Farm Research in South Dakota

Fourth Annual Station Report

July 1, 1940 - June 30, 1941

Agricultural Experiment Station
South Dakota State College
of Agriculture and Mechanic Arts
Brookings, S. D.
Table of Contents

Soils, Crops and Crop Breeding ........................................ 3
Livestock Production .................................................. 13
Dairy Production ....................................................... 24
Livestock Diseases, Parasites and Poisoning ...................... 34
Poultry Production .................................................... 40
Fruits and Vegetables .................................................. 49
Substations ........................................................................ 55
Crop Insects ....................................................................... 59
Farm Engineering ........................................................... 65
Home Economics ............................................................ 70
Farm Income and Community Welfare ............................... 72
Cooperative Agreements With Federal Agencies ................ 84
Active Research Projects .................................................. 88
Station Staff ..................................................................... 93
Publications ...................................................................... 94
Journal-Articles by Staff Members ................................... 95
Financial Statement .......................................................... 96

INDEX BY STATION DEPARTMENTS

Agricultural Economics .................................................. 72
Agricultural Engineering .................................................. 65
Agronomy ......................................................................... 3
Animal Husbandry .......................................................... 13
Station Chemistry ........................................................... 34 and 39
Dairy Husbandry ............................................................. 24
Entomology ....................................................................... 59
Home Economics ............................................................ 70
Horticulture ...................................................................... 49
Pharmacy ......................................................................... 12 and 36
Poultry ............................................................................. 40
Rural Sociology .............................................................. 78

Explanation of South Dakota Map on Cover

The map shows the six agricultural regions of South Dakota and the location of the Agricultural Experiment Station at Brookings; the four state Substations at Vivian, Highmore, Eureka and Cottonwood; and the two federal Field Stations at Newell and Ardmore.

Agricultural production practiced in the areas, as indicated by the numbers on the map, includes:

1. Corn, livestock feeding and dairying.
2. Corn transition, livestock feeding and dairying.
3. Small grain transition and general livestock production.
4. Small grain and general livestock production.
5. Grazing and production of feeder stock.
6. Diversification, grazing, feeding and dairying.
Letter of Transmittal

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

Dear Dean Eberle:

This publication represents the fifty-fourth annual report of the South Dakota Agricultural Experiment Station; it covers the period from July 1, 1940, to June 30, 1941.

As in the two previous annual reports the year’s research work has been classified by subject matter. The index on the Table of Contents page also provides a convenient reference to departmental activities.

Toward the close of the fiscal year added demands were placed upon the Experiment Station to meet some of the more pressing agricultural problems brought on by the National Defense program. Research workers have been asked to carefully scrutinize their present work and make necessary changes in their research procedure to more effectively meet the defense situation. The necessity for a thorough appraisal of post-war period problems has also been emphasized as carefully planned research will be needed to obtain basic facts for effective agricultural planning then.

Respectfully submitted,

[Signature]

Director Experiment Station
Soil, Crops and Crop Breeding

How Does Crop Production Affect the Soil?

The work on this project has been confined largely to a study of the changes the element phosphorus has undergone since the beginning of the project. The study is divided into three phases, namely, total phosphorus, organic phosphorus and available phosphorus.

It has been found that there has been a gradual decrease in the amount of total phosphorus on the control plots and that the plots which have received phosphorus fertilizer contain more total phosphorus than the control plots.

The amount of organic phosphorus present is about one-half the total phosphorus. There is a rapid decrease in the available phosphorus with depth. Plots which have received phosphorus fertilizer are higher in available phosphorus than the control plots and there is an increase in available phosphorus upon the continuous application of phosphorus fertilizers. The trials also indicate that the control plots have decreased in soil phosphorus which is soluble in four normal hydrochloric acid.

Contrary to the trials with phosphorus, it was found that the application of nitrate fertilizer did not increase the amount of total nitrogen in the soil. (Project 3. Leaders: L. F. Puhr and Ralph Arms, Agronomy Department.)

Do Crop Residues Increase Availability of Plant Food?

The results of an experiment designed to evaluate the effect of crop residues on the availability of plant nutrients in the plow layer and the layers of soil immediately below the surface indicate that the plant nutrients in the sub-surface and sub-soils have a low availability, especially the element phosphorus, and that crop residues do not seem to increase the availability of this element. The reduced yields of crops on lands where the surface soil has been partially or completely removed by erosion appears to be due to a lack of available phosphorus as well as nitrogen.

In order to determine the value of crop residues, stover, straw and legumes under field conditions in terms of crop production, soil erosion and moisture control field plots were established this spring, 1941. The soil treatments are as follows: (1) All crop residues returned, (2) All residues remove, (3) Crop residues plus nitrogen, phosphorus and manure. The effect of the placement of crop residues in the soil on crop production, conservation of soil moisture and erosion control, will be meas-
ured by comparing sub-surface tillage which leaves the crop residues largely on the surface of the soil and plowing which incorporates the crop residues with the soils. (Project 46. Leaders: L. F. Puhr and Ralph Arms, Agronomy Department.)

Inbred Strains of Corn Studied

During 1940 and 1941, eight inbred lines of corn were released to members of the Crop Improvement Association for increase purposes. Ample seed was produced from all inbred lines. This coming season the increased lines will be combined into 12 single cross combinations for making double cross commercial seed. Three hundred sixty inbred lines are being improved and studied further with regard to their disease resistance, drouth resistance, yielding ability and combination qualities.

Close selection of high and low protein corn has been continued as in the past. The low protein strains average approximately 8.2 percent, and high protein strains approximately 20 percent.

The Station Agronomy Department cooperating with the South Dakota Crop Improvement Association plans to release all inbred lines through this association. At the present time they have made definite plans for the production and distribution of South Dakota hybrids. The Agronomy Department will be relieved of the production of known lines in quantity and it will enable them to make further study on material on hand and also any other new material.

A Proposed New Method for Controlling Pollination of Corn. A possible new method for controlling pollination in corn with the use of a so called over-all bag designed to cover the tassel and silk of the corn plant or plants, at an opportune stage of growth, usually during dehiscence and just previous to emergence of silk has been developed. A very brief statement describing this method and suggesting some of the results was presented at the annual meeting of the American Society of Agronomy, December, 1940.

The method will apparently be practicable. Such a statement is based on the outcome of experimental trials carried through three seasons, 1938-1940 inclusive.

Results of trials leave little room to doubt that the method indicated for controlling pollination in corn is not only successful, but more important, that it may be depended upon for accuracy in experimental or commercial operations.

The material used in making the over-all bags is heavy muslin of the following description:

- Name of fabric: high quality unbleached muslin.
- Width: 39 inches
Carefully controlled pollination demonstrated by the bag-covered tassels is essential in the development of successful adapted inbred lines of corn.

Yarn count in number of yarns per inch: warp—80, filling—93
Weight in ounces per square yard: approx. 4.2

A limited number of trials made in the field in 1940 furnished the basis for estimating that the foregoing method for controlling pollination in corn can be carried through in half the length of time utilized for methods previously employed.

Corn, Early or Late Planting. It is a reasonable hypothesis to assume that, other things equal, relatively early planting of corn would result in increased yields as compared with a later planting. Such hypothesis cannot be accepted as a foregone conclusion. Three successive years, including 1940, corn has been planted at Northern Experiment Farm, Eureka, at dates approximately one week apart beginning about April 25 and extending to the usual date of planting about May 15. The present indication is that the average yield resulting from the earlier planting as compared with the later planting is higher by around two bushels per acre. In case such an outcome is borne out by further trials, it will indicate that an improvement in farm practice may be made by attention to planting corn promptly in the spring at an optimum date.

Corn experiments also are continued with the development of Eureka corn designed as an early variety for northern latitudes. One strain of Eureka corn has been developed as the result of 17 years of ear row se-
lection. In the present season the effect of close breeding, essentially in-
breeding which must have resulted from such close selection, is evident.
For instance, two row strains from the foregoing ear row plot at Eureka
in the present season, developed a high number of albinos and numerous
virescent plants. Other row strains developed striking individual
differences. Nevertheless, the average yield of Eureka corn from these
close selected rows was 2.9 bushels per acre higher than the yield of in-
tervening rows which were continuously detassled. Such results are of
technical interest.

It is practical too, to note, however, that no strains of corn planted
with seed introduced from either another part of South Dakota, or from
adjoining states yielded comparably with the foregoing close selected
seed of Eureka corn. The yield of the latter was 30.3 bushels per acre.
The average yield from planting plot rows from three introduced strains
was 16.4.

Fungus Diseases Are Studied. In several parts of South Dakota there
were found in 1940 an abundance of green barren corn plants with con-
spicuous purplish discoloration, particularly of the internodes. In an oc-
casional such plant the vascular bundles were darkened. Portions of such
bundles, when planted on nutrient agar, yielded cultures of Cephalospor-
i um acremonium, the black bundle disease fungus. Gibberella saubinet-
tii was recovered from discolored crowns and Diplodia zeae was taken
from discolored nodes of corn. (Project 66. Leaders: C. J. Franzke, A. N.
Hume and L. F. Puhr, Agronomy Department; W. F. Buchholtz, Plant
Pathology Department.)

Bindweed Control Practices Still Under Test

One season of summer fallow and thereafter seeding to a heavy rate of
fall sown rye, either harvesting the rye for grain or turning it under as a
green manure crop and then fallowing the remainder of the season—
that's the formula being used at this Station to control heavy infesta-
tions of bindweed.

This method apparently is better adapted to large areas of infestation
than small. Seeding a heavy rate of fall rye following a previous
season of fallow is about as effective as one season of fallow, insofar as
holding the bindweed in check.

There is some work being done utilizing chemicals, both dry and
spray applications. Sodium chlorate is the principal chemical and is
being combined with other elements to work out a combination spray
that may be important as a cheaper and more effective control measure
than sodium chlorate alone. (Project 32. Leaders: C. J. Franzke and E.
L. Erickson, Agronomy Department.)
Sorghum Poisoning of Livestock

Study was continued on liberation of HCN in sorghum strains, the diurnal varieties of HCN content in sorghum strains and its relationship to the total sugars produced. The continued selection for low HCN strains of sorghum was made.

Twelve strains of the newer combinations of grain and forage type sorghums are being tested in the Extension county sorghum variety test plots. It is the aim of the Agronomy Department to release only those strains that are reasonably low in HCN and better adapted to South Dakota conditions.

At the Central Substation, Highmore, four separate strains of sorghum were placed in an actual pasture experiment in cooperation with the Department of Animal Husbandry. These strains were as follows: Low Prussic Acid, 3730-S; High Prussic Acid, 1530-S (Fast Liberator); High Prussic Acid, 1930-S (Slow Liberator) and a Commercial Forage sorghum.

Eight low grade cows were purchased by the Animal Husbandry department and used in the grazing experiment, two head to each of the four sorghum lots. The cattle in each lot were changed twice a week so that in a two weeks period all eight cattle had had an opportunity of grazing on all four varieties of sorghum. The cattle were permitted to graze on the sorghum for a 12-hour period and were then kept in a dry lot for the next 12 hours and then turned back into their respective lots for grazing. This practice was continued throughout the entire grazing period of 60 days.

On three of the lots of sorghum no ill effects were observed from the cattle grazing the sorghum. In the fourth lot, which involved the high prussic acid sorghum 1530-S (the fast liberator), three cases of poisoning were noted on the cattle. All cases recovered in a short time and no further losses or ill effects were noted even when the cows grazed on second growth and frozen sorghum. (Project 61. Leaders: C. J. Franzke, L. F. Puhr, and A. N. Hume, Agronomy Department.)

Cereal Breeding Progresses

Hard Red Spring Wheat. About 3,100 lines representing 12 crosses were included in the pedigree nursery in 1941 from which superior types will be selected.

Of the 90 Thatcher x Hope, Rival x Thatcher and Rival x Reward selections tested in the preliminary rod-row nursery during 1940, 40 survived and were placed in the 1941 rod-row trials in competition with standard varieties. Two outstanding Rival x Thatcher lines have been select-
ed to be entered in the Uniform Regional Hard Red Spring Wheat Nursery in 1942 in order to test them under a wide variety of soil, climatic and disease conditions. All outstanding lines will be increased for milling and baking tests and will be further tested under South Dakota conditions.

Sixty-four lines of Hope x Ceres, Rival x Thatcher and Rival x Reward are being tested in the preliminary nursery in 1941, and those showing superior disease resistance, earliness, stiffness of straw and yield will be placed in the rod-row tests during 1942 for further elimination.

Several varieties of spring wheat were tested for grasshopper resistance in the greenhouse during the winter of 1940-41 and the experiments are being continued in the field under wire cages. Striking differences which were highly significant statistically have been obtained both in the greenhouse and in the field. Plant samples have been obtained from all varieties being tested and these will be analyzed for chemical and structural differences in an effort to determine the factors involved in resistance or susceptibility to grasshoppers.

**Hard Red Winter Wheat.** The winter wheat nursery at Brookings was completely winter killed and the work has consequently reverted to its status in 1940. There are on hand five crosses of winter x spring wheat for the purpose of obtaining rust resistance in adapted winter wheat types. These crosses are Hope-Reward x Minard-Minhardi, Marquis-Kota-Hope x Minard-Minhardi and Double Cross-Hope x Minard-Minhardi.

**Durum Wheat.** No breeding work is in progress. Several new strains developed recently, however, are being tested in rod-row nurseries and 1/66 acre plots at Brookings, Highmore, Vivian and in the 1/66 acre plots at Eureka.

**Rye.** Selfing work in rye has been continued and many lines are in the second generation of selfing. These will be further inbred and tested for disease resistance and combining ability.

**Barley.** Sixty lines from six crosses were tested in rod-row nurseries at Brookings, Highmore and Vivian. Over half of these will be eliminated on the basis of maturity, disease resistance, yield, diastatic action and other agronomic characteristics to make room for several crosses increased from bulked lines in 1940. Of especial interest are several lines of the Odessa x Dryland, Atlas x Wisconsin 38 and Peatland x Dryland crosses which exhibit considerable promise as early, stiff strawed, high yielding types. The cross Lion-Manchuria x Peatland-Glabron made for the purpose of combining earliness, yield, stiff straw and resistance to rust into a desirable malting barley is now in the F4. Several other crosses using Chevron as the source of rust and mildew resistance are in the F2 and F3.
Oats. Eighty-one lines of oats were tested in the rod-row nursery, including several crown rust resistant strains developed by Dr. H. C. Murphy, USDA, which show promise for South Dakota conditions. Mio-mark oats were released this year and have been distributed to the South Dakota Crop Improvement Association.

Rod-row and 1/66 acre plot trials were grown at Brookings, Highmore, Vivian and 1/66 acre plots at Eureka. Several new strains from other states also were included.

Cooperative Nurseries and Plots. In addition to the regular experiment station plots, a number of rod-row nursery and 1/66 acre plot trials are being grown at Brookings, Highmore, Eureka and Vivian to cooperate with the Division of Cereal Crops and Diseases, and the Bureau of Plant Industry of the United States Department of Agriculture. These are as follows:

**Hard Red Spring Wheat.** Uniform Regional Rod-Row Nursery at Brookings, Uniform 1/66 acre plot trials at all four Sub-stations, Uniform Rust Nursery at Brookings.


**Barley.** Uniform 1/66 Acre Plot Trial at Brookings, Uniform Great Plains Rod-Row Nursery at Highmore and Vivian and Uniform Rust Nursery at Brookings.

**Oats.** Uniform Rust Nursery at Brookings.

**Flax.** Uniform Rod-Row Nursery at Brookings.

Pathologist Studies Rust in Wheat. Thirty-six F₃ lines of a Thatcher X Triumpho wheat cross were subjected in the greenhouse to infection by race 9 of *Puccinia triticina*. All were found to be susceptible when the rust seeding was made on the prophyll in the seedling stage. When 17 representative lines of the same group were planted in the field 2 were resistant, 5 were susceptible and 10 were segregating for resistance and susceptibility to field infection in the "mature plant" stage. These observations supplement a similar experience with lines from the same cross in the field of 1940. In all cases both parents were highly susceptible. Isolations from roots of plants from this same cross yielded cultures of *Pythium, Helminthosporium* and *Fusarium*. (Project 25. Leaders: S. P. Swenson and J. E. Grafius, Agronomy Department, and W. F. Buchholtz, Plant Pathology Department.)

Breed Toward a Drouth and Insect Resistant Forage Crop

In cooperation with the Soil Conservation Service the dates of seeding on 22 species of grasses and methods, types of seed bed and seed bed preparation for three species of grasses are being studied.
Seed was selected from 104 individual plants of *Agropyron pungens* which were planted in individual mother plant rows for further study in regard to segregation and type. Two hundred fifty selections of crested wheat grass which were the survival of a badly infested root rot field were planted. Also 280 individual crested wheat plants which survived the badly infested cropping system soils.

Considerable trouble has been encountered in securing grass and legume stands due to root rot. It is the Station’s aim to study crop systems, fertilizer treatments and other chemical treatments which may control or enable the farmer to establish grass and legume stands on his cultivated land. Considerable work has been done on the chemical treatments and very promising results appear to be in the making. These are being studied much more extensively in regard to the rate of application, time of application and method of application. Individual plants are being selected from these several thousand cultures in the hope of securing more resistant strains to enable the farmer to establish stands. The culture, cropping systems and the application of fertilizers and chemicals are being studied in hope of finding a better soil sanitation means.

Strains of alfalfa, sweet clover, red clover, vetches and of miscellaneous grasses and other plants have been planted at Brookings and Highmore for observation and for seed production. New strains as they are required will be planted at Brookings and Highmore for adaptation studies.

Those species or strains which offer possibilities for forage production will be studied in detail in subsequent tests.

The objective is to develop improved strains of the standard legume crops and miscellaneous crops, discover new ones and develop, if possible, a forage crop with a high degree of drought resistance and insect resistance.

Isolations from crested wheat seedlings grown on soil from plots in continuous cropping, two-year rotation, three-year rotation and four-year rotation systems yielded isolates of the genera, *Pythium*, *Helminthosporium*, and *Fusarium*. The Fusarium isolates tested were only slightly pathogenic and were not studied further. *Helminthosporium sativum* and *Pythium debaryanum* were very pathogenic to germinating seed and young seedlings and *H. sativum* was sometimes pathogenic to larger seedlings. *Pythium graminicolum* was pathogenic to crested wheat seedlings at all ages tested up to five weeks. The symptoms induced were similar to those occurring in plants grown in infested field soil and reisolations were successful. *P. graminicolum* was as pathogenic in unsteamed field soil as in steamed soil. (Project 74. Leaders: C. J. Franzke, E. L. Erickson, J. E. Grafius and L. F. Puhr, Agronomy Department; W. F. Buchholtz, Plant Pathology Department.)
Soybean Variety Tests Continued

In addition to experiments with soybeans previously reported, variety tests have been continued in cooperation with the United States Bureau of Plant Industry and Bureau of Agricultural Chemistry and Engineering. The variety tests in Brookings in 1940 included 94 strains with the use of Manchu 831 as a standard variety. The yield of said variety in this particular test was somewhat higher than Manchuria which has been reported as one of the most satisfactory varieties for making yields of seed in South Dakota under conditions at Brookings. The nursery yield of Manchu 831 at Brookings was 14.78 bushels per acre. It is true that a number of newer introductions produced higher yields than either Manchu or Manchurian in 1940, which is an indication that the limit of seed yield for soybeans in this area has not been reached. The maximum nursery yield last year at Brookings was 18.2 bushels per acre.

There is reason to believe that in case a sufficient economic demand arises, it will be possible for a considerable area in South Dakota to produce an average yield of 15 bushels per acre. The utilization of such an annual legume in South Dakota cropping systems would be beneficial to agriculture in a number of respects, partly because it would increase the legume area and add another crop to further diversify production on the farms of the state.

Two varieties of soybeans have been seeded this year at the North Central Substation at Eureka, partly to utilize and restore certain cropping systems previously discontinued and also to secure information about possible yields which may be secured from soybeans in Northern South Dakota. Previous trials indicate that the cropping question is a possible one throughout the entire eastern part of the state.

Amount and depth of seeding soybeans—A test of theoretical and also some practical interest was carried in the season 1940 at Brookings with two varieties of soybeans, namely, Manchu and Manchuria. It is generally recognized that the seeding of soybeans in drill rows for cultivation in this latitude is a better method than that of seeding them in close drills and leaving them without cultivation, the reason being that soybeans seeded even in close drills like small grain, fail to subdue weeds.

In 1940 the rates of seeding per acre, two separate varieties of soybeans as indicated above, were 15 pounds, 30 pounds, 45 pounds and 60 pounds per acre. The yields from different nursery rows of the varieties thus seeded at different depths varied somewhat, but the variations were not significant enough to indicate any actual difference in production from the rates of seeding extending from 15 to 60 pounds per acre. In this limited trial a thinner seeding was as successful as a heavier seeding.
The same was true whether the depth of seeding was one or three inches. The difference in yield of the two varieties was significant from the nursery rows and the higher yield was secured from Manchuria rather than from Manchu. (Project C-2. Leader: A. N. Hume, Agronomy Department; Bureau of Agricultural Chemistry and Engineering and Bureau of Plant Industry cooperating.)

Ephedra Investigation Continued

The cooperative project with the Agronomy Department to determine the practical possibilities of Ephedra sinica in South Dakota was continued during the year and definite progress reported.

Four more or less separate projects were undertaken, including:

1. Alkaloidal assay of individual plants from which seed has been collected to endeavor to produce a high-yielding strain.
2. Seed collection and increased plantings.
3. Test plantings at the Vivian and Highmore Sub-stations.
4. Tests on the animal toxicity of the whole Ephedra.

Much of the work has confirmed the belief that Ephedra can be cultivated successfully in east central South Dakota. Its success in other parts of the state is still questionable.

Plants apparently are prolific seed producers when from two to five years old, and the seed has been found highly viable. Results of assays of individual plants show that those two to four years old contain enough alkaloid to make them commercially valuable. These assay results, however, cannot be applied to a general field crop of Ephedra.

Due to the fact that the plants assayed were those that had the most fruit, looked the best and were more or less set apart from their neighbors, they do not constitute a statistically valid random sample.

Until further work is carried out, Ephedra should not be released as a general field crop, as there are indications that it is toxic to animals. Work on this problem will be carried further during the ensuing year. (Project 65. Leader: R. P. Ahlquist, Pharmacy Division.)
HOW WILL THESE GRAINS COMPARE WITH CORN FOR HOGS?

In many areas of the state farmers can raise sorghums where they can't raise corn and they desire information about the feeding value of sorghum. In addition to feeding trials with hogs, the Station is also testing the value of sorghums for beef and dairy cattle and poultry.

Livestock Production

Seek Improved Rations for Pigs After Weaning

A series of experiments was started in 1939 by the Station Animal Husbandry Department to determine if there is any relation between the ration fed and pigs becoming lame and unthrifty after weaning. Also an attempt was made to determine suitable feed combinations or rations to feed pigs under South Dakota conditions for best results. The second feeding trial has been completed and the results tabulated.

For this second trial 90 thrifty spring pigs were divided into nine uniform lots and self-fed different feed combinations as follows:

Lot 1—80 parts coarsely ground yellow corn, 20 parts of trio mixture No. 1.*
Lot 2—80 parts coarsely ground yellow corn, 20 parts of trio mixture No. 2.**
Lot 3—60 parts coarsely ground yellow corn, 20 parts standard wheat middlings, 20 parts trio mixture No. 2.
Lot 4—60 parts coarsely ground yellow corn, 20 parts of ground oats, 20 parts trio mixture No. 2.
Lot 5—80 parts coarsely ground yellow shelled corn, 20 parts of a protein mixture consisting of 35 parts tankage, 25 parts alfalfa meal, 25 parts soybean oil meal and 15 parts dried skim milk.

