boom and six nozzles. This duster operated very unsatisfactorily because it was impossible to operate the machine without having some of the leads of hose become detached. The result was a very poor coverage.

It was found that both Chlordane and Toxaphene, when properly applied either as a wet spray or dust and when applied at sufficient concentration per acre, will give better than a 99 percent kill of grasshoppers. Both of these chemicals gave us about the same percentage of kill of grasshoppers, but Chlordane we believe has longer lasting qualities. Further, Chlordane seems to have a definite repellent effect even after its killing ability has disappeared.

There apparently was no difference in ultimate kill of grasshoppers when the dust or spray was applied in the early morning, mid-day, or evening. At the rate the dust and spray were applied, there was just as good a kill when dusting as when spraying.

In one dusting experiment, a strong gusty wind was blowing at about 30 miles an hour. It was impossible to keep the canvas trailing the duster on the ground, even with weights attached to it. A light rain began to fall before this dusting was completed and before the next morning a heavy rain hit the area. The field dusted was in winter wheat about waist high. Under these extremely unfavorable conditions one would expect a poor kill in this experiment, but in three days time we got better than a 99 percent kill of the grasshoppers.

Both Chlordane and Toxaphene kill grasshoppers in all stages of development. Young grasshoppers are apparently killed in the shortest time, but recently molted adults are killed as readily as nymphs in their latest stages. Older well hardened adults require a heavier dosage of the insecticides for a good kill.

Fields of wheat, barley and oats, alfalfa and native grass, western wheatgrass, buffalo and other grasses were dusted and sprayed without burning of any vegetation with the formulations of the poisons used. Grain fields sprayed and dusted were six inches high, 12 inches high, two feet high and waist high. In all of the fields we got highly satisfactory kills.

Alfalfa fields sprayed and dusted varied in height from 14 inches to 20 inches, and in these cases, with one exception, the kill was better than 99 percent. The fields of small grain dusted or sprayed had a heavy luxuriant stand of grain in every case. The alfalfa fields varied from thin to thick heavy stands.

There was one failure or partial failure in dusting an alfalfa field with Chlordane. In this field we got between a 50 and 60 percent kill of grasshoppers at the end of the fourth day. We are certain that this partial failure was due not to the use of Chlordane dust, but to the use of poor equipment and inadequate application of the dust.

The lesson learned from this experiment leads us to emphasize the need of satisfactory equipment for either dusting or spraying and thorough coverage. Skipping of areas in any infested field cannot be recommended at the present time; nor can dusting or spraying of infested fields in strips. Work of this type needs further investigation.
In liquid spraying, from 50 to 400 pounds of pressure was used in the various experiments. All of the experiments, regardless of pressure, gave excellent kills. Higher pressure seems to be best, however, because of the driving force of the spray. The same may be said of the dusts.

When fields of grain, grass, or alfalfa were sprayed or dusted with Chlordane or Toxaphene, it was found that many insects both harmful and beneficial were killed besides grasshoppers. Among the insects killed were the following: many species of cutworms; adult wireworms; adult western wireworms (*Eleodes opaca*); many Miridace; some leaf hoppers; adult alfalfa weevils; ground beetles, or *Carabidae*; many species of flies, including Sarcophagidae, lady bird beetles (*Coccinellidae*), and a host of others. Very few grasshopper mites were killed. Millipedes infested the grain fields very heavily, but five days after dusting or spraying less than 20 percent of the millipedes were dead. The rest were apparently but little affected.

How toxic Chlordane or Toxaphene sprayed or dusted on alfalfa or small grain or grass might be to cattle, sheep, hogs or horses that feed upon such foliage we do not know. Neither do we know how long after spraying or dusting it would remain toxic to livestock. This phase of the work requires further investigation. (Project No. 18. Leader: H. C. Severin, Entomology Department).

**Insect Pests of Shelter Belts.** The spotted willow leaf-beetle (*Lina lapponica*) and its larvae, several species of the flea beetles (*Halticini*), caterpillars of the mourning cloak butterflies (*Euوانessa anitopa*), and caterpillars of the Cecropia moth (*Samia cecropia*) were the most important insect pests of willow in South Dakota during the past year.

These pests were readily controlled through spraying with Paris green or lead arsenate.

On evergreens, mites gave us the greatest trouble. The mites became exceedingly abundant as time went on, both in 1946 and 1947, and many spruce trees were killed outright by these pests. Spraying with Vapotone or Dow 17 gave us excellent control. Trees thoroughly sprayed were cleaned up through one spraying.

The cottony maple scale occurred in outbreak form in 1946 and 1947. It attacked chiefly maple, boxelder, elm and willow trees. Some trees were lost through the attack of this pest. Spraying with Vapotone or miscible oil, summer, strength, gave excellent control. Spraying was timed so that the spray was applied shortly after the eggs hatched.

The cottonwood leaf beetle (*Lina scripta*) and the fall webworm (*Hyphantria textor*) were the principal insects attacking cottonwood in South Dakota during the past year. Excellent control was obtained by spraying with Paris green or lead arsenate.

The coke cherry tortrix (*Archipes carasivorana*) continued to be the major pest of choke cherries in South Dakota during the past year. Methods of control as recommended in the 1945-46 Annual Report worked out satisfactorily this year.

Canker worms of the spring species *Paleacrita vernata* gave us considerable trouble on certain shelter belt trees such as elm, chinese elm, and boxelder. Neglected trees looked as if a fire had swept over them in June. These worms were
Click Beetles or Elateridae of South Dakota. A manuscript has been prepared on this project listing the species of Elateridae that we have taken in South Dakota. Other data includes the locality where each species was taken, the period of the year during which it was taken, and the peak of abundance of each species. A general discussion on the life cycle and seasonal cycles of the Elateridae is included in the manuscript, and a discussion is added on the economics of this family of insects. This work should be ready for distribution some time early in 1948. (Insect Control Project No. 1. Leader: H. C. Severin, Entomology Department).

Light Trap Studies. Light traps for catching insects were operated in Brookings, Clay, Union, Hand and Lawrence counties during May, June, July, August, September and October. Daily catches in these traps were shipped to the laboratories at the main station where they were studied. Data was recorded regarding the economic species. About 15,000 specimens were sorted out, pinned, labelled and added to our collections. This work is extremely valuable not only for the particular year in which the traps are operated, but also over a long time period. Much valuable information is obtained through this project regarding the abundance of certain species in the localities where the traps are operated. We also get information to some extent on life cycles, seasonal peaks and distribution of the insects. (Insect Control Project No. 2. Leader: H. C. Severin, Entomology Department).

Carabidae, Cicadellidae, and Coccinellidae. A great deal of work has been done on these three families of insects. Thousands of specimens have been collected in each of these groups. These specimens are all properly labelled with locality and date labels, and most of the material has been identified. We are now assembling the data and preparing a manuscript covering the work for publication. (Insect Control Project Nos. 3, 4 and 5. Leader: H. C. Severin, Entomology Department).

Tillage and its Effect Upon Grasshopper Populations. For the past several years, the station has studied test plots of various present day tillage practices as methods of controlling grasshoppers. Tillage methods properly used (Experiment Station Bulletin 379) have proven definitely helpful in grasshopper control.

Certain of our detrimental species of grasshoppers do not concentrate in restricted areas for egg laying. They therefore may not be so readily held in check by some of the fairly recently developed insecticides. This is especially true of such species as Melanoplus femur rubrum, the red-legged locust, and M. Mexicanus, the lesser migratory locust. Tillage practices may be used to good advantage in concentrating the egg laying of these two species in definite areas which may later be treated for egg destruction.

Studies are now being conducted in an attempt to find some method of tillage which may be used to destroy grasshopper eggs in native prairie sod without damaging the grass. During the past year tests have been carried on in the Kennebec and Presho areas. The implement used was an alfalfa renovator. Single and double treatments are being checked, but the work has not been conducted over sufficient time and number of repetitions to justify definite conclusions. (Project No. 86. Leader: Gerald B. Spawn, Entomology Department).
Control of heel flies and grubs on Range and Feed Lot Cattle. In a study of the relative values of the various control measures for heel flies and grubs on cattle—wet spray, dry dust, and automatic currier—experimental cattle in a Sioux Falls packing plant's feed lots were examined for grubs every 28 days from February 12 to June 15 and treated. On July 9, these cattle were slaughtered and the hides and carcasses were examined for grub damage and live grubs.

With the help of county agents, about 150 grubs were collected throughout the state, together with pertinent information dealing with control methods that were being practiced in their areas. The grubs were identified as Hypoderma bovis with the exception of two specimens which were identified as H. Lineatum. These two were collected during the first week in April.

A herd of cattle was located near Wolsey, and the calves born in this herd throughout the summer will be examined next winter and spring. All birth dates will be recorded, so that the examination of these calves should give us the latest date of egg laying by either species of heel flies in this area for the summer of 1947.

On May 23, a trip was made to Brown county in the Aberdeen and Cresbard vicinities to collect seasonal history data. The grubs taken here were H. Bovis, but not as fully developed as in the rest of the state.

From June 25 to 30, a trip was taken across the state to collect grubs and information dealing with the life history, presence and abundance of grubs in cattle; the presence and abundance of heel flies on the range; and the controls practiced, including numbers and time of application, and spray pressures used. Miller, Highmore, Pierre, Philip, Rapid City, Spearfish, Belle Fourche, and Buffalo and surrounding areas were included in the areas covered. Much valuable information pertaining to the seasonal history study was obtained from county agents, commercial spray operators, farmers and ranchers. The relative effects of the various control methods and some of the problems of control were discussed. All data was recorded for use in further study of this problem. (Project No. 163. Leader: John Lofgren, Entomology Department).

Livestock Production

Systems of Producing Fat Yearlings for South Dakota. Many farmers in South Dakota have different amounts and types of roughages available for beef cattle. With present trends and needs for more pasture and hay in a conservation program, livestock production must find more profitable ways to use these in meat production. This is an experiment to (1) determine the efficiency of various South Dakota roughages in rations for wintering calves to be fattened as yearlings and (2) to compare deferred feeding with full-feeding during the winter months to utilize the most roughage and least grain possible.

The first phase of the experiment compares three lots being wintered so that ten calves gain from one pound to 1½ pounds daily with one lot full-fed. Forty-eight head of good Hereford calves (32 steers and 16 heifers) were brought from the range area and divided into four uniform lots on the basis of weight, sex, type, condition, origin, and other indications of probable outcome. Each lot consisted of eight steers and four heifers.
These calves were started on feed January 21, 1947. Individual weights at the beginning were taken on three consecutive days and the average of the three weights were used as the initial weight. The animals were weighed every 28 days thereafter.

Results of the experiment up to the present time are shown in the opposite table.

In the second phase of this experiment, Lots 1, 3 and 4 were redivided into four uniform lots on May 26, 1947. Each lot consisted of six steers and three heifers and were treated as follows:

Lot 5: native grass pasture for 50-90 days and then full-fed on grain until marketed.

Lot 6: brome-alfalfa pasture for 50-90 days and then full-fed on grain until marketed.

Lot 7: brome-alfalfa pasture with full feed of grain until marketed.

Lot 8: native grass pasture with full feed of grain until marketed.

Comparing Lots 1 and 2, Lot 2 gained about .51 pound more per animal daily. On the basis of feed required per cwt., 100 pounds of shelled corn plus 11 pounds of soybean meal equals 388 pounds of corn silage plus 38 pounds of alfalfa hay.

Comparing corn silage to brome hay in Lots 1 and 3, 100 pounds of corn silage is equal to 76 pounds of brome hay plus 8.9 pounds of alfalfa hay plus 5.3 pounds of shelled corn on the basis of feed per cwt. gain. Animals in Lot I gained .34 pound more per head daily than those in Lot 3.

Comparing corn silage to alfalfa hay in Lots 1 and 4, 100 pounds of alfalfa hay is equal to 177 pounds corn silage plus two pounds of corn. Lot 4 gained only .02 pound more per head daily. This gives corn silage a value of about 50 percent of alfalfa hay in these experiments. The corn silage was of good quality while the alfalfa hay was only fair.

Comparing brome to alfalfa hay where both were full fed, in Lots 3 and 4, 100 pounds of alfalfa hay is equal to 161 pounds of brome hay plus 12 pounds of shelled corn. This gives brome hay a value of about 55 percent of alfalfa hay in these trials. The brome hay was not very palatable and this is a low value. (Project No. 164. Leaders: Charles S. Hobbs and Arnold Nelson, Animal Husbandry Department).

Systems of Breeding Swine. The purpose of this project is the development of available inbred lines for efficiency in pork production.

