Farm Research in South Dakota

Fifty-Second Annual Station Report
July 1, 1938 - June 30, 1939

Agricultural Experiment Station
South Dakota State College of Agriculture and Mechanic Arts
Brookings, S. D.
Explanations of the 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.
Farm Research in South Dakota

Fifty-Second Annual Report
South Dakota Agricultural Experiment Station

I. B. Johnson, Director

SOUTH DAKOTA STATE COLLEGE of Agriculture and Mechanic Arts
Brookings - South Dakota
Letter of Transmittal

Dean C. Larsen,
Division of Agriculture
South Dakota State College

Dear Dean Larsen:

As required by law there is submitted herewith the fifty-second annual report of the South Dakota Agricultural Experiment Station for the fiscal year July 1, 1938 to June 30, 1939. The details of editing the manuscript material have been ably handled by the Assistant Station Editor, John A. Rohlf.

In this report the progress of the year's research work has been classified from the standpoint of subject matter rather than station departments. However, for those interested in noting the work of any of the 13 station departments, the index on page three provides a suitable reference for that purpose. There is included in this report a complete list of the active research projects of the station showing the fund or funds from which each is supported.

Problems of the farm, home and community are constantly arising. The progressive work of the agricultural action agencies has tended to focus popular attention on several of these and your research workers are doing their part toward solving them with the funds and personnel available. The best use of our land and our agricultural resources has always been uppermost in the minds and in the planning of those engaged in agricultural research. Members of the station staff are meeting periodically to discuss research problems and to so coordinate their work and their efforts that such problems may receive the fullest consideration of the staff.

Respectfully submitted,

[Signature]

Director, Experiment Station
## Table of Contents

- Soils, Crops and Crop Breeding ......................................................... 5
- Livestock Production ........................................................................ 17
- Dairy Production ................................................................................ 25
- Livestock Diseases and Parasites ...................................................... 33
- Poultry Production ............................................................................ 37
- Fruits and Vegetables ........................................................................ 42
- Crop Insects ...................................................................................... 46
- Farm Engineering ............................................................................... 49
- Home Economics ................................................................................ 52
- Farm Income and Community Welfare ............................................. 54
- Cooperative Agreements With Federal Agencies ............................. 64
- Active Research Projects .................................................................. 68
- Station Staff ...................................................................................... 72
- Journal Articles by Staff Members .................................................. 75
- Financial Statement ........................................................................... 78

## INDEX BY STATION DEPARTMENTS

- Agricultural Economics ................................................................. 54
- Agricultural Engineering ............................................................... 49
- Agronomy .......................................................................................... 5
- Animal Husbandry ............................................................................ 17
- Station Chemistry ............................................................................ 15 and 35
- Dairy Husbandry .............................................................................. 25
- Entomology ....................................................................................... 46
- Home Economics .............................................................................. 52
- Horticulture ....................................................................................... 42
- Pharmacy .......................................................................................... 12 and 33
- Poultry .............................................................................................. 37
- Rural Sociology .................................................................................. 59
- Veterinary .......................................................................................... 34
To Our South Dakota Farmers

In establishing the state agricultural experiment stations, the sub-stations and the field stations, our federal and state legislative bodies had two principal objectives in mind, namely:

1. To enable trained employees to carry on scientific investigation and experimentation respecting the principles and applications of agricultural science.

2. To give the citizens of the state and the United States the results of such research work so that the best use possible may be made of the research service.

During the present fiscal year we requested the heads of the farm commodity organizations listed below to serve as an Agricultural Research Council. The purpose in seeking a closer relationship with these groups was mutual in that these groups might have a clearer understanding of the work and procedure of the station and could counsel more effectively as to the development and expansion of its research activities.

State Crop Improvement Association.
South Dakota Potato Growers Association.
State Agricultural Conservation Committee.
State Horticultural Association.
State Livestock Committee.
Cooperative Wool Growers of South Dakota.
State Poultry Association.
State Dairymen’s Association.
State Livestock Sanitary Board.

Farmers and those associated with the agricultural industry have been generous in their cooperation with the experiment station. We of the station take this opportunity of thanking you and sincerely request your continued cooperation.