* Trio mixture No. 1 consisted of two parts tankage, one part linseed meal and one part alfalfa meal by weight.
** Trio mixture No. 2 consisted of two parts tankage, one part soybean meal and one part alfalfa meal by weight.
Lot 6—Shelled yellow corn; a protein mixture consisting of tankage 2 parts and soybean meal 1 part, self fed; alfalfa hay, self fed.

Lot 7—Same as Lot 2.

Lot 8—Same as Lot 5 except dried buttermilk used instead of dried skim milk.

Lot 9—60 parts coarsely ground yellow corn, 30 parts standard wheat middlings, 5 parts tankage and 5 parts soybean meal; alfalfa hay, self fed.

After the pigs reached approximately 125 pounds average weight the ration of trio mixtures to corn was changed to 88 parts corn and 12 parts trio mixture.

The mineral mixture was then made by mixing 40 pounds steamed bone meal, 40 pounds ground limestone and 20 pounds common salt. One pound of this mineral mixture was added to each 100 pounds of the feed mixture for all lots except Lots 6 and 9 which were self fed the same mineral mixture.

The most important thing shown by the data obtained was that the pigs in Lot 6, self fed, free choice method, again made the most economical gain. The total feed requirement for 100 pounds of gain for this lot was 357 pounds as compared with 400 pounds for Lot 3, the next lowest, and 492 for Lot 7, the highest. The pigs in Lot 3, however, while showing a higher feed cost made as rapid gains as those in Lot 6.

Trouble was experienced in all of the lots except Lots 3 and 6 with pigs becoming unthrifty and contracting pneumonia. In all such cases, except one, in Lot 5, the pigs were taken out of the experiment. In this case the pig seemed to recover; however, it made very slow gains afterward.

On November 15 one pig from Lot 4, three from Lot 7 and one from Lot 8 which had been making very slow gains and were decidedly unthrifty in appearance, being classed by various observers as "necrotic" or "wormy," were taken off their rations, put in one group and self fed, free choice, the same as the pigs in Lot 6 which had been making satisfactory gains. Samples of feces from these pigs were examined to see if worm eggs were present but the examination did not show the presence of worms. Marked improvement in all of these pigs was noted almost immediately. The average weight of these pigs when taken out of their respective lots after four months of feeding was 92 pounds. After 43 days of self feeding the five pigs averaged 138 pounds showing a gain of 46 pounds per pig or a daily gain of a little more than one pound. During the following 28 days these same five pigs made a gain of 62 pounds each or an average daily gain per pig of a little better than two pounds. These results from free choice, self feeding would seem to indicate that the unthriftiness of those pigs which contracted pneumonia during the early part of the experiment or made slow gains, was due to the ration fed or
method of feeding rather than to disease or parasitic infection. (Project 85. Leader: Turner Wright, Animal Husbandry Department.)

**Pasture Fed Pork Tastes Good**

The fourth trial of an experiment designed so as to compare the quality and palatability of pork produced by growing fattening pigs allowed various pasture crops with that produced by similar pigs fed in a dry lot has been completed.

Forty head of weanling spring pigs were divided into four uniform lots of 10 head each and were fed out to a market weight of 225 pounds on a ration of yellow shelled corn, tankage and minerals in the 1940-41 trial. The check lot was self-fed this ration, free choice, in dry lot while the other lots were allowed either alfalfa, sweet clover or rape pasture in addition.

When each of the hogs reached the market weight, it was weighed out of the experiment and slaughtered under test in the College meat laboratory. Palatability and Warner-Bratzler shear tests were made of cooked samples and fat and lean samples were analyzed chemically for each carcass.

The results obtained in this fourth trial further substantiate those obtained in the previous trials as follows: (1) Growing, fattening pigs will produce pork of excellent quality and palatability when fed a ration of yellow shelled corn, tankage and minerals in dry lot or when allowed alfalfa, sweet clover or rape pasture in addition. (2) Significant differences cannot be detected between the quality and palatability of the pork produced on this ration when it is fed in dry lot or when any of these various forage crops are allowed in addition. (3) The use of such forage crops lowers the feed requirements and cost of gains for growing fattening pigs. (4) The poor quality pork produced during the summer season, concerning which packers have received so many complaints, does not come from hogs properly finished on a full feed of corn, tankage and minerals while on alfalfa, sweet clover or rape pastures.

A mimeographed report was submitted to the National Conference on Cooperative Meat Investigations, May, 1941. The four years' work on this project is being summarized and a bulletin manuscript is being prepared at present. (Project 50. Leaders: Turner Wright and F. U. Fenn, Animal Husbandry Department.)

**Compare Sooner Milo and Corn for Hogs**

The third feeding trial in which grain from Sooner milo is being compared with corn is now in progress. In this trial both whole and ground milo grain are being compared with shelled and ground yellow
corn for fattening fall pigs. The pigs at this date are still on feed and it will not be possible to make final comparisons until they have reached market weight. (Project 24. Leader: Turner Wright, Animal Husbandry Department.)

**Baby Beeves Produced Profitably**

The second trial of a baby beef production project was completed with the marketing of the second crop of calves as fat baby beeves during the spring and summer of 1940. The complete data for this trial were summarized and an average of the results for the first two trials was issued as a mimeographed progress report during the past year.

The third trial has been in progress throughout the year including calving in the spring of 1940, summer and fall pasturing from May 24 to November 6, weaning and beginning of feedlot feeding of the calves on the latter date, and marketing of the fattened baby beeves during the spring and early summer of 1941.

The fourth trial is now in progress. The breeding herd of cows was wintered at the Station, calved this spring and they and their calves have been on pasture since May 17.

The results obtained in the first three trials indicate that: (1) Baby beeves can be produced profitably in this section of the Northern Great Plains. (2) Satisfactory baby beeves can be obtained by breeding common grade beef cows to a choice purebred beef bull. (3) The same cows when bred to a common grade or scrub sire do not produce calves of satisfactory type or quality for baby beef and such calves, handled under identical conditions, yield much less profit than calves sired by a choice purebred beef bull. (4) Creep feeding of nursing baby beef calves while on pasture may not pay when it is followed by a long fattening period (5 to 8 months) in the feedlot. (5) Creep feeding does result in weightier calves, grading higher as feeder calves at weaning time and may result in an increased profit to the producer of feeder calves in this area. (Project 67. Leaders: I. B. Johnson and F. U. Fenn, Animal Husbandry Department.)

**Sorghum Grains Differ in Feeding Value for Fattening Steers**

In order to determine the comparative feeding value of various varieties of sorghum grains for fattening steers, a second feeding trial was conducted from July 23 to December 10, 1940. In addition to the three rations used in the first trial, a fourth lot fed on low prussic acid cane seed was included in this second trial.

Forty head of two-year-old Hereford feeder steers were obtained in
central South Dakota. These steers were allowed a fill and several days rest and were then weighed on three successive days to obtain their average initial weight and started on the following rations:

- **Lot 1.** Ground shelled corn, soybean oil meal, alfalfa hay.
- **Lot 2.** Ground Sooner milo, soybean oil meal, alfalfa hay.
- **Lot 3.** Ground Dakota amber cane seed, soybean oil meal, alfalfa hay.
- **Lot 4.** Ground low prussic acid cane seed, soybean oil meal, alfalfa hay.

At the close of the 141-day feeding period the steers were weighed individually on three successive days. The average of these weights was taken for the final weight. Market and carcass data were obtained for each lot. The feeding and marketing data are summarized in the following table:

<table>
<thead>
<tr>
<th>Ten steers per lot—Fed 141 days</th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. initial weight per steer (lbs.)</td>
<td>803.1</td>
<td>795.1</td>
<td>803.9</td>
<td>804.4</td>
</tr>
<tr>
<td>Av. final weight per steer (lbs.)</td>
<td>1233.5</td>
<td>1187.7</td>
<td>1165.6</td>
<td>1160.3</td>
</tr>
<tr>
<td>Av. daily gain per steer (lbs.)</td>
<td>3.05</td>
<td>2.78</td>
<td>2.57</td>
<td>2.52</td>
</tr>
<tr>
<td>Feed for 100 lbs. gain: (lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>630.7</td>
<td>695.9</td>
<td>1018.7</td>
<td>1030.6</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>31.9</td>
<td>35.0</td>
<td>38.0</td>
<td>38.6</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>190.0</td>
<td>208.9</td>
<td>227.8</td>
<td>231.5</td>
</tr>
<tr>
<td>Minerals (Salt, steamed bone meal, limestone)</td>
<td>10.0</td>
<td>11.6</td>
<td>12.6</td>
<td>12.1</td>
</tr>
<tr>
<td>Feed cost per 100 lbs. gain*</td>
<td>$7.01</td>
<td>$8.71</td>
<td>$12.25</td>
<td>$12.38</td>
</tr>
<tr>
<td>Total cost per head (cattle and feed)</td>
<td>105.33</td>
<td>108.61</td>
<td>119.55</td>
<td>119.35</td>
</tr>
<tr>
<td>Selling price per cwt.</td>
<td>11.25</td>
<td>10.75</td>
<td>10.25</td>
<td>10.00</td>
</tr>
<tr>
<td>Net proceeds per head</td>
<td>132.55</td>
<td>122.66</td>
<td>115.34</td>
<td>110.71</td>
</tr>
<tr>
<td>Profit or loss per head</td>
<td>27.22</td>
<td>14.05</td>
<td>-4.21</td>
<td>-8.64</td>
</tr>
</tbody>
</table>

* Feed Prices—Corn, No. 2 yellow shelled, 48 cents per bu.; Sooner milo $1.00 per cwt.; Dakota amber cane $1.00 per cwt.; low prussic acid cane $1.00 per cwt.; soybean oil meal $32.00 per ton; alfalfa hay $6.00 per ton; salt 65 cents per cwt.; steamed bone meal $2.45 per cwt.; and limestone 85 cents per cwt. Grinding charge 6 cents per cwt.

As can be noted in the foregoing table, faster and more economical gains were produced in Lot 1 by the steers fed corn. The Sooner milo-fed steers required only 65.2 pounds more grain than the corn-fed steers for producing 100 pounds of gain but the steers fed amber and low prussic acid cane seed in Lots 3 and 4 respectively required excessively large amounts of grain for the production of the same amount of gain. Their rate of gain was also slower. The corn-fed steers also outsold the others and yielded a nice profit. A much smaller amount of profit was obtained from the steers fed Sooner milo while both of the lots which received cane seed were fed at a loss.

The results obtained for Lots 1, 2, and 3 are similar to those ob-
tain in the 1939 trial. The one-year results obtained with low prussic acid cane seed indicate that it is similar to amber cane seed in feeding value and is still less economical. It should be remembered, however, that both amber and low prussic acid cane are forage sorghums and are much better suited for use as fodder or silage than for grain for cattle feeding.

The average live grade of the steers in Lot 1 was good to choice while Lots 2, 3, and 4 averaged top good, good and good, respectively. The dressing percent was: Lot 1, 59.2; Lot 2, 59.1; Lot 3, 58.6 and Lot 4, 58.4. The carcasses from the Lot 1 steers were graded top good and from Lots 2, 3, and 4, good.

When the carcasses were ribbed down in the cooler the rib eye muscle did not average as bright or as well marbled as is desired in the top grades of beef. There was no difference, however, between the color of the rib eyes of the steers fed corn and those fed sorghum grain. The color of the rib eye of each carcass was checked objectively with the aid of a Munsell color analyzer. Hence, it did not appear that the feeding of sorghum grain produced dark cutting beef. (Project 90. Leaders: I. B. Johnson and F. U. Fenn, Animal Husbandry Department.)

Are Gummer Ewes or Lambs More Profitable to Feed?

Each season there are large numbers of aged gummer ewes marketed from the western range. The price that these ewes command on the market has attracted feeders as source of feeder stock. Such factors as the comparative economy of feeding gummer ewes and western lambs, expected death loss in feeding aged ewes, efficiency of gains, and method of preparation of the grain ration have never been experimentally demonstrated.

In each of the past three years, the South Dakota Station has been feeding 100 gummer ewes and 50 western lambs to answer the questions confronting feeders. These 100 ewes were divided equally and uniformly into four lots and fed ground and whole barley and corn and the lambs divided into two lots similarly and fed whole corn and barley. The average of these three years' trials are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
<th>Lot 5</th>
<th>Lot 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>67 Ewes</td>
<td>67 Ewes</td>
<td>68 Ewes</td>
<td>62 Ewes</td>
<td>70 Lambs</td>
<td>72 Lambs</td>
</tr>
<tr>
<td>Feed required per 100 lbs. gain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>803.5</td>
<td>829.3</td>
<td>647.6</td>
<td>666.8</td>
<td>524.6</td>
<td>449.9</td>
</tr>
<tr>
<td>Whole Barley</td>
<td>431.2</td>
<td>486.1</td>
<td>389.3</td>
<td>428.4</td>
<td>386.6</td>
<td>373.0</td>
</tr>
<tr>
<td>Whole Corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit or loss per head after deducting feed costs</td>
<td>$0.33</td>
<td>$0.80</td>
<td>$0.14</td>
<td>$0.64</td>
<td>$1.68</td>
<td>$2.23</td>
</tr>
</tbody>
</table>
The results of these three trials indicate a fair profit for lambs while three of the lots of ewes showed a loss and only one lot (fed whole shelled corn and alfalfa) showed a profit. There was a high death loss in ewes, reaching 16.2 percent in Lot 4, which adds to the cost of the feeding of ewes. Grinding grain is not a profitable method of feed preparation. Gummer ewes eat more whole grain and make more efficient gains on whole grains. Corn is superior to barley as a fattening grain. Feeding gummer ewes increases the quality and palatability of the meat as well as increasing the dressing percentage and the amount of lean and fat. Roasted leg of mutton from finished gummer ewes compared very favorably with roast leg of lamb from finished lambs. (Project 78. Leaders: James C. Watson and Forrest U. Fenn, Animal Husbandry Department.)

Test Rations for Pregnant Ewes

During the fall of 1940, 45 grade Hampshire ewes were divided into five different lots of nine head each. These ewes were bred to the purebred Hampshire ram, the same ram that was used the four previous years of this experiment.

These ewes were fed the following rations:

- Lot 1. Shelled corn and alfalfa hay.
- Lot 2. Shelled corn and wild hay.
- Lot 3. Whole oats and wild hay.
- Lot 4. Whole oats and alfalfa hay.
- Lot 5. Cottonseed cake and alfalfa hay.

There were 57 lambs born of which 47 were weaned. Six of these lambs died when from a week to ten days old from "stiff disease." Three of these lambs were in Lot 1 where the dams received shelled corn and alfalfa hay; one in the lot that received whole oats and wild hay; one in the lot that received whole oats and alfalfa hay and one in the lot that received cottonseed cake and alfalfa hay. This is the first experience in this experiment in losing lambs from this disease.

The ewes and their lambs were turned on rye pasture, fall sown, but afterwards to a temporary pasture of rape and oats and followed by a sudan grass pasture.

The results of the five year's work will be printed in bulletin form soon. (Project 54. Leader: J. W. Wilson, Animal Husbandry Department.)

Progress Reported in Notail Sheep Development

Since the last annual report of this Station, Circular No. 28, "Development of the Notail Sheep," was issued. This circular includes the results, year by year, from 1915 to 1939, inclusive. It is well illustrated and shows
what can be accomplished within a comparatively short time in changing the characters of animals by selection.

Four rams were used for the lamb crop of 1941. There were 67 ewes that had 82 living lambs. Ram No. 5780 got 39 lambs, 21 of which had no tails, 11 had tails one inch or less and seven over one inch, or an average of 2.46 inches.

Ram No. 5758 sired 16 lambs, two of which had no tails, six had tails one inch and less and eight had tails, the average length of which was 2.09 inches.

Ram No. 5666 sired 20 lambs, one of which had no tail, one had a tail less than one inch and the remaining 18 head had an average length of tail of 2.73 inches.

Ram No. 7313 sired seven lambs, three of which were no tails, three with an average length of tail of 2.25 inches and one with a tail less than one inch.

These were the choice of the 17 rams of this strain and had not only the breeding but the body conformation as well. (Project 9. Leaders: J. W. Wilson, Animal Husbandry Department.)

**Study Carrying Capacity of South Dakota Ranges and Pastures**

There has been a necessity for a grazing capacity inventory in South Dakota to be used as a basis for agricultural planning, arriving at land values, leasing and rental fees, and use in livestock improvement programs and farm and ranch management practices. A carrying capacity study was conducted this last year in 30 counties in eastern South Dakota. The information for the western part and some of the counties in the eastern part of the state was supplied by the Soil Conservation Service and the United States Forest Service.

The results of this study indicate that in the 27,244,030 acres of grass land in the state, there is a wide variation of carrying capacity due to use, soil type, climate, and rainfall. Carrying capacities vary from 5 to 10 acres per animal unit on the year-long basis, to 81 to 100 acres per animal unit in parts of the western section of the state, including the Black Hills. (Project 97. Leaders: I. B. Johnson and James C. Watson, Animal Husbandry Department.)

**Newell Field Station**

Beet Tops Good Feed for Lambs

For the purpose of studying the use of sugar beet by-products, such as beet pulp and beet tops, as well as methods of handling the beet tops, a
new series of lamb feeding rations was set up in connection with the lamb feeding experimental work at the Newell Field Station in the fall of 1940.

The rations for the seven different lots of 100 range lambs each were as follows:

Lot 1—Shelled corn and alfalfa hay.
Lot 2—Barley and alfalfa hay.
Lot 3—Barley, pressed beet pulp and alfalfa hay.
Lot 4—Barley, pressed beet pulp, field-cured beet tops and alfalfa hay.
Lot 5—Barley, pressed beet pulp, green beet top silage and alfalfa hay.
Lot 6—Barley, pressed beet pulp, wilted beet top silage and alfalfa hay.
Lot 7—Barley, pressed beet pulp, corn silage and alfalfa hay.

An additional lot was carried as a replacement lot and lambs dying in any one of the other lots were replaced by lambs from this lot.

The general practice in handling beet tops has been to pasture the tops in the field or to pile them into small piles and haul them in as fed. The first practice is a very wasteful way of handling the tops and at times causes considerable death loss. Piling and leaving the tops in the field to be hauled as fed is not desirable under unfavorable weather conditions. In an effort to find a more satisfactory manner of utilizing beet tops in the rations, three different methods of handling the tops were used in the experimental feeding. These were:

1. Green beet top silage—tops hauled and stacked following harvesting of beets.
2. Wilted beet top silage—tops left in field two weeks before stacking.
3. A mixture of corn and beet top silage made and put into trench silo.

For comparison beet tops were also fed in the usual manner to determine if there was any advantage in beet top silage over dry beet tops. In Methods 1 and 2 the tops were stacked on top of the ground which involves the same principle as is used in putting up green pea silage at the canning factories.

Analyses were made of the different silages and dry tops. The carotene content was considerably higher in the green top silage compared to the wilted, and the wilted beet silage had a higher carotene content than the dry tops.

This year the lambs were marketed in three shipments, the first on January 2, the second on February 10 and the third on March 5, rather than in one shipment as heretofore. The feeding periods for the lambs in the three shipments were 86 days, 125 days and 152 days, respectively. This seems to be a more desirable practice as, from several years of individual weighing, it has been found that about one-third of the lambs make more than average gains, one-third average gains and one-third
less than average gains. Marketing the lambs in three shipments insures a uniform lot going to market each time, except possibly in the last shipment.

While no definite statement can be made on one year's results, indications seem to be that beet top silage is preferable to dry beet tops.

Results of the Lamb Feeding Experiments Conducted at the U. S. Belle Fourche Field Station, Newell, South Dakota, October 8, 1940, to March 5, 1941.

<table>
<thead>
<tr>
<th>Length of Feeding Period:</th>
<th>First Shipment 86 days</th>
<th>Second Shipment 125 days</th>
<th>Third Shipment 152 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave. Length Feeding Period 120 days</td>
<td>100 Lambs in Each Lot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Lot number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lambs shipped to market</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Gain per lamb during average test period</td>
<td>30.24</td>
<td>28.08</td>
<td>30.36</td>
<td>29.04</td>
<td>30.60</td>
<td>30.96</td>
<td>30.48</td>
</tr>
<tr>
<td>Ave. daily gain per lamb during test</td>
<td>0.252</td>
<td>0.234</td>
<td>0.253</td>
<td>0.242</td>
<td>0.255</td>
<td>0.258</td>
<td>0.254</td>
</tr>
<tr>
<td>Feed Required Per 100 lbs. Gain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>373</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>511</td>
<td>446</td>
<td>513</td>
<td>438</td>
<td>441</td>
<td>451</td>
<td></td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>860</td>
<td>836</td>
<td>681</td>
<td>265</td>
<td>328</td>
<td>255</td>
<td>235</td>
</tr>
<tr>
<td>Pressed beet pulp</td>
<td></td>
<td></td>
<td>1132</td>
<td>1149</td>
<td>1124</td>
<td></td>
<td>1119</td>
</tr>
<tr>
<td>Tons beets required to produce silage</td>
<td></td>
<td></td>
<td>1.41</td>
<td>0.33*</td>
<td>0.24*</td>
<td>0.12*</td>
<td></td>
</tr>
<tr>
<td>Cost of feed per 100 pounds gain</td>
<td>$7.88</td>
<td>$8.01</td>
<td>$7.79</td>
<td>$7.56</td>
<td>$7.16</td>
<td>$6.89</td>
<td>$7.02</td>
</tr>
<tr>
<td>No. of Lambs and Final Net Selling Wt. Per Shipment:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First shipment (1/2/41)</td>
<td>31</td>
<td>32.86</td>
<td>34</td>
<td>3322</td>
<td>21</td>
<td>2090</td>
<td>37</td>
</tr>
<tr>
<td>Second shipment (2/10/41)</td>
<td>35</td>
<td>3478</td>
<td>23</td>
<td>3208</td>
<td>25</td>
<td>2540</td>
<td>35</td>
</tr>
<tr>
<td>Third shipment (3/5/41)</td>
<td>32</td>
<td>3072</td>
<td>43</td>
<td>4043</td>
<td>39</td>
<td>3807</td>
<td>41</td>
</tr>
<tr>
<td>Total net selling weight</td>
<td>9677</td>
<td>9437</td>
<td>9669</td>
<td>9559</td>
<td>9669</td>
<td>9817</td>
<td>9651</td>
</tr>
<tr>
<td>Gross receipts @ ave. selling price $10.67 cwt.</td>
<td>$1032.54</td>
<td>$1006.93</td>
<td>$1031.68</td>
<td>$1091.94</td>
<td>$1031.68</td>
<td>$1047.47</td>
<td>$1029.76</td>
</tr>
<tr>
<td>Marketing expense &amp; interest (83c each)</td>
<td>81.34</td>
<td>81.34</td>
<td>81.34</td>
<td>80.51</td>
<td>82.17</td>
<td>82.17</td>
<td>81.34</td>
</tr>
<tr>
<td>Net selling price per lot</td>
<td>$951.20</td>
<td>$925.59</td>
<td>$950.34</td>
<td>$939.44</td>
<td>$949.51</td>
<td>$965.30</td>
<td>$948.42</td>
</tr>
<tr>
<td>Weight per lot at beginning of test</td>
<td>7405</td>
<td>7319</td>
<td>7315</td>
<td>7318</td>
<td>7414</td>
<td>7350</td>
<td>7318</td>
</tr>
<tr>
<td>Cost of lambs per lot @ $7.75 cwt.</td>
<td>573.89</td>
<td>576.22</td>
<td>566.91</td>
<td>567.14</td>
<td>574.58</td>
<td>569.62</td>
<td>567.14</td>
</tr>
<tr>
<td>Feed cost per lot</td>
<td>240.07</td>
<td>231.68</td>
<td>239.89</td>
<td>232.52</td>
<td>214.51</td>
<td>209.20</td>
<td>221.22</td>
</tr>
<tr>
<td>Total cost per lot</td>
<td>$813.96</td>
<td>$798.90</td>
<td>$806.79</td>
<td>$799.66</td>
<td>$789.09</td>
<td>$778.82</td>
<td>$788.36</td>
</tr>
<tr>
<td>Profit per lamb</td>
<td>$1.37</td>
<td>$1.27</td>
<td>$1.44</td>
<td>$1.40</td>
<td>$1.60</td>
<td>$1.86</td>
<td>$1.60</td>
</tr>
</tbody>
</table>

Value of feed based on following prices: Corn, $1.25 cwt.; barley, $0.95 cwt.; alfalfa hay, $7.50 ton; pressed beet pulp, $1.75 ton; and beet tops are figured @ $0.50 per ton yield of beets.