Last year two inbred lines were started at Brookings—one Duroc Jersey line and one Poland China line. These lines are being inbred slowly (half-sib matings chiefly) and selected for: (1) rapid growth rate; (2) high productivity; (3) freedom from defects; and (4) meaty body conformation.

The breeding tests compared in 1946 were: (1) crosses between inbred lines of a breed (a two-line Poland China cross and a three-line Poland China cross); (2) a cross between inbred males of a breed and outbred females of the same breed (Poland China line-top cross); and (3) purebreds (outbreeds).

The two-line cross sows (mothers of the three-line cross pigs) were especially prolific in the number of pigs weaned per sow. The two-line cross pigs made the fastest gains, but the mothers of these pigs which were themselves inbreds were not so prolific and this gave a low market weight per litter for this cross. In gen-
(Phase 1, January 21 to May 26, 1947)

<table>
<thead>
<tr>
<th>Rations</th>
<th>Alfalfa Hay</th>
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1. Number animals in lot | 12 | 12 | 12 | 12
2. Number days in period | 125 | 125 | 125 | 125
3. Initial | 485 | 486 | 488 | 488
4. Final | 647.7 | 712.3 | 607.2 | 652.2
5. Total gain | 163.2 | 226.3 | 119.5 | 165.4
6. Daily gain | 1.30 | 1.81 | 0.96 | 1.32
7. Average daily ration (lbs.)
   Shelled corn | 3 | 9.3 | 3 | 3
   Soybean oilmeal | 5 | 0.58 | 5 | 16.8
   Alfalfa hay | 20.55 | 8.7 | 11.5 |
   Corn silage |
   Brome hay |
   Salt | 0.04 | 0.03 | 0.03 | 0.03
   Bonemeal | 0.03 | 0.03 | 0.03 | 0.03
   Limestone | 0.02 | 0.02 | 0.01 | 0.01
8. Feed per cwt. gain (lbs.)
   Shelled corn | 229.8 | 512.0 | 313.8 | 226.7
   Soybean oilmeal | 32.1 |
   Alfalfa hay | 383.0 | 276.1 | 523.0 | 1270.8
   Corn silage | 1574.6 | 480.7 |
   Brome hay |
   Salt | 2.4 | 1.8 | 3.0 | 2.2
   Bonemeal | 1.0 | 0.8 | 1.1 | 0.9
   Limestone | 1.9 | 1.6 | 2.6 | 1.8
9. Feed cost per cwt. gain | 12.44 | 16.69 | 18.82 | 15.52
10. Financial results per steer ($)
   Cost per cwt. in feed lot | 16.00 | 16.00 | 16.00 | 16.00
   Initial cost | 77.60 | 77.76 | 78.08 | 78.08
   Feed cost | 20.30 | 37.77 | 22.49 | 25.67
   Total cost | 97.90 | 115.53 | 100.57 | 103.75
11. Necessary selling price per cwt | 15.11 | 16.22 | 16.56 | 15.91
12. Appraised price per cwt | 22.00 | 22.23 | 19.42 | 20.64
13. Value per steer (3% shrink) | 138.23 | 153.59 | 114.38 | 130.57
14. Net return per steer based on appraised selling price | 40.33 | 38.06 | 13.81 | 26.82

Feed Prices
- Shelled corn $1.30 per bu., .0232 per lb.
- Soybean oilmeal $82.00 per ton, .041 per lb.
- Alfalfa hay $16.00 per ton, .008 per lb.
- Brome hay $12.00 per ton, .006 per lb.
- Corn silage $5.00 per ton, .0025 per lb.
- Ground limestone $1.30 per cwt., .13 per lb.
- Bonemeal $4.40 per cwt., .044 per lb.
- Salt $1.50 per cwt., .015 per lb.

[21]
eral, this year’s work indicates that crosses between inbred lines within a breed may be a profitable breeding system for producing pork economically. (Project No. 124. Leaders: Leslie E. Johnson and Turner Wright, Animal Husbandry Department).

**Carrying capacity of South Dakota Ranges and Pastures.** A survey, started in May, 1946, of the ranges and pastures of South Dakota was completed. This survey was conducted in cooperation with the Soil Conservation Service to obtain data to be used as a basis for recommended stocking rates for this area.

The information obtained from this survey has been summarized and is being prepared for publication. The 1946 survey shows a definite increase in carrying capacity over those made in 1940 and 1942. This increase is due primarily to the greater rainfall of the past few years. (Project No. 97. Leaders: Earle W. Klosterman and Harlan R. Olson, Animal Husbandry Department; Leslie R. Albee, Soil Conservation Service.)

**Breeding the Notail Sheep.** The object of this experiment is to develop a superior mutton and wool breed of sheep without tails. This project was started in 1913 by crossing Fatrump Siberian sheep with purebred Hampshire and Shropshire ewes and high grade Cheviot ewes. In more recent years some Southdown and Columbia stock has been crossed into the breed.

There are now 56 native ewes, 18 yearling ewes and 11 rams in the flock. Last spring the wool clip for the ewes, yearlings and rams averaged 7.0, 7.5 and 10.7 pounds respectively. The ewes lambed a 100 percent lamb crop.

Six Columbia and 15 Rambouillet ewes have recently been added to the flock. These were mated to the best Notail rams this fall. Some of the best Notail ewes were mated to Columbia and Rambouillet rams. From these crosses, selections will be made to improve mutton and wool production. (Project No. 9. Leaders: J. W. Wilson, Leslie E. Johnson, and Earle W. Klosterman, Animal Husbandry Department.)

**Comparing Soybean Meal and Linseed Meal and Methods of Feeding for Fattening Pigs.** This work was a continuation of that started in 1939. Eighty pigs, farrowed late in the spring of 1946, were divided into ten lots of eight pigs each and fed as follows:

- Lots 1 and 5 were self fed a feed mixture consisting of 82.5 parts coarsely ground yellow corn and 17.7 parts of a protein mixture. This protein mixture was tankage, two parts; linseed oil meal, one part; and ground alfalfa, one part. Mineral mixture was fed free choice.
- Lots 2 and 6 were self fed a feed mixture consisting of 84 parts coarsely ground yellow corn, and 16 parts of a protein mixture consisting of tankage, two parts; soybean meal, one part; and ground alfalfa, one part. Mineral mixture was fed free choice.
- Lots 3 and 7 were fed shelled yellow corn, self fed; a protein mixture consisting of two parts tankage, one part linseed oil meal self fed, alfalfa hay self fed, and mineral self fed.
- Lots 4 and 8 were self fed shelled yellow corn; a protein mixture consisting of two parts tankage, one part soybean meal self fed, alfalfa hay self fed, and mineral self fed.

All the above lots were fed in dry lot on concrete floors.
Lot 9 was self-fed a feed mixture of 82.5 parts coarsely ground yellow corn, 16.0 parts linseed meal, one part ground limestone and .5 parts common salt. The pigs had access to alfalfa pasture.

Lot 10 was self-fed a feed mixture of 87.4 parts coarsely ground yellow corn, 11 parts soybean oil meal, .8 parts ground limestone, .3 parts steamed bonemeal, and .5 parts common salt. These pigs also had access to alfalfa pasture.

The rations for Lots 1, 2, 5 and 6 were calculated to contain 16 percent protein and for Lots 9 and 10, 14 percent protein. When the pigs reached an average weight of approximately 135 pounds per pig, the rations were changed to 14 and 12 percent protein, respectively. The mineral mixture used consisted of 40 pounds of steamed bonemeal, 40 pounds of ground limestone, and 20 pounds of common salt.

The results were favorable to the use of soybean meal as a protein supplement to feed with tankage for fattening pigs in dry lots. There was, however, quite a lot of variation in feed utilization even with duplicate lots. For example, the pigs in Lot 7, fed free choice method and getting linseed meal as a part of the protein supplement, showed the lowest feed requirements for a unit of gain. Those in Lot 3, fed exactly the same way, showed next to the highest. When all lots are considered, the results are in favor of the soybean meal.

In the four lots fed free choice method on shelled corn, alfalfa hay, protein supplement and mineral, and in the four lots fed ground corn and ground alfalfa mixed with the same protein supplements and mineral and fed as mixed feeds, the pigs fed the mixed feeds made faster gains. There was, however, a definite advantage in economy of gains in favor of the free choice method of feeding. The labor for grinding and mixing the feed was not included in the feed cost for the pigs getting the mixed feed. (Project No. 85. Leader: Turner Wright, Animal Husbandry Department.)

**Alfalfa, Brome and Alfalfa-Brome for Wintering Breeding Ewes.** With increasing acreages of alfalfa-brome grass mixture being grown in eastern South Dakota, there is more of this mixed hay available for sheep feeding. This project was started to determine the value of the two hays and a mixture of the two for wintering breeding ewes. There is considerable difference in the protein content of these two hays, so we are also studying the protein requirements of pregnant ewes.

Ewes from the Notail sheep breeding project were used in this experiment. Five lots of 15 ewes each were fed from January 3 (the end of the breeding season) to April 11, 1947. All lots were fed approximately equal amounts of total digestible nutrients and were allowed free access to salt and to a mixture of equal parts of steamed bonemeal and salt.

Lot I was fed alfalfa hay and shelled corn; Lot 2, alfalfa-brome hay and shelled corn; Lot 3, brome hay and shelled corn; Lot 4, brome hay, soybean pellets and shelled corn to equal the protein content in the Lot 1 ration; and Lot 5, brome hay, soybean oil meal and shelled corn to equal the protein content in Lot 2 ration.

The ewes fed alfalfa hay made the largest gains and those fed brome hay made the smallest gains. The ewes in Lot 5, fed enough soybean pellets to equal the
protein in the alfalfa hay ration fed to Lot 1, made satisfactory gains but gave 
birth to light lambs. Further lamb weights will be taken to determine the effect 
of winter rations on the gain of lambs. (Project No. 162. Leaders: Earl W. Klos-
terman and J. W. Wilson, Animal Husbandry Department.)

**Feeding Value and Digestibility of Northern Great Plains Grasses and Hays.**
This project has been revised and will include research on digestion and metabol-
ism. The revised project includes digestion work with cattle instead of sheep, 
digestion study on grasses as used, and feeding trials on hay cut at different stages 
and stored different numbers of years. This work will be carried on at the same 
time as the digestion and metabolism research.

Work will be conducted at four or more stations varying in soil types, types of 
grasses, rainfall and other conditions. (Project No. 120. Leaders: Charles S. 
Hobbs and Arnold Nelson, Animal Husbandry Department; A. L. Moxon, 
Chemistry Department; and C. F. Franzke, Agronomy Department.)

**Cost, Management and Marketing Comparisons of Spring and Fall Pigs.** This 
experiment compares the one litter and two litter systems, compares spring and 
fall farrowed pigs, and compares the efficiency of early, late and summer far-
rowed pigs. We are also attempting to determine the effect of weaning age on 
efficiency of pork production. The first group of 12 gilts have been selected and 
bred for this work.

The following production data will be taken: (1) birth weights; (2) 56-day 
weights; (3) 77-day weights; (4) 28-day weights after weaning until 225 pounds; 
(5) finished type and market grade; (6) complete feed records from breeding of 
sows until pigs are finished; (7) market data; (8) labor costs; (9) equipment 
costs; and (10) financial returns. (Project No. 168. Leaders: Charles S. Hobbs 
and Turner Wright, Animal Husbandry Department.)

**Sweet Clover Silage for Fattening Beef Calves.** The cattle feeder wants to 
make full use of the feeds that he can grow easily. Sweet clover grows abundantly 
throughout eastern South Dakota but is usually very difficult to cure into a high 
quality roughage for fattening cattle.

The purpose of this experiment was to determine (1) the effects of sweet 
clover silage on fattening cattle, (2) the value of sweet clover silage in a fattening 
ration, and (3) the ability of sweet clover silage to furnish all or part of the pro-
tein needed to balance a shelled corn and alfalfa hay ration for fattening cattle.

The sweet clover was ensiled on July 2 and 3, 1945, when about 10 percent of 
the crop was in blossom. After cutting, it was allowed to wilt until the crop con-
tained approximately 65 percent moisture, the amount varying from 55 to 69 
percent. We added 160 pounds of ground ear corn to each ton of sweet clover 
silage. The sweet clover yielded 5.6 tons of ensilage per acre.

There was little difference between the moisture content of sweet clover silage 
and corn silage, but there was about twice as much protein in sweet clover silage.

Forty head of good to choice Hereford calves weighing about 464 pounds per 
head were divided in four uniform lots based on type, breeding, quality, source 
of origin, weight and other indications of probable outcome. They were started on 
feeding trial February 1, 1946.