The Director
Soils, Crops and Crop Breeding

Do South Dakota Soils Need Fertilizers?

Maintaining productivity of the soil is, without doubt, one of the most important material problems of any nation. The basic needs of humanity—food, clothing, shelter and fuel—are, with the exception of fuel, obtained almost exclusively from the soil.

The soils of South Dakota are relatively new. Some of the pioneers who helped to turn the virgin sod are still with us. Yet soils differ widely in physical characteristics—some deplete more rapidly than others and some are going to need fertilizer application to maintain their productivity.

What soils need fertilizers and what kind, if any? At the Agricultural Experiment Station at Brookings and three substations at Cottonwood, Eureka and Highmore tests have been carried on for more than a quarter of a century to find an answer to these problems.

This past year a bulletin—"Thirty Years of Soil Fertility in South Dakota" by J. G. Hutton—was published incorporating all of the experimental data to date.

The complete fertility trials in which nitrogen (N), phosphorus (P) and potassium (K) were applied singly and in combination as compared to no treatment (0-100) and set forth in this bulletin were:

<table>
<thead>
<tr>
<th>Total Amount of Dry Matter Produced Based Upon</th>
<th>The Yield Following no Treatment as 100</th>
</tr>
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<tbody>
<tr>
<td>Yrs. O N P K NP NK PK NPK</td>
<td></td>
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<tr>
<td>Brookings 30 100 112.82 127.59 101.55 116.95 107.72 121.02 121.24</td>
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</tr>
<tr>
<td>Cottonwood 25 100 96.52 105.25 109.74 108.22 106.55 102.41 108.39</td>
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<tr>
<td>Eureka 25 100 98.45 93.30 93.72 98.19 96.34 97.16 100.78</td>
<td></td>
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<tr>
<td>Highmore 25 100 104.54 104.14 97.48 116.83 108.03 103.64 113.93</td>
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At Brookings—All treatments were followed by increases in yield of total dry matter. Phosphorus alone gave the largest increase, 27.59 percent. Potassium alone gave the smallest increase, 1.55 percent. Potassium has had a depressing effect when applied with other elements.

At Cottonwood—All treatments except nitrogen alone have been followed by increases in yield of total dry matter. The largest increase, 9.74
percent, followed potassium. The decrease following nitrogen was 3.48 percent.

At Eureka—The only treatment which was followed by an increase in yield of total dry matter was nitrogen, phosphorus and potassium, and the increase, 0.78 percent, is too small to be significant. The lowest yield followed the application of phosphorus alone and the decrease was 6.70 percent.

At Highmore—Increase in yield of total dry matter followed all treatments except potassium alone where a decrease of 2.52 percent is recorded. The largest increase, 16.83 percent, followed the application of nitrogen and phosphorus in combination.

MANURE, PHOSPHATE AND LIMESTONE TRIALS AT BROOKINGS. For 25 years the application of 10 tons of manure per acre every four years in the rotation was followed by an increase in yield of total dry matter of 17.14 percent. The application of acid phosphate with manure increased the yield 2.17 percent over manure, a total increase over the yield following no treatment of 19.31 percent. This was the largest increase for any treatment applied. Rock phosphate applied with manure seems to have decreased the beneficial effects of manure alone by 3.17 percent.

Limestone when applied alone was followed by an increase of 2.34 percent, but when applied with manure or manure and acid phosphate it has reduced the beneficial effects observed where these substances were applied without limestone. Where limestone was applied with rock phosphate there is an apparent increase of 0.62 percent over rock phosphate alone. (Project 7. Leader: J. G. Hutton, Agronomy Department.)

GRAIN AND LIVESTOCK FARMING SYSTEMS AT BROOKINGS. All treatments were followed by higher yields of total dry matter than that following no treatment. The largest increase, 13.64 percent, followed the application of manure. The application of phosphorous and potassium with manure gave lower yields than manure alone.

Plowing under crop residues with sweet clover and peas did not prove as effective as manure. The application of phosphorus and phosphorus and potassium with the residues has increased the yields over those following the residues alone but has not equalled the yields following manure alone.