* Fed field cured beet tops first month while waiting for silage.

Performance of Ewes Bred First As Lambs Compared With Ewes Bred First As Yearlings

Data have been collected on Hampshire ewes born during an 8-year period. One hundred nineteen pairs were studied. Pairing was based on age, weight, and family relationship. One of each pair was to be bred first as a lamb at the age of 9 or 10 months and the other first as a yearling at the age of 18 or 19 months. Eighty-four of the 119 exposed to breeding as lambs actually conceived. This group of 84 was designated group A and [22]
the 35 that failed to conceive as lambs were designated as group B. Their pair mates were classified as groups C and D, respectively. Performance was followed for 5 years.

Conception as lambs resulted in lighter weight of ewes at 2 years of age, but this deficiency was overcome by the third year.

Group A produced 89 lambs at 14 to 16 months of age. Total lambs born in groups A, B, C, and D were 427, 135, 370, and 140, respectively, and the totals reared to weaning were 305, 92, 255, and 102.

Average weaning weights of lambs in the 4 groups were 67.0, 68.2, 70.1, and 70.0 pounds, respectively. The average weaning weight of lambs from group A in the first year was 54.3 pounds, the lightest of any group of lambs. Group A produced a total of 2,572 pounds more lambs at weaning than group C.

Average annual fleece weights of the ewes in the groups were 7.9, 8.3, 8.2, and 8.0 pounds, respectively.

On the basis of the findings reported, the practice of breeding ewes for the first time as lambs is recommended. The data show that this practice, under farm flock conditions, resulted in a material increase in total lamb production, with only a small decrease in wool production.
Dairy Production

New Facts Discovered About Bloat in Cattle

Unless farmers can be assured that pasturing legumes will not result in unexpected death of one or more animals they will be reluctant to pasture legumes, even though the experimental results show excellent returns from legume pastures.

In this project the work for the past year has consisted largely of determining the cause of death when cows are bloated. The results to date have indicated that the following gases are present in the rumen of cows when not bloated: Carbon dioxide, methane, carbon monoxide and hydrogen sulphide. The last two gases are present in small quantities. These gases are highly toxic, and if they should be absorbed in the systemic blood, would cause immediate death by paralyzing the respiratory center.

In line with these hypotheses we are injecting small quantities of these gases in the rumen of experimental cows from which previous blood samples have been taken. Blood samples are taken after each injection of gas to note any change in its composition. Any physiological changes occurring, such as great distress, increased respiration, and cessation of peristalsis of the rumen, are noted. It is hoped that these trials will disclose which gas or gases are responsible for the death of the animal. With this information, a study of an antidote, or preventive measures, may lead to a solution of the bloat problem.

The work to date has revealed several hitherto unknown facts:
(1) The gases present and the percentage of each in the rumen of normal animals, or animals on feeds which do not ordinarily produce bloat. (2) The gases produced by legumes and other plants when the gases are generated in the laboratory. (3) The gases present and the percent of each in the rumen of bloated animals. (4) The pressure produced in the rumen when animals are bloated. (5) That pressure of the gases in the rumen is not the direct cause of death from bloat.
(6) Pressure due to the gases which collect in the rumen are indirectly responsible for the absorption of the toxic gases. These gases are thrown off through the excretory channels under normal conditions. (7) Cows vary in their resistance to the gases injected into the rumen.

One station circular, No. 27, and two technical articles have been published on these trials. (Project 17. Leader: T. M. Olson, Dairy Department.)
Legume-Sorghum Silage Tested for Milk Cows

This is the second trial in which the sorghum-alfalfa silage was compared to corn silage for dairy cows. Because of insufficient moisture during the latter part of the summer not enough green alfalfa was available to adequately fill the silo to provide sorghum-alfalfa silage enough to complete the second 30-day feeding trials.

Twenty-four cows were used in the trial, and divided into two equal groups. Each group was equal in total milk production, and contained animals of the four major breeds. The cows were weighed on three successive days at the beginning and close of the 30-day trial. The cows were allowed out in a dry lot whenever the weather conditions permitted.

The cows were fed alfalfa hay at the rate of one pound of alfalfa hay for every 100 pounds of live weight, and three pounds of silage for every 100 pounds of live weight. The grain was fed according to milk production. The refused feed was weighed back at regular intervals.

The 12 cows on corn silage produced 10,566.3 pounds of milk and 517.16 pounds of fat, as compared to 10,763.2 pounds of milk and 434.83 pounds of fat on sorghum-alfalfa silage.

Average weights of the 12 cows at the beginning and close of the corn silage feeding period was 1,201.9 pounds and 1,172.1 pounds, respectively. The 29-pound loss in average weight is considered significant.

Average weights at the beginning and close of the sorghum-alfalfa silage period were 1,219.1 pounds and 1,175.4 pounds, respectively. The total decrease is greater than for the corn silage feeding period. When the weights of the individual cows at the beginning and close of the trial are compared, there is a smaller average decrease in weight.

This experiment will be continued for one more year, when it is hoped to have sufficient alfalfa-sorghum silage to continue the trial for 60 days. The trials to date justify the following conclusions:

1. Sorghum can be ensiled with alfalfa to produce a desirable silage.
2. Sorghum-alfalfa silage is not as palatable as corn silage. It does not have to the same degree the desirable acid aroma characteristic of good corn silage.
3. The third cutting alfalfa, which has been used in these trials, is too mature before the sorghum is fit to ensile. This fact probably increases the fiber of the sorghum-alfalfa silage.
4. The two trials have indicated that sorghum-alfalfa silage is equal to corn silage for milk production.
5. The sorghum-alfalfa silage does not maintain the weight of the cows as well as corn silage. However, in neither case was the decrease great. (Project 89. Leader: T. M. Olson, Dairy Department.)
Test Sorghum and Corn Stovers for Milk Cows

Four heavy milking cows were chosen for this trial. Two were started on ground corn and alfalfa hay and the other two on Sooner milo and alfalfa hay. The ration was balanced as nearly as practical with these two feeds.

The Jersey cow 190 would not consume an adequate amount of ground milo to meet the requirements, and as a consequence she dropped in milk production. After she became accustomed to the Sooner milo she ate 10 pounds daily, which was sufficient to meet requirements. The cows were weighed on three successive days at 10-day intervals. They were permitted to exercise in a dry lot when the weather was fit.

The two cows which started the trial on ground corn and alfalfa produced an average of 1,257.35 pounds of milk and 48.66 pounds of fat for the first and third 30-day periods as compared to 1,267.5 pounds of milk and 50.68 pounds of fat for the second or Sooner milo feeding period. This indicated that there was no significant difference in the feeding value of corn and milo. The number of pounds of grain and alfalfa fed was the same throughout the experiment.

The two cows which started the series of trials on Sooner milo produced an average of 944.2 pounds of milk and 44.21 pounds of fat on the milo, as compared to 1,014.2 pounds of milk and 46.96 pounds of fat during the corn feeding period. The small increase of milk and fat on the corn feeding period over the average of the two Sooner milo feeding periods can be attributed to the change in grain, rather than any difference in nutritive value of the two grains.

In averaging the production of all cows on Sooner milo and corn, there was an advantage in favor of the corn periods of 372.99 pounds of milk and 5.28 pounds of fat. Inasmuch as one Holstein cow which started on the corn was the heaviest milk producer of the four cows, this difference is not significant.

There was no significant change in weight of the cows during the 90-day feeding period. The results of this trial indicate that there is no significant difference in the nutritive value of yellow corn and Sooner milo for milk production or maintenance of weight of dairy cows. (Project 100. Leader: T. M. Olson, Dairy Department.)

How Fine Should Grain Be Ground for Milk Cows?

From the work of this experiment, the results reported by other stations, and the observations of practical dairymen, it can be stated that the food value of the harder grains with smooth, glossy seed coats, such as corn, is increased more by grinding than is the case with softer grains.
having rougher hulls such as oats. Smoothness and hardness seem to be more important than mere thickness of the hull. More of the hard smooth grains pass through the digestive processes without being broken open or penetrated by the digestive juices; hence, more of the food value escapes into the manure. Chemical analysis of whole kernels appearing in the manure shows that practically none of the food value has been removed.

Dairy calves and heifers under one year seem to prefer whole grain. They chew it until it is well broken up which makes complete digestion possible. Older cows, however, find ground grain more palatable, especially corn and other grains with hard seed coats. To insure complete digestion it seems to be necessary to merely break up the kernel into several portions so that the interior parts are exposed to the digestive processes. Nothing further is gained by the increased cost in time and money required for fine grinding. Furthermore, the finely ground grain is less palatable for dairy cows, and there is likely to be more loss in feeding, especially if it is handled outdoors where it is exposed to the wind.

From the standpoint of the food value obtained, palatability, cost, and ease of mixing and handling, the medium grinding of grain which is just sufficient to break up the kernels into several portions is the best practice in preparing grain for dairy cows. The results of this project have been included in Station Circular 34, "How Fine Should Grain Be Ground for Milk Cows?" (Project 56. Leaders: T. M. Olson and G. C. Wallis, Dairy Department.)

**Milk Production Not Affected by Grinding**

Four fresh cows were chosen for the second trial of this experiment. The cows were fed for three 20-day periods a ration of ground oats and corn, equal number of pounds, and an equal number of pounds of alfalfa hay. Both the fine and coarse ground oats and corn were fed. A 10-day digestion trial was conducted for the last 10 days of each period.

Two of the four cows were started on the coarse ground grain, two on the fine ground grain. At the close of the 20-day period the cows were changed to fine and coarse ground grains. At the close of the second 20-day period they were receiving the grain the same as in the first period.

The production in the first and third periods is averaged, and compared to the second period, thus the normal decline in milk, due to advancing lactation is provided for.

The two cows which started on the coarsely ground grain averaged 481.02 pounds of milk and 21.51 pounds of fat, as against 512.6 pounds
of milk and 22.04 pounds of fat for the period on finely ground grain. The total amount of feed fed remained the same throughout the three periods.

The two cows which started on the finely ground grain, produced an average for the first and third periods of 430.9 pounds of milk and 19.0 pounds of fat, as against 442.2 pounds of milk and 18.9 pounds of fat on the coarse. This is a slight advantage for the coarse ground grain in milk production, but in favor of the finely ground grain for fat. The increase or decrease is so small that no great significance can be ascribed to it. The ration remained the same throughout the three periods.

The cows were weighed for three successive days at the beginning of each 20-day period. The following table shows the average weight at the beginning of each period.

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>150</th>
<th>438</th>
<th>439</th>
<th>263</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
</tr>
<tr>
<td>First period</td>
<td>1058</td>
<td>1188</td>
<td>1265</td>
<td>1258</td>
</tr>
<tr>
<td>Second period</td>
<td>1072</td>
<td>1195</td>
<td>1233</td>
<td>1233</td>
</tr>
<tr>
<td>Third period</td>
<td>1036</td>
<td>1215</td>
<td>1305</td>
<td>1232</td>
</tr>
</tbody>
</table>

There was no significant difference or trend in the weight of the cows. The first two cows started on the coarsely ground grain, the last two on the finely ground. The analysis of the feeds and feces for the digestion trials have not been completed. However, the dairy farmer is more concerned with the total ration fed and that was the same throughout the trials.

The results of these trials seem to indicate:
1. No significant effect on milk production, whether fine or coarse grain is fed.
2. The degree of fineness of the grain has no effect on the weight of the cows.
3. Observations indicated that the cows preferred the coarsely ground grain.
4. A 1/16 inch screen was used for the finely ground grain, and a 3/4 inch screen for the coarsely ground grain.
5. The cost of grinding the grain fine is 2 to 3 times as much as coarse grinding. (Project 88. Leader: T. M. Olson, Dairy Department.)

**Weed Flavors in Dairy Products Studied**

_This year_ peppergrass was secured from Davison and Walworth counties, onions from Walworth county, and French weeds from
Brookings county and Park River, N. D. The primary purpose in the experiment was to identify the flavors of these weeds in butter. There is considerable difference of opinion on the exact flavor resulting from these weeds. Official butter judges do not agree as to the exact flavor produced by each weed. To clarify this point varying quantities of these weeds were fed to three grade cows, and their milk separated and the cream churned.

Four ounce sample jars of the butter were sent to the Dairy Department, Ames, Iowa, and to the Federal Butter Graders at Chicago, for scoring. One set of samples remained in our hardening room for scoring.

The results so far seem to indicate that French weed produces a pronounced flavor and odor in the milk, cream and butter. It is much more objectionable than the flavors from either onion, or peppergrass. The flavor in butter due to French weeds is distinctive enough to be readily identified.

The flavor due to feeding wild onion tops is distinctive and can be readily identified but it is not so objectionable as the French weed.

The experimental results from the peppergrass is in accordance with previous findings, but the station results are not in agreement with the reports from the industry throughout the state. Creamery operators are convinced that peppergress produces flavors that are objectionable, and that are impossible to remove from the cream. Our findings do not confirm these experiences. In trials the cows ate the peppergrass about as readily as a good quality grass. When the peppergrass arrived at the station in fresh condition, only slight flavors were discerned in the cream and butter, and occasionally no flavor at all was found. (Project 75. Leader: T. M. Olson, Dairy Department.)

Factors Affecting Vitamin A and D Content of Roughages

How can roughages with greater food value be produced for South Dakota dairy cows? Some of the answers to this question are being discovered as the work of this project progresses. For instance, the results of the past year's work indicated a rather striking difference in the final vitamin D content between samples of second cutting alfalfa hay cured under favorable July sunshine and samples from a third cutting cured under good fall sunshine of mid-September. Hay from the third cutting in September contained between 2,000 and 2,500 International units of vitamin D per pound which was practically four times as much as the July second cutting.

If such a wide difference as this is common, the information would be of great importance to stockmen. One season's work is not sufficient for drawing final conclusions, hence further studies are being planned to
see if third cutting alfalfa always contains more vitamin D than second cutting and what the reasons may be for these variations. Measurement of the vitamin A (carotene) content of the above samples revealed only relatively small differences for this vitamin in samples with comparable curing history.

Several other factors concerned with securing a good quality roughage of high food value were indicated by curing separate portions of one field of alfalfa hay in the swath, windrow, and cock respectively. In this case it was found that for as long as the first day of curing the vitamin A (carotene) in the swath-cured hay was as great as in the windrow and cock, but after that the losses were more rapid. Furthermore, preliminary results indicate that considerably more vitamin D activity developed in the cock-cured hay as compared with the hay cured in the swath and windrow than would ordinarily be expected.

There were also some interesting differences in the rate at which moisture was lost from the hay under the three methods of curing. For instance, at the end of the second day there was 39.6 percent moisture in the swath-cured hay and 37.7 percent in the windrow that was left unturned. At noon of the second day a part of one windrow was turned and a sample taken from this in the evening contained only 15.9 percent moisture.

Using the information now at hand, plans are being made to try various combinations of curing practices in an effort to find a method that will be speedy, and practical which will at the same time insure a hay high in both vitamin A and D and of otherwise good quality. Studies with other types of roughages are also contemplated as soon as general principles have been worked out on alfalfa. (Project 41. Leader: G. C. Wallis, Dairy Department.)

**Breeds Are Compared in Vitamin D Study**

For the third time butterfat from a Jersey cow has been found to contain more vitamin D than from a Holstein cow receiving the same vitamin D intake. Samples were taken from both animals at monthly intervals throughout the lactation period while the cows received a known amount of vitamin D in the alfalfa hay which was fed at a constant level for the entire lactation period. The butterfat from the Jersey was about 50 percent higher than the Holstein in the first part of the lactation period but the difference became smaller toward the end. The Jersey butterfat varied in vitamin D content between 0.22 and 0.35 International units of vitamin D per gram. The higher butterfat test of the Jersey milk coupled with this higher vita-
min D potency would tend to make the vitamin D content per quart still more favorable to the Jersey. It should be remembered that in this case both cows received the same vitamin D intake.

Under usual herd feeding conditions Holsteins would be expected to eat more roughage than Jerseys. As roughages constitute the main source of vitamin D for dairy cows during the winter this would give the Holsteins a larger vitamin D intake and what effect this would have on the potency of the milk and butterfat is not definitely known. Neither is it known as yet what effect summer sunshine would have on the vitamin D potency of the butterfat from the two breeds. Information on these questions may be obtained in future experiments.

The higher vitamin D content of the Jersey butterfat undoubtedly results from the fact that the blood plasma of the Jersey cow was found to be somewhat higher in vitamin D than that of the Holstein. These blood plasma samples were an added feature in the study this year. They were taken at the same time that the monthly butterfat samples were saved. The blood of the Jersey contained more vitamin D in preliminary tests while the cows were receiving usual herd management. This difference continued at about 50 percent more for the Jersey until toward the end of the lactation when the difference was somewhat smaller. Why the blood plasma of the Jersey should be higher in vitamin D than the Holstein on the same intake can not be answered from the results of this experiment to date. During the experiment proper the Jersey plasma contained about 3.50 to 4.00 International units of vitamin D per cubic centimeter.

The vitamin D content of these butterfat samples is being determined by the use of a modified method which gives more accurate results with fats and oils of relatively low potency. Considerable effort was expended this past year in developing the new method. It consists of modifying the mineral portion of the test diet for the rats at the time the butterfat feeding starts. The minerals are adjusted so that each rat continues to get the same total intake as well as the same ratio of calcium to phosphorus in spite of the lower food consumption during the test period because of the large fat content of the ration. This practically prevents initiation of healing by large intakes of supposedly inert fats and oils and avoids an increase in the amount of healing obtained when known amounts of vitamin D are fed along with these fats and oils. This method was tried out on vegetable oils and a sample of butterfat from a vitamin D deficient cow which presumably contained little or no vitamin D.

Information from three pairs of Jersey and Holstein cows is now nearly assembled. This will be studied carefully to determine what
points have been established definitely enough to serve as a basis for further investigations on the relation of breed, feeding, and management of dairy cows to the vitamin D potency of milk and dairy products. (Project 47. Leader: G. C. Wallis, Dairy Department.)

Vitamin D Deficiency Studies in Dairy Cows

The conditions under which the profitableness and efficiency of dairy cattle may be interfered with by the development of a vitamin D deficiency have been more definitely determined by the work of the past season. Two cows have been fed more than twice the required calcium and phosphorus (mineral) intake while being maintained on the vitamin D deficient ration. In spite of this liberal mineral intake these cows developed all the usual symptoms of a vitamin D deficiency so it seems quite evident that for dairy cows a large mineral intake will not prevent the disasters resulting from a shortage of vitamin D.

The deficiency symptoms became severe on one of these cows last fall and she had to be turned out to try the healing effects of fall sunshine on October 25. She was giving 25 to 30 pounds of milk at this time which increased her vitamin D requirements but nevertheless the late fall and winter sunshine was effective enough to restore her essentially to normal in a month to six weeks time. The other cow had to be turned out on April 27 and we are now studying the effects of spring and summer sunshine on this animal. She is responding satisfactorily. These observations give direct evidence of the usability of sunshine in curing and preventing a vitamin D deficiency of dairy cows. The effectiveness of late fall and winter sunshine was greater than has been commonly supposed providing the weather is not so severe as to prevent the animals from being outdoors.

Some idea of the amount of vitamin D required by a dairy cow was obtained when two cows suffering from a deficiency were given 2 pounds of alfalfa hay daily for a short period of time. The hay contained 2,500 International units of vitamin D per pound making a total of 5,000 units daily. The stiffness soon disappeared and the appetite and milk production improved. The calcium and inorganic phosphorous of the blood returned toward normal. Figures are not yet available as to the effect on the vitamin D content of the blood and butterfat and on the ability of the cows to utilize the minerals in their rations to better advantage.

To be certain that the ration and conditions were complete for these cows in all respects except for vitamin D, one cow has been fed a cod-liver oil concentrate along with regular vitamin D deficient ration during
most of the experiment. The amount of vitamin D in the blood plasma of this cow receiving a well-known amount of vitamin D has been determined at frequent intervals and will be compared with the amount found in the plasma of other cows as a result of sunshine exposure during the coming summer. This will give a very interesting indirect measure of the value of sunshine as an antirachitic agent.

The concentration of magnesium in the blood plasma of these cows has been determined throughout the year. The magnesium concentration has remained at normal levels regardless of wide variations in the concentration of total calcium and inorganic phosphorus during the development and recovery from a vitamin D deficiency.

Other phases will be studied during the coming year so that a complete statement may eventually be made as to the conditions under which a vitamin D deficiency may be expected, what the various effects and symptoms may be, and how it may be prevented and cured. (Project 55. Leader: G. C. Wallis, Dairy Department.)

Holding Cream For Buttermaking

This work is a study of the problem of how to handle cream in the creamery when it must be held for about two days. Many creameries receive cream Saturday evening until 10 or 11 o'clock. Care of this late received cream differs and the best method of handling has not been determined. Large central creameries have made Sunday one of the heaviest work days in order to avoid holding cream from Saturday to Monday. Most local creameries hold the cream. Some neutralize, pasteurize, cool and hold, while others merely cool and hold.

Both first and second grade cream was used in these trials. The first grade cream was all less than 0.6 percent in acidity. The first series ranged from 0.19 to 0.49 percent and the second series ranged from 0.48 to 0.60 percent. The second grade cream ranged from 0.68 to 0.78 percent and had definite off-flavors.

Three portions (20 gallons each) were used from one lot of cream. These portions are identified thus:

A—churned fresh; B—held pasteurized 48 hours; C—held raw 48 hours.

All portions were handled alike when neutralized and pasteurized. Acidity was reduced to 0.18 percent and conditions of pasteurization were 160°F. for 20 minutes.

Starter was used in the first grade cream of 0.48 to 0.60 percent acidity. Six percent was used in that churned fresh and one percent in that held 48 hours. The starter butter showed slightly higher fresh butter
scores even though the cream acidity was somewhat higher than non-starter butter made from first grade cream.

Bacterial counts were made on the raw cream and on the cream of the A, B, C lots just before churning. Highest counts were those of the starter butter as was expected.

Cream holding methods influenced the types of organisms found. Cream held pasteurized 48 hours had more lipolytic bacteria and more of these churnings had lipolytic organisms. Proteolytic bacteria were also present in somewhat greater numbers in the “B” cream. The starter cream showed more proteolytics than the non-starter and appeared to lower butter quality. Counts on butter showed no significant difference in the three methods of cream handling.

Butter pH was determined electrometrically and the average of all samples was 6.96 (range 6.47 to 7.4). Judged by pH of the butter there was some tendency to use proportionately more neutralizer with the high acid cream. The flavor criticism “neutralizer” showed no correlation with pH of butter, appearing as often in butter below 6.8 as it did in butter above 7.0.

Results indicate that the method of holding cream is not particularly important although a slight advantage in holding raw may be expected. It should be pointed out that in this work the raw cream was mixed in one lot including the A, B, C portions. If cream were held raw in the original container and were showered with cold water or properly refrigerated, results might be different. (Project 76. Leader: D. H. Jacobsen, Dairy Department.)

Livestock Diseases, Parasites and Poisoning

Can Arsenic Prevent Selenium Poisoning?

When it was realized that the cause of “Alkali” disease was a toxic mineral, selenium, much work was done to find out where this element occurred and how it was obtained by animals.

At present it is known that grains, grasses, garden produce, milk, eggs, certain meats, and in a few cases even water may contribute selenium to the diets of the people and the livestock in the selenium areas. Usually the trouble cannot be attributed to any one plant or any one source of food, but to a combination of several foods raised in that area.