Lot 1 was fed shelled corn, linseed oil meal and alfalfa hay. Lot 2 was fed 
shelled corn, linseed oil meal, corn silage and alfalfa hay. Lot 3 rations were
shelled corn, linseed meal, and sweet clover silage. Lot 4 was fed shelled corn, sweet clover silage and alfalfa hay. The sweet clover silage was palatable to the calves.

In comparing alfalfa hay to corn silage between Lots 1 and 2, 191 pounds of alfalfa hay is about equal to 447 pounds of corn silage. This would indicate a value for corn silage of about 42.7 percent on feed per cwt. gain as fed in this trial, compared to alfalfa hay.

In comparing Lots 1 and 3, the sweet clover silage is worth about 46 to 51 percent of alfalfa hay on feed per cwt. as fed in this trial.

Comparing the results of Lot 4 to Lots 1, 2, or 3, shows that limited feeding of sweet clover silage and alfalfa hay for rapidly fattening calves does not furnish enough protein to balance the ration. (Project No. 143. Leaders: Charles S. Hobbs and Lyle Hoyt, Animal Husbandry Department.)

**Stack Hay as Soon as it is Dry to Save Carotene (Vitamin A).** Determinations of carotene and moisture in native hay, mostly western wheatgrass, carried out during the past year have shown that the carotene is lost rather rapidly during the first few days after mowing. Over half of the carotene may be destroyed in the first three days after mowing, even though the hay is raked into a windrow at the time of mowing. The hay dried rapidly and was dry enough for stacking one day after it was mowed.

If the hay is stacked as soon as it is dry enough (20 percent moisture) a large part of the carotene loss can be avoided. After the hay is in the stack the loss of carotene is greatly reduced.

Studies on stacked hay revealed very little change in chemical composition in one year. Carotene and protein were retained very well with only negligible losses. The hay was, however, very low in carotene at the time it was stacked because it had remained in the windrow for about two weeks between mowing and stacking. The initial value for carotene was 12.42¢ per gram, and after one year in storage it was 12.00¢ per gram. Protein was 6.82 percent at the time of stacking, and was 6.28 percent after one year in the stack.

**Composition of Dehydrated Grasses.** Various dehydrated grasses were analyzed in connection with a study of their nutritive values as compared with dehydrated alfalfa for poultry rations. Feeding trials with poultry have been made using these dehydrated meals. (See Poultry Production, page ?)

**Non-protein Nitrogen Compounds in Western Wheatgrass.** Western wheatgrass was sampled at ten-day intervals on a plot between Volga and Arlington, South Dakota, for an investigation of the non-protein nitrogen constituents present at the various stages of growth.

Depending on stages of growth and environmental conditions, γ-amino nitrogen accounts for ten to 30 percent of the water-soluble nitrogen. Glutamine and asparagine amide nitrogen contribute three to four percent of the water-soluble nitrogen, asparagine predominating, while ammonium nitrogen makes up only one to one and one-half percent.

Soluble nitrogen precipitated by phosphotungstic acid varies between 40 to 60 percent. Nitrate nitrogen was present as 20 percent of the water-soluble nitrogen in the first sample harvested in 1945 but rapidly fell to about one percent. In 1946 nitrate was low at all sampling dates.

[25]
Fertilization of western wheat grass with either ammonium or nitrate nitrogen showed as its main effect an increase in "true" protein nitrogen. Nitrate nitrogen also increased with either form of nitrogen fertilizer; apparently ammonium nitrogen is rapidly oxidized to nitrate under the soil conditions existing at the time of fertilization.

The ratio of sucrose to glucose in western wheatgrass is about 3:1 in the spring and approaches 1:1 in midsummer. (Project No. 120. Leaders: A. L. Moxon, G. F. Gastler, E. I. Whitehead, Station Chemistry Department; C. S. Hobbs, Animal Husbandry Department; C. J. Franzke, Agronomy Department.)

**Dairy Production**

**Bovine Mastitis: Its Treatment and Prevention.** Mastitis can be controlled. During the past two years special attention has been given to the use of penicillin and to several herd practices which might help prevent mastitis outbreaks in the college dairy herd.

When this phase of work was started in May, 1945, more than half of the cows in the herd had records of mastitis at some time during the previous year. Some were mild, subclinical cases; others were serious. Because of this, milk production was much lower than it should have been. After two years of penicillin treatments, the adoption of herd practices that help prevent further spread of the disease, and the culling of hopeless cases, the general condition of the herd is improved and milk production has increased.

The average daily milk production per cow in the herd of four breeds during the months of April was: 1945, 22.85 pounds; 1946, 25.44 pounds; and 1947, 36.16 pounds. Other factors were partly responsible for this increase.

Cow No. 472 as she looked before freshening. After she freshened, she only milked five pounds a day.
The fact that comparatively few new cases were observed during the second year of this study is a further indication that mastitis can be controlled.

**Udder Damage Caused by Mastitis.** When cow 472 freshened just after her picture shown was taken, she milked only five pounds per day. In a previous lactation she had averaged 55 pounds of milk per day for the entire 365-day period. Before this freshening she developed a very large udder and appeared able to produce milk.

After a few weeks she was sent to the slaughter house and her udder was brought back for study. A dye solution was injected into the teat canal to show how much of the tissue that secretes milk was still connected by ducts to the teat. The white areas in the photographs of the two udder halves show milk-secreting tissue which was still normal, but could not function because there was no means of draining the milk produced. The same condition existed in one front quarter and almost all of the other. Even in the areas of the rear quarters which show staining there are large amounts of unstained tissue. Very few of the many secretory cells in the gland were connected by ducts with the teat canal. The pictures show that the most serious damage was in the lower part of the mammary gland where the main drainage ducts were destroyed.

Cross section of right and left halves of udder, through teats of udder, from cow No. 472 after injection of a stain through the teat canal. Stained portion shows tissue drained by open milk ducts. The white portions do not produce milk because the drainage to the teat canal has been blocked. Note that two quarters (right front and left front) produced practically no milk.

The next photograph shows the udder of cow 616. She was producing 40 pounds of milk per day when she was slaughtered, though she had a long history of abnormal milk production which injections of penicillin and good care had failed to cure. The left half took the stain almost uniformly, showing very little destruction of the ducts. The only unstained secretory tissue appeared in the upper right rear quarter. Since the infection could not be eliminated, with careless handling she could have spread the disease to other cows although her own producing ability had been only slightly impaired.

**Effects of Penicillin Treatments.** With few exceptions, the dosage used was 100,000 Oxford Units of penicillin dissolved in 100 ml. of sterile distilled water. This was infused by gravity into the infected quarter after it had been completely milked out. There were no adverse reactions following these treatments.
Penicillin was more effective for certain types of bacteria than for others. Much better results were obtained when the mastitis was caused by *Streptococcus agalactiae* than when it was caused by *staphylococci*. The severity of the infection, no matter what kind of organism was the cause, was an important factor in the effectiveness of treatments. In general, penicillin treatments were less effective on severe, chronic cases than on mild, subclinical cases.

Characteristics of chronic mastitis are: cell counts above one million per ml.; bacteria capable of causing mastitis can usually be grown in a culture; the milk appears abnormal (continuously or intermittently) in one way or another, such as stringy, flaky, thick, thin or off-color; the udder or quarters may show congestion.

In subclinical, or mild mastitis, cell counts are above one million per ml. and bacteriae capable of causing mastitis are present. The milk, however, has a normal appearance.

Cell counts above one million are common with cows late in lactation and following injuries. This was considered when the mastitis cases were classified. Results of penicillin treatments are given in the accompanying table.

During the two-year period in which these experiments were conducted, approximately 60 percent of the quarters cured of mastitis caused by *S. agalactiae* later showed reinfections of this organism. These infections occurred after an average time of six months for the chronic cases and ten months for the subclinical cases. Where the mastitis was caused by *staphylococci*, one of the three cases cured became reinfected two months later.

Following these reinfections of *S. agalactiae*, 30 treatments were given, 15 for chronic and 15 for subclinical cases. In each instance eight, or 53 percent, were cured and seven were not cured. In reinfections of *staphylococci*, only four cases were treated and none was cured.

Although penicillin treatments are not 100 percent effective, they have made it possible to keep 23 cows in this herd for periods of a few months to two years after they normally would have been sold. This has helped to maintain the quality of the herd, since 19 calves were obtained from these cows during this period.
Dairy Herd Practices Help to Control Mastitis. From November 28, 1945, to April 30, 1946, dairy cows of comparable quality were divided into two groups; 25 remained in stanchions in the main barn and 11 were placed in loafing sheds. Both groups were milked in the milking parlor by the same men. The main barn was not particularly good in some respects. The floor was not insulated, the ceiling rather high, stalls too small for the larger cows, and some of the cows were subject to cross drafts on windy days. In the loafing sheds or pen-type barn, the floors were warm due to an accumulation of manure and bedding, and the cows could move away from uncomfortable drafts of cold air.

During the winter season in which this experiment was conducted, 40 percent of the cows in the stanchions and 27.3 percent in the pens had attacks of mastitis severe enough to be observed on the daily strip cup test. These flare-ups occurred more often among the stanchioned cows.

Some cows with mastitis will show some improvement over a period of time and others, especially those with mild cases, recover naturally without treatment. Somewhat more improvement of chronic cases was observed among the cows in the pen type barn than with the group in stanchions. On the other hand, the pen barn group showed a slightly greater percentage of mild, subclinical cases of mastitis; bacteria capable of causing mastitis without other indications of infections were also found in a greater percentage of the quarters in this group. Although the numbers of cows in these trials are too small for definite conclusions, it does appear that the pen-type barn is an aid in overcoming a severe outbreak of mastitis.

Other herd practices which are believed to have helped in controlling mastitis in this herd are (1) fast and complete milking, (2) improved sanitation in the milking parlor by the use of individual paper towels for washing udders, (3) using an extra set of teat cups at each milking unit, thus permitting longer exposure of the cups to the disinfecting solution, (4) reducing drafty conditions in the barn, and (5) elimination of some of the causes of udder injuries.

Results of this study indicate a close relationship between environmental conditions and the ability of the cow to resist mastitis. The control of mastitis appears to depend largely upon the prevention of injuries and other conditions which weaken the natural resistance of the mammary gland to infections. Without these adequate preventative measures, penicillin can be of little permanent value.

(Project No. 134. Leaders: Philip L. Kelly, D.F. Breazeale and Emery Bartle, Dairy Department; G.S. Harshfield and A. B. Horlein, Veterinary Department.)

Growth Studies of Growing Calves and Heifers. So far this experiment has been limited to taking weights and measurements to get normal growth rates of calves and heifers in the college herd. These data are used often by dairy cattlemen to learn if their own cattle are growing at a normal rate. Figures of this nature are available for all breeds of cattle except Brown Swiss though the information has been obtained in other areas of the United States and may not be applicable to our conditions.

While this work will need another year of study before enough data is obtained for Brown Swiss and Holsteins, it is becoming increasingly evident that our Holsteins grow at a faster rate than the Missouri Growth Curves would indicate. Our soil has leached less than areas in the Eastern and Southern parts of the
United States and our crops carry more feeding value. Breeders in this area prefer larger cattle. The growth curves for cattle in our area may all need to be revised to meet these conditions. (Project No. 153. Leaders: Philip L. Kelly and Emory Bartle, Dairy Department.)

Poultry Production

Dehydrated Grass Meals in Poultry Rations. Feed cost is the largest single item of cost in poultry and egg production. The present high prices for grains and other feed ingredients make it imperative to search for economical and effective feeding materials and methods.

For many years we have known that alfalfa and alfalfa products are valuable sources of vitamins and minerals for poultry. These feedstuffs have been expensive with the great decrease of alfalfa grown in South Dakota since 1930.

During the past year feeding trials with chicks were conducted in which certain dehydrated grass meals were used to replace the alfalfa meal. Two feeding trials were conducted, using New Hampshire X Barred Plymouth Rock cross-bred chicks. Since these chicks can be sexed accurately by down color at hatching time, separate comparisons were made between males and females in each trial. The chicks were brooded in battery brooders in a basement room for eight weeks. Individual chick weights were taken at two-week intervals throughout the trials. The following basal ration was used.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Pounds or Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground yellow corn</td>
<td>38.5</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>15.0</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>15.0</td>
</tr>
<tr>
<td>Meat and bone scraps</td>
<td>5.0</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>15.0</td>
</tr>
<tr>
<td>Dried buttermilk</td>
<td>5.0</td>
</tr>
<tr>
<td>Salt mixture</td>
<td>0.5</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>1.0</td>
</tr>
<tr>
<td>&quot;Delsterol&quot;</td>
<td>30 grams</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>95.0</td>
</tr>
</tbody>
</table>

Alfalfa, brome, crested wheat grass and western wheat grass, all in dehydrated meal form, were used in each trial. In the first trial a brome-alfalfa mixture was also used, and in the second series sudan was used. All meals were added to the basal ration at the level of five percent of the total ration. Results of both trials are given in the following table.