The amount of water required to produce one pound of dry matter on the plots receiving no treatment was: Brookings, 1,593 pounds; Cottonwood, 2,086 pounds; Eureka, 1,323 pounds, and Highmore, 1,638 pounds. (Project 4. Leaders: J. G. Hutton and Leo F. Puhr, Agronomy Department.)
How Does Organic Matter Affect the Soil?

An experiment is under way to secure, if possible, information about the effect of organic matter upon the soil itself, separate from whatever factors are controlled by the immediate growth of crops.

A series of pots, with specific amounts of organic matter added, are being maintained in the greenhouse. These are run without the growth of crops and with the moisture content being maintained at a standard level. On the basis of these results other cultures will be prepared wherefrom additional results may be secured as expressed in terms of crop yields. (Project 46. Leaders: J. G. Hutton and Leo F. Puhr, Agronomy Department.)

Developing a Superior Hybrid Corn

Extensive work is being done in corn breeding correlating characters of selfed strains and their combinations, in both single and double crosses, to obtain the highest yielding variety possible.

At the present time there are 768 double-cross combinations derived from 18 inbred lines on test. These double-crosses are being tested along with 21 commercial double-cross hybrids and two adapted open pollinated varieties. They are each repeated four times and the crosses randomized within each repetition.

Select on Basis of "High and Low Pull." Being continued again this year are 203 inbred lines isolated from 33 adapted varieties. These lines are isolated on their "high and low pull pounds" per plant, meaning the measured tension necessary to pull the plant out of the soil.

Seed is being produced from 41 purebred lines which will later be made into single and double cross combinations to be tested out on their merits as producers of corn with desired characteristics. (Project 66. Leaders: A. N. Hume, C. J. Franzke and Leo F. Puhr, Agronomy Department.)

Selecting a High Yielding, High Protein Content Corn

The corn grain is particularly rich in starch, containing about 70 percent of nitrogen-free-extract, nearly all of which is starch. But, being so high in starch, corn is naturally low in protein. In the development of the present high-yielding varieties of corn, there has apparently been an appreciable lowering of the fat content, a slight lowering of the protein and a slight increase in starch and fiber.
By long continued selection a strain of corn has been developed at the South Dakota Station that tested 17.66 percent protein in the 1938 crop (the normal protein percentage of corn being slightly over 10 percent). Seed selected from the high protein ears of 1937 yielded a higher protein content than the low protein seed. As yet the strains are not of practical importance because they are relatively low yielding but it is hoped that more time may be devoted to the breeding in the future of a high yielding, high protein corn. (Project 6. Leader: Mathew Fowlds, Agronomy Department.)

Map of South Dakota Soils Has Been Prepared

A reconnaissance map of the soils of South Dakota has been prepared in cooperation with the Federal Soil Survey and the Soil Conservation Service. It is hoped that the map will be printed within the next fiscal year.

How Deep Should South Dakota Soil Be Plowed?

One of the standard subjects of controversy when farmers get together in the spring or fall is how deep to plow. At the Experiment Station and three of the substations 25 years work on tillage problems is nearing summarization and a bulletin will probably be forthcoming this fall. Test depths of 0, 4, 6, 7 and 12 inches have been used with yield, fertility and erosion factors entering into the summary. (Project 8. Leaders: J. G. Hutton and Leo F. Puhr, Agronomy Department.)

Find Prussic Acid Content in Sorghums Heritable

Farmers and others concerned with the production and feeding of forage crops long have known that certain crop plants may be poisonous to animals. It has also been found that the poisonous property of certain plants consists of, or is associated with, prussic acid or hydrocyanic acid (HCN). The research conducted was concerned with one principal forage crop, sorghum and its varieties.

Some of the principal findings were:

1. The factors which control content of HCN in sorghum are heritable and consequently subject to modification by selection and breeding. It is hoped this fact might serve as a basis for production of varieties and strains of forage and grain sorghum utilizable in the northern Great Plains and elsewhere with little or no danger of prussic acid poisoning.