At the present time there is little hope of raising crops which are free from this toxic element where selenium occurs in the soil. It is true
that certain plants take up far less selenium than others, but in general most plants which occur in seleniferous areas will contain some selenium.

The problem then has developed into a search for some means of counteracting or preventing the toxic effects of selenium. In other words a search is being made to find a way for ranchers to continue living in those areas, producing crops and livestock at a profit without endangering their health or financial independence.

Several years ago it was observed at this Station that a high level of milk protein (casein) in the diet helped to prevent the poisonous effects of selenium. During the past year the work has shown that linseed meal is even better. Dogs receiving a ration containing 10 parts of selenium in a million parts of ration will die ordinarily in about three months. If 20 percent of linseed meal (old process) is included in the diet the dogs will live indefinitely. The same holds true for rats. Rats receiving linseed meal will live indefinitely while those receiving most other protein supplements will die in five to seven weeks.

Other proteins which are somewhat less effective yet show some beneficial effects are casein (milk protein) and dried beef liver. Cottonseed meal, soybean meal and corn gluten, have little or no beneficial effects while tankage, sardine meal and meat scraps seem to make matters worse instead of better.

Why some proteins are so effective while others not only fail to give protection against selenium but even go so far as to increase the toxicity of selenium, is not known at the present time. Work is being extended to find out the reasons for these differences. Because of the species difference in response to the proteins it will be necessary to carry the studies on to include farm animals before definite recommendations can be made to farmers.

About four years ago it was discovered at this Station that small amounts of arsenic would prevent the toxic effects of selenium in rats. Since that time the work with arsenic has been carried on with dogs and hogs and at present an experiment is underway with cattle to determine whether or not arsenic will prevent them from becoming "alkalied." This experiment is now in its third year and the results are very promising. Steers which have been receiving 25 parts per million of arsenic in their salt have gained about 150 pounds more than those which did not receive arsenic in their salt. They have also showed but few of the typical symptoms of the "alkali" disease, while those which did not receive the arsenic have all been more or less lame and stiff and have shed their hoofs every fall. The result has been so striking that the ranchers living in the vicinity of the experimental ranch (Reed ranch north of Presho, South Dakota) have asked for the salt mixture for their cattle. Several of the ranchers have been using the mixture for about a year.
and are well pleased with the results. So far all of the work on the Reed Ranch has been with steers, but they are being sold and heifers bought at the present time, and it is planned to continue the work with the arsenic-salt mixture to determine the influence of the arsenic on reproduction of cattle in a seleniferous area.

Eight head of steers were slaughtered after they had been grazing on seleniferous vegetation for 15 months. Samples of meat, blood and of the various organs were taken and analyzed for selenium and the results indicated that none of the organs or tissues contained selenium in quantities large enough to be harmful if eaten in ordinary amounts. If, however, a family living in a seleniferous area produces its own meat, milk, eggs and vegetables there is likely to be danger of consuming enough selenium to be detrimental to the health of the members of the family.

Dr. Ray E. Lemley of Rapid City, South Dakota, has been studying selenium poisoning in the human and has found several cases among families living on farms or ranches in highly seleniferous areas. This Station has cooperated with Dr. Lemley in the study and treatment of these human cases of selenium poisoning.

In the laboratory, two sulfur-containing compounds have been isolated from the blood taken from the steers slaughtered after they had been on seleniferous range for 15 months. The two compounds were glutathione and thioneine. Good evidence was found that some of the sulfur of blood glutathione is replaced by selenium in these animals, but there is no indication that any of the sulfur of blood thioneine is replaced by selenium under the same conditions.

The search for other elements which might be as effective as arsenic in preventing selenium poisoning has continued. It has been found that germanium and gallium, both of which are very close to arsenic in the periodic table, are ineffective. Studies on the mechanism by which arsenic acts are likewise still in progress. The work to date indicates that arsenic hinders the absorption of selenium from the intestinal tract.

The selenium content of range grasses and plants was investigated for the third year on the Reed Ranch. A map is being prepared to show the variations in selenium content of western wheat grass over the four pastures on the ranch. For the third year western wheat grass (Agropyron smithii) absorbed more selenium than any of the other range grasses. (Project 19. Leaders: A. L. Moxon, H. D. Anderson and O. E. Olson, Station Chemistry Department.)

Chenopodium Eradicates Worms in Lambs

Lamb producers and feeders are all confronted with at least one major problem and that is how best to eliminate or eradicate worms in lambs.
Copper sulfate-nicotine sulfate used as a drench is the usual method employed and lambs often are given this treatment every three to six weeks while on pasture. The lambs must be starved 24 hours before worming and kept from feed six hours thereafter. The solution used is poisonous and considerable care must be exercised in giving the correct dosage.

From a previous experiment on the college pure-bred lambs the year before it was found that chenopodium added to the creep fed ration eliminated the use of copper sulfate-nicotine sulfate solution. It was evident that the chenopodium fed was, at least, partly responsible for the eradication of the parasites usually present.

This year's work consists of three feeding trials with two groups of lambs creep-fed on pasture and one group of feeder lambs.

On May 30, 1940, an experiment was started to compare the chopped chenopodium plant added to the creep fed ration and the usual copper sulfate-nicotine sulfate treatment on the college pure-bred lambs.

Two uniform lots of 22 and 23 lambs were selected. Lot 1 received no treatment other than the addition of chopped chenopodium to the ration as follows: 5 parts oats, 2 parts corn, 2 parts chenopodium, 1 part linseed oil meal.

Lot 2 was wormed as needed with the usual copper sulfate-nicotine sulfate solution and fed the following ration: 5 parts oats, 2 parts corn, 1 part linseed oil meal.

Records of weights of feed consumed and gains in weights of the lambs were kept at 28-day intervals. Both lots received similar treatment as to pasture conditions and supplemental feed for the ewes.

The lot receiving chenopodium made much more efficient gains than the lot treated with copper sulfate-nicotine sulfate.

The addition of approximately 13 percent of chopped chenopodium to the ration reduced the feed consumption for 100 pounds gain 37 percent when compared with the lot receiving the usual copper sulfate-nicotine sulfate treatment and no chenopodium.

Second Trial. The second trial was started on July 3 using crossbred lambs. The same procedure was carried out as in the first trial except that the lambs were divided into three uniform lots.

Lot 1 received no treatment and was fed a ration of oats, corn, and linseed meal.

Lot 2 was wormed with the copper sulfate-nicotine sulfate solution and fed the same ration as Lot 1.

Lot 3 received no treatment other than that chopped chenopodium was mixed with the oats, corn, and linseed meal ration.

The results of this second trial show that chopped chenopodium added to the ration in the amount of 25 percent reduced the feed consumed 30 percent over the lot which received no treatment, and 15 per-
cent over the lot treated with copper sulfate-nicotine sulfate. Consistently lower feed requirements have been evident in all trials conducted.

The lower feed requirement in the lots receiving chenopodium is likely due in part to a decrease in worm infestation and it would seem to indicate that the chenopodium is of a high feed value or influences the nutritional value of other feeds.

Because of the excellent results obtained, it is planned to run a trial on turkeys and chickens. By so doing results can be checked on smaller animals and obtain quicker results at a small cost. If the same excellent results are obtained on poultry, various extractions on the chenopodium plants will be made to determine the fraction that is responsible for the efficient gains. If the feeding of chenopodium to poultry is effective it may prove to be of inestimable value to poultry, sheep, and swine producers.

**Feeder Lambs.** On October 8, 1940, 40 lambs were obtained and divided into four uniform lots of 10 lambs each.

Lot 1. Wormed with copper sulfate-nicotine sulfate and fed chopped chenopodium, corn and alfalfa.

Lot 2. Not treated in any way, but fed chopped chenopodium, corn, and alfalfa.

Lot 3. Wormed with copper sulfate-nicotine sulfate and fed corn and alfalfa.


The greatest value in feeding chopped chenopodium to feeder lambs is that it reduces the feed consumption and costs. The addition of 20 percent of chopped chenopodium to the grain ration reduced the corn consumption approximately 14 percent and the alfalfa consumption approximately 12 percent.

This reduction of feed consumption on the feeder lambs is not as great as in the case of nursing lambs probably due to the fact that older lambs have reached the stage where worm infestation does not greatly retard normal gains. Lambs of this age apparently have a tendency to expel internal parasites without the aid of treatment.

**Plants Grown in 1940.** Two varieties of chenopodium were planted in 1940, namely: (1) Hybrid, a cross developed at this Station between the Maryland and a wild variety found growing in Kansas, (2) Maryland. The germination was excellent, the growing season favorable, and more than a sufficient amount harvested to carry on feeding trials.

**Cultural Development.** The cultural development of chenopodium in South Dakota requires more study than it has been possible to give thus far. Selection of plants and the collection of seed from plants which contain a high percentage of good quality oil should be started.

Plots on which chenopodium was grown last year had an excellent
stand of volunteer plants. Seed sown directly in several plots germinated well and a good stand of chenopodium was obtained. These plots had to be thinned out as the plants were too thick for normal growth. Chenopodium is a hardy plant and will grow in almost every type of soil we have as well as stand adverse weather conditions. Plants were set out at the Sub-stations at Vivian and Highmore this year.

**Distillation.** Several batches of chenopodium were cut and distilled between September 10 and October 12. The ascaridol content ranged from 44 to 52 percent when run according to the U.S.P. XI method. (Project 20. Leaders: Floyd J. LeBlanc and Guilford Gross, Pharmacy Division, and Turner Wright and James Watson, Animal Husbandry Department, cooperating.)

**Seek Antidote for Oat Hay Poisoning?**

Oat hay poisoning or nitrate poisoning has caused the loss of a large number of cattle in South Dakota and other Great Plains states during the past few years, but still there is no explanation for the high concentration of nitrates in oat plants which cause the trouble. It is only under certain undetermined conditions that the plants accumulate these high concentrations of nitrates.

During the past year we studied the affect of molybdenum, arsenic, and manganese on the nitrate content of Richland oat seedlings in water culture solutions. Molybdenum was found to be definitely toxic to the seedlings at all concentrations studied, while arsenic stimulated plant growth in concentrations up to 0.25 parts per million. Concentrations above 0.25 parts per million were toxic. Seedlings grown in manganese deficient solutions were extremely high in nitrate content. Oat plants grown in pots under drouthy conditions were also high in nitrate content.

So far the work indicates that any condition which depresses the growth of the oat plants also tends to raise the nitrate content of the plants. There also appears to be a correlation between nitrate concentration and protein synthesis in the plants.

The rate of formation and disappearance of methemoglobin in laboratory animals was studied. In dogs the maximum concentration of methemoglobin occurred about 80 minutes after injection of sodium nitrite. The effect of a number of compounds on the rate of disappearance of methemoglobin was studied in a search for a practical antidote for nitrate poisoning. This work is being continued with a few compounds which show some promise. (Project 87. Leaders: A. L. Moxon, O. E. Olson and H. D. Anderson, Station Chemistry Department.)
Poultry Production

Sorghums and Proso Millets Tested for Turkeys

The production of sorghums in South Dakota has made rapid growth during the past few years. Turkey production has also increased considerably. In 1939 more than a million birds were produced. South Dakota now ranks 10th in the United States in number of turkeys annually produced.

Experiments dealing with the utilization of milo, feterita, and cane were started in 1939. Because of its adaptability and early maturity, proso millet was also included in these studies. Tests during the last year were conducted with two objectives in mind; first to determine the comparative feeding values and growth rates obtained from each of these grains when fed in hoppers, and secondly to determine whether or not it would be practical to allow turkeys to harvest the grains by pasturing them as soon as they were matured.

Sorghums and Millet in Starting Rations. Several all-mash starting rations were fed to turkeys during the first eight weeks. Three trials included levels of 34.5 percent of either ground milo, feterita, or millet, added to the basal starting mash which included the following: 18 pounds of pulverized oats, 10 pounds each of meat and bone scraps, fish meal, soybean meal, and dried buttermilk, 5 pounds of alfalfa leaf meal, 1½ pounds of chick-size granite grit, and ½ pound each of manganized salt and cod liver oil concentrate, total 65.5 pounds. The control ration included the same basal starting mixture, but instead of using 34.5 pounds of ground yellow corn, only 18 pounds of ground corn were used with 16.5 pounds of ground wheat. This particular control ration previously had given unusually good results. Three trials also included the addition of 34.5 percent of whole millet to the basal mash instead of ground millet. In addition, two trials included a comparison of ground amber cane and corn used in starting mashes. Still other trials included the feeding of scratch grain consisting of either whole milo, feterita, or Red Proso millet along with the starting mash containing the same grain.

The control ration and the starting mashes including either milo, feterita, or proso millet produced equal growth when fed to turkeys during the first eight weeks.

The growth obtained from the ration having 34.5 percent of whole millet was equal to that obtained with the mash containing the same level of ground millet. Starting mashes utilizing ground amber cane proved as good as the control ration which included yellow corn and wheat.

[40]
When either cracked corn, whole milo, whole feterita, or whole proso millet was fed in hoppers with the starting mash, beginning at four weeks, the rate of growth was decreased. In some lots, the mortality was increased slightly when scratch grain was added. From these results, it would appear desirable to either feed an all-mash starting ration or feed the scratch grain sparingly during the first eight weeks if maximum growth and viability are desired.

**Hopper-Fed Sorghums in Growing Rations.** In the experiments involving the hopper feeding of sorghums, the following simple basal mash mixture was used: Ground oats 30 pounds, meat and bone scraps 18, dried buttermilk 5, alfalfa leaf meal 5, and salt 1 pound. To this mixture was added 41 pounds of either yellow corn, feterita, or Sooner milo. The same grain that was used in the mash was also fed as the only grain in hoppers. The yellow corn was fed cracked until the birds were 16 weeks of age, after which it was fed whole. All other grains were fed whole throughout the test periods. A second trial included the same basal mash mixture, added to which was either amber cane or low prussic acid variety of cane.

The first trial, with 85 turkeys in each lot, covered a period beginning when the turkeys were eight weeks of age and ending at 24½ weeks. The number of pounds of feed required to produce a pound of gain in weight was 4.56 for the turkeys receiving yellow corn. This was given a value of 100. For the milo 4.79 pounds were required, while 4.78 pounds of feterita were needed to produce a pound of live turkey during the growing period. The feeding values of milo and feterita were calculated to be 95 percent that of yellow corn.

The turkeys receiving feterita grew just as fast as those receiving corn, but those receiving milo weighed about ½ pound less per bird. These differences in growth rate may not be considered significant. Further work is necessary.

The second trial covered the age period from 8 to 20 weeks. The very bad November snow storm made it necessary to discontinue this prematurely. The results from feeding cane for this 12-week growing period probably give a good indication of its feeding value. With the feeding value of corn being 100, Dakota Amber cane’s value was 95, and the low prussic acid cane had a value of 92. There were no appreciable differences in the live weights of the turkeys at 20 weeks of age.

**Pasture-Fed Sorghums.** Turkeys were grown to 10 weeks of age at the Station Farm, Brookings, and were then moved to the North Central Substation (Eureka). They were divided into three groups with 67 or 68 birds in each lot. Each lot was fed the same mash mixture, consisting of 40 pounds of ground yellow corn, 30 ground oats, 18 meat and bone scraps, 5 dried buttermilk, 6 alfalfa leaf meal, and 1 pound of salt.
“TURKEYING-OFF” AMBER CANE

Sorghums were pasture-fed to turkeys at the North Central Substation farm at Eureka with satisfactory results.

One lot received yellow corn in hoppers in addition to the mash. The second lot was given proso millet for the first 5½ weeks, after which Sooner milo was substituted for the millet for a 5½-week period. Amber cane was used to replace the milo during a third period, which was five weeks in length. Each of these grains was kept before the birds in hoppers in addition to the mash mixture. A third lot (Group 3) received the same mash mixture as the other two lots. This group was allowed to pasture proso millet grain for the first 5½-week period and no grain was fed in hoppers. During the second feeding period, Group 3 had access to Sooner milo pasture, but because of low yields some milo was also hopper-fed. During the final five-week feeding period, this group of birds was confined to amber cane pasture. At the end of each feeding period, all the birds were individually weighed and feed consumption determined. At the conclusion of the third feeding period, all the turkeys were graded and marketed.

There were no appreciable differences between the growth-rates or market grades of the turkeys receiving the yellow corn and those receiving millet, milo, and cane in hoppers. With the pasture-fed group, the growth rate for the millet feeding period was practically equal to that of the corn-fed group. For the pasture feeding period, involving either milo or cane, the rate of growth was not quite so good as the growth obtained from either the corn or hopper-fed sorghum groups. It is believed that these small differences were due to a shortage of milo and cane pasture during the last week of the two feeding periods. Further experiments are being conducted.
Feed Grinding Costs May Be Reduced. Two mash mixtures were fed for the period when turkeys were 8 to 26 weeks of age. Seventy-four poults were used in each lot. The control mash mixture included about 20 percent protein, while the other mixture included about 29 percent protein. The control mixture was comprised of 41 pounds of yellow corn, 30 ground oats, 18 meat and bone scraps, 5 each of dried buttermilk and alfalfa leaf meal, and one pound salt. (Total 100 pounds.) The mash mixture having 29 percent protein, included 23 pounds of ground yellow corn, 20 ground oats, 36 meat and bone scraps, 10 each of dried buttermilk and alfalfa leaf meal, and one percent salt. Equal parts of corn and oats were kept before the birds in both groups, in addition to oyster shells and grit.

About 48 percent of the total feed consumed by the turkeys receiving the 20-percent protein ration was scratch grain, while 58 percent of the 29 percent protein ration was scratch grain. In other words, the turkeys receiving the lower protein ration consumed an average of seven more pounds of mash per bird. It took 5.3 pounds of the control ration to produce a pound of live weight while 5.1 pounds of the other ration were required. The rate of growth was practically the same for both lots. (Project 79. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

Hatchability of Turkey Eggs Studied

In recent years, the West North Central area has become an important center of turkey production, and there is a growing tendency to keep over breeding flocks for the production of hatching eggs instead of having eggs shipped in from other areas. Great differences in hatchability have been reported by farmers and hatcherymen. With many flocks the hatchability is very low. There is comparatively little information available on the causes of low hatchability in turkey eggs.

These experiments were confined to a study of feeds and their effects on hatchability. Twenty-five turkey breeders were used in each of six lots. The hens were the native strain produced by the Agricultural Experiment Station. They were mated to toms of the broad breast strain which were obtained from a western breeder.

The control ration included a mash mixture which was fed one lot with yellow corn and oats given free-choice. A second lot was given the control ration and all the alfalfa silage they would consume. A third lot received all the liquid buttermilk they would consume in addition to the control ration. A fourth group was given 10 percent of liver meal to replace the same amount of meat and bone scraps in the control ration.
Lot 5 received the formula of an all-mash turkey breeder ration which is commonly used at the Beltsville Research Center, Md. The feeds for this mixture were obtained from local elevators in Brookings, S. D. Lot 6 received the same formula as Lot 5 except that the feeds were sent to Brookings from Washington, D. C. This was an established ration fed for the purpose of determining whether South Dakota feeds or formulas were responsible for the poor hatchability that had been obtained in previous years. Two other lots of turkeys included both males and females from the Western broad breast strain, the same strain as the males used in the first six groups. These two lots were fed the control mash and grain mixture with two modifications. One lot received 10 percent of sardine fish meal in place of the same amount of meat and bone scraps, while the second lot received 10 percent of liver meal instead of this percentage of meat scraps.

The feeding period for all lots began January 4 and ended April 19. The following results were obtained with five hatches set at two-week intervals.

<table>
<thead>
<tr>
<th>Ration Variable</th>
<th>Av. No. Eggs Produced Per Hen</th>
<th>Total No. Eggs Incubated</th>
<th>Percentage Hatch of Fertile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native hens, broad breast toms</td>
<td>41.4</td>
<td>821</td>
<td>75.5</td>
</tr>
<tr>
<td>Control ration (Lot 1)</td>
<td>45.0</td>
<td>883</td>
<td>72.3</td>
</tr>
<tr>
<td>Washington all-mash formula, Washington feeds (Lot 3)</td>
<td>38.1</td>
<td>725</td>
<td>76.7</td>
</tr>
<tr>
<td>Washington all-mash formula, South Dakota feeds (Lot 4)</td>
<td>36.5</td>
<td>716</td>
<td>75.4</td>
</tr>
<tr>
<td>10% liver meal (Lot 5)</td>
<td>42.2</td>
<td>839</td>
<td>73.3</td>
</tr>
<tr>
<td>Control ration plus liquid buttermilk (Lot 6)</td>
<td>36.0</td>
<td>672</td>
<td>76.6</td>
</tr>
<tr>
<td>Broad breast hens and toms</td>
<td>47.2</td>
<td>754</td>
<td>63.3</td>
</tr>
<tr>
<td>10% fish meal plus silage (Lot 7)</td>
<td>35.8</td>
<td>622</td>
<td>72.4</td>
</tr>
</tbody>
</table>

* The turkeys receiving the Washington formula with Washington feeds hatched poorly for the first two hatches. This is probably due to the fact that cod liver oil was omitted through a misunderstanding. When the averages for the last three hatches are considered, however, the hatchability of fertile eggs was as follows: Lot 1, 64 percent; Lot 2, 50; Lot 3, 65; Lot 4, 65; Lot 5, 60; Lot 6, 60; Lot 7, 44; and Lot 8, 50 percent.

Slightly better egg production was secured when mash and grain was used instead of the all-mash rations. It is doubtful, however, that these differences are significant.

The results of this experiment indicate that no improvement in hatchability could be obtained over the control ration when alfalfa silage or liquid buttermilk is used. Liver meal also proved ineffective. The breeder ration that was used in Washington with excellent results gave no better hatchability than the control ration.

The strain of broad breast hens and toms when mated together did
not give as good hatchability as when broad breast toms were used with native hens. Fertility was also lower in one group. Further work involving different supplements is in progress. (Project 96. Leaders: W. E. Poley and W. O. Wilson, Poultry Department; A. L. Moxon and H. D. Anderson, Station Chemistry Department; and J. B. Taylor, Veterinary Department.)

Selenium Effects Checked by Linseed Meal

Cereal grains containing selenium are produced in some areas of South Dakota. Past experiments have shown that starting, growing, and laying rations should contain not more than five parts per million of selenium. This will provide a reasonable margin of safety. Cereal grains may be readily analyzed at the Experiment Station Chemistry Department to determine the quantities of grain that can be safely used.

More recent experiments included the use of different protein supplements such as soybean meal, cottonseed meal, linseed meal, dried buttermilk, and meat and bone scraps. Each of these feeds was included in an all-mash starting ration fed for the first eight weeks. The starting mash included about 11 parts per million of selenium, this level of selenium having previously given very poor growth and health.

No appreciable benefits were obtained from the use of either 20 percent soybean meal, 10 percent cottonseed meal, 15 percent dried buttermilk, or 15 percent meat and bone scraps. A 5 percent level of linseed meal produced the best growth when used in the toxic ration. Efforts are now being made to determine the factor in linseed meal that may be responsible. (Project 28. Leaders: W. E. Poley, W. O. Wilson, Poultry Department; A. L. Moxon and H. D. Anderson, Station Chemistry Department; and J. B. Taylor, Veterinary Department.)

Grain Varieties May Affect Egg, Poultry Quality

The production of poultry meat in South Dakota is nearly as important to the farmer as the production of eggs. About $5,000,000 worth of poultry meat is produced annually. The poultry industry is in need of more adequate methods of grading live and dressed poultry. Market grades should be closely associated with the amount of fleshing. Various physical measurements of different parts of the carcass are being taken with the view of obtaining measurements which will give a reliable indication of the amount of flesh and fat present.

The percentage of fat in the total edible meat in roasters and fowls was found to be correlated significantly with the thickness of the fat in
the cervical and pectoral feather tracts. Other important correlations were found to exist between the dressed weight and observed grade, the calculated breast volume and weight of edible meat, and fleshing index and total edible meat. These measurements are only applicable to dressed birds.