No death losses occurred which could be attributed to the kind of meal being fed. Growth and feathering was good in all lots. It seems quite evident that these meals could be used as a substitute for alfalfa in the formulation of chick starting rations.

Grass Meals in the Breeding Ration. In order to test the effectiveness of grass meals in breeding and laying rations, four pens of White Plymouth Rocks—34 pullets and three males per pen—were placed on test January 28, 1947, and fed
Experimental rations for 24 weeks. Egg production and mortality were recorded. Three test hatches were conducted with eggs laid during this period. Eggs were set on February 27, April 3, and July 17. The following basal all-mash breeding ration was used.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground yellow corn</td>
<td>90.0</td>
</tr>
<tr>
<td>Ground oats</td>
<td>43.5</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>20.0</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>20.0</td>
</tr>
<tr>
<td>Meat and bone scraps</td>
<td>15.0</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>6.0</td>
</tr>
<tr>
<td>Fish oil concentrate</td>
<td>.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>195.0</td>
</tr>
</tbody>
</table>

Five pounds of alfalfa meal was added to the basal ration for the control pen. Additions to the basal rations for the other pens were brome, western wheatgrass, and sudan. Grit, oyster shells, and water were also provided. Artificial lights were used during the winter months.

These preliminary experiments with grass meals in laying and breeding rations for chickens indicate that perhaps any of the meals tested may be used as a substitute for alfalfa meal in the basal ration which was fed. Average egg production and hatchability was slightly in favor of the ration containing alfalfa, but the differences were small. Further study on this problem is needed.

**How Much Oats in Turkey Growing Rations?** In years when corn is high in price turkey growers ask how much oats can be fed to growing birds. To learn more about this problem a feeding trial using four lots of 12-week-old turkeys was carried out. There were 90 poults per lot. Each lot had access to rape range, grit, shell and water. The following mash rations were fed.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground yellow corn</td>
<td>145</td>
<td>95</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Ground oats</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>295</td>
</tr>
<tr>
<td>Meat and bone scraps</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Alfalfa meal</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Dried milk</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Salt mixture</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

A grain mixture of equal parts of shelled corn and oats was trough-fed throughout the period from 12-26 weeks of age. The consumption of grain during this period was about half the consumption of mash. The average weights of males and females at 26 weeks are shown.

Both sexes in Lot 4 showed a somewhat lower average weight than the birds on the other rations. It may be that they were getting about all the oats that they could use without a reduction in rate of growth. Feed efficiency was about the same for each lot. (Project No. 52. Leaders: William Kohlmeyer and Dean G. Jones, Poultry Department; A. L. Moxon, Station Chemistry Department.)
Influence of Feeding and Management Upon Hatchability of Turkey Eggs. Commercial hatcheries report that on the average they get much lower hatches from turkey eggs than from chicken eggs. This criticism is most often leveled at eggs from Broad Breasted Bronze turkeys which have become our most important commercial variety. These low hatches represent an important item in the costs of turkey production.

Four breeding pens of Broad Breasted Bronze turkeys were used to compare the influence of two different levels of alfalfa meal in the ration and to observe results obtained when dehydrated brome grass and sudan grass meals were substituted for alfalfa meal. The ration consisted of ground yellow corn, ground oats, wheat middlings, meat and bone scraps, soybean oil meal, dried buttermilk, ground limestone, salt mixture and fish oil concentrate. In addition, Pen 1 received 15 percent alfalfa meal; Pen 2, 15 percent brome meal; Pen 3, 15 percent sudan meal; and Pen 4, 7.5 percent alfalfa meal.

Grit, oyster shells, and water were supplied. Artificial lights were used starting January 1, 1947, for the toms and January 15, for the hens. Each pen was provided with a cobblestone yard.

There were 25 hens and two toms in each pen at the start of the experiment. The hens were trapnested and eggs were set once each week. Toms were rotated from pen to at weekly intervals.

Because of an outbreak of disease midway through the hatching season, the results are presented combining the first seven and the last nine hatches. The respiratory disorder undoubtedly affected the results for the latter part of the season. Percent hatch is based upon fertile eggs.

Pen 1, which received the high level of alfalfa meal, seemed to perform better than Pen 4, which received the lower level. Pen 2, which received the brome grass meal, and Pen 3, which was fed the ration containing sudan grass meal, did quite well until the onset of the respiratory disease.

We noticed that all three of the rations containing the 15 percent level of dehydrated meal were decidedly green in color and somewhat dusty. Since the infection also appeared in flocks receiving only half this level of meal, it seems improbable that there would be any connection between the level of meal fed and the appearance of the respiratory trouble.

Broody Hens Do Not Hatch Best. Recently it has been reported that turkey hens which become broody during the laying season show higher fertility and hatchability than non-broody hens. In order to study this, an analysis was made of the reproductive performance of 235 turkey hens that completed their first laying seasons in 1945 and 1946.

This study showed that hens that were broody and hens that "paused" or stopped laying for a time without showing any broodiness, were no better—and no worse—with respect to fertility and hatchability than hens showing no broody or no pause periods.

Either broodiness or pause, however, did have a marked tendency to reduce the number of eggs produced during the hatching season. (Project No. 96. Leaders: William Kohlmeyer and Dean G. Jones, Poultry Department; A. L. Moxon, Station Chemistry Department.)
Grain and Forage Sorghums and Proso Millet for Turkeys. There is some reason to believe that tom turkeys are more efficient at self-harvesting tall varieties of grain sorghum than are the hens. One group of females were put on plots of Day Milo October 1. Two similar groups were put on plots of Sooner Milo at the same time. Since unfavorable growing weather prevented the sorghum from maturing, no valid conclusions could be drawn.

There were no decided differences in rates of gain between the lots placed on the tall and short sorghums. It seemed evident that all lots depended upon their growing mash for their grain feed. (Project No. 79. Leaders: William Kohlmeyer and D. G. Jones, Poultry Department.)

Livestock Diseases and Poisoning

Effect of Selenium and Arsenic on Reproduction of Range Cattle. The work with cattle on the seleniferous Reed Ranch has continued. Twenty head of heifers which were raised on the ranch were bred this spring. One lot (10 head) of the heifers have had the arsenic-salt mixture containing 37.5 parts per million of arsenic since they were put on experiment in the spring of 1946. The other lot have had access to salt which does not contain arsenic.

These animals will be continued under these same conditions until they have calved to determine whether or not the amount of arsenic consumed in the salt might influence reproduction. Blood studies are being made on these heifers to determine the selenium content of the blood and to determine what effect the selenium and selenium with arsenic might have on levels of important blood constituents.

Since this spring, cattle have been brought to the Reed Ranch at two week intervals from Cottonwood, where there is no appreciable amount of selenium. The selenium content of the blood of these cattle is being determined at intervals, and observations will be made for the appearance of symptoms of selenium poisoning. This will determine whether or not the length of time an animal consumes seleniferous vegetation might influence the occurrence of selenium poisoning symptoms.

Hamsters as Experimental Animals for Selenium Toxicity Studies. In the laboratory, Syrian hamsters were used as experimental animals with seleniferous feeds to determine their usefullness as subjects for work on selenium toxicity. They are an ideal animal for experimental work with bulky diets. For this reason they might have been valuable in studies on the toxicity of selenium in grasses and forages, but unfortunately they are not especially sensitive to selenium and probably would be of little value in selenium studies.

The unusually large numbers of new cases of selenium poisoning on farms where it has not occurred before, or at least not for several years, emphasizes the importance of rainfall and soil moisture conditions to the selenium content of grasses and crops.

Combined Action of Arsenic and Proteins in Counteracting Selenium Toxicity. Arsenic will counteract selenium toxicity in rats. Ten parts per million (p.p.m.) of arsenic in the drinking water will counteract the toxicity of 15 p.p.m. selenium in the ration.
Linseed meal when fed as 25 percent of the ration will also prevent the toxic action of 15 p.p.m. selenium in the ration, although the growth of the rats is not as rapid as when they are fed a ration containing 25 percent of either tankage or dried beef liver without selenium. Neither tankage nor dried liver will prevent the toxic action of selenium, and if selenium is included in the ration the rats will develop typical liver damage. The inclusion of arsenic in the ration containing either tankage or dried liver will prevent this liver damage.

**Composition of Blood from Range Cattle.** Blood samples have been taken from 88 head of range cattle over a period of five years for calcium, phosphorus, hemoglobin, vitamin A, and carotene analysis. Forty head of these cattle were on experiment at the Reed Ranch in connection with selenium research. Blood samples were taken at 18 different dates over a period of four years. The other 48 head were on experiment at Cottonwood. They were sampled in early spring, midsummer, and early winter for four years. The data obtained will be of value in establishing normal blood values for range cattle in the Northern Great Plains. (Project No. 19. Leader: A. L. Moxon, Agricultural Chemistry Department; Animal Husbandry Department cooperating.)

**Nitrate Poisoning.** The amount of oxygen reaching the corn roots affects the accumulation of nitrate nitrogen in the tissues of the corn plants. Seedlings of South Dakota single cross 105 x 107 were grown in culture solutions at the greenhouse. Half of the culture jars were given mild aeration while the other half were not aerated. After nitrogen depletion, nitrate nitrogen was added to the culture solutions and the plants were harvested 24, 48, and 96 hours later. The plants were dried at 60 degrees C. in a forced-draft oven and analyzed for nitrates.

The plants in the aerated cultures showed steady accumulation of nitrate nitrogen in both root tissue and stalk tissue. Some increase in nitrate nitrogen occurred in sheath tissue, but there was no distinct change in the nitrate content of leaf tissue.

The non-aerated cultures produced plants which had accumulated little nitrate nitrogen. Earlier work with non-aerated culture had produced corn plants which accumulated some nitrate nitrogen at a more immature stage of growth. Corn plants may utilize some of the nitrate nitrogen in satisfying certain oxidative mechanisms. (Project No. 87. Leader: A. L. Moxon, Agricultural Chemistry Department.)

**Cornstalk Poisoning of Cattle.** Flint and dent corn were grown on plots at the North station farm as in previous years to furnish material for chemical studies and experimental cattle feeding. Samples were taken for analyses at two different sampling dates and data were obtained from these samples as well as for the series harvested during the summer of 1945.

Three head of cows were put into each plot of corn on December 26, 1946, and left in the plots until the ears and stalks were well utilized. No symptoms of cornstalk disease appeared.

Cattle losses due to cornstalk disease were reported to us from only one farm during the past year. Four head were lost but the losses stopped when the cattle were removed from the field and the corn was picked and fed in a dry lot.

Analyses made on the samples of corn harvested from plots on the North station farm showed the leaf tissues to be the highest in total nitrogen content. The
nitrogen content of leaf and sheath tissue was high early in the growing season but declined rapidly with advance in the growing season.

Water-soluble nitrogen (considered as percent of total nitrogen) remained high in stalk tissue throughout the season. A high proportion of water-soluble nitrogen in sheath tissue early in the season decreased to about one-third of that value at the time the ears were maturing. Leaf tissue had the lowest proportion of water-soluble nitrogen; late in the season about 15 percent of the total nitrogen was water-soluble.

Ammonium nitrogen was about twice as high (as percent of the water-soluble nitrogen) in leaf tissue as compared with other tissues of the corn plant. Even in the leaf, however, it represented only one to two percent of the total water-soluble nitrogen.

Glutamine and asparagine amide nitrogen were present in about equal amounts and constituted only a small portion of the water-soluble nitrogen fractions. The amides were found in least amount in leaves and are somewhat greater (about five percent) in stalks, tassels and immature ears.

γ-amino nitrogen constituted about 30 percent of the water-soluble nitrogen in leaf tissue early in the season but diminished to 20 percent with advance of the season. While the γ-amino nitrogen content of stalks was low, sheaths and immature ears contained relatively large amounts of this fraction.

A study of the effect of luxury consumption of nitrate nitrogen on corn seedlings (S. Dak. single cross 105 x 107 in water cultures) has been made. The experimental design is the same as used in previous study of luxury ammonium nutrition.