2. Low-HCN appears to be partially dominant over high-HCN although the Mendelian ratio is not considered established as yet.
The HCN content in green forage at a given growth stage for the high HCN strain, 19-30-S; low HCN strain, 39-30-S (Dakota amber), and Sudan grass strain, 176-S, is shown at the Brookings Station over a three-year period.
3. The amount of HCN occurring in strains of sorghum investigated is subject to decided modification by environment, weather, condition of soil, climate or storage.

4. It was observed that conditions of environment which promote normal and regular growth in sorghum plants result in a minimum HCN content therein. Consequently, conditions which retard such normal development of the sorghum plant, in greater or lesser degree, bring about corresponding increase in amounts of HCN in subsequent growth.

A complete account of this work is included in Technical Bulletin 1 "A Study of Sorghum With Reference to the Content of HCN." (Project 61. Leaders: C. J. Franzke, Leo F. Puhr and A. N. Hume, Agronomy Department; James W. Wilson, Animal Husbandry Department and C. C. Lipp, Veterinary Department.)

Geneticists Breed for Rust Resistant Small Grain

As in previous years, uniform regional small grain nurseries were grown in cooperation with the United States Department of Agriculture. The station is continuing genetic studies with barley, wheat and oats. Several barley and wheat crosses are being studied at the present time.

Nakota, a new variety of hulless oats, was released and distributed to farmers in the spring of 1939. In the hard red spring wheat experiments several crosses were made with Triumpho and Argentine wheat and produced higher yields than the standard varieties during seasons of heat and drouth. (Projects 5 and 25. Leaders: Mathew Fowlis and S. P. Swenson, Agronomy Department.)

What Is the Best Forage Crop for Our State?

This station, in cooperation with the Soil Conservation Service, launched a comprehensive pasture investigation program this last year in an attempt to find the answer to this question. Early fall, late fall and early spring seedings were made of 11 species of grass, 22 varieties for each date of planting.

In addition an observational grass adaptation field trial was started last spring consisting of 24 varieties of grasses and 10 legumes. The grasses are coming along in splendid shape and it is hoped to have definite data on their progress next year.

Seeking to introduce new varieties into South Dakota, 101 varieties—most of them grasses of southern origin with seed secured from high altitude varieties of foreign introductions with a climate similar to ours—were planted this past spring.
Considerable trouble was experienced in securing stands of Crested wheatgrass, Russian wild-rye, Grama grasses, Stipas and Indian rice due to what appeared to be root rots. This year the seeds of these grasses were treated with chemicals as follows: Semesan Jr., improved ceresan and cu-procide checks with no treatment of each variety to obtain a comparison. (Project 74. Leaders: C. J. Franzke, Leo F. Puhr and S. P. Swenson, Agronomy Department and I. B. Johnson, Animal Husbandry Department.)

Seek Adapted Soybean Varieties

In cooperation with the United States Department of Chemistry and Soils adaptation experiments with early and late varieties of soybeans are being continued at the station. On the Brookings farm 25 varieties from many regions are planted both in triplicate and randomized.

The object of the work is to learn the characteristics of varieties best suited to production and subsequent processing into industrial products. Variety tests and breeding experiments are being continued. (Project C-2. Leaders: A. N. Hume, Agronomy Department: Bureaus of Chemistry and Soils and Plant Industry Cooperating.)

Chilean Alfalfa Unadapted to South Dakota Winters

Two cuttings of hay were obtained during 1938 from the uniform alfalfa nursery sown the previous spring. The Chilean variety showed considerable winter injury and several others were slightly injured.

A number of selfed progenies of alfalfa have also been grown at the nursery. After three or four selfings many of the plants become self sterile and it is difficult to continue. (Project 10. Leader: Mathew Fowlds, Agronomy Department.)

Investigate Inheritance of Color in Sweet Clover

The varieties of sweet clover commonly grown have yellow seed. In certain varieties the coat may be mottled with a reddish purple pigment. Pale yellow or green seeds are occasionally found as a mixture.

Some of the findings in this genetic study were:

A pale green seed color was observed in a hybrid between green and yellow and failed to breed true in the next generation.

In a hybrid between yellow mottled and green, a segregate has been found that has the mottled condition combined with a green seed coat.