**Grading Dial Makes Market Meat Selection Easy.** Measurements with live birds were made using turkeys in preliminary trials. Shank length, body depth, and live weights were taken according to the recommendations of Jaap of the Oklahoma Experiment Station. A grading dial was made at the South Dakota Station, utilizing these measurements. It is felt that turkey growers will be much more likely to make use of the standards set up for market quality in turkeys when this grading dial is made available, as it provides a method of scoring birds according to meat type.

The main advantages of this grading dial may be listed as follows: (1) Measurements are easy to apply, and dependable, (2) A uniform description of market meat quality is provided, (3) The breeder can select his birds according to definite quality standards, (4) The progress made in a breeding program to improve meat quality may be easily measured. Efforts will be continued so that simple, easily applied, dependable measurements of market meat type may be made available for chickens.

**Individual Cereals and Combinations Used in Laying Rations.** Large quantities of either corn, wheat, or barley were fed in laying rations containing about 32 percent protein. The results from feeding these individual grains were compared with the results obtained when all three of these grains were fed free-choice with either a 20 percent protein mash or a concentrate including 32 percent protein. Seven lots of 30 Rhode Island Red pullets each were started in the first of two trials which covered a laying period of 40 weeks.

<table>
<thead>
<tr>
<th>Average Number of Eggs Produced per Bird for the Test Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAYING HOUSE NO. 1</td>
</tr>
<tr>
<td>20% protein mash Whole corn, wheat, and barley</td>
</tr>
<tr>
<td>26% protein mash Whole corn, wheat, and barley</td>
</tr>
<tr>
<td>32% protein mash Whole corn, wheat, and barley</td>
</tr>
<tr>
<td>No. of eggs</td>
</tr>
<tr>
<td>92.8</td>
</tr>
<tr>
<td>96.4</td>
</tr>
<tr>
<td>97.3</td>
</tr>
<tr>
<td>LAYING HOUSE NO. 2</td>
</tr>
<tr>
<td>20% protein mash Whole corn, wheat and barley</td>
</tr>
<tr>
<td>32% protein mash Whole corn</td>
</tr>
<tr>
<td>32% protein mash Whole wheat</td>
</tr>
<tr>
<td>32% protein mash Whole barley</td>
</tr>
<tr>
<td>No. of eggs</td>
</tr>
<tr>
<td>93.2</td>
</tr>
<tr>
<td>88.9</td>
</tr>
<tr>
<td>97.2</td>
</tr>
<tr>
<td>86.3</td>
</tr>
</tbody>
</table>

[46]
Definite conclusions cannot be made from the results of the first trial as it will be noted the differences in egg production were not large. The results of Trial 2 are not yet available. Further work will be necessary. (Project 52. Leaders: W. O. Wilson; R. L. Dolecek, Physicist: W. E. Poley, Poultry Department.)

Low Grade Grains Can Be Fed Successfully

Corn, wheat, and barley are the most commonly used grains for poultry in South Dakota. In 1939, these three grains amounted to about 75 percent of the value of all the principal grains produced in South Dakota. Variable soil and climatic conditions produce wide differences in the qualities of grain grown in different localities of the North Central area. Lack of sufficient rainfall probably has the most important influence on the production of light-weight cereals with a high percentage of shrunken or damaged kernels. Consequently, there are considerable differences in market values, and it is particularly desirable to know the comparative feeding values and the extent to which light-weight grains can be satisfactorily used for poultry feeding.

The starting all-mash rations included three grades of Manchurian-type barley and two grades of Trebi barley, each fed to chicks at a level of 44 percent for the first two weeks.

Tests with growing rations included three grades of Trebi barley fed at a 52-percent level. The same grade of barley that was used in the mash was also fed as the only whole grain. Both mash and grain were kept in hoppers before the birds for the duration of the trial (12 weeks).

The laying rations tested included two grades of yellow corn, three grades of Mindum wheat, and three grades of Trebi barley, fed at a level of 49 percent. The same quality and variety of grain that was used in the mash was also kept in hoppers before the birds. All birds were weighed at regular intervals and records of feed consumption were kept.

The amounts of feed required to produce a pound of gain in live weight, and the feed needed to produce a dozen eggs were calculated for each grade of grain used. Also, the comparative rates of growth and egg production were determined. The feed requirements for the light-weight corn, wheat, and barley are reported with the best grade of each of these grains given a value of 100, and the values of the lower grades compared as to the percentage of 100.
From the results obtained, it is evident that in only two trials involving the medium grade barley weighing 42 pounds per bushel was the feeding efficiency appreciably lower than for the higher grades of grain used in the starting, growing, and laying rations tested. In most other trials, the amounts of feed required to produce a pound of gain were practically equal with three noteworthy exceptions where less lightweight barley and wheat were required. The rate of growth and the number of eggs produced were practically equal when the lightweight grains are compared with the heavier, better quality grains used.

These experiments confirm previous findings and show that one is not justified in paying premium prices for top-quality corn, wheat, and barley. Large percentages of these lightweight grains can be satisfactorily used in properly supplemented starting, growing, and laying rations, and one can expect practically as good growth, egg production, and hatchability as can be obtained from the use of grains having higher test weights per bushel.

It is recommended that if large quantities of lightweight grains are on hand they may be fed sparingly at first and the amounts gradually increased as the birds become accustomed to them. Feed them along with adequate protein, vitamin, and mineral supplements, the same as would be used with heavier grains.

It should be emphasized that these experiments did not involve diseased or moldy grains. There are many different kinds of molds, and it would be a difficult task to carry controlled tests on their feeding values. For a complete report of extensive experiments covering a period of four years, see Bulletin No. 353 of the South Dakota Agricultural Experiment Station, 1941, entitled, "Feeding Values of High- and Low-Test Weight Grains for Chickens." (Project 53. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)
Fruits and Vegetables

Many new seedling fruits, roses, other ornamentals and vegetables are coming on, which will be released as soon as they are deemed worthy of propagation. Some of them are offered primarily for distribution to plant-breeders to help in the work of improving hardy fruits and roses elsewhere.

New Ornamentals Being Introduced

Plants of the following were distributed for the first time in the spring of 1941.

Hidatsa: A Hardy Double-Flowered Hawthorn. In England, Hawthorn hedges are one of the greatest charms of the rural landscape. This species, Crataegus oxyacantha, is native of Europe and North Africa and is not hardy enough for the prairie Northwest. There are a number of varieties in England of which the best is Paul’s Double Scarlet Hawthorn. Several years ago, this variety was crossed with the native wild Hawthorn of Pilot Mound, Manitoba. A number of seedlings were obtained that are very ornamental. Hidatsa, the first to be offered, has abundant double light shell pink flowers. The glossy attractive foliage with each sprig provides a “beautiful, ready-made corsage.” (Hidatsa: a Sioux Indian tribe.)

New Hardy Roses Are Developed. Plants were distributed of the new Pax thornless roses and the Lillian Gibson rose, introduced in 1938. Pedigree: Wild rose (Rosa blanda) from Wilton, northern Minnesota x Red Star (a red Hybrid Tea) pollen. This rose has proved to be very productive; a strong sprout planted in 1938 bore 31 flowers in 1939 and about 237 in 1940, and 240 in 1941. The flowers are large, double, over 40 petals, a beautiful lively rose pink, about three inches across with delightful rich fragrance. A very abundant bloomer in late June. Plant of strong upright sturdy growth. The plant is sparsely thorny on young shoots, with scattered thorns on the old shoots. (Project 2. Leader: N. E. Hansen, Horticulture Department.)

Fruit Breeding Is Progressing

Out of 37 acres of the Hansen Bushcherry, Prunus Besseyi, of the fourteenth generation under cultivation, the best seedlings were numbered and budded on native plum in 1938 and 1939. Most of these selections will be used for a new budded plantation. Seventy-seven of these new selections together with three older selections were sent out in 1940 as one-year buds for preliminary trial and as a basis for further experiments. These numbered, budded bushcherries are highly productive.
In addition there are 10 named bushcherries. The nine varieties listed in South Dakota Agr. Exp. Sta. Bulletin 309, and the Sioux, are available in small numbers budded on native plum.

The 37 acres of Hansen Bushcherry were cleared in the fall of 1940, and the ground made ready for the plants of the fifteenth generation. Part of this area was filled with plants of the fifteenth generation under cultivation. The remainder of the area is being summer fallowed for plants in the spring of 1942.

*New Apples and Crabapples.* The blizzard of Armistice day 1941 caused an estimated loss of $1,500,000 in the orchards of several of the western prairie states, ranging as far south as Kansas and northern Missouri. This disaster emphasizes the importance of greater hardiness in apples; also that apples must be bred to ripen early in the fall. The greatest damage appeared to be further south where the wood was not ripe when the freeze came. More frequently injury to apple trees comes from root-killing of the French crab roots or stocks grown from commercial apples of southern origin. At this Station stock experiments have been under way for many years with the Siberian crabapple to prevent root-killing. The Anoka, bred at this Station, survived the freeze, because of the early ripening of the wood.

*Fruit Tree Diseases Are Studied.* An isolate of *Erwinia amylovora* was pathogenic to Selenga, Krylov, Sladkey, Finsib, Yermak, and Tanya pears when the pathogen was applied in moist cheese cloth wicks wrapped around young twigs from which several leaves had been removed. Glassine bags served to keep the wicks moist. The work was done in the greenhouse.

An inspection of the Sioux Falls orchard containing the named apple varieties developed by the Station revealed an absence of scab on all sorts. Fire blight was present only on the Wecota variety. Aecia of cedar apple rust was found on the Goldo, Tipi, Kola, Wetonka, Mercer Crab, Zapta and Shoko varieties and on an unnamed Mercer crab selection.

In the Watertown sand cherry seedling orchard, selected seedlings varied markedly in susceptibility to brown rot and a leaf spot which was not finally diagnosed.

Two seasons’ observations have revealed that the sand cherry, *Prunus Besseyi*, is very susceptible to plum pocket caused by a species of *Taphrina*. Since no spray work has been reported for this host, such an experiment has been planned for the coming season. (Project 1. Leader: N. E. Hansen, Horticulture Department and W. F. Buchholtz, Plant Pathology Department.)

[50]
A Color Break in Wild Roses

The "Red Red Rose," celebrated by the poet Robert Burns, has arrived finally for South Dakota planters. For many years attempts have been made to get away from the light mauve or purplish pink, or lavender pink of the wild rose (Rosa blanda) as found in the prairie Northwest, especially South Dakota, North Dakota, Minnesota and Manitoba. After producing thousands of hybrids, the long expected "break" came in June 1941. Several seedlings flowered for the first time, with colors ranging through various shades of red, including cerise and crimson. The two-color and scarlet, it is hoped, will appear in the near future. The new roses, some of them quite smooth in wood, will be propagated as rapidly as possible for trial elsewhere. (Project 23. Leader: N. E. Hansen, Horticulture Department.)

Breeding Hardy Apricots with Sweet Kernels

The general name Manchu was given to the apricots brought by N. E. Hansen in 1924 from a 50° below zero region at Harbin, North China. They form the basis of an important new industry. In the spring of 1936 twelve of the original 45 seedlings were named as follows: Sing, Ninguta, Chow, Sino, Lalin, Sansin, Tola, Hulan, Anda, Manchu, Mandarin, Zun. They are now widely distributed across the continent and are in extensive propagation. These apricots are of strong growth, fully twice that of plum trees. They are extremely drought resistant, and also are annual bearers. Several acres of their seedlings have been planted for further selection. The main effort is to hybridize them with the best and largest sweet kernel apricots of the Orient as grown in California.

Siberian Apricot. A distinctly different species from the Manchu apricots released from this Station in 1937, the Siberian apricot is an interesting ornamental shrub or small tree, around 10 feet high and 10 feet across; flowers appear early, white to light pink; leaves round ovate, long-pointed; fruit inedible, and flesh splitting into two leathery parts. Linnaeus named it Prunus Sibirica; later authors classify it as a sub-species of the common apricot, Prunus Armeniaca, Linn. var. Sibirica, Koch. The greatest value of this species may be as a nursery understock for the Manchu apricots. In budding in nursery they unite in an apparently perfect union. It should cause earlier bearing as it is more dwarf in growth than the tall-growing Manchu apricots. In addition it has much ornamental value as the small trees are loaded with blossoms.

The Siberian apricot was collected in two places in East Asia. The Shilka Siberian apricot is from Shilka, East Siberia, an area with a min-
imum low winter temperature of -67°F. The Mendo Siberian apricot is from Mendochino, north Manchuria, in the Great Khingan Mountains. (Project 58. Leader: N. E. Hansen, Horticulture Department.)

Breeding Triploid Apples from Tetraploids and Diploids

More triploid apples (with 51 chromosomes) are desirable because of higher vitamin C content, according to recent European research. Some of the best standard apples are triploids. Hitherto of unknown accidental origin, they are now made possible by breeding diploids (34 chromosomes) with tetraploids (64 chromosomes). The Kola crab, the first tetraploid with other seedlings of similar pedigree make this possible. It is expected that some triploids will appear in the new seedlings being produced each year. Many were transplanted in the spring of 1941. (Project 59. Leader: N. E. Hansen, Horticulture Department.)

Seek Sweet Tomatoes With Minimum Seeds

One hundred six selections of tomatoes were made in 1939 which were planted in 1940. These were from crosses made previously and represent the F₁ and F₄ generations. Twenty-six selections were made from these during the growing season of 1940. The Canadian Experiment Station at Morden cooperated in the variety trial work. During the winter Stokesdale variety was grown in the greenhouse to make Vitamin C studies. From these cuttings were made and are now planted for Vitamin C determination in the field.

One selection, given the name of Dakota Red, was released in the spring of 1941. The fruit possesses many characteristics desirable for tomatoes grown in the plains area. The plant assumes compact determinate growth habits, has medium to a light amount of foliage and was not attacked by diseases common to this area. Growing conditions were very unfavorable for tomatoes at Brookings in 1940. The report from Canada was more consistent with the results obtained at Brookings in 1939 than in 1940. Since last year was typical of what may occur in the plains area, this served as a basis for discarding some selections.

Vitamin C analyses were made of the fruit beginning with the first to mature continuing until the end of the season. Three analyses were made and the average considered as being characteristic. Dakota Red showed a high ascorbic acid content. Other seedlings show promise and were selected for 1941 planting. (Project 49. Leader: L. L. Davis, Horticulture Department.)
Tree Growth as Affected by Cultural Practices

Shelterbelt arrangement composed of Russian olive, caragana, green ash, American elm and Ponderosa pine was planted in such an arrangement as to give 21 units. Cultural practices consisted of cultivation throughout the summer in plots 1-4-7-10-13-16-19, cultivation in the fall with the weeds cut at intervals during the summer in plots 2-5-8-11-14-17-20, and no cultivation but weeds cut as needed in plots 3-6-9-12-15-18-21. Quantitative determinations were made for percent of total nitrogen, nitrate nitrogen PPM, organic matter and the pH value. The data for 1938, 1939 and 1940 were statistically analyzed.

Loss of Ponderosa pine was so great that data collected from their growth was considered inaccurate. Preliminary analysis of the data obtained seems to indicate that there is little benefit from one cultivation over no cultivation but considerable benefit of clean cultivation over either of the other treatments.

Soil samples were collected at 6-inch intervals to a depth of 3 feet. The data from soil analysis do show a significant difference in the quantity of total nitrogen, nitrate nitrogen PPM, or organic matter from 1938 to 1940. The pH value for these three years has not changed significantly. (Project 77. Leader: L. L. Davis, Horticulture Department.)

Progress Made in Hybrid Sweet Corn Work

Eighty commercial hybrids were used for this study. They were classified as producers of a few, a medium number, and many tillers. They were further classified according to the time of tiller development as early, medium-season, or late. The corn was planted in parallel rows of 10 hills each, with the tillers removed from one row.

The yield was not changed materially by the removal of tillers on plants having but few tillers. Those having a medium number and many tillers showed a very slight increase in yield when tillers were removed. The greatest yield came from lines having several tillers. This evidence is not conclusive but indicates that sweet corn for this area should have some 3-5 tillers per plant, and for varieties developing extremely early tillers should be avoided.

None of the samples suffered from drought during 1940 so that the influence of tillers in this respect could not be determined. Soil samples were collected from a depth of one foot and at comparable locations from hills with and without tillers. The combined capillary and hygroscopic water loss was not of sufficient magnitude to be of value though slightly greater near the hills bearing tillers.
Inbred Lines. Temperatures of 107°F., accompanied by a southwest wind, were reached on July 19 and 24. Much of the corn was injured by the intense heat. This offered an opportunity to group them into resistant and susceptible lines. During July many lines showed definite symptoms of weakness. On examination the lines showed diseased roots. No attempt was made to determine the exact causal agent but will be later in cooperation with the plant pathologist. The plants were grouped according to diseased and disease-free roots. There seemed to be much positive correlation between disease-free roots and resistance to heat.

Hybrids. A total of 909 inbred lines were collected from sweet corn breeders all over the country. These were observed for their heat resistance, and crosses were made from those showing greatest resistance. Of the 350 crosses made from these lines, only a few would tolerate the heat of 130°F. for five hours. Fifty-nine hybrids were selected for trial during 1941. Twenty were sent to the Sub-stations at Eureka and Highmore for trial.

Conclusions. Results of the experiment to date indicate the following facts:
1. A sweet corn selected for hybridization should carry from 3-5 tillers.
2. Excess tillering may increase the plants' water requirement.
3. A greater root system may be extensive enough to compensate for any increased water requirement caused by excess tillering.
4. The absence of tillers seems to delay maturity.
5. Most of the 909 inbred lines under observation are susceptible to severe injury at temperatures of 107°F.
6. Much of the disease of the root system is responsible for drouth susceptibility as well as causing the plant to offer little resistance to pull.
7. Artificial drouth can be used with a high degree of accuracy to supplement field drouth conditions.

Cause of Corn Smut Studied. Careful observations revealed that in some lines of sweet corn discolored mesocotyls, crowns, and secondary roots were more common than in others. In many instances such plants exhibited extreme drouth susceptibility in the field and laboratory.

After needle inoculation with Ustilago zeae, the corn smut fungus, sweet corn lines normally free of smut in the field became as heavily smutted as lines normally smutted in the field. (Project 68. Leaders: S. A. McCrory, Horticulture Department, and W. F. Buchholtz, Plant Pathology Department.)
State Substations

Experimental Work Is Expanded

In view of readjustments necessarily made in projects at the four outlying substations, it is being attempted to re-establish those Soil and Crop projects, bearing most directly upon the problems of field management within the areas represented. Obviously these problems differ both in kind and degree between the areas.

Range Field Station—Cottonwood

At the foregoing station a full-time foreman, Mr. Robert G. Smith, was employed by South Dakota Experiment Station. He was requested to put in crops for 1941 experimentally on three separate crop-systems on Pierre loam soil in the southwest quarter of the original section of the substation.

The crop-systems involved included (1) continuous crops (2) close seeded crop, for instance, feed oats or barley on either fallow or cultivated land for comparison (3) a long-term rotation which includes both corn and sorghum thus making it possible to use the land where feed crops are grown as a seed bed for succeeding crops. Obviously the use of such crop-systems may furnish data for determining how to produce the largest amounts of most suitable feed for livestock.

Additional crop-systems at Cottonwood provide for corn or sorghum in succession with other crops with a view to studying crop yields and also measuring changes in soil due to erosion and possible changes in fertility. Measurement of such changes may help to define the effect of sorghum upon soil where it is produced.

Grass nurseries are continued at the Range Field Station in cooperation with the United States Soil Conservation Service. This nursery includes not only the principal native varieties of grass found in the Great Plains area but some additional introduced varieties. The comparison of these varieties in the nursery over a number of seasons will give an indication not only of productiveness but likewise survival of the native grasses.

Central Substation—Highmore

In 1941 three general divisions of cultivated land at Highmore were employed in a general crop system or three-year rotation. These were as follows: (1) corn and sorghum, (2) small grain and flax, (3) grasses and legumes.

Such an arrangement made it possible to secure an amount of information some of which consisted in observations which were fairly
general. These were as follows: (1) Comparison of growth of corn and sorghum under conditions of limited rainfall and considerable grasshopper injury. The advantage of sorghum over corn in resisting these difficult conditions was evident during the growing season. (2) A comparison of early, medium and late planting of corn. The advantage of the early planted corn over the medium or late planted corn was apparent. The date of earliest planting was May 3, second planting May 13, and third planting May 23. The yield of total forage from the earliest planting was 40% higher than the yield from the late planting by field weight. (3) Yields of small grain made it possible to compare production in pounds of feed for livestock from barley, including Spartan and Odessa and Richland oats. (4) A spring grain nursery in cooperation with the United States Cereal Office including oats, barley and wheat, and flax. (5) Comparison of fall and spring seeding of the following: Western wheat grass, crested wheat grass and alfalfa. (6) A nursery of forage crops including varieties of standard and introduced varieties of alfalfa, grasses and native plants not heretofore utilized for forage. (7) Observations of the effects of previous fertility treatments upon growth of grass for forage. These treatments included nitrogen, phosphorous, potassium and combinations of the same in comparison with no fertility application. (8) Tests of sorghum varieties including pasture trials of same. These latter are in charge of Department of Animal Husbandry and are reported on Page 7.

The work in Horticulture at the central substation consists of a vegetable and fruit planting started in the spring of 1941. Plans are in the making for establishing a shelterbelt to protect these plantings as well as the buildings. It was planned to determine the value of a snow fence in trapping moisture for the garden area. The more commonly planted vegetables were used in the spring garden, and some perennials were started. A block 132' x 135' was planted with fruit trees consisting of apples, plums, apricots and sand cherries.

North Central Substation—Eureka

Production of forage with planting corn and sorghum in alternate pairs of rows was continued experimentally in 1941. Seasonal conditions including an appreciable outbreak of grasshoppers caused the relatively greater resistance of sorghum over corn to these seasonal injuries to be strongly indicated. It was observed that the method of planting corn and sorghum in alternate pairs of rows may result in a degree of stabilization of forage crop yields and of grain produced thereon.

Corn breeding of "Eureka-corn" with the use of ear row selection was continued in 1941 which is the 15th year of the trial. It is quite definite that the process of ear row selection at Eureka over a long term of years has produced a characteristic variety of very early corn
adapted to north central South Dakota and no doubt to other northern locations. A comparison of yields of grain from corn and sorghum at Eureka up to date indicates that corn has produced higher yields per acre of grain than sorghum. Evidently both crops will continue to have a place in the production of forage in north central South Dakota.

Within recent years a number of the comparative crop rotations were greatly simplified and others abandoned for lack of funds. A number of the comparative rotations, however, were partially reconstructed in 1941. These comparative rotations in due course will make it possible to find those which produce highest yields of forage for livestock and likewise to determine the best one designed to conserve soil fertility and prevent erosion.

In 1941 corn was planted at Eureka at early, medium and late dates in the spring. It is impossible at the present writing to state the optimum date of planting corn. Observations in the field indicate advantages of early planting over late.

Native grasses for hay were harvested in 1941 and yields thereof computed in order to compare such yields with those of other forage crops produced experimentally in representative sections of the area.

In May, 1941, a fruit planting of approximately four acres was made at the Substation. The land was terraced, and trees were planted on the contour. Shelter or protecting trees were distributed throughout this planting with the intention that they would serve as a windbreak and snow trap. Only the more hardy varieties of fruit trees were planted. The work at this Station will be expanded to include a vegetable planting in 1942.

West Central Substation—Vivian

The earliest trials with seeding corn and sorghum together for forage in alternate pairs of rows were carried on at this experiment farm in 1941. It was again possible to observe the stabilizing effect of thus seeding sorghum and corn together under somewhat difficult seasonal conditions, although in 1941 the yields of corn and sorghum harvested for silage and computed separately were more nearly equal than the average. The total field weight of silage from the experiment indicated, including corn + sorghum, in 1941 was 3,206 pounds, 1,296 pounds corn + 1,910 pounds sorghum. Yields of small grain including oats and barley for feed in rotation were highest in the history of the experiment farm. Richland oats produced 67 bushels per acre whereas 60-day oats produced 51 bushels per acre.