In general, the effect of luxury nitrate metabolism by the corn plant is reflected in changes in the constituent nitrogen fractions similar to those found during luxury ammonium consumption. At the 120 meq. nitrogen level after 12 days the total water-soluble nitrogen quadrupled for top or root issues, ammonium nitrogen tripled, and glutamine and asparagine approximately doubled, the latter amide dominating. The magnitude of γ-amino nitrogen increase approached that for similar ammonium-fed plants.

As with the field samples, sugar data are not complete and the effect of nitrate nitrogen metabolism upon sugars cannot be reported at this time.

A note is given in the 59th annual report of a possible clue to the cause of corn stalk poisoning. Dr. J. H. Standen of Boyce Thompson Institute for Plant Research has sent this laboratory seed of inbred No. 113 corn, the cobs of which possess a substance toxic to dry rot fungi and also to rats when administered in small amounts either orally or intraperitoneally. At present the plant pathology department is increasing the seed of this inbred so that it may be used in future studies. (Project No. 130. Leaders: A. L. Moxon and E. I. Whitehead, Station Chemistry Department; G. S. Harshfield, Veterinary Department; C. M. Nagel, Plant Pathology Department.)

Controlling Internal Parasites of Sheep. The seasonal fluctuation of worm infestations in range ewes and lambs was determined by counts of the parasite eggs in fecal samples collected at intervals throughout the year.

Six flocks of breeding ewes, all of which carried light worm infestations during the winter months, acquired moderate to serious infestations in the spring months
before going on summer range. There was, however, a decided drop in numbers of eggs when lambing was completed and the ewes given access to better range. Another rise in egg numbers occurred in both ewes and their lambs during the summer, reaching a peak in late July and August. No anthelmintic treatments were given.

Another flock of 160 ewes and their lambs was maintained under a controlled grazing system. The range was stocked at the rate of six acres per ewe and lamb and the flock rotated every six days. A 30-day rest period was allowed for grazed areas before using them again. Although the worm infestation in this flock never became serious, a similar seasonal curve occurred.

In field trials covering a ten week period, two groups of 47 and 48 lambs on range were treated July 17 and August 14, respectively, with lead arsenate for tapeworm control. The treated lambs gained an average of almost one pound more than the lambs of a third group of 50 in the same flock left untreated. A marked reduction in numbers of lambs shedding tapeworm eggs followed treatment, but reinfestation occurred by the close of the trials on September 25. No scouring was noted in any of the lambs.

"Cunic" treatment of feeder lambs at the start of the feeding period has not proven effective in reducing liver condemnations at slaughter due to fringed tapeworms in the bile ducts. The total liver condemnations in 454 feeder lambs at slaughter was 23.8 percent. 231 of the lambs had been treated with "cunic" drench (1.5 percent copper sulfate, one percent commercial nicotine sulfate 40 percent) on entering the feedlot November 6, 1946. The liver condemnation in the treated group was 22.5 percent compared to 25.1 percent in the untreated. (Project 139. Leaders: G. S. Harshfield, Veterinary Department; F. N. Carlson, South Dakota Livestock Sanitary Board; Animal Husbandry Department, Zoological Division of the U. S. Bureau of Animal Industry, and U. S. Bureau of Plant Industry cooperating.)

Control of Fowl Cholera. Forty-eight outbreaks of fowl cholera were diagnosed in the laboratory in 1946 compared to 28 in 1945. Outbreaks have been most numerous during early fall months and lowest in early spring. The housing of young with old birds, some of which are carriers, probably accounts for this seasonal incidence. The close similarity of symptoms of subacute fowl cholera and Newcastle disease has required the use of bacteriological and serum-Newcastle disease virus neutralization in differential diagnosis of the two diseases.

Almost all field strains of Pasteurella multocida used in the preparation of plate antigens show the tendency to spontaneous agglutination in the testing of chicken blood samples. The agglutination test has not proven satisfactory for identifying fowl cholera carriers in poultry flocks. (Project 141. Leaders: J. B. Taylor, and G. S. Harshfield, Veterinary Department; Poultry Department cooperating.)

Sporadic Bovine Encephalitis. A new disease of cattle characterized by generalized peritonitis and an inflammation of the brain has been found in three herds. Several animals in each herd sickened, with up to 50 percent of those affected dying. Preliminary studies indicate that the disease is due to a virus. Guinea pigs are susceptible on inoculation. (Project 171. Leaders: G. S. Harshfield, and Carl Rehfeld, Veterinary Department.)
Newcastle Disease of Poultry. Newcastle disease has been diagnosed by laboratory tests in 41 of the 48 states since its recognition in the United States in 1944. The Animal Health Laboratory has identified the disease in 18 flocks in 12 counties of South Dakota either by serum neutralization or by virus isolation. Deaths in flocks have ranged from less than five percent to over 80 percent. Heaviest losses have occurred in chicks less than a month old. (Project No. 170. Leaders: G. S. Harshfield and Carl Rehfeld, Veterinary Department.)

Control of Selenium Poisoning in Poultry. Earlier work at this station has shown that turkey egg hatchability was affected very little when a ration containing six parts per million of selenium was fed to turkey breeders for a 30-day period during the main part of the laying season. This year a similar trial was conducted, using a higher selenium level.

Two pens of Broad Breasted Bronze turkey breeding hens were used. Both pens were kept in outdoor lots during the winter and spring, and were provided with roosting shelters enclosed on three sides. Individual hen records were kept of egg production, fertility and hatchability.

Pen 7 consisted of 12 hens and one tom. This pen received an all-mash ration containing about 9.5 parts per million of selenium during the month of April. During the rest of the season Pen 7 was fed the control ration.

Pen 8 consisted of 25 hens and two toms, and was used as the control pen. These birds were fed the standard all-mash breeder ration throughout the season. Toms were not rotated nor were artificial lights used. Eggs were gathered several times daily, stored in a basement room and set once a week. The table gives the egg production, fertility and hatchability by weeks for the two pens. The percent hatchability is based upon fertile eggs.

<table>
<thead>
<tr>
<th>Hatch No.</th>
<th>Eggs Set</th>
<th>Pen 7</th>
<th>Pen 8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>Hatch No.</td>
<td>Eggs Set</td>
<td>Hatch</td>
<td>Eggs Set</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>100</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>60</td>
<td>76</td>
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<tr>
<td>5</td>
<td>49</td>
<td>38</td>
<td>110</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td>67</td>
<td>115</td>
</tr>
<tr>
<td>7</td>
<td>59</td>
<td>52</td>
<td>106</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
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</tr>
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<td>9</td>
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<tr>
<td>10</td>
<td>57</td>
<td>70</td>
<td>97</td>
</tr>
<tr>
<td>11</td>
<td>61</td>
<td>61</td>
<td>118</td>
</tr>
<tr>
<td>12</td>
<td>57</td>
<td>53</td>
<td>102</td>
</tr>
<tr>
<td>13</td>
<td>63</td>
<td>51</td>
<td>103</td>
</tr>
<tr>
<td>14</td>
<td>56</td>
<td>59</td>
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</tr>
<tr>
<td>15</td>
<td>42</td>
<td>65</td>
<td>85</td>
</tr>
<tr>
<td>16</td>
<td>52</td>
<td>63</td>
<td>90</td>
</tr>
<tr>
<td>Total or</td>
<td></td>
<td>720</td>
<td>1324</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>58</td>
<td>58</td>
</tr>
</tbody>
</table>

Average Eggs per hen: Pen 7—60; Pen 8—53.

[37]
Malformed embryos resulting from selenium poisoning. Note the absence of an eye on the poult at left and the extra set of legs on the poult at the right.

Eggs set from Pen 7 for hatches 6 to 9 were laid during April when the selenium was being fed. Fertility in Pen 7 was poor early in the season, so a substitute tom was used after mid-April. Hatchability of fertile eggs from this pen was rather poor throughout the season. The poults obtained from the seventh, eighth and ninth hatches, however, showed a wiry, sparse down similar to that ascribed to selenium poisoning in chickens.

Examination of fertile eggs which failed to hatch showed that three different hens were responsible for malformed embryos in hatch No. 8. These abnormalities included shortened beaks, the absence of one eye, and additional sets of legs or wings. Neither abnormal down nor such structural malformations were encountered in the poults from the control pen. Egg production in each pen was good.

It appears that breeding turkeys may be able to tolerate a higher level of selenium than breeding chickens. Evidently the selenium level used this year—9.5 parts per million—is high enough to show rather definite effects in the poults hatched, but is not high enough to greatly affect the percentage hatch of fertile eggs.

Eggs laid only three or four days after the normal ration had replaced the selenium ration hatched apparently normal poults. Chemical analysis of infertile eggs showed a sharp decline in selenium content of the albumin after the birds were returned to the control ration. (Project No. 28. Leaders: William Kohlmeyer, Poultry Department; A. L. Moxon, Station Chemistry Department.)
Farm Engineering

Storing Sorghum Grains. In the 1946 crop season, there was not a large acreage of grain sorghum planted; nor did the ripening season produce marked problems with wet grain. Grain sorghum seed from the 1945 crop year was carried over for test purposes. These samples were tested on the small load sized dryers. Results of former years were duplicated on cold air tests. In addition, the heater-drier was compared to the cold air methods.

In mid-summer weather, sorghum grain can be dried with cold air from 20 percent moisture content down to 12 percent in five or six days. Former tests show that this could not be done in the spring months when the temperature is lower and relative humidity is higher.

By use of the blower and heat applied with a weed burner torch, the same drying can be done in one day if high heats are used. When heats of 110 degrees F. or less are used, between two and three days are required. The small dryers gave an air passage through the grain of less than 24 inches, yet the grain next to the in-coming warm air dried first. Grain farthest from the in-coming air may become damp and warm and mold before it becomes dry.

The studies of the Hygroscopic properties of grain sorghum seed were completed by the Experiment Station Chemistry Department. A paper summarizing this study was presented at the South Dakota Academy of Science by E. I. Whitehead and G. F. Gastler of the Chemistry Department. (Project No. 114. Leader: H. H. DeLong, Agricultural Engineering Department.)

New Hay-Harvesting Machines. Cost of operation figures were recorded for the field pick-up baler for the second year. Data such as speed of work, weight of bales, weight of load, number of untied bales, time of unloading, moisture of bales, and distance and time of load were recorded.

Running a complete outfit of baling, hauling, and unloading crews and equipment cost $66.57 for a six-hour day. This was based on current wages and included depreciation, interest, repairs and fuel. An average six-hour day resulted in 12 two-ton loads of bales delivered to the barn. This is a cost of $2.78 per ton, not counting the mowing and raking necessary for any haying procedure. Only part time wages were charged for the hauling crews who did considerable chore work each day.

Actual baling rate is three bales per minute when no stops or wagon changing is considered. (Wagons were trailed behind the baler for direct loading). Considering stops and wagon changing, a two-ton load is baled in 30 minutes or less.

By delivering the bales to the field, the pick-up baler, tractor, and one operator alone would operate for $33.52 per day and bale slightly more than the complete outfit. This cost per ton would be $1.40.

The field baler and its accompanying tractor, three or four wagons, loaders, haulers, and unloaders, make an outfit of high first cost and large labor crew. Probably only large operators can have this equipment for individual farm use. The small operator can get his field baling done by the custom operator and do the hauling with a smaller crew, though at some added cost in labor. This method means running greater risks from weather, due to the fact that bales will lay on
the field for short periods. (Project No. 136. Leader: H. H. DeLong, Agricultural Engineering Department.)

**Storage of High Moisture Corn.** Six cribs of soft corn from the 1945 crop, with beginning moisture contents of 27 to 38 percent, were carried through to July 12, 1946. By this time, the moisture contents had reached 14 to 16 percent. The crib which gave best results was eight feet wide with a wood floor, wood roof, and an eight-inch ventilator flue running its entire length and placed in the center of the crib. This flue extended from the floor up to within two feet of the top of the corn.

Corn from the 1945 crop had definite limitations for experimental work, in that when cribbed it showed considerable molding and damage from field deterioration. Cribbs with floors and roofs again proved to be better storage structures than cribs without floors or roofs.

Individual ear moisture tests were run on September 18, October 4, October 22, and November 5. Early in the season some ears showed kernel moisture of 50 percent and cob moisture of 60 percent. When corn harvest was well underway some individual ears had moisture contents of 14 percent and others from the same field, 38 percent. Such a variation creates real problems in the storage of corn.

Ventilator fans made from old silo fillers, shredders, blowers, etc., are usable for drier installations, but not very efficient as to the power applied. Fans built for the exact purpose are more desirable. For a small drying unit, a $25 weed burning torch produces plenty of heat but needs considerable attention. (Project No. 152. Leader: H. H. DeLong, Agricultural Engineering.)