The green seed color is inherited as a recessive to yellow and its determination
appears to be dependent upon one main factor pair. The pale yellow seed color is also recessive to yellow.

Cross-pollination occurred freely between the different varieties observed. If sweet clover selections are to be kept pure, the seed plant must be well isolated from all other varieties. (Project 10. Leader: Mathew Fowlds, Agronomy Department.)

Continue Projects at Substations

Experimental work was continued at the state substations at Vivian, Cottonwood, Eureka and Highmore during the past year.

At both Eureka and Highmore encouraging yields were secured from ear rows in corn breeding plots. Cooperative weather observations were enlarged at Highmore to accommodate the air transportation service and additional sorghum variety tests were seeded. Arrangements have been made to compare the possible pasture utilization of low-HCN sorghum in comparison with sudan and winter rye.

At Cottonwood the cooperative grass nurseries were continued and two separate varieties of barley seeded for comparison. Additional elm and hackberry trees have been planted at Vivian to replace those gone from the tree grove.

Cultivation of Ephedra Sinica in South Dakota

Two years ago the project on ephedra sinica was started with the idea of increasing its alkaloid content as well as adapting it as a field crop for the marginal land in western South Dakota.

Ephedra sinica and its various preparations are now recognized as one of our most valuable groups of medicinal substances. Clinical use has established this drug as a valuable remedy for respiratory affections such as asthma, hayfever, head colds and difficult breathing. Its recognized therapeutic value has led to the adoption of the alkaloid, ephedrine, and several preparations from it into the official books, namely, the U. S. Pharmacopoeia and the National Formulary. This distinction classes the ephedra products with those drugs which have a tried and proven therapeutic value.

There is no domestic supply for this drug. Tons of the crude drug are imported annually into the United States from China, which to the present time has been the greatest producer. The drug grows wild there on their dry windswept plains, and no attempt has been made to put the plants under cultivation. It is reported that this project in South Dakota is the original attempt to place ephedra sinica under strict cultivation in
order to study its possibilities as a commercial crop. Its successful completion means the shifting of a valuable industry to a domestic site, with the distinct advantages to be gained by having a constant and reliable source of supply for one of our most important medicinal drugs.

This cooperative project represents a comprehensive study of the introduction, acclimation, propagation and cultivation methods best suited to the production of ephedra sinica in South Dakota. Two phases of investigation are being carried out: (1) Its possibilities as a commercial crop for this area and western South Dakota, and (2) Its use in the control of soil erosion.

Thus far considerable time has been devoted to the propagation methods best suited to the production of ephedra plants. It has been definitely established that the plants can be reproduced from both seeds and subdivision of the older plants. During the past year of 1938-39, marked success was made in the development of new plants. Cultivation, together with maturation of the perennial stems increased the seed production many times over that produced in previous years. Exclusive of the seeds held in reserve, it is estimated that the 1939 spring planting should increase the number of plants by several thousand. This increase in available plants for field work has made it possible to extend active cultivation into the substations at Highmore and Vivian where plantings were made.

**EPHEDRA SINICA (FOREGROUND) IN THE MEDICAL GARDENS**
Marked progress has been made with the cultivation of ephedra the past year. Source of one of the more valuable groups of drugs, the plant is also being tested for erosion control properties.
during June 1939. This is the area in which it is proposed to establish ephedra cultivation on a commercial scale.

Samples of the soil where these plantings are to be made, as well as that of the local plots, are being taken for analysis by the Soils Department. This is the initial step in the determination of the soil types best suited to its production, as well as the influence they have on the alkaloidal content. Assayed plants are being used in this development.

A plot of special plants was established in the spring of 1939 and was isolated from any possible contact with the remainder of the plants in an endeavor to confine pollination to these superior specimens, carrying the factor for high ephedrine production. It is hoped that seed collected from these plants will produce plants uniform in their high alkaloid content.

In addition to this work, propagation of a better quality plant was also started by increasing their number through subdivision of the older plants. By removing the plants which consistently run low in their ephedrine production, the quality of the drug should be greatly improved.