The method of seeding oats in the early spring (April 1, 1941) at the rate of one bushel per acre directly on a remaining thin stand of alfalfa in an old field was continued experimentally. In 1941 the yield of mixed alfalfa and oats hay (mostly oats) was one ton per acre. The observation
may be worth emphasis that old stands of alfalfa that have become too thin to be profitable in themselves may be considered too valuable to plow under in view of the possibility of utilizing them for the production of mixed hay for forage as indicated.

Grasses for forage seeded in the fall and spring were continued experimentally in 1941. The varieties of grass include western wheat, crested wheat and brome grass. These were in addition to alfalfa. Seven acres of crested wheat grass produced 400 pounds of seed or 57 pounds per acre. Said grass was seeded July 28, 1937. Western wheat grass seeded under comparable conditions on the same date produced in 1941 one ton of hay per acre field weight. Alfalfa seeded in the early fall, under similar conditions at nearly the same date, winter-killed. Similar alfalfa seeded the following spring produced 650 pounds of hay per acre in 1941.

The brome grass in the comparative experiment made a thin stand. Field observations in 1941 indicated that the species would apparently not survive and be productive under the conditions of west central experiment farm. That was apparently true even though the brome grass appeared more vigorous than any other stands that could be found in the area.
Crop Insects

Research Work With Grasshoppers

What are the facts concerning the red mites that are found attached to the wings, legs, and body of grasshoppers?

During the past few years, extensive and detailed work was done by the Station Entomology Department on the life cycle, feeding habits, and importance of the red grasshopper mite, *Eutrombidiurn trigonum* Herm. It was found that the mite passes through four stages, namely, the egg, larva, nymph, and adult. The eggs are laid in the ground, a single adult mite being capable of laying almost 10,000 eggs. The eggs hatch into six-legged larvae which try to attach themselves to the bodies or appendages of grasshoppers. Here they remain for about a week, feeding upon the blood of the grasshopper. The larvae then drop from the grasshopper, enter the ground, and molt, thus changing into eight-legged nymphs. The nymphs seek grasshopper egg masses and when they find such, each nymph sucks out the contents of a few grasshopper eggs. The nymphs now molt and change into adult mites. Adults, like the nymphs, also prefer to feed upon the contents of grasshopper eggs. However, neither nymphs nor adult mites are limited to grasshopper eggs for food, for they may feed upon the juices of other animals, or even dead organic matter. The winter is passed in the soil by the adult mites. One complete, and in addition, one partial generation of these mites are produced during the year.

Larval mites do not cause any serious harm to grasshoppers, but may interfere with efficient flight. A grasshopper whose wings are heavily infested with larval mites cannot close its wings fully, and this may result in damage to the wings when the grasshopper moves about.

Nymphal and adult mites do considerable harm to grasshopper egg masses, and when abundant, may reduce viable eggs in a field considerably. In other words, as larvae fastened to grasshoppers, the mite does little good so far as mankind is concerned; but as nymphs and adult mites, the grasshopper red mite is of considerable value to man.

Are there any insects whose immature stages feed inside of grasshopper eggs, and if so, what can a farmer expect from such insects so far as control of grasshoppers is concerned?

Through research work carried on in South Dakota, it was found that there are two different species of minute wasp-like insects that meet these requirements. Neither one of these insects has a common name,
but our most abundant species is called *Scelio calopteni* Riley. This parasite has destroyed as high as 20 percent of the eggs of the two-striped grasshopper in some sections of the state in some years. And it should be remembered that the two-striped grasshopper is one of our most harmful species of grasshoppers. In other years, however, the percent of eggs destroyed by this same parasite in these same areas has dropped below three percent.

How many different kinds of grasshoppers occur in South Dakota, and how can a layman find out just which species are doing harm to his crops?

Classification keys have now been prepared by means of which it is possible for the layman to identify any of the 115 different varieties and species of grasshoppers that are found in South Dakota. These species of grasshoppers differ from each other in body structure as much as do the different birds that we have in the state. Further, they frequently differ in their feeding habits, places where they lay their eggs, kinds of plants preferred for food, type of area inhabited, life cycle and seasonal cycle. (Project 18. Leader: H. C. Severin, Entomology Department.)

**Will Tillage Aid in Grasshopper Control?**

During the fall of 1939 the Station Entomology Department began a study of the effect of various tillage methods upon grasshopper populations. Working in cooperation with the Soil Conservation Service in the Winner and Hecla districts, tests were conducted to evaluate the effectiveness of the following methods for grasshopper control by egg destruction or prevention of hatching: Fall plowing, fall discing, fall cut-away discing, double discing, regular listing (spring and fall), and duck-foot type sub-surface cultivating.

Results of the first year's study are available in mimeographed form in Entomology Pamphlet No. 1, "Tillage Methods in Grasshopper Control," which was released in November, 1940.

In brief, the following approximate controls were obtained: In the Winner area, in edge of barley stubble, heavy soil—Boyd clay-loam (S. C. S.)—

Fall moldboard plowing (not recommended by the author for large blocks of land in central or western South Dakota because of soil blowing hazard), 100 percent control.

Fall discing (regular), 90 percent control.

Fall one-way discing (wheatland plow), 85 percent control.

Fall cut-away-disc discing, 36 percent control.

Spring sub-surface cultivation (duck foot type), 90 percent control.

Spring regular discing, 83 percent control.
Spring regular listing, below 10 percent control.

In the Winner area, in western wheatgrass sod, such as may be found in headlands and on roadsides—

One-way discing (wheatland plow), regular listing, double discing and moldboard plowing (latter not ordinarily recommended), all gave above 95 percent control.

In the Hecla area, idle land and wheat stubble, light sandy soil—Valentine sand (S. C. S.)—

Fall one-way discing (wheatland plow) not planted, 59 percent control.

Fall one-way discing followed by drilling of rye, 67 percent control. Moldboard plowing, 100 percent control. Plowing with moldboard removed, no control. Tandem discing, double, 50 percent control.

Subsequent experiments are expected to change somewhat the above figures.

During the present year in addition to continuing the work in the Winner and Hecla districts, experiments are being conducted near Chamberlain and in Baker Township, Davison County, the latter in conjunction with a rather well-publicized roadside tillage project in control of grasshoppers. A subsequent report will be issued on this particular project.

The two-year results of this project will be set forth in a progress report to be released during the late summer of 1941. (Project 86. Leader: G. B. Spawn, Entomology Department.)

Research Work on Blister Beetles

How far do blister beetles migrate? In an attempt to answer this question, several thousand blister beetles were caught, sprayed with bright colored lacquer and then liberated. Red, green, orange, and yellow lacquers were used in the experiment. Lacquered beetles were recovered from one to 11 days after they were liberated, and as far away as five miles from the point of liberation. One may conclude from these experiments that blister beetles that were produced in one area may invade another area from one to five miles or more away.

Are pasture lands adjacent to beet fields infested with first instar blister beetle larvae? If so, how abundant may the overwintering larvae become in such locations? Pasture land one and two miles removed from any beet or potato field was examined for first instar larvae of blister beetles at a time of year when it was known that the eggs of some of our common species of beetles were hatching. Blister beetle larvae were
found actively crawling over the ground at each point of examination. It was never necessary to examine any one area for a period longer than one or two minutes before finding the larvae. Pasture land was examined for overwintering coarctate larvae and pupae. A plot of pasture land four feet square was examined and all the coarctate larvae and pupae were counted. The numbers found totaled approximately 50,000 per acre or slightly more than one per square foot. One must conclude from these observations that immense numbers of blister beetles may be produced even on pasture or range lands and that many of these beetles may reach cultivated lands by migration.

Is it possible to protect crops by spraying or dusting them with a chemical of some kind? If so, what treatment has given the best results?

Several different insecticides were applied as a dust or spray to potato and sugar beet fields in the Belle Fourche area in an attempt to control blister beetles. The results of these experiments are indicated below:

**Paris Green**

On beets
- As a dust (1 part to 8 or 9 parts of lime)
  - good control in 3 fields
  - poor control in 1 field
- As a spray (4 lbs. in 50 gal. of water)
  - good control in 1 field of 30 acres
  - fair control in another field of 15 acres

On potatoes
- As a dust
  - good control in 2 patches

**Dutox and Barium fluosilicate**

On beets
- As a dust (1 part to 4 parts of flour)
  - no control in 1 field
  - no control on caged beetles

On potatoes
- As a dust (1 part to 4 parts of bentonite)
  - no control in 1 patch

**Pyrocide dust, 7 to 10 percent**

On beets
- Webworms: good control in 1 field. Also good control in garden of miscellaneous plants.
- Blister beetles: good control in 6 fields
  - fair control in 1 field
  - poor control in 1 field
POWER DUSTER USED TO FIGHT BLISTER BEETLES

This type of equipment is especially effective when the beets are small to medium sized. Six rows are dusted at a time with this method.

Derris, 1 percent Rotenone
   On potatoes
       no control in 3 patches, repelled beetles in one instance
   On beets
       no control in 1 field

Lime
   Dusted on beetles caged over sugar beets: no control
   Dusted on ¼ acre of potatoes: repelled beetles but no control

Copper arsenate
   As a dust (1 part to 3 parts of bentonite)
       on potatoes: no injury to plants, fair control; the beetles which were not killed left the plants and those plants remained uninfested until the plants matured.

Red River Mix
   As a dust on beets
       good control on 1 acre
   As a spray on potatoes
       good control on 1 patch
   As a dust on potatoes
       good control in 4 patches
       fair control or repelled in 4 patches

Miscellaneous garden plants
   good control in 3 gardens
   fair control in 1 garden

[63]
In explanation, the terms "good control," "fair control," and "poor control," indicate that when good control was obtained, 90 percent or more of the beetles were killed; with fair control, from 70 to 90 percent of the beetles were destroyed; and when poor control resulted, less than 70 percent of the beetles were killed.

Power dusters: The power duster shown in the illustration is mounted on a trailer ready to be drawn through the field by a team of horses. Six rows are dusted at a time by means of such equipment. This is a good piece of equipment as long as the beets are small to medium sized. Care must be taken, however, to avoid running over rows of beets. After the beets are large, it is impossible to draw such an apparatus through the field without doing considerable damage to the plants. For this reason it was desirable to determine if the crop might be protected by some other method of application.

Dusting with airplane: It was found that such a method could be used if necessary to protect the crop when the plants are large. It is also very rapid and the cost not prohibitive.

Dusting with hand guns: The hand guns used were of the fan type. (Project 14. Leader: N. P. Larson, Entomology Department.)
Farm Engineering

Build And Test Rubber Tired Farm Trailers

The second part of this study was started this year and has to do with rubber tired trailers of various types that will be very serviceable on farms. The study included trailers, from the light single castor-wheel trailer for the farm automobile to the heavy dual wheel trailer that is pulled behind the farm tractor or truck.

Four homemade trailers were built and thoroughly tested during the year. They are: (1) A light one-wheeled castor-wheel trailer for the farm automobile, (2) a four-wheeled wagon box trailer for the farm with a simple hydraulically operated dump, (3) a heavy duty dual-wheel trailer with a tilting platform for transporting heavy machinery and equipment that can be pulled behind the farm tractor, and (4) a light two-wheeled marketing trailer for the farm car.

These trailers were also studied from the standpoint of balance, springing, length of tongue and trailing ability. Plans were drawn and instructions for making these trailers prepared and published in Station Bulletin 349. Additional studies were made of the effect of pulling these trailers behind the car upon fuel consumption. (Project 73. Leader: H. H. DeLong, Agricultural Engineering Department.)

Does It Pay To Buy Galvanized Steel Fence Posts?

A total of 500 galvanized steel posts and 500 common painted steel fence posts were set in the fence lines of the college farms in 1925. These posts were of the same brand and were identical except for the protective covering used on them. The painted posts cost 35 cents each and the galvanized posts cost 50 cents or an additional 15 cents each. After 16 years of service the galvanized posts are still standing in the fence row. At this year’s inspection they still look good and the galvanized surface seems to be entirely intact but upon closer inspection they show a number of small blisters of pin head size. A few of these blisters have broken and rust is evident underneath.

Twenty of the painted steel posts have been left without any repainting. The paint is gone except for a trace. The color is black and the surface is rusting very badly.

Three hundred of the painted posts were repainted after seven years when fully one-half of the original paint was gone. One hundred were painted with a single coat of metallic zinc paint. After nine years these posts look good. The paint is still covering well and the color is bright.
One hundred were painted with a single coat of ordinary lead-oil painted drab gray in color to exactly match the metallic zinc paint. After nine years this paint is about 20 percent gone although the posts are not rusting badly as yet. The paint has faded and the posts are dull in appearance. They should be repainted and will be repainted this fall. One hundred posts were painted with a single coat of titanium-lead-oil paint with the color matching the others. This paint did not hold its color as well as the lead-oil paint. The color faded more quickly but it has covered and protected the surface quite satisfactorily. About 15 percent of this paint is now gone and the posts are dull and blotched in appearance. They will be repainted this fall. (Project 15. Leader: R. L. Patty, Agricultural Engineering Department.)

Conversion of Horse Machinery for Tractor Farming

A project was started this year to make a study of better utilization of horse-drawn machinery with the modern tractor. The rapid displacement of horses in South Dakota has been the cause for many machines to become discarded.

A horse-drawn mower was mounted on a tractor in such a manner that the power take off was used to drive the mower mechanism. This arrangement made it possible for the operator to have better control of the mower and its operation than trailing the mower behind the tractor. Special emphasis was placed on simplicity and low cost of construction. Further trials are to be made.

Projects for a suitable and practical method of mounting horse-drawn mowers seem entirely feasible. (Project 34. Leaders: L. F. Larsen and R. L. Patty, Agricultural Engineering Department.)

Experiments In The Use Of Rammed Earth Walls Continued

An experimental rammed earth poultry house was built on the North-Central Substation at Eureka using labor furnished by the National Youth Administration (N.Y.A.). The building is one story 20' x 40' outside dimension with 14-inch rammed earth walls. The building contains equipment for raising turkey poults and for housing adult turkeys for egg production and will be used in cooperation with an experimental project of turkey production by the Station Poultry Department. Numerous building practices were tested out in the construction of the house, some of them entirely new and some of them will be used as further checks against practices that have been tried before on a smaller scale.

Experimental walls were built in the yard for the purpose of determining the feasibility of using admixtures (other than sand) with ram-
med earth walls in order to increase their weather resistance. Only a few soils are sufficiently weather resistant when built into a wall to stand indefinitely as a bare wall. The use of certain admixtures no doubt will greatly increase this resistance. A wall was built of soil containing 75 percent of sand and an admixture of five percent of portland cement (by measure of volume) throughout the wall. Results already indicate that the wall will not be satisfactory and that five percent of portland cement is not enough to use as an admixture.

Three walls were built using an admixture of resistant material as a veneer (plated walls) on the outside surfaces only. The plating averages two inches in thickness and included soil-cement, sawdust-cement concrete, and a lignin by-product from paper manufacture. Methods of building-in this veneering was a part of this study.

The work on stucco and paint coverings was continued during the year and lacquer paints and ox blood paint were tried and have all failed within the 12-month period.

A second study on the effect of the shape of the rammer head used in building, on the transverse strength of the wall was completed. Cylindrical test pieces 8" x 16" were made by hand. The test pieces on knife-edge bearings and a 10-inch span carried an average load as follows: For flat rammer head 189 lbs., for sharp rammer head 266.7 lbs., and for medium rammer head 250.2 lbs. Since it is not customary to figure on any transverse strength in design, these strength figures proved entirely satisfactory and the figures for the work of the flat rammer which is by far the most practical to use were only 21 percent below that for the sharpest rammer head. The strength of these same test pieces in compression for the same soil, according to former tests would average 20,000 pounds. (Project 22. Leaders: R. L. Patty and H. H. DeLong, Agricultural Engineering Department.)

Tests of New Materials and Methods
For Farm Building Floors

Five additional new hard surfaced floors were built for comparison and study in poultry house pens during the year. These included one of soil-cement, one of stabilized adobe floor brick, one of lignin stabilizing admixture and two of oil-surfaced rammed earth. All of these top surfaces were placed over a foundation course of rammed earth. In the oiled-surfaced rammed earth floors the thickness and rate of oiling varied.

Three duplicate floors of oil-surfaced, and stabilized adobe floors were built outside and a straight rammed earth floor was also built outside. The soil-cement floor was built for testing on a larger scale in a 20 x 40
foot experimental rammed earth poultry house at the North Central Experimental Substation. Reports of the success of these floors will not be available for at least one more year of service. Types of floors under test from last year include sawdust-cement concrete, cinder concrete, plain concrete, asphalt-oil road surface and tar-oil road surface. (Project 83, Leaders: R. L. Patty and L. F. Larsen, Agricultural Engineering Department.)

Can Mechanical Injury to Barley Be Prevented?

This project, after the preliminary survey of 1939 which was reported in the 53rd annual station report, was closed in July 1940. A series of tests were run on a combine during the 1940 harvest season. This combine was equipped with a rasp bar cylinder and from the series of 13 tests with various cylinder speeds and various concave clearances, it was found that a cylinder speed of 5,000 to 5,800 feet per minute together with a concave spacing of 7/32 to 5/16 inch gave the best results. The cylinder speed is expressed in the linear feet per minute of travel of the rasp bar, and the clearance measurement is from the concave channel iron to the tips of the serrations on the cylinder rasp bar. A very close setting of the cylinder to the concaves ground up the straw too much and caused loss of grain by over loading chaffer, sieves and return.

Results of a more complete study of the subject are given in, “A Study of the Effects of Threshing Cylinder Types and Adjustments on the Mechanical Injury of Barley;” a thesis submitted to the graduate faculty of the University of Minnesota by Henry H. DeLong on November 16, 1941. While this work was not a part of the South Dakota Experiment Station activities, it is a more detailed and systematic work than was done in South Dakota in the summer of 1939. Three different types of cylinders were used at the same location, under similar conditions, in a very short space of time; thus removing many of the variable factors which made the former work inconclusive. A few of the paragraphs of the summary from this thesis will be quoted:

Previous investigational work on the threshing and combining of malting barley in Minnesota, North Dakota, and South Dakota has shown that all types of threshing cylinders can be made to thresh properly but that all types can also be made to damage too much grain when improperly set.

The purposes of the study were: (A) to find the best cylinder speed; (B) the best cylinder clearance; (C) the differences in cylinder types; and (D) observe all other major factors in threshing barley thoroughly without causing an excess of cracked or damaged kernels.

Tests with three types of cylinders showed that they all did their best work when operating at a peripheral speed of 5000-6000 feet per minute.
The clearance between cylinder part and concave part, for proper threshing, varied somewhat among the cylinder types. The rubber faced bar type required $\frac{1}{2}''$ to $\frac{3}{8}''$; the rasp bar, $\frac{7}{32}''$ to $\frac{1}{2}''$; and the spike-toothed, from $\frac{5}{32}''$ to $\frac{7}{32}''$. The smooth bar cylinder operates with a little more clearance.

Either the cylinder speed change or the concave clearance change may be used singly to make a minor adjustment, but for the most major changes both speed and clearance must be changed.

Tests showed that all three types of cylinders could be adjusted to thresh properly. On the other hand, all types could be set so that grain passed through unthreshed; or they could be set so that more than 5 percent of damaged kernels resulted. The rasp bar showed a slightly greater tendency to crack kernels than the rubber faced bar.

Both a quick change cylinder speed control and a quick change concave clearance control with calibrated dial are recommended for use on combines. (Project 84. Leaders: H. H. DeLong and L. F. Larsen, Agricultural Engineering Department.)

Rammed Earth Poultry House Work Continued

The roof was constructed and inside fixtures installed in a new rammed earth poultry house constructed by members of the Department of Agricultural Engineering. Moving pictures were taken showing the operation of the mechanical rammer which was developed in the Department of Agricultural Engineering. Several different type floors which had been installed were tried out during the winter months when turkey breeders were confined to this house. The results of this experiment are not yet available. (Project 35. Leaders: R. L. Patty, Agricultural Engineering Department and W. E. Poley, Poultry Department.)
Home Economics

Effect Of Wear On Wool And Part Wool Fabrics Studied

Actual wear tests of trousers made from wool and part wool fabrics were conducted during the year in an effort to determine the relative degrees of wear at various points, the relative wearability of the various weights of fabrics, and the effects of dry cleaning and storage upon suiting materials. Three weights of wool fabrics of types used for men's suits were purchased in sufficient yardage to allow for:

1. The tailoring of nine pair of trousers from each type of fabric.
2. Physical and chemical tests of the new fabrics.
3. Physical and chemical tests of the fabrics after dry cleaning and storage periods equivalent to the cleaning and service periods contemplated for the trousers.

Twenty-seven students at State College who cooperated in the wear tests were divided into nine groups depending on the length of time and weight of fabric in the trousers worn.

Each of these individuals has supplied certain information regarding his trouser-wear habits and activities affecting wear. In addition, each has indicated in detail his routine day.

From a tabulation of points of wear noted by the students cooperating, it appears that the areas over the pockets, the seat, and just above the knees are the principle points of wear.

Tests of new fabric, stored fabric, and dry-cleaned and stored fabric are to be made after 1500, 3000, and 4500 hour periods have elapsed. (Project 99. Leaders: Barbara Bailey and Edith M. Pierson, Home Economics Department.)

Flannel Materials From Wool Fibers Tested

In an effort to determine the effect of wear on flannel materials manufactured from different grades of wool fibers, 8 to 9 yard lengths of each of four flannel fabrics, which had been dyed navy blue, were made into 12 four-gore women's skirts to be worn by individuals during the fiscal year.

Records of hours worn, brushing, pressing, damage to garment, and commercial dry cleaning are being kept by each individual wearing one of the skirts. The skirts are inspected and dry cleaned after each 150 hours of wear. Each skirt is to be worn 1,000 hours, the length of time calculated to be equivalent to the wear a college girl will ordinarily give a skirt during a school year.

The dyed fabrics have been tested physically and chemically using standard procedures. Upon withdrawal from service each skirt will be
sampled and the physical and chemical properties of the worn fabrics determined. A comparison of new and worn fabrics and the effects of blending new and reprocessed wool in varying proportions will be indicated from the results. (Project 26. Leader: Barbara Bailey, Home Economics Department.)

**Kind And Variety Of Fruits And Vegetables Important In Freezing**

Not all kinds and varieties of fruits and vegetables respond well to freezing. Some excellent canning and market sorts suited to freezing in other states are not adapted to freezing in this state. Because of these facts and on account of the increased number of locker patrons seeking information concerning the care of fruits and vegetables for freezer locker storage, a study of the freezing qualities of varieties of different kinds grown in South Dakota was undertaken.

Varieties of different kinds of fruits and vegetables that were successful in other states were used in this study as well as varieties developed by the Horticulture Department of the Experiment Station. The products were grown by the Horticulture Department, thus insuring known varieties and definite times of harvesting. Quick freezing and storing were taken care of by a local locker plant and the products, after graded lengths of time in storage, were judged for quality by a tasting committee.

Three varieties of spinach were used; three of green beans and two of wax beans; 13 of corn; three of rhubarb; three of apricots; two of plums and one of sand cherries.

Results to date cover the three and six months storage periods and indicate that on the whole there is little change in the quality of the fruit or vegetable when frozen and stored for that length of time. Corn on the cob did not show up as well as corn cut from the cob according to the score of the judges. Out of a possible score of 20, corn cut from the cob was at least two points higher than corn on the cob. Varietal differences were shown in green beans; two varieties kept well for the six months period while the third variety did not.