**Hard Surfaced Floors.** A number of low cost hard-surfaced floors have been constructed both for indoor and outdoor locations. There seems to be more materials that can be used for indoor floors than for outdoor locations. Soil cement, zonalite cement, oiled adobe and some of the tar oiled products are satisfactory for indoor floors as proven by five or six years of use in poultry houses at the local station.

Soil cement floors are proving satisfactory in some locations. They are entirely satisfactory for poultry houses. Floors placed indoors in beef cattle barns in 1942 are in good condition but have been patched in some spots. Soil cement has not been usable for outdoor floors yet, but different treatments are being tested which may make it satisfactory. An elastic cement made from Portland cement, sand, and an asphalt derivative have been placed on old wood floors to prolong their life. After one year's time it is in perfect condition. However, it has not been subjected to heavy wear.

A series of small test floors on outdoor locations have been built. These floors are serving as experimental patterns for livestock feeding floors to be built later in larger panels. The larger floors will be placed in the feeding lots for beef steers.

Two floors were made from concrete building blocks laid on their side, one floor with mortared joints and one without. Another floor has been constructed of concrete stepping stone blocks. These are concrete blocks 16 inches square and three and one-half inches thick made by concrete block manufacturers. They are ordinarily used to construct semi-permanent sidewalks and drives.
Another floor was made by using a rototiller to mix the sand, cement and water on the floor location, rather than to run all of the mix through the conventional concrete mixer. The sand and cement are placed in the forms as directly as possible from the truck. The tiller is then run back and forth as water is added through a hose and sprinkling can. Observations of this small trial floor indicate that this method saves considerable labor. The quality and strength of the resulting concrete must be thoroughly tested before such a method can be recommended.

A fifth floor was made from conventional soil cement, mixed by the rototiller and then rammed with the pneumatic air hammer. Another was made by putting an eight-inch tamped base of rock, two inches to four inches in diameter, under a one-and-one-half inch layer of concrete.

All six floors will be subjected to weathering, freezing, load tests, shock tests, and abrasion tests during the coming year. These trials will supplement the tests of the larger floors on which the beef steers will be quartered. (Project No. 83. Leader: J. L. Wiersma, Agricultural Engineering Department.)

Septic Tanks and Cistern Construction of Concrete Silo Staves. A new experiment was started to find ways of reducing the cost and time of construction of septic tanks and cisterns. Concrete silo staves are used for the side walls. Tests are being made to determine whether they have the required strength and durability. Tests are also being made of various commercial waterproofing products to determine which is best adapted to cisterns and septic tanks.

The project was begun late in the year, and to date one septic tank and one cistern have been constructed. The septic tank is on a farm location east of Brookings and, while nearly complete, has not been put into actual operation. The cistern is located at the Agricultural Engineering building at the Experiment Station. During the coming year several additional structures will be built and tested.

The construction procedure is very similar to the method used in building a concrete stave silo. A cement floor is first poured and cured. On this floor the cement staves are placed. Bands spaced at regular intervals hold the structure together. An additional one-inch floor is poured inside the tank after the staves are in place, and at the same time the interior surface is plastered with a mortar of screened sand and cement.

The cistern is now in use and works satisfactorily, although some trouble was experienced in waterproofing the structure due to small cracks that developed on the plaster coating. These were stopped up with asphalt paint. (Project No. 165. Leader: N. B. Anderson, Agricultural Engineering Department.)

Farm Income and Community Welfare

Efficient Farming Pays Off. A farm management study of a group of North Central South Dakota farms in 1946 indicates the importance of over-all efficiency. The following six factors were studied: (1) size of business; (2) labor efficiency; (3) crop yields; (4) crop selection; (5) amount of livestock; and (6) livestock feeding efficiency.
Farmers who excelled in five of the management factors earned seven times as much as the farmers who were above average in only one of these factors. The table shows the relationship of efficient management to earnings.

The most efficient group of farmers had twice as large farm businesses, accomplished 55 percent more work per worker, averaged 30 percent larger yields, and received 30 percent greater livestock returns per $100 of feed fed than did the least efficient group of farmers.

Size of farm business was one of the most important factors affecting earnings. The 47 North Central area farms were divided into three groups on the basis of size of business. The upper 25 percent of the farms averaged $13,289 operator’s labor earnings, compared to $3,846 for the farms with the smallest size

<table>
<thead>
<tr>
<th>Number of factors above average</th>
<th>Number of farms</th>
<th>Average operator’s labor earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—1</td>
<td>10</td>
<td>$2,122</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>$5,691</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>$7,694</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>$9,710</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>$15,984</td>
</tr>
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</table>

### Relationship of Number of Factors Above Average to Farm Earnings
North Central South Dakota, 1946

### Size of Business Related to Earnings, Farm Organization and Efficiency in Operation

<table>
<thead>
<tr>
<th>Item</th>
<th>upper 25% of farms</th>
<th>middle 50% of farms</th>
<th>lower 25% of farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Farms</td>
<td>12</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>Operator’s Labor Earnings</td>
<td>$13,289</td>
<td>$6,256</td>
<td>$3,846</td>
</tr>
<tr>
<td>Size of Business</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total work units</td>
<td>1,082</td>
<td>616</td>
<td>396</td>
</tr>
<tr>
<td>Number of workers</td>
<td>2.5</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Labor Efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop acres per worker</td>
<td>375</td>
<td>259</td>
<td>178</td>
</tr>
<tr>
<td>Animal units per worker</td>
<td>52</td>
<td>39</td>
<td>31</td>
</tr>
<tr>
<td>Livestock increase per worker</td>
<td>$6,042</td>
<td>$4,968</td>
<td>$4,518</td>
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<tr>
<td>Crop Organization and Efficiency</td>
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</tr>
<tr>
<td>Number of crop acres</td>
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<td>437</td>
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<tr>
<td>Crop yield index</td>
<td>106</td>
<td>100</td>
<td>96</td>
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<tr>
<td>Crop selection index</td>
<td>104</td>
<td>99</td>
<td>98</td>
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<tr>
<td>Power and Machinery Efficiency</td>
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<tr>
<td>Investment per crop acre</td>
<td>$7.95</td>
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<td>$10.56</td>
</tr>
<tr>
<td>Livestock Organization and Efficiency</td>
<td></td>
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</tr>
<tr>
<td>Number of animal units</td>
<td>122</td>
<td>66</td>
<td>48</td>
</tr>
<tr>
<td>Percent roughage consuming</td>
<td>86</td>
<td>80</td>
<td>73</td>
</tr>
<tr>
<td>Percent concentrate consuming</td>
<td>14</td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>Livestock returns per $100 feed</td>
<td>$151</td>
<td>$178</td>
<td>$209</td>
</tr>
</tbody>
</table>
of business. The largest farm averaged one more worker per farm and accomplished more work per worker.

The larger farms ranked higher in crop yields and in the selection of high return crops. The larger farms also had the advantage in lower power and machinery investments per crop acre. The farmers with the largest size of business produced more livestock, a higher percent of which were roughage consuming such as beef cattle and sheep. The small farms had a $41 advantage in livestock returns per $100 of feed fed.

It would appear from this study that the larger farm has the advantage in most of the farm organization and efficiency factors studied. This may be partly due to the operation of the larger size farms by the superior managers. (Project 137. Leader: C. R. Hoglund, Agricultural Economics Department.)

Farm Lease Agreements for Beginning Farmers. The large amount of money needed and scarcity of farms for rent make it extremely hard for many young men to start farming on their own. The total investment in a full-time farm or ranch averages about $30,000. Development of farm business agreements between fathers and sons or between non-related parties is one of the most encouraging methods of starting farming.

A lease study in 20 selected counties of South Dakota reveals the use of several types of business agreements. These range from deals in which the son gets a share in a few acres of crops or from livestock to those in which a father and son or two non-related parties share equally in the farm business.

The proportion of production resources contributed by junior and senior members should form the basis for a division of farm receipts and expenses. Three farm business plans have been developed which provide for a beginning farmer to (1) provide only his own labor, (2) furnish half the labor, power and machinery and one-third of the productive livestock, and (3) provide all the labor, power and machinery and half of the productive livestock. Under plans one and two, the junior member would receive one-third, and the senior members two-thirds, of the receipts. Plan three is a 50-50 share arrangement. The suggested division of income and expenses under the three plans are shown in the accompanying table.

A major factor contributing to the success of a father-son or other farm business agreement is a farm large enough to support both families. (Project 147. Leader: C. R. Hoglund, Agricultural Economics Department.)

Farming Adjustment Study Continued. Extremely good climatic conditions and high prices for crops in recent years have tended to over-emphasize the importance of cash grain production at the expense of tame hay and permanent grass. Although the tame hay acreage has been increased during 1946 and 1947, it is still only 50 percent of the 1924-33 pre-drought period. The plowing up of a considerable acreage of grassland in many central and western South Dakota counties may add up to several hundred thousand acres.

A study of crop adaptations in the various areas of the state shows the limitations of flax as a dependable crop in several areas of South Dakota. During the 20-year period 1926-45 a yearly average of only 62.4 percent of the state flax acreage planted was harvested. The percent of spring wheat harvested for the same period averaged 81.5. In the range area during this same period, an average of only 44.1 percent of the flax acreage was harvested compared with 70.6 percent of

[43]
the spring wheat acreage. On the other hand, flax averaged almost as high as spring wheat in the Northeastern and Southeastern areas of the state. (Project 150. Leader: C. R. Hoglund, Agricultural Economics Department.)

<table>
<thead>
<tr>
<th>Area</th>
<th>Spring Wheat (percent)</th>
<th>Flax (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>81.5</td>
<td>62.4</td>
</tr>
<tr>
<td>1 Black Hills</td>
<td>85.5</td>
<td>53.6</td>
</tr>
<tr>
<td>2 Range</td>
<td>70.6</td>
<td>44.1</td>
</tr>
<tr>
<td>3 North Central</td>
<td>73.8</td>
<td>53.5</td>
</tr>
<tr>
<td>4 North James</td>
<td>81.9</td>
<td>68.1</td>
</tr>
<tr>
<td>5 Northeastern</td>
<td>86.9</td>
<td>81.0</td>
</tr>
<tr>
<td>6 South Central</td>
<td>78.3</td>
<td>51.9</td>
</tr>
<tr>
<td>7 South James</td>
<td>84.9</td>
<td>65.2</td>
</tr>
<tr>
<td>8 Southeastern</td>
<td>90.2</td>
<td>84.1</td>
</tr>
</tbody>
</table>

Selling Slaughter Lambs by Carcass Grade and Weight. A study is being made to determine whether it is desirable and practical to market slaughter lambs on a carcass grade and weight basis. The significant questions to be answered are: (1) How accurately does the present method of marketing lambs pay the producer the difference in value the packer places on different shipments of lambs? (2) Would a system of sale by carcass grade and weight more accurately reflect these differences in value of slaughter lambs to producers? (3) What are the economic and physical problems involved in marketing slaughter lambs by carcass weight and grade and how can these problems be solved?

The uncertainty of prices during a large part of the past year and lighter receipts of lambs at the markets limited the amount of work that could be done. Information was obtained on 12 lots comprising 518 lambs. However, further study is needed before the questions outlined above can be answered.

One of the practical problems that has been encountered is that of maintaining identity of the lambs from time of receipt at the market through the slaughtering process. Two methods have been tried, but neither has been too satisfactory.

This study will be continued and results should be much more complete next year. (Project 156. Leaders: D. G. Paterson, Agricultural Economics Department, and J. W. Cole, Animal Husbandry Department.)

Farm Finances Good so Far. What of the Future? Farm mortgage foreclosures have been declining for 14 years. During 1946 only 36 foreclosures on 8,448 acres were made. This is only two percent of the 1921-46 average. During and immediately after World War I the farm mortgage debt rose rapidly. During the recent war inflation period the farm mortgage debt declined until January 1, 1947. More recent reports indicate that it may be rising again.

The value of farm and ranch land ultimately is founded on expected future income. Estimates of future income from land, however, must be based on past production and prices. Data on land prices and values indicate that farmers have
more knowledge of the productivity and relative value of the lands in different production areas of the state. Thus, in 1910 the average census value per acre in the range area was 21.4 percent of the value of land in the southeastern area. According to the last census report, however, the average value per acre of the range area land was only seven percent of that in the southeastern area.

Continued rise in land prices is indicated by data from four counties selected as representative areas of South Dakota (1942 prices = 100 on index).