A complete report of the cultivation of ephedra sinica in South Dakota was published in the Journal of the American Pharmaceutical Association, XXVIII, No. 4, 199 (April, 1939). In addition to this work, a complete and satisfactory assay has been perfected for determining the alkaloidal content of the crude drug. A histological study was also made and a monograph prepared for the crude drug ephedra in anticipation of its adaptation as an official drug. This will mean added prestige for the drug itself, as well as for the cooperating departments now engaged in its cultivation.

The past year has been particularly successful for the following reasons:

1. Seed production has been greatly increased through cultivation methods. This means added impetus to the development of new plants for more extensive investigation.

2. A plot of select plants has been established containing an average ephedrine content of 1.64 percent as compared to the Chinese drug which averages only about 1 percent.

3. The groundwork has been laid for controlled pollination of these plants in an endeavor to produce seeds with which to improve the quality of the drug.

4. Development of a high quality group of plants by subdivision of the root-stock of the unusual plants has been started.

5. Plots of select plants have been established at two of the experiment substations at Highmore and Vivian.
6. Soil samples have been taken from the local and substation plots to inaugurate a study of the influence of soil types on the growth and development of ephedrine in ephedra sinica.

7. A monograph has been prepared for the adoption of ephedra, the crude drug, into the official books. (Project 65. Leaders: L. David Hiner, Division of Pharmacy, and J. G. Hutton, Agronomy Department.)

The Geological Distribution of Selenium

Preliminary work by the Station Chemistry Department on the geological distribution of selenium indicated that the selenium was more or less confined to two distinct stratigraphical positions of the Pierre formation. During the summer of 1938 six weeks were spent in collecting geological and vegetation samples and mapping the outcrops of the seleniferous strata of the Pierre formation. Approximately 600 samples of rocks, soils and vegetation were collected and analyzed for selenium. The results of the geological part of the study which have been published in a technical bulletin can be summarized briefly as follows:

1. Most of the geological formations and especially those of Cretaceous age contain selenium in detectable amounts.

2. The Niobrara formation is the most consistent highly seleniferous formation in South Dakota.

3. The Sharon Springs member of the Pierre formation which lies directly above the Niobrara formation is highly seleniferous.

4. The Interior (Mobridge) member of the Pierre formation which is the second member from the top of the formation is highly seleniferous in its outcrop along the west bank of the Missouri river in southern South Dakota and in northern Nebraska. To the north and west the selenium content of the Interior member decreases and in the southwestern part of South Dakota it is selenium-free in many places.

5. The uppermost part of the Virgin Creek member of the Pierre formation is highly seleniferous in central South Dakota.

Field Studies on Plants. During the summer of 1938, at the same time at which the geological study was being made, a study of the selenium content of plants was also made.

Two common “converter” plants, milk vetch, Astragalus racemosus, and Stanleya, Stanleya bipinnata, were found to grow best in bedrock which had been weathered very little, provided the rock contained some selenium. Because of this, these plants were found to be very useful in the location of seleniferous formations or zones within formations.

Milk vetch, Astragalus racemosus, and stanleya, Stanleya bipinnata, were found to be about equal in their ability to absorb selenium from bed-
rock, provided they grew under similar conditions. Three other important “converter” plants, white aster, *Aster multiflorus*, turpentine weed, *Gutierrezia sarothrae*, and gumplant, *Grindelia souarrosa*, were studied. Their selenium contents were found to be considerably lower than the selenium content of stanleya, *Stanleya bipinnata*, and milk vetch, *Astragalus racemosus*, growing under similar conditions. White aster, however, is considered very important from the standpoint of conversion because of its very common occurrence in the seleniferous area along the Missouri river.

Several grass samples were collected during the summer, and the analyses of these samples show that Western wheatgrass, *Agropyron smithii*, is considerably more seleniferous than are the other common grasses of the state.