Freezing retains rather than improves the quality of any product so the selection at proper maturity is more important for freezing than when selecting products for canning. Fruits and vegetables used for freezing should be of the highest quality. Vegetables must be table-ripe and tender. Fruits should be ripe enough for immediate use and yet not soft. Both fruits and vegetables should be processed and put in the freezer the same day they are harvested and as soon after picking as possible. (Project No. 98. Leaders: Minerva Kellogg and Edith M. Pierson, Home Economics Department.)
Farm Income and Community Welfare

Study ‘Why’ of Profits and Losses in South Dakota Ranching

For the last 10 years records kept in cooperation with ranchers in Northwestern South Dakota have been collected. Station workers have recently completed the analysis of these records and results have been published in Station Bulletin 352, “Profits and Losses in Ranching, Western South Dakota, 1931-40.”

From a consideration of the climate, land, water supply and grass the study indicated that an individual can be successful with either cattle or sheep, depending upon which he likes to work with best. Some few operators who are located in sections where the soil is fertile may find it profitable to farm some land to produce feed and, in some cases, cash crops. It is important to remember, however, that crop and feed production in this area is uncertain due to the great variation in precipitation. Also that while some winters are mild and open so cattle can be grazed nearly all winter others are cold and occasionally snow lays on the ground for over three months.

Operators who have been successful in this area over a period of years have built reserves in good years to assist in carrying through the poor periods. Some have made a practice of stacking up roughage and accumulating other feeds, others have managed to accumulate financial reserves and some have accumulated reserves of both feed and cash. Records of ranchers for the past decade provide convincing evidence that only those who have reserves when dry years such as 1934 and 1936 come are able to continue to operate and live without accepting public relief. Even operators who had feed reserves were forced to liquidate a large proportion of their livestock in 1936 and only those with financial reserves were able to purchase stock again and take advantage of the good range conditions and prices of recent years.

In addition to building reserves some of the other more important factors which contribute to a higher income are: (1) Moderately large units, if well managed, pay best in the long run. (2) Careful buying and selling with an eye to the future is the policy of successful operators. (3) Well blocked out units held for a relatively long period of time give the greatest returns. (4) Good ranges, including adequate water supply, are important to facilitate the rapid growth and development of livestock. Several recommended practices for improvement and use of the range
are given in the bulletin. (5) A flexible organization aids in carrying
through poor periods. Some supplementary enterprises give flexibility
and increase income with little extra expense. (6) Good stock, high calf
or lamb crop, and low death loss all aid in increasing income.

This and other studies indicate that from 90 to 100 cows and appurten-
ant young stock, or the equivalent in sheep, and from 3,400 to 6,500
acres of land are necessary to support an average family where there are
few or no supplementary enterprises.

These conclusions are based on the assumption that the operator has
average managerial ability and that the relative price, cost, and yield
relationships of the past will not change materially. As these factors or
the size of family varies, the size of unit required will also vary.

Many operating units in the area are smaller than that required to
support a family. (Project 30. Leaders: Aaron G. Nelson and Gerald
E. Korzan, Agricultural Economics Department.)

Find Many Ranches and Farms Too Small
in Hyde County Area

In sections of South Dakota where the average precipitation is low and
fluctuates so greatly from year to year and from period to period, ranch-
ers and farmers will find it difficult to make a living unless they have a
sufficiently large acreage. In such areas it is difficult to intensify opera-
tions enough to offset a lack of acreage.

A study made in and around Hyde County showed that under aver-
age ranch conditions (where about 10 percent of the land is in crops)
around 2,560 acres is the minimum which will support a family. Nine
hundred sixty acres is the minimum where extensive farming is practiced
(where about 33 percent of the land is in crops) and 640 to 480 acres
where intensive farming is practiced (where about 45 percent of the land
is in crops.) The acreage required will vary, of course, according to such
things as the productivity of the land, the capacity and efficiency of the
operator and the amount required for family living and other things,
such as buying a farm.

Station Bulletin 346, "Planning Minimum Sized Ranches and Farms
for the Hyde County Area in South Dakota," contains a detailed discus-
sion of these and other topics pertaining to the agriculture of Hyde and
adjoining counties and may be obtained free upon request. (Project 71.
Leader: Aaron G. Nelson, Agricultural Economics Department; Bureau
of Agricultural Economics cooperating.)
Wheat or Livestock Emphasis for North Central South Dakota?

Wheat producing farmers in North Central South Dakota might well consider the possibilities of shifting emphasis to livestock production, a 10-year study of farm records in this area would indicate.

It was found that the production of wheat and livestock probably will be about equally profitable on farms in the area where operators are able to obtain “average” yields of wheat, providing the price of wheat is relatively high (bring more per pound) compared with that of feed grains.

With the present large wheat acreage and supply, however, both in the United States and in the world, the tendency will be to hold the price of wheat down relative to that of feed grains. Wheat prices may be supported by the government loan program for a time but will it be advisable to do this over a long period of time? If the price of wheat is not above that of feed grains, livestock production will be the more profitable regardless of wheat yields.

The results of this study are published in Station Circular 33, “Should Farmers Emphasize Wheat or Livestock in North Central South Dakota?” (Project 29. Leaders: Aaron G. Nelson and Gerald E. Korzan, Agricultural Economics Department.)

Station Studies Agricultural Marketing Problems

Because of a lack of information in the field of agricultural marketing, the Station has four projects underway in an effort to determine the most efficient marketing methods through analysis of the present systems.

Livestock Marketing. In an effort to obtain a comprehensive picture of how different species and classes of livestock are moving from the farm or ranch to the butcher, or back to feedlot or pasture, a study of livestock marketing methods was initiated this past year. The immediate objectives were to determine:

1. The relative importance of various marketing agencies in handling specific classes of livestock in the several sections of the state.
2. The relative importance of methods of sale, and
3. The effect that volume, location and class seem to have on the marketing agency employed.

The sources of information are questionnaires obtained from ranchers and farmers throughout the state, auction sales barns, dealers, packing plant and livestock shipping associations and schedules from retail meat dealers who do their own slaughtering. All of these questionnaires
deal with livestock bought and sold in 1940, agencies employed, methods of sale and trade territory.

The field work has been completed and publication of the results will be made on an areal basis for the state within the next few months. (Project 104. Leader: W. P. Cotton, Agricultural Economics Department; Bureau of Agricultural Economics cooperating.)

**Freezer Locker Plants.** In connection with the field work in the livestock marketing study data were obtained on freezer locker plants throughout the state. The objectives of this study were:

1. To determine the number, location, business connection, size, date of organization and services of all plants;
2. To study their possibilities of increasing the market for fruits, vegetables, pork, beef and mutton;
3. To study their economy of operation by size of plant, business connection, location and type of organization;
4. To determine the extent of economies of operation by size of plant, business connection, location and type of organization; and
5. To study the cooperative features of those plants so operating.

To attain the first objective questionnaires were obtained from 100 of the 117 plants known to be operating in the state. For objective 2, 3, and 4, five thousand five hundred questionnaires were mailed to patrons of 30 representative plants while operators of 17 plants are keeping records on the grade and value of animals they slaughter for their patrons. In addition a detailed study is being made of the operations of some 30 representative plants together with the actual storage records of some 600 patrons.

The results of this study are expected to be ready for publication by December, 1941. (Project 82. Leader: W. P. Cotton, Agricultural Economics Department, with F. U. Fenn, Animal Husbandry Department, cooperating.)

**Dairy Marketing.** A three-year study dealing with cooperative features, methods of marketing, financial outcome and services rendered of some 40 cooperative creameries in the state is nearing completion. A publication of findings is expected to be made early in 1942.

During the past two years operating records have been obtained, tabulated and summarized for these creameries. (Project 81. Leaders: L. M. Brown and W. P. Cotton, Agricultural Economics Department, with Dairy Department cooperating.)

**Poultry Products.** A study dealing with marketing methods of cooperative and independent poultry marketing businesses is underway.
at the South Dakota Station. The objects are to analyze the general poultry marketing situation and to determine standards as a guide to cooperative organizations. (Project 80. Leaders: L. M. Brown and W. P. Cotton, Agricultural Economics Department, with Poultry Department cooperating.)

How Should Public Lands Be Managed?

How shall we use our land to the best advantage, keeping in mind our own best interest both in the short run and over the long pull, not forgetting the welfare of the land itself nor the needs of the rest of society?

That question has been more and more in the minds of farmers and land owners in recent years, both in their capacity as individual farmers and as members of land use planning committees.

In South Dakota an increasing area of land has come under the control of various public agencies through foreclosure and purchase. The management policies of these public bodies stem from the different objectives which they, as agencies of the state and federal government, were created to serve. In some instances, particularly in the handling of county lands, there has been no clearly thought out policy to achieve fuller use, better conservation practices or even maximum revenue to the agency itself. While it is unlikely that an absolutely uniform policy for all public lands would be either possible or desirable, it is probable that better coordination with the land use planning program and management policies of farmers would be all to the good.

Information has been collected on the extent of publicly owned lands in representative counties during the last few years in order to indicate the trend in public ownership. Management and sales policies have been studied. Meetings were held with county planning groups in order to obtain suggestions as to how certain of these policies might be improved in the interest of more effective land use.

A report of these findings and an analysis of their implications is now in preparation and will be completed in the near future. (Project 94. Leader: Alvin E. Coons, Agricultural Economics Department; Bureau of Agricultural Economics cooperating.)

Analyze Operating Economics Of Cooperative Elevators

A three-year study of approximately 75 cooperative grain elevators in the state has been completed with the publication of Station Bulletin 351, “Farmers’ Elevator Operations in South Dakota.” Among the more
significant findings is the fact that as the years have passed fewer and fewer patrons have participated in ownership and control. To remedy this situation the following things have been done:

1. Modify articles of incorporation and by-laws to conform to what is considered best in cooperative principles and practices today.
2. Eliminate non-producers and non-patrons as voting members.
3. Extend membership among active patrons.
4. Develop an organization set-up which will assure ownership and control remaining always in the hands of producer-patrons.

Careful consideration of side-lines and services, closer attention to operating economies and stricter credit policies are likewise held to be necessary for success. (Project 60. Leader: L. M. Brown, Agricultural Economics Department; Farm Credit Administration cooperating.)

South Dakota Farm Mortgage Foreclosures
Lowest In 20 Years

According to reports received from the county registers of deeds the gradual decline in foreclosures during the two previous years was greatly accelerated during 1940. In 1939 there were 1,776 foreclosures involving 432,451 acres. For 1940 this was reduced to 733 foreclosures on 171,767 acres. This is the lowest farm mortgage foreclosure volume in South Dakota in 20 years. A mimeographed report on foreclosures will be available soon. Complete data on farm mortgage changes in five sample areas distributed over the state have been obtained and a report on these changes during the past decade will be prepared during the next fiscal year. (Project 13. Leader: Gabriel Lundy, Agricultural Economics Department.)

Study Relationship Of Prices And Farm Income

In discussing agricultural problems the importance of the prices that farmers receive for their produce has frequently been overlooked. Attempts have been made to increase farm income by increasing production or reducing costs but a third and equally important factor in farm income, prices, has been relatively neglected.

This project has been set up to secure records of prices farmers have received for their livestock and grain products over a 50-year period, 1890-1940. Most of the tabulation and computation has been completed on the 57 counties included in this study. The data are now being pre-
pared in tabular form for use by planning agencies in developing agricultural programs for the various counties; these data are also being analyzed graphically and verbally for use by various local, state or national action agencies.

It is hoped that as a result of this study action agencies and planning groups will be better informed and thereby better equipped to meet the problems confronting the farmer of South Dakota. (Project 102. Leader: Weber Peterson, Agricultural Economics Department.)

Station Strives for More Equitable Tax Assessment

Some agricultural land in South Dakota has been assessed and taxed out of proportion to its capacity to produce income. In certain areas within the state land owners have virtually been penalized as a result of inequitable assessment. A study of this problem is underway in Hand County. The possibilities of land classification are being explored. Information about the agricultural land of that county has been assembled. Township land-use planning committees composed of experienced farmers are working under the direction of a central county Committee and the County Extension Service in assembling the information necessary for classification. Technical assistance has been given by the South Dakota Experiment Station. This approach to the establishing of fair assessment may be used in additional counties in South Dakota when detailed soil surveys have been made in order that the necessary information may become available.

Requests for a change in assessment procedure are coming from certain areas in South Dakota. The continuance of township government in these certain areas is a trend in support of change. A large number of small assessment districts within a county is believed to be a handicap to the attainment of equitable assessment. The elements of weakness and elements of strength in the county assessor and the locally-elected township assessor systems are under study. It is believed by some that if a county assessor system were established by law, thus permitting all counties to use this method of assessment, the outlook for improvement in assessment procedure would be more encouraging. The more complete establishing of equitable assessment is the goal. (Project 42. Leader: Norris J. Anderson, Agricultural Economics Department.)

Work on Social Change Continues

During the current year two additional bulletins have been written and published in the projected series entitled "Basic Trends of Social Change in South Dakota." The secondary titles of those published this year are: (a) Local Government and (b) Religious Organization. The
publication of these last two makes a total of five that have now been completed in the series.

I. The following are what we have concluded to be the most important trends in local government during the past 50 years from 1890-1940.

2. Increasing centralization of local government.
3. Increasing costs of local government.
4. Changes in population have gradually modified local government services.
5. Transfer of certain functions from other social institutions to local government.
6. Shift of certain functions from one unit of local government to another.
7. The operation of democracy has become more difficult and complex.
8. Public office does not always attract the best-qualified officials.
9. Improvement in the average qualifications of public officials.

Conclusions which have been arrived at for this particular study are as follows:

1. In practically every instance, the basic trends of state and local government outlined in this bulletin have been found to be similar to those of nearby states.
2. One of the most beneficial results of governmental change has been the reduction in the number of small taxing units.
3. One of the most important trends is toward centralization of government.
4. The structural pattern of local government in South Dakota has been based upon forms found in a number of states directly east of it.
5. The functional changes in the state and local governments probably have taken place at a relatively faster rate than in some of the older states.
6. Another factor which has facilitated the smooth operation of South Dakota's units of government is the preponderance of population of North European origin who are descendants of peoples experienced in self-government.
7. There are still a number of problems, especially in local government, which we may reasonably expect to see gradually worked out in the near future. Some of these problems are: (a) The high cost of county government, (b) making the local taxing units of government coincide more closely with the boundaries of community trade and service areas, and (c) abandoning township organization, especially in areas of low population density.

II. The main trends in the evolution of religious organization which have occurred from 1890-1940 are as follows:

1. Between 1926 and 1936 both church and Sunday School declined in numbers and in proportion to the total population.
2. The ratio of males to females among church members has increased slightly.
3. There is a distinct relationship between denominational preference and nationality background.
4. Decreasing number of church units in the state between 1926 and 1936; increasing average number of members per church.
5. Church comity is slowly decreasing denominational overlapping and overchurching at certain crucial points in the state.
6. The average church budget has been decreased in amount.
7. Church programs are tending to be more realistic and community-centered.
8. The ministers seem to be preaching less about theology and doctrine and are including more discussion of present-day problems and world events.
9. The ministers now have more professional training.
10. The average age of ordained ministers has changed little during the past decade.
Conclusions deduced from this study are:

1. In keeping with other social institutions the church has fewer, but larger and more active units in the state. A number of factors have contributed to this end.
2. Certain functions have been transferred from the church to other social agencies.
3. Church communities are developing more like-mindedness and homogeneity.
4. Changes in population have also affected the church.
5. The increasing average extent of education has put religion on a higher plane and has tended to integrate it with other phases of living.

III. In addition to the bulletins on local government and church organization, we have mimeographed some 31 different pamphlets dealing with the Social Aspects of Land Use Tenure in South Dakota. These pamphlets have been prepared on county findings and so far each publication has dealt with one of four problems as follows:

1. The problem of population adjustment.
2. The delineation of rural community boundaries.
3. The declining enrollment problem in elementary schools.
4. The problem of overchurched and unchurched areas.

The enclosed chart shows which counties we have worked in thus far together with the particular problems which have been studied up to date. Where the study has been completed in a particular county a mimeographed circular has been issued.

It should be noted that the pamphlets mentioned above dealing with Social Aspects of Land Use Planning pertain to research findings. In each case the data have been gathered from the above counties by WPA workers operating under the supervision of non-relief WPA supervisors. The data is then tabulated and edited in mimeographed manuscript form.

These separate circulars are distributed only within the county to which they apply. Each county is treated as a separate unit in itself. When all of the counties have been covered with reference to some one single phase we will then prepare a summary bulletin with proper conclusions for the state as a whole.

The problem is now emerging as to how this information can best be translated into planning action. Thus far during the current year we have presented the facts in connection with the declining enrollment problem at some six county wide meetings of school board members. Such chart talks have been given in Brookings, Kingsbury, Beadle, Moody, Hyde and Day counties. In these counties the local County Superintendent called a county-wide meeting of all the rural school district boards together with the independent district boards of education. The attendance in all six counties was gratifying. Considerable interest was evinced by the school board members. The County Superintendent in
one county recently reported that six schools (each with less than five pupils) had all decided to close next year as a result of the study in that particular county. The boards were unaware of the inefficiency of operating local schools with less than five pupils and had not realized before that the matter of declining enrollment was a problem throughout the entire state. (Project 64. Leader: W. F. Kumlien, Rural Sociology Department.)

Migration Out of State Decreasing

The primary object of this cooperative study has been to determine, on the basis of an adequate and representative sample, the number of persons living on farms in South Dakota as of January 1, 1940, the number of births and deaths in the farm population, the number of persons who moved to and from farms during the year. This particular project has been carried on for a number of years with the BAE as the latter is charged with making estimates of population changes within the various states for the intercensal ears. For the current year some 1800 questionnaires were sent to the entire list of local committee chairmen of the Triple A in the state. These committee members were asked to report on movements in population on their own and adjoining farms. Practically every township was represented by this method. Of the questionnaires sent out 774 were returned and edited as being complete. Replies were received from every county but only 46 reported any movement in or out of the state. Our main conclusion is that the trend of heavy migration out of the state has now been definitely slowed up. (Project 70. Leader: W. F. Kumlien, Rural Sociology Department.)

Land Tenure Study Is Underway

Preliminary fieldwork leading toward an analysis of the social aspects of the land tenure situation in South Dakota has been nearly completed. Analysis of these data will be undertaken next year.

Information concerning the farm labor situation in the state has been referred to the State Land Use Planning committee as collected. (Project 101. Leader: Walter L. Slocum, Rural Sociology Department.)

Occupational Research Is Started

A study of the occupational status of persons reared in South Dakota is being conducted, with the prospects of analysis of data early in the coming year.
Stratified sampling of data on South Dakota families is being taken from schedules already collected in rural mobility studies. (Project 103. Leader: Walter L. Slocum, Rural Sociology Department.)

Economic Phases of Land Use Planning

The county land use planning activities in the state received assistance from the Experiment Station both in the form of technical assistance or advice and research. In addition to the regular staff members who assisted the LUP movement one man was employed on a full-time basis in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture to furnish technical assistance to and make contacts with the county and community land use planning committees. Request for information or research on problems faced by these committees were thus brought back to the Experiment Station research staff. All such requests for help were complied with to the limit of the Experiment Station resources.

Marshall County requested and received help with a survey of its tax problems. A special study was made for the benefit of the people in Hamilton and Lake townships in that county. Some county commissioners have also requested and received help on the tax problems of their county. Other counties that received personal assistance on their taxation studies are Meade, Perkins, Pennington and Haakon. Assistance in the form of a tax study outline and instructions were given a larger number of counties. In Hand and Brown Counties additional assistance was rendered in presenting or developing the land classification plan for attaining equitable assessment of farm land. It is probable that this plan was given an initial trial in Hand County in the spring of 1940.

In addition to the above examples of research assistance to land use planning must be mentioned various other research projects in agricultural economics, and also in other departments. (Project 92. Leaders: Gabriel Lundy, Norris J. Anderson and Aaron G. Nelson, Agricultural Economics Department; Louis E. Joy, cooperative employee, South Dakota Station and Bureau of Agricultural Economics.)

Land Use Planning Makes Progress

The following work was completed in Hand County during the year 1940-1941 as part of the cooperative research project of the South Dakota Agricultural Experiment Station and the Division of Farm Population and Rural Welfare, USDA, to study social conditions related to Land Use Planning in Hand County:

2. An analysis of public relief programs and the kinds and amounts of relief ex-
tended to farm and non-farm families; the relation of relief incidence to type of farming, tenure status and family composition; the need of public assistance as an indicator of land use maladjustments; and the characteristics of families receiving relief.

3. A study of the levels and standards of living of farm families by type of farming areas in the county.

The schools study involved an analysis of secondary source material gathered from records of the County Superintendent of Schools. The main phases of the educational situation, particularly as it applies to the rural schools, was covered. These phases included the school census population, enrollments, school abandonment, attendance areas, tax levies, taxable evaluations, receipts, and expenditures. (A preliminary report has been prepared. A final report will be prepared later and this will be submitted to the Hand County Land Use Planning Committee for their use in recommending and bring about adjustments in the county.)

All source material for the public assistance-family composition study has been gathered. This material is now ready for summarization and analysis.

Family living schedules are being obtained through group meetings of farm women in Hand County. The meetings are under the direction of the County Home Demonstration Agent. The information from the schedules will be tabulated and analyzed when the field work is complete. This study will assist the County Land Use Planning Committee in determining the size and organization of farm necessary by type of farming areas to produce a desirable standard of living in the county. (Project 95. Leader: W. F. Kumlien, Rural Sociology Department, and Division of Farm Population and Rural Welfare, USDA, cooperating.)
Cooperative Project Agreements
With Federal Agencies

The following cooperative research projects were conducted by certain federal agencies or bureaus cooperating with the Agricultural Experiment Station.

BUREAU OF AGRICULTURAL ECONOMICS

1. Annual Change in Population in South Dakota (Rural Sociology Department). To estimate from a selected sample the number of persons living on farms in South Dakota, the number of births and deaths in the farm population and the number of persons who moved from farms. Additional studies were made of out-of-the-state movements. A report of the year's work accomplished on this project will be found on Page 81. (Project C-7.)

2. Adjustment of Agriculture to Environment in Central South Dakota (Agricultural Economics Department). To analyze the present agricultural conditions in Central South Dakota in relation to environment and to try to determine the adjustments necessary to place agriculture in this area on a more stable basis. A report of the year's work accomplished on this project will be found on Page 73. (Project C-8.)

3. Cooperative Work in Agricultural Land Use Planning (South Dakota Experiment Station). To develop an agricultural land use program, in which will be correlated the suggestions and work of farmers, the State Agricultural Extension Service, the Experiment Station, the Bureau of Agricultural Economics and the action agencies of the United States Department of Agriculture. In this project all the above-mentioned agencies may make the greatest and most effective contribution to agricultural adjustment, conservation, crop insurance, farm forestry, flood control, land retirement, rehabilitation and water utilization. Consideration will be given the land use implications of community facilities, credit, marketing, public finance, land taxation, tenancy and transportation. A report of the year's work accomplished on the project will be found on Page 82. (Project C-12.)

4. A Study of the Management of Publicly-Owned Lands in South Dakota, Including a Determination of Programs and Policies, Land Use Adjustments and Directional Measures Desirable for Such Lands (Agricultural Economics Department). (a) To determine the amount, location and use of land in South Dakota which is controlled and managed by public agencies—federal, state and county, (b) To investigate the management policies of the county, state and federal agencies which con-
trol substantial amounts of land in South Dakota or in problem areas requiring major adjustment, (c) To study the possibility of coordinating the management policies of various public agencies as a means of land use adjustment in problem areas, and (d) To determine the programs and policies, land use adjustments and directional measures which are desirable for such publicly-owned lands. The year's work is summarized on Page 76. (Project C-14.)

**BUREAU OF ANIMAL INDUSTRY**

1. *Cooperative Research for the Improvement of Swine Through Breeding* (Agricultural Experiment Stations of Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota and Wisconsin). To study the improvement of swine through breeding methods. (Project C-6.)

2. *Improve of Viability in Poultry* (Agricultural Experiment Stations of Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Missouri, Pennsylvania, New York, Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, West Virginia, Maryland, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, Delaware and New Jersey). To study the improvement of viability in poultry. (Project C-9.)