<table>
<thead>
<tr>
<th></th>
<th>First Quarter 1947 Prices</th>
<th>1946 Average Price indexes</th>
<th>Normal annual precipitation in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>$94.41</td>
<td>175</td>
<td>167</td>
</tr>
<tr>
<td>Brookings</td>
<td>60.37</td>
<td>178</td>
<td>148</td>
</tr>
<tr>
<td>Brown</td>
<td>30.23</td>
<td>196</td>
<td>169</td>
</tr>
<tr>
<td>Haakon</td>
<td>6.06</td>
<td>257</td>
<td>178</td>
</tr>
</tbody>
</table>

Credit agencies and agricultural leaders are expressing concern over the land price inflation, and are warning farmers against increasing their indebtedness by land speculation. Farmers and ranchers should reduce their debts and built up reserves now while income is good. (Project 157. Leader: Gabriel Lundy, Agricultural Economics Department; U. S. Bureau of Agricultural Economics cooperating.)

Public School Studies Continued. For several years the Rural Sociology department has made various research studies pertaining to the public school situation in South Dakota. Because of the far reaching implications of the long-term trends in this field, it has seemed wise to continue studies along this line until some corrective action could be taken by the citizens and educational agencies of South Dakota.

Detailed surveys have been made of school conditions in every county of South Dakota and later brought together into an integrated review for the state as a whole. A series of four mimeographed pamphlets have been issued and sent out to local administrative school units of the state. Two successive school district atlases have been issued, setting forth the changing situation in each county, with special reference to closed school movements. These included maps showing where the pupils from these closed schools now attend as tuition pupils.

Since proposals for corrective legislation were drawn up by the state commission appointed to study the high school aspects of public school conditions in the state, some gains have been made. The basic problem of school district reorganization, however, was not acted upon. Most of the school district boundaries have not been changed since they were first established.

During this period of some 60 years, far reaching social and economic changes have occurred, such as improvements in transportation facilities, methods of farming, and in industry. It is difficult to estimate the significance of the introduction of the automobile, bus, tractor, truck, airplane, telephone, radio and electric lights. During this same period there have been drastic changes in the redistribution of our population and in the increase or decrease of assessed valuation of property. All these changes have directly affected the number of children in the
school census and in school enrollments. When the state was first established, the population was largely rural, but today South Dakota has more people living in the villages, towns, and cities than in the open country.

School patrons and school agencies are now waking up to the fact that patchwork school legislation education has not solved our basic problems. With this in mind these same school agencies are now preparing the groundwork for some satisfactory plan for modernizing school district organization, so as to better meet present day and future educational needs for the children of the state.

A re-study of the general situation as of 1946-47 revealed the following facts.

School Census. While the rate of decline in school children from 6 to 21 years of age has slowed down somewhat, the downward trend continues, especially in the country school districts. This trend started in 1931 with the decline of population. Since 1930, South Dakota has lost approximately 125,000 people. The numbers of youth from 6 to 21, however, has declined somewhat faster than the population as a whole. This is largely due to the fact that families or individuals leaving the state were of child bearing age. A disproportionately larger number of people past 50 years of age have remained in the state. This is clearly reflected in the increased number of people receiving old age assistance.

School Enrollment. A decline in school enrollment has naturally paralleled a decline in the school census since 1931. This is shown in all 12 grades of the public school system, although there may be a temporary rise of enrollment in the lower grades in the near future. Under South Dakota conditions, however, this is not so likely to affect rural schools, as farms in most areas of the state are still growing larger. This naturally means a decrease in the number of farm people.

School Tax Base Continues at Low Level. During the year a temporary movement was started to raise the assessed valuations of property in various counties. While this movement was successful in some counties, it was not made state wide. It was then necessary for the state legislature to pass a law permitting school districts to raise their maximum levies for the biennium in order to avoid further indebtedness.

School Costs Soar. The chief reason for recent financial distress of South Dakota school districts has been the greatly increased costs of school operations. Practically every item of school expenditure has been raised drastically.

Closed School Movement Continues. For the past 29 years an average of 70 rural schools have closed annually. The school year of 1946-47 has been no exception. It is likely that this trend will continue as long as such wide differences in resources exist within the state. Declining school enrollments, inadequate finances, and an unequal distribution of school tax burdens are the three main causes for schools closing. The present high school costs have merely made the situation worse.

There are still 936 rural schools in the state with enrollments of six or fewer pupils. In addition to the closing of common schools, a similar problem exists among the small high schools of the state. Since 1918, 228 rural schools have discontinued their two-year course, 26 have dropped their three-year course, while 53 small high schools have dropped the operation of their four-year course.

Increase in Tuition Students. This trend naturally follows in the train of closed schools. When local rural schools close there are usually a few pupils re-
maining. These students have to be taken care of by some adjoining district so that they might receive the rest of their education. This past year rural schools sent in a total of 12,307 high school tuition students to town independent or consolidated high schools. Most of these farm boys and girls did not live in town, but went back and forth from their homes each day. It was natural, therefore, that when the home rural school closed, that their younger brothers and sisters would attend the grades as tuition pupils in the same town school system.

Returns from 175 town schools indicate that the number of grade tuition pupils has increased by 30 percent during the current year. This represents a 62 percent sample of all the present town schools in South Dakota having four-year high schools. At present it appears that approximately 4,000 rural school children were attending town grade schools as tuition students in 1946-47. There are approximately one-third as many grade school children attending town schools as tuition students as there are high school tuition students. This is a very significant trend, and indicates that it is only a matter of time before some satisfactory redistricting must take place within the state.

*Community School Attendance Areas Growing in Importance.* There are now 282 four year school districts in South Dakota offering 12 years of public school work. The bulk of high school and grade school tuition students are being sent to these 282 public schools. In addition, there are a number of parochial, private and special government high schools which also offer both grade and high school work.

*Rural Districts Operating no School.* Another significant trend for the year has been the rapid increase in the number of rural districts operating no school of their own. While the returns are not yet complete, our findings show that 677 districts operate no school. Most of these districts are among those which have traditionally operated as one school district. These same districts still retain their legal status as such, but send their children elsewhere to be educated. While there are exceptions, most of these districts find it necessary to make only a small educational tax levy. With only a few pupils to educate, they have found it much cheaper to transport the students and pay tuition than to keep their own school open.

*Transportation Law Liberalized.* During this past 1947 legislative session, a school transportation measure was passed making it easier for rural districts to send tuition pupils to community attendance areas. Any district may now own and operate a school bus for transporting pupils. This should make it easier for rural schools to close, and transport their remaining pupils if their enrollment is unduly low. Spot studies indicate that when a local school has less than 12 pupils, it is usually cheaper to close the local school and send their children elsewhere as tuition pupils.

*Urgent Need for District Reorganization.* Practically all long term trends indicate that the time is now ripe for some form of district reorganization that is satisfactory to both country and town schools. One thing has become certain. South Dakota cannot afford to run two parallel systems of public schools, one for rural children and a second for those living in town.

Some plan must eventually be arrived at for blending all social institutional services on a community wide basis, similar to what has been done in the fields of health and recreation. The church and school are still in a transition state.
Home Economics

Serviceability of Wool Blends. The serviceability of fabrics made from various blends of re-used wool is being studied. Five pieces of flannel were made which contain 100, 75, 50, 25, and 0 percent of new wool blended with re-used wool.

These fabrics were made into skirts which are being worn by girls attending South Dakota State College. The garments are worn 200 hours and then dry cleaned and checked. After 1,000 hours of wear, three skirts of each fabric were withdrawn from service, cut into samples and tested in the laboratory along with swatches of the same materials which had been dry cleaned an equal number of times.

A similar group of skirts has been removed from service after 2,000 hours of wear and are being sampled. These will be tested in the laboratory along with swatches of the new materials which were dry cleaned ten times. A few skirts remain in service to be worn 3,000 and 4,000 hours. Lengths of these fabrics are being dry cleaned to correspond with the treatment of the worn materials. (Project No. 140. Leader: Lillian Lund, Home Economics Division.)

Substations

Soil, climatic conditions and topography, and thus the type of farming and ranching done, vary greatly in the different areas of South Dakota. It is necessary, therefore, that agricultural research be done throughout the state if the work of the Experiment Station is to benefit all South Dakota. Located in these various agricultural areas of the state are substations, where experiment workers carry on research in the problems confronting the farmer and the livestock man.

Range Field Station, Cottonwood

Hay Yield Tests. Yields of hay from native grass for one-fourth-acre plots were as follows: (1) cut every year, 1029 pounds per acre; (2) cut every two years, 913 pounds per acre; and (3) cut every three years, 717 pounds per acre.

Good quality hay was obtained on plots cut every year and once every two years, but that cut every three years had a lot of old growth.

New crop varieties. Several hundred new strains of wheat, oats, barley and soybeans were grown and appraised for their adaptability.

Wintering, Summer Grazing, and Breeding of Range Beef Cows for Calf Production. Four lots of cows with nine cows per lot were given the following winter rations for the 1946-47 winter feeding period at Reed’s Ranch.

Lot 1: A 60-acre winter pasture plus stacked hay moved from 25 acres of the pasture on July 12, 1946.

Lot 2: A 60-acre winter pasture plus windrowed hay, windrowed from 25 acres of the pasture on July 12, 1946.

Lot 3: A 60-acre winter pasture plus one pound per head daily of 20 percent protein cube (farm grains and soybean oil meal).

Lot 4: A 60-acre winter pasture plus one pound of a soybean oil meal cube per head daily after January 21, 1947.
Considering the January 7 weights as the beginning, and April 16 weights as the ending of the period, the average loss in weights per cow, with calf weight added in, are as follows: Lot 1 lost an average of 37 pounds per cow. Lot 2, 69 pounds per cow; Lot 3, 71 pounds per cow; and Lot 4, 47 pounds per cow.

The cows used on the wintering and summering work, with the addition of enough cows to make 60 head, were divided into five uniform lots with 12 cows per lot at Cottonwood. These cows were put into the winter pastures on January 10, 1947, but were allotted on December 5 and run together until January 10. The supplemental feeding started then.

Lot 1 was given a 100-acre winter pasture for winter grazing only.

Lot 2 was given a 100-acre winter pasture for winter grazing only, plus one pound per head daily of a 20 percent protein cube (soybean oil meal and farm grains which cost $18.00 less per ton than soybean oil meal).

Lot 3 was given a 100-acre winter pasture, of which 20 acres had been cut and stacked the previous July. The stacked hay measured 8.2 tons, of which 5.7 tons were fed.

Lot 4 was given a 100-acre winter pasture, of which 20 acres had been cut and windrowed at the same time as in Lot 1. These 20 acres produced 7.14 tons of windrowed hay.

Lot 5 was given a 100-acre winter pasture for winter grazing, plus one pound per head daily of soybean oil meal cube.

The average gain or loss for the period from January 1 to May 1, 1947, was:
Lot 1, loss of 39 pounds; Lot 2, loss of 10 pounds; Lot 3, loss of 61 pounds; Lot 4, loss of 38 pounds; Lot 5, gain of 11 pounds. These weights include the weight of calves that were born during the period.

These cows were reallocated to six summer pastures on May 1. These summer pastures are in series of three in duplicate. Thus two groups of ten cows each will have about 8.5 acres of grazing per cow from May 1 to December 1, 1947; two groups will have about 13.5 acres per cow; and two groups will have about 18.5 acres per cow.

In 1946, the average gain per cow for the above three rates of grazing was 129.5, 134.8, and 172.0 pounds respectively. The pounds of calf weaned per cow in the three sets of pasture were 292, 279 and 322 respectively.

Each year the cows in each series are bred to one bull and the progenies tested to determine their ability to make economical gains. Only high quality purebred bulls are used (as judged by visual inspection).

Of the first four sires tested, the calves of the best one returned the producer $7.26 more per head than those of the poorest sire. In 1946, one sire's calves weighed 440 pounds at weaning, while those of the bull being tested in the adjoining pastures weighed only 397.5 pounds.

The herds at the Cottonwood station and Reed's Ranch are being replaced with purebred Hereford animals. (Project No. 121. Leaders: Leslie E. Johnson and Charles S. Hobbs, Animal Husbandry Department; A. L. Moxon, Station Chemistry Department.)
Central Station, Highmore

**Fruit and Shelter Belt Trees.** Although temperatures dropped to 20 degrees F. at the time of fruit tree blossoming, the plum-sandcherry hybrids bore good crops of fruit. Little or no fruit was found on other trees.

In the shelter belt plantings, Russian Olive has suffered severely from hail damage. Other hardier types of shelter belt trees made good growth.