**Greenhouse Studies on Soils and Plants.** A preliminary study of the relationship between the form of selenium in the soil and the amount of element crop plants will absorb from it was published in *Soil Science*. It was found that the water-soluble and dilute ammonium hyroxide-soluble selenium content of the soils studied were relatively accurate indicators of the availability of selenium in the soil. Further studies on this problem have been carried on using non-seleniferous soil which has been selenized with different chemical forms of the element. From these studies it has been found that selenate selenium and organic selenium (plant extract) are the most readily available forms as concerns crop plants. However, “converter” plants such as milk vetch, *Astragalus racemosus*, and stanleya, *Stanleya bipinnata*, are capable of removing considerable selenium from the soil when it occurs there as the selenite.

**Laboratory Studies on Forms of Selenium in Soils and Rocks.** Through absorption studies an attempt is being made to explain the binding of selenite selenium by soils. Work done thus far indicates that iron and aluminum oxides or hydroxides are important in this respect.

In order to determine in what chemical form selenium occurs naturally in soils and bed rock, several studies have been made concerning the solubility of the element as it occurs in relatively unweathered rock. Although the element as found in rock is not soluble in acids which do not act as oxidizing agents, acids such as nitric and sulphuric (concentrated) do convert the elements to a soluble form. (Project 19. Leaders: A. L. Moxon, O. E. Olson and Walter V. Searight, Station Chemistry Department.)
Livestock Production

Find Tankage Lacking Palatability for Beef Calves

Fattening calves need more protein than older cattle and thus there is a greater benefit from feeding them a protein supplement in addition to corn, legume hays or silages.

What kind of protein supplement should be fed? The market affords supplements of both animal and vegetable origin. Tankage is a by-product of the slaughterhouse while linseed oil meal, cottonseed meal and soybean oil meal are vegetable by-products.

For the last three years, work has been conducted at this station with the feeding of tankage to beef calves as compared to the vegetable supplements. The summarized results, completed this year, appear in Bulletin 329 as follows:

1. Dry-rendered tankage when used as a protein supplement is not as palatable as linseed oil meal or cottonseed meal.
2. There is no evidence that dry-rendered tankage fed as a protein supplement to cattle interfered with digestion.
3. Tankage and linseed oil meal mixed equal parts by weight proved more palatable than tankage fed alone.
4. Calves fed tankage did not make as rapid gains as those fed linseed or cottonseed meal. The calves were well finished at the end of the feeding period, however, and rated above those fed corn and alfalfa alone.
5. A mixture of linseed oil meal and tankage did not prove superior to either cottonseed or linseed oil meal fed alone, but it did prove superior to tankage alone. (Project 43. Leaders: J. W. Wilson and Turner Wright, Animal Husbandry Department.)

Will Creep Fed Calves Be Most Profitable?

The production and marketing of early finished beef cattle results in a quicker turnover to the producer and possibly lower production costs. Producers of this area are not agreed upon this possibility and have repeatedly asked the station for available local data regarding such a method of beef production. Our producers maintain that such a practice, which may be profitable in a locality further to the south or east, may or may not be adapted for the local territory.

In order to obtain a satisfactory answer to this question an experiment was started in the winter of 1937-38 with the purchase of 30 head of grade Shorthorn cows. They were bought locally from farmers and through a
livestock auction agency and represented an average farm herd of cows. These cows calved later in the spring, the station securing 31 calves from 30 cows.

On July 5 both the cows and calves were weighed and divided as uniformly as possible into two lots, the calves in Lot 1 being managed somewhat differently than those in Lot 2 as they were creep fed grain while running with their dams on the summer pasture. The ration consisted of a mixture of equal parts of ground shelled corn, oats and ground barley. After being on pasture for four months the cows and calves were weighed again on November 5. The lot wherein the calves were creep fed showed an average gain per calf of 234 pounds and those not creep fed an average of 192 pounds. There was a loss in weight of the cows, those in the creep fed lot losing 69 pounds per head compared to 16 pounds per head loss for the cows in the other lot.

The two lots of calves were put into the dry lot and fed the same ration consisting of shelled corn, linseed oil meal and alfalfa hay. The heifers were to be fed to a weight of 800 to 850 pounds and the steers to a weight of 900 to 950 pounds. Six of the heifers have already been marketed, four of the original creep fed and two of the others. A cooking and palatability test is being conducted on representative carcasses. (Project 67. Leaders: I. B. Johnson and