**BUREAU OF ANIMAL INDUSTRY AND BUREAU OF PLANT INDUSTRY**

1. *The Maintenance and Operation of a Cooperative Field Station on the Belle Fourche Reclamation Project Near Newell* (Animal Husbandry Department). The object of the major project is to study problems pertaining to the sheep industry under conditions of irrigation farming, relative to (1) sheep breeding, (2) sheep feeding, (3) sheep pasture utilization and management, (4) lamb production, and (5) wool production. In 1932 a project was started on grain rations for pigs on pasture. A summary of this work will be found on Page 20. (Project C-1.)

**BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING AND BUREAU OF PLANT INDUSTRY**

1. *Cooperative Research into the Laws and Principles Underlying Industrial Utilization of the Soybean and Soybean Products* (Agricultural Experiment Stations of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio and Wisconsin). To obtain through basic research facts and materials applicable to the utilization of the soybean and soybean products and to

[85]
develop methods whereby these facts and materials may be utilized to the benefit of agriculture. A report of the Station’s activities on this project will be found on Page 11. (Project C-2.)

SOIL CONSERVATION SERVICE AND BUREAU OF PLANT INDUSTRY

1. Cooperative Activities for Improving the Effectiveness of Vegetation in Controlling Soil Erosion (Agronomy Department). To conserve more effectively soil and moisture through the use of superior plants and improved methods of vegetative control.

Observational grass adaptation field trials are being made at Brookings and the Highmore and Cottonwood Substations. Twenty-two species were seeded at different dates in the fall and spring to determine the best time of planting and the adaptability of each variety to different sections of the state. (Project C-16.)

SOIL CONSERVATION SERVICE

1. Soil Erosion Control in South Dakota (Agricultural Experiment Station). To study the main factors and forces involved in the incidence of soil erosion under general farming conditions, methods of prevention and control and the most economic method of restoring lands already injured by the uncontrolled action of wind and water through such measures as contour furrowing, strip cropping and tree and shrub planting on the Huron and Winner-Dixon projects, and terracing in the Winner-Dixon area.

Grass clippings are being made over the state, particularly in the western part, to determine the volume by weight of forage produced per unit density of the various native grasses. Sufficient data are not yet available to give the different grasses definite ratings.

HURON AREA: Contour pasture furrows on the 13.1 percent slope.

The average (3 years) yield of grasses on the furrowed area is 752 pounds per acre compared to 489 pounds per acre on the corresponding unfurrowed check area.

The 3-year average yield on the 1.7 percent slope is 1,018 pounds per acre while the corresponding yield for the non-furrowed area is 431 pounds.

The yield of barley on the contour was 20.7 bushels per acre while that from up and down hill farming was 14.6 bushels, indicating that considerable moisture was conserved by the practice of contour farming.

Fields tilled in the spring with a sub-surface machine yielded 32.5 bushels of oats compared to 21.5 bushels on fall-plowed land.

WINNER AREA: Pastures that were contour furrowed yielded
685 pounds of hay per acre while the corresponding check area yielded only 300 pounds per acre. The furrows showed a decided increase in yield compared with a year ago when very little increase was noted. This condition is due in part to the fact that the furrows and ridges are grassed over with a denser covering than a year ago and the weed growth is better controlled by the grass. It took from 3 to 4 years for the furrows to completely grass over. The large furrows, especially those made with a blade or grader, appear to be superior to the smaller type because by the time they are grassed over they are not filled up and will provide good water storage. Some of the smaller types of furrows were completely filled up at the end of 3 years and before they were grassed over.

Revegetation studies show that it has been necessary to seed grass an average of twice per field before a stand is secured. Some fields were seeded as many as 4 and 5 times. The hazards of grass establishment as observed on the project rank in importance approximately as follows:

1. Lack of soil moisture during seedling stage.
2. Diseases including root rots.
3. Grasshoppers
4. Drought (midsummer)
5. Lack of plant residue cover

Barley seeded on the contour yielded 22.9 bushels per acre while that on an equal slope and soil condition not on the contour yielded 16 bushels.

A soil removal study shows the relation of wheat yields to Depth of Topsoil:
- 8 inches of topsoil remaining yielded 14.8 bushels.
- 6 inches of topsoil remaining yielded 13.2 bushels.
- 4 inches of topsoil remaining yielded 11.8 bushels.
- 2 inches of topsoil remaining yielded 12.4 bushels.
- 0 inches of topsoil remaining yielded 9.2 bushels.

No topsoil and only one inch of B horizon yielded 7.8 bushels (Project C-3).

2. To Determine the Proper Utilization of Seleniferous Land (Experiment Station Chemistry Department). To furnish information which will be helpful in planning the future economical use of seleniferous land. A summary of this work will be found on Page 34. (Project C-11).

3. Soil and Water Conservation Research on Pasture and Cultivated Lands in South Dakota (Agronomy Department). (a) To determine methods of reducing wind and water erosion and effecting water conservation through re-establishing vegetative covers of grasses or shrubs upon eroded agricultural and pasture land, (b) To determine the rela-
tive efficiency of different types of tillage equipment for contour cultivation to aid in erosion control and to find the best methods to handle the residues to reduce water and wind erosion, (c) To develop methods of spreading and utilizing flood waters, and to determine the possibility of retaining rains of varying degrees of intensity upon the land, so as to reduce soil and water loss and develop a better vegetative plant cover for erosion control.

A wind tunnel has been constructed to measure the effect of plant residues, crop rotations, tillage practices, and the surface condition created by different types of tillage upon soil erosion by wind, and to study relations which may exist between rate of soil blowing and certain physical properties of soil. A system of plots to create the various conditions were planted in the spring of 1941 and the wind tunnel tests will be started in the fall. (Project C-15).

**Active Research Projects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fruit Breeding.</td>
<td>Adams, State Exp.</td>
</tr>
<tr>
<td>2.</td>
<td>Breeding Hardy Ornamentals.</td>
<td>Hatch</td>
</tr>
<tr>
<td>3.</td>
<td>Temporary and Permanent Effects Which Processes of Crop Production May Have on the Physical, Chemical and Biologic Conditions of the Soil.</td>
<td>Adams</td>
</tr>
<tr>
<td>5.</td>
<td>Oat Breeding. (Combined with Project 25.)</td>
<td>Purnell</td>
</tr>
<tr>
<td>6.</td>
<td>Corn Breeding for High and Low Protein. (Combined with Project 66.)</td>
<td>Adams, State</td>
</tr>
<tr>
<td>7.</td>
<td>Manure, Phosphate and Limestone Trials. (No report.)</td>
<td>Bankhead Jones</td>
</tr>
<tr>
<td>8.</td>
<td>Depth of Tillage. (No report.)</td>
<td>Hatch, Station</td>
</tr>
<tr>
<td>9.</td>
<td>Development of Notail Breed of Sheep.</td>
<td>Local</td>
</tr>
<tr>
<td>10.</td>
<td>Breeding Forage Crops—Alfalfa and Sweet Clover. (Combined with Project 74.)</td>
<td>Hatch</td>
</tr>
<tr>
<td>12.</td>
<td>Study of Credit Needs of South Dakota Agriculture and Agencies Serving It.</td>
<td>Federal Bankhead</td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>Purnell</td>
</tr>
</tbody>
</table>

[88]
15. The Comparative Length of Service of Galvanized Steel Posts and Painted Steel Posts. (Observational.)

17. A Comparison of Sweet Clover, Alfalfa, and Sudan Grass Pastures under South Dakota Conditions and Permanent Pasture Mixtures.

18. The Grasshoppers of South Dakota and Their Control.

19. Chemical Forms of Selenium in Soils and Plants and Toxicity to Animals Including Proper Use in Grazing.


22. Rammed Earth Construction for Farm Buildings.

23. The Genetics of Hardy Thornless Rose Stocks.

24. Fattening Fall Pigs on South Dakota Grains.

25. Cereal Breeding with Special Reference to the Inheritance of Rust Resistance and a Study of Modes of Reaction of Strains to Physiological Forms of Black Stem Rust of Wheat.


28. Studies of the Nutrition of the Growing Chick. (Alkali Disease.)

29. A Study of Farm Organizations and Practices in the Wheat Producing Areas of South Dakota. (Completed.)

30. Cattle Ranch Management in Northwestern South Dakota. (Completed.)

32. Weed Control.

33. Some Routine Tests for Garget or Mastitis in Cow's milk. (No report this year.)

34. Conversion of Horse Machinery for Tractor Farming.

35. Rammed Earth Poultry Houses.

38. Feeding Grains Affected with Ergot. (Dormant until grain affected with ergot can be obtained.)

39. A Study of Turkey Egg Hatchability. (Replaced by Project 96.)

41. Factors Affecting the Vitamin A and D Content of Roughages. (Revised.)

42. Taxation Problems in South Dakota. (Revised.)

47. A Breed Comparison in Ability to Transfer and Convert the Vitamin D of the Feed Ingested to the Milk Produced.

48. The Relationship Between the Lipolytic and Proteolytic Micro-organisms and the Development of Specific Flavor Defects in Butter. (Completed.)

49. Sweet Firm-fleshed Tomatoes with a Minimum of Seeds.


52. Relative Values of Common Grain Varieties and Their Effects Upon Egg Quality and Poultry Carcass Quality.

53. Comparative Values of High and Lower Grades of Corn, Wheat and Barley in Poultry Rations.

54. Feed of Ewe During Pregnancy.

55. Vitamin D Deficiency Studies on Dairy Cows.

56. The Influence of Fineness of Grinding Grain on the Coefficients of Digestion of Dairy Cows. (Completed.)

57. Vitamin Content of Lamb Tissues and Organs. (No report.)

58. Breeding Hardy Apricots with Sweet Kernels.

59. Breeding Triplloid Apples from Tetraploids and Diploids.

60. A Study of Cooperative Grain Elevators for Developing Standards of Performance as to Membership, Finances and Operation in the State of South Dakota. (Completed.)

61. Occurrence of Forage Poisoning of Livestock with Special Reference to Cyanide (Prussic Acid) in Various Species of Sorghum.

63. A Study of the Methods of Handling Weedy Cream with the Purpose of Reducing the Grassy and Weedy Flavors in Butter. (Completed.)

64. A Social History of Population Settlement in South Dakota.

65. A Study of the Cultural Development of Ephedra Sinica with a View to the Increase of its Alkaloidal Content as Well as Its Adaptability as a Field
Crop for Marginal Lands in Western South Dakota.

66. A Study of Inbred Strains of Corn and Their Combinations with Reference to Physiological and Genetic Characteristics Associated with Yield and Quality Including Absences of Smut and Other Corn Diseases.

67. Methods of Baby Beef Production.

68. The Development of Hybrid Drought-Resistant Sweet Corn.

70. Annual Change in Population in South Dakota. (Discontinued.)

71. Agricultural Adjustment to Environment in Central South Dakota. (Completed.)

73. Use of Rubber on Farm Vehicles.

74. The Breeding and Improvement of Forage Crops.

75. The Effect of Peppergrass on Flavor of Milk and Cream and Products Made Therefrom.

76. The Influence of Various Methods of Holding Cream on Butter Quality. (Completed.)

77. Tree Growth as Affected by a Cover Crop.

78. Comparison of Economy of Feeding Western Gummer Ewes and Western Lambs. (Completed.)

79. The Utilization of Grain and Forage Sorghums and Proso Millets in Growing and Finishing Turkeys.

80. Analysis of the Marketing of Poultry Products in South Dakota.


82. Analysis of the Operation of Freezer Locker Plants in South Dakota.

83. Farm Building Floors—Material and Construction.

84. The Study of Machinery Involved in Handling Malting Barley. (Completed.)

85. Improving Rations for Pigs After Weaning.

86. Tillage and Its Effects Upon Grasshopper Populations; Strip Farming and Grasshopper Populations.

87. Oat Hay Poisoning.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>The Effect of Fine and Medium Grinding of Grain on Milk Production. (Completed.)</td>
<td>Federal Bankhead Jones</td>
</tr>
<tr>
<td>89</td>
<td>The Feeding Value of Sorghum-Legume Silage, Compared to Corn Silage.</td>
<td>State Exp.</td>
</tr>
<tr>
<td>90</td>
<td>The Grain from Sorghums Versus Corn for Fattening Steers.</td>
<td>Station Local</td>
</tr>
<tr>
<td>92</td>
<td>Economic Phase of Agricultural Land Use Planning in South Dakota.</td>
<td>Purnell</td>
</tr>
<tr>
<td>93</td>
<td>Rural Zoning as a Method of Controlling Land Use, Location of Settlement, and Local Government Costs in Corson County, a Marginal Farming Area. (Completed.)</td>
<td>Federal Bankhead Jones</td>
</tr>
<tr>
<td>94</td>
<td>Management of Publicly-Owned Lands in South Dakota, Including a Determination of Programs and Policies, Land Use Adjustments, and Directional Measures Desirable for Such Lands.</td>
<td>Purnell</td>
</tr>
<tr>
<td>95</td>
<td>A Survey by Communities of Social Conditions Related to Land Use Planning in Hand County, South Dakota.</td>
<td>Federal Bankhead Jones</td>
</tr>
<tr>
<td>96</td>
<td>The Influence of Feeding and Management Upon the Fertility and Hatchability of Turkey Eggs.</td>
<td>Purnell</td>
</tr>
<tr>
<td>97</td>
<td>Carrying Capacity of Eastern South Dakota Ranges and Pastures.</td>
<td>Station Local</td>
</tr>
<tr>
<td>98</td>
<td>Refrigerated-Locker Storage of Fruits and Vegetables.</td>
<td>Purnell</td>
</tr>
<tr>
<td>99</td>
<td>The Effect of Wear on Wool and Part Wool Fabrics.</td>
<td>Purnell</td>
</tr>
<tr>
<td>100</td>
<td>The Relative Nutritive Value of Sorghum Stover and Sorghum Grain vs. Corn Stover and Grain for Milk Cows.</td>
<td>Station Local</td>
</tr>
<tr>
<td>101</td>
<td>Social Aspects of Land Tenure in South Dakota.</td>
<td>Purnell</td>
</tr>
<tr>
<td>102</td>
<td>Agricultural Production and Price Relationships for South Dakota.</td>
<td>Purnell</td>
</tr>
<tr>
<td>103</td>
<td>Residence and Occupational Status of Persons Reared in Rural South Dakota Families.</td>
<td>Purnell</td>
</tr>
<tr>
<td>104</td>
<td>Livestock Marketing from Farm or Ranch to Processors.</td>
<td>Federal Bankhead Jones</td>
</tr>
</tbody>
</table>

[92]
## Experiment Station Staff

### BOARD OF REGENTS
- Honorable Frank Cundill
- Honorable E. M. Mumford
- Honorable Mrs. E. R. Doering
- Honorable A. R. Ferguson
- Honorable M. E. Hafner

### EXECUTIVE
- Honorable A. R. Ferguson
- Lyman E. Jackson, Ph.D.
- G. L. Brown, Ph.D., LL.D.
- A. M. Eberle, M.S.
- J. W. Wilson, LL.D.
- A. N. Hume, Ph.D.
- R. A. Larson
- Phyllis C. Wendell

### AGRICULTURAL ECONOMICS
- Gabriel Lundy, M.S.
- L. M. Brown, M.S.
- Aaron G. Nelson, M.S.
- W. H. Peterson, M.S.
- Norris J. Anderson, M.A.
- Louis E. Joy, B.S.
- Gerald E. Korzan, B.S.
- Alvin E. Coons, M.S.
- Walter P. Cotton, M.S.

### AGRICULTURAL ENGINEERING
- R. L. Patty, B.S.
- H. H. DeLong, B.S.
- L. F. Larsen, M.S.

### AGRONOMY
- A. N. Hume, Ph.D.
- S. P. Swenson, Ph.D.
- Leo F. Puhr, Ph.D.
- E. L. Erickson, M.S.
- C. J. Franzke, B.S.
- J. E. Grafius, M.S.
- W. F. Buchholtz, Ph.D.

### ANIMAL HUSBANDRY
- J. W. Wilson, LL.D.
- Turner Wright, B.S.
- F. U. Fenn, M.S.
- J. C. Watson, B.S.

### CHEMISTRY
- A. L. Moxon, Ph.D.
- H. D. Anderson, Ph.D.
- O. E. Olson, M.S.

### DAIRY HUSBANDRY
- T. M. Olson, M.S.
- D. H. Jacobsen, Ph.D.

### ENTOMOLOGY
- H. C. Severin, M.A.
- N. P. Larson, Ph.D.
- Gerald B. Spawn, M.S.

### HOME ECONOMICS
- Edith M. Pierson, M.S.
- Minerva Kellogg, Ph.D.
- Barbara Bailey, M.S.

### HORTICULTURE
- L. L. Davis, M.S.
- N. E. Hansen, Sc.D.
- S. A. McCrory, M.A.

### PHARMACY
- F. J. LeBlanc, Ph.D.
- R. P. Ahlquist, Ph.D.
- Guilford C. Gross, M.S.

### POULTRY
- W. E. Poley, Ph.D.
- W. O. Wilson, M.S.
- W. L. Slocum, Ph.D.

### PUBLICATIONS
- L. E. Donelson, M.S.
- John A. Rohlf, B.S.

### RURAL SOCIOLOGY
- W. F. Kumljen, M.S.A.
- W. L. Slocum, Ph.D.

### VETERINARY
- J. B. Taylor, V.M.D.

### APPOINTMENTS
- R. P. Ahlquist, Pharmacologist, July 1, 1940
- Guilford C. Gross, Assistant in Pharmacy, July 1, 1940
- Harlan D. Anderson, Associate in Pharmacy, July 1, 1940
- W. F. Buchholtz, Plant Pathologist, July 1, 1940
- W. L. Slocum, Assistant Rural Sociologist, August 1, 1940
- Gerald E. Korzan, Assistant Economists, August 1, 1940
- Alvin E. Coons, Assistant Economists, September 1, 1940
- J. E. Grafius, Assistant Agronomist, March 1, 1941
- Walter P. Cotton, Assistant Economists, April 1, 1941
Publications

During the period July 1, 1940, to June 30, 1941, the South Dakota Agricultural Experiment Station published the annual report, 10 bulletins of the popular series and five circulars.

BULLETINS

346 Planning Minimum Sized Ranches and Farms for the Hyde County Area in South Dakota by Aaron G. Nelson.
349 Homemade Rubber Tired Wagons and Trailers by Henry H. DeLong.
351 Farmers' Elevator Operation in South Dakota by L. M. Brown and Harold Hedges.
352 Profits and Losses in Ranching, Western South Dakota, 1931-1940 by Aaron G. Nelson and Gerald E. Korzan.
353 Feeding of Low- and High-Test Weight Grains to Chickens by W. E. Poley and W. O. Wilson.
354 Fattening Western Lambs and Gummer Ewes by James C. Watson and Forrest U. Fenn.

CIRCULARS

31 Operation of Webber Demonstration Farm 1929-1938 by C. Larsen.
32 Miomark Oats by S. P. Swenson.
35 Questions and Answers on Fruit Culture by Niels E. Hansen.
Journal Articles by Staff Members

AGRONOMY


STATION CHEMISTRY


DAIRY


HOME ECONOMICS


# Financial Statement—Agricultural Research Funds

**July 1, 1940 to June 30, 1941**

## RECEIPTS

<table>
<thead>
<tr>
<th>FEDERAL RESEARCH FUNDS</th>
<th>STATE RESEARCH FUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hatch</strong></td>
<td><strong>Adams</strong></td>
</tr>
<tr>
<td>Appropriations</td>
<td>$15000.00</td>
</tr>
<tr>
<td>Bal. on hand July 1, 1940</td>
<td>$8854.72</td>
</tr>
<tr>
<td>Sales of Produce</td>
<td></td>
</tr>
<tr>
<td>Rentals</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>$15000.00</td>
</tr>
</tbody>
</table>

## EXPENDITURES

<table>
<thead>
<tr>
<th></th>
<th><strong>Salaries and Labor</strong></th>
<th><strong>Stationery &amp; Off. Supplies</strong></th>
<th><strong>Scientific Supplies</strong></th>
<th><strong>Feeding Stuffs</strong></th>
<th><strong>Sundry Supplies</strong></th>
<th><strong>Communication Service</strong></th>
<th><strong>Traveling Expense</strong></th>
<th><strong>Transportation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEDERAL RESEARCH FUNDS</strong></td>
<td>$9648.03</td>
<td>$10819.20</td>
<td>$46503.65</td>
<td>$17816.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STATE RESEARCH FUNDS</strong></td>
<td>$7048.68</td>
<td>$11068.51</td>
<td>$5725.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bankhead-Jones Offset</strong></td>
<td>$72.27</td>
<td>$34.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Horticulture &amp; Livestock</strong></td>
<td>$66.27</td>
<td>$6.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Substations</strong></td>
<td>$287.70</td>
<td>$53.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Popular Bulletin</strong></td>
<td>$351.38</td>
<td>$56.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sales Fund</strong></td>
<td>$1725</td>
<td>$87.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>Publications</td>
<td>852.82</td>
<td>—</td>
<td>1748.59</td>
<td>511.08</td>
<td>37.97</td>
<td>114.21</td>
<td>—</td>
<td>760.00</td>
</tr>
<tr>
<td>Heat, Light, Water, Power</td>
<td>67.43</td>
<td>80.46</td>
<td>38.18</td>
<td>74.31</td>
<td>11.49</td>
<td>28.64</td>
<td>414.24</td>
<td>58.97</td>
</tr>
<tr>
<td>Furniture and Fixtures</td>
<td>54.56</td>
<td>278.29</td>
<td>993.46</td>
<td>306.20</td>
<td>226.83</td>
<td>24.00</td>
<td></td>
<td>269.99</td>
</tr>
<tr>
<td>Library</td>
<td>45.25</td>
<td>135.72</td>
<td>284.73</td>
<td>19.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientific Equipment</td>
<td>479.04</td>
<td>586.00</td>
<td>1133.69</td>
<td>373.00</td>
<td>249.70</td>
<td></td>
<td></td>
<td>719.98</td>
</tr>
<tr>
<td>Tools and Machinery</td>
<td>312.53</td>
<td>732.35</td>
<td>557.69</td>
<td>357.16</td>
<td>123.74</td>
<td>144.13</td>
<td>547.43</td>
<td>365.44</td>
</tr>
<tr>
<td>Livestock</td>
<td>26.00</td>
<td>—</td>
<td>785.80</td>
<td>—</td>
<td>243.52</td>
<td>4578.91</td>
<td>3796.39</td>
<td>683.58</td>
</tr>
<tr>
<td>Buildings and Land</td>
<td>774.82</td>
<td>633.67</td>
<td>885.60</td>
<td>376.99</td>
<td>480.08</td>
<td>62.13</td>
<td>544.16</td>
<td>25.29</td>
</tr>
<tr>
<td>Contingent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bal. on hand June 30, 1941</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>$15000.00</strong></td>
<td><strong>$15000.00</strong></td>
<td><strong>$60000.00</strong></td>
<td><strong>$24432.44</strong></td>
<td><strong>$10000.00</strong></td>
<td><strong>$12500.00</strong></td>
<td><strong>$27730.53</strong></td>
<td><strong>$760.00</strong></td>
</tr>
</tbody>
</table>

* State funds were appropriated in the amount of $450.00 for each of the four sub-stations, Cottonwood, Eureka, Highmore and Vivian, and in the amount of $500.00 for the Newell Field Station, all of which were expended for salaries and labor.

† Sales funds represent the receipts from the sale of by-products of experimental work that has been completed, and these funds must again be expended strictly for experimental purposes.

‡ $3,732.85 of the $8,854.72 represents the balance on hand in the Newell Field Station fund at the beginning of the year.

§ $10,929.97 of the $11,681.90 received from Sale of Produce represents produce sold from Newell Field Station.

¶ $5,364.56 of the $11,514.57 represents the balance on hand in the Newell Field Station fund at the close of the year.