**Vegetable Testing.** Strong winds and lack of moisture accounted for poor vegetable growth. Early planted cabbage was severely injured by frost where it remained unprotected.

Frost also did considerable damage to peas. These plants are frost hardy, but prolonged cold or severe freezing are injurious. This is perhaps the greatest danger for early gardens.

**Crop Testing.** Several hundred new strains of wheat, oats, barley, sorghum and corn were grown and appraised for adaptability. A possible new spring wheat No. 2280 is being increased for distribution to farmers in 1948.

Recently developed strains of grasses, clovers and alfalfa introduced from the United States Department of Agriculture and other states were planted and yields obtained. Foundation fields of two new grasses, Green Stipagrass (*Stipa viridula* or Feather bunchgrass) and Mandan Wildrye (*Elymus canadensis*), were planted at this station to increase seed for the Highmore area.

**Tillage and residue trials.** Experiments indicate that wheat yields have been about equal, regardless of previous tillage or residue treatment. Oats and sorghum yields have been higher on plowed land. The application of manure increased oat and sorghum yields more than did application of straw residues. Decreased oat and sorghum yields have resulted when all of the residue from the previous small grain crop was returned to the land. Weeds have been most prevalent on oat and sorghum land prepared with the duckfoot cultivator.

**Dates for Planting Corn.** Corn yields were not affected in 1946 by planting made on May 1 and May 20. The moisture content of the corn was associated with the strain planted rather than with date or thickness of planting.

North Central Station, Eureka

**Agronomic Tests.** Agronomic tests involve (1) hybrid corn breeding, and testing of important commercial hybrids, (2) small grain breeding nursery and variety plots, (3) sorghum breeding and adaptation, and (4) yield of native grasses and pastures.

The average yield of oats in the six-year-rotation, where a crop of sweet clover is regularly plowed under every third year, was about ten bushels per acre higher than the average in the two year rotation where oats follows either corn or sorghum with no return of such legume to the soil.

**Fruits and Vegetables.** Plum-sandcherry hybrids, Opata and Sapa, have made good progress. Despite late spring frosts, fruit set was good on these two varieties. Yields of other plum varieties, crabapples, and apples were negligible for 1947.

Vegetable plots of peas, carrots, early planted cabbage, tomatoes, beans and sweet corn were made. The only insect that threatened to give trouble was the [50]
cabbage butterfly. Golden Acre cabbage planted in early May was ready for harvest soon after the first of July.

Newell Station

**Swine Production for Irrigated Areas.** This project is designed to develop more effective swine breeding and production methods for the irrigated area in western South Dakota. A shortage of local grains necessitated limiting the 1946-47 experiments to breeding work.

This breeding work involves the development of one inbred line of Hampshire swine. The average inbreeding coefficient of last year’s pigs was .24, the litters varying from .16 to .38. The gilts in the line farrowed an average of 10.5 pigs in 1946. The average 180-day weight for the herd was 198.2 pounds. Nine of the 1946 gilts were transported to the Brookings station last fall and are being tested in a breed-line cross (Minnesota Poland China-line A males x Newell Hampshire females). (Project No. 132. Leader: Leslie E. Johnson, Animal Husbandry Department.)

**Levels of Feeding for Ewe Lambs.** This project was started to determine the effects of three levels of nutrition for the development of ewe lambs upon their ultimate body size, wool production and lamb production. Many ewe lambs are fed through their first winter upon roughage alone. A much smaller number are fed a liberal amount of grain along with good quality roughage. In range areas concentrate feeds are more expensive than roughages. It is therefore important to determine the best feeding level for their development.

The lambs used in this experiment were good quality range lambs of Ramboullet and Romney breeding. They were divided into three uniform lots of 75 ewes each on November 2, 1946. They were then fed in pens in a stockade until they were taken to the range on April 28, 1947.

All three lots were fed alfalfa hay and wheatgrass hay. In addition, Lot 1 was given two-thirds pound of barley per head daily; Lot 2 was fed one-third pound of barley per head daily; Lot 3 was fed only the hay, (.21 pound more wheatgrass hay than Lot 2 and .32 pound more than Lot 1).

All lots were allowed free access to salt and to a mineral mixture of two parts steamed bonemeal and one part salt.

The ewes fed barley in addition to alfalfa and wheat grass hay made greater gains during the winter feeding season than those fed hay and no grain. When all ewes were turned out on the range with no supplemental feed, however, the ewes wintered on hay only made faster gains than those which had received grain. The ewes fed two-third pound barley daily sheared .7 pound more wool per head than the other two lots.

These ewes will be grazed under similar conditions during the entire grazing season with monthly weights being taken to determine the effect of the previous winter’s feeding. To study these effects further, one-third of the ewes from each lot will be fed on one of three levels of feeding during the following winter period and lamb and wool production as influenced by levels of feeding will be studied. (Project No. 161. Leaders: Earle W. Klosterman and Charles S. Hobbs, Animal Husbandry Department; Harry E. Weakly, Newell Station.)
Rations for Pregnant Ewes. The objects of this experiment are: (1) to determine the level of concentrate feeding bred range ewes that will produce the most return through wool and lambs produced; (2) to compare alfalfa hay as the only roughage to a mixture of alfalfa hay and western wheat grass hay; and (3) to determine the value of chopping hay for the winter feeding of pregnant ewes.

Solid-mouthed Western ewes of good quality were divided into 12 lots of 20 ewes each on November 1, 1946. Four ewes from each lot were then placed in a breeding pen with one of five rams. All ewes were fed an average daily ration of one pound of alfalfa and 2.4 pounds of wheatgrass hay during the breeding season from November 1 to December 5. On December 5 they were divided into the 12 lots to which they were originally assigned and started on experimental rations. The average gain per ewe during the breeding season was 7.8 pounds with an average feed cost of $0.75 per ewe.

During the feeding experiment six lots were fed chopped hay and six were fed long hay. Three lots in each of this group of six lots were fed only alfalfa hay; the other three lots in each group was fed one pound of alfalfa hay and wheat grass hay. One lot from each ration group was given one-third pound of barley per head daily the last 50 days before lambing. Another lot from each ration group was given two-third pound of barley per head daily the last 100 to 150 days before lambing. The remaining four lots received no barley at all.

All the ewes were allowed free access to salt and to a mineral mixture of two parts steamed bonemeal and one part salt. The hays fed were of average to good quality. An estimated cost of $2.00 per ton was charged for chopping the hay fed to six lots. The ewes were all fed the same ration during the lambing season (March 28 to May 1) and were taken to the range on April 28, 1947.

The ewes fed chopped hay made greater gains than those fed long hay and, as would be expected, the addition of barley increased the gains. The ewes fed only alfalfa outgained those fed a mixture of alfalfa and wheat grass hay when the hay was fed chopped. The differences in gains were greater, but in the opposite direction, when the hay was fed long.

The ewes fed chopped hay gave birth to larger lambs and their lambs weighed slightly more at 45 days than the ewes fed long hay. The average of four lots showed that the addition of barley increased the birth weight of the lambs and also their weights at 45 days, but that there was no distinct advantage in feeding more than one-third pound of grain the last 50 days of pregnancy. Weaning weights of the lambs will also be taken.

There were no consistent differences in average fleece weights per ewe except a tendency for the ewes fed long alfalfa hay to shear slightly less wool than ewes on the other hays. (Project No. 159. Leaders: Charles S. Hobbs and Earle W. Klosterman, Animal Husbandry Department; Harry E. Weakly, Newell Station.)
Publications

Bulletins


Circulat.s


Journal Articles by Staff Members

Agronomy


Animal Husbandry


Chemistry


Home Economics


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EXPERIMENT STATION STAFF 1946—1947

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Honorable Mrs. H. T. Dory Watertown
Honorable Frank Cundill Isabel
Honorable C. Y. Berry McLaughlin
Honorable Eric Heidepriem Custer

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Honorable Frank Cundill Regent Member
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I. B. Johnson Director
R. A. Larson Treasurer
Eudora Crook Secretary

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Max Myers, M.S. Assistant

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N. B. Anderson, B.S. Assistant

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A. N. Hume, Ph.D. Associate
Leo F. Puhr, Ph.D. Associate
John E. Grafius, Ph.D. Associate
C. F. Franzke, B.S. Assistant
M. W. Adams, M.S. Assistant
L. O. Fine, Ph.D. Assistant
D. B. Shank, Ph.D. Associate
Glen Avery, B.S. Soil Survey Supervisor, SCS
Ralph Cline, B.S. Project Supervisor, SCS
Rose D. Greenwalt, M.S. Soil Scientist, SCS
L. M. Stahler, Ph.D. Associate, USDA

Animal Husbandry
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J. W. Wilson, M.S., Ph.D. Animal Husbandman Emeritus
Leslie E. Johnson, Ph.D. Associate

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Eugene I. Whitehead, M.S. Assistant

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A. A. Schock, M.S. Assistant

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Gerald B. Spawn, Ph.D. Assistant

Home Economics
Alice Rosenberger, M.S. Home Economist
Lillian Lund, M.S. Assistant

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S. A. McCrory, M.A. Horticulturist
N. E. Hansen, Sc.D. Horticulturist Emeritus

Leonard Yager, B.S.A. Assistant

Pharmacy
Floyd J. LeBlanc, Ph.D. Pharmaceutical Chemist

Plant Pathology
C. M. Nagel, Ph.D. Plant Pathologist

Publications
D. D. Burchard, A.M. Editor
Alice Holton, A.B. Assistant Station Editor

Rural Sociology
W. F. Kumljen, Ph.D. Rural Sociologist

Veterinary
G. S. Harshfield, D.V.M., M.S. Veterinarian
Carl Rehfeld, D.V.M. Assistant
J. B. Taylor, D.V.M. Assistant

Poultry
Wm. Kohlmeier, M.S. Poultry Husbandman
D. G. Jones, Ph.D. Assistant

[54]
RESIGNATIONS

J. S. Boyd, Assistant Agricultural Engineer — September 1, 1946
W. H. Burkitt, Assistant Animal Husbandman — July 13, 1946
Fred H. Carlson, Assistant Veterinarian — November 1, 1946
E. L. Erickson, Assistant Agronomist — December 31, 1946
A. B. Hoerlien, Associate Veterinarian — January 29, 1947
Lewis Holm, Associate Chemist — June 30, 1946
Minerva Kellogg, Associate Home Economist — June 1, 1946
Karl F. Manke, Assistant Agronomist — August 20, 1947
Norman G. Patterson, Assistant Agronomist — February 15, 1947
Lorraine M. Schirmer, Station Analyst — June 30, 1947

APPOINTMENTS

M. W. Adams, Assistant Agronomist — May 15, 1947
N. B. Anderson, Assistant Agricultural Engineer — September 25, 1946
L. O. Fine, Assistant Professor Agronomy — July 1, 1946
Alice Holton, Assistant Station Editor — July 1, 1946
D. G. Jones, Assistant Poultryman — July 15, 1946
E. W. Klosterman, Assistant Professor and Assistant Animal Husbandman — July 1, 1946
Max Myers, Assistant Professor Agricultural Economics — September 1, 1946
A. B. Nelson, Assistant Animal Husbandman — September 16, 1946
Carl Rehfeld, Assistant Professor and Assistant Veterinarian — February 15, 1947
A. A. Schock, Instructor Dairy Manufacturing — October 1, 1946
D. B. Shank, Associate Agronomist — October 1, 1946
John Wiersma, Assistant Agricultural Engineer — September 1, 1946
### Financial Statement—Agricultural Research Funds—July 1, 1946, to June 30, 1947

#### REVENUES

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**Total**                      | **$15,000.00**          | **$15,000.00**        |                                  | **$5,734.84** |

#### EXPENDITURES

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<td>$1,172.19</td>
<td>$4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent and Utilities</td>
<td>$456.16</td>
<td>$29.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Contractual Services</td>
<td>$292.56</td>
<td>$30.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions to Retirements</td>
<td>$23.05</td>
<td>$268.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance on hand June 30, 1947</td>
<td>$7,000.00</td>
<td>$5,734.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total**                      | **$15,000.00**          | **$15,000.00**        |                                  | **$5,734.84** |

#### VARIANCE

- **Total** $0.00

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*Sales fund represents the receipts for the sale of by-products of research work that has been completed, and these funds must be expended strictly for research purposes.*

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*Table notes:*

- **Sales Proceeds:** $19,562.92
- **Rentals:** $4,398.68
- **Balance on hand July 1, 1946:** $21,302.14
- **Balance on hand June 30, 1947:** $3,522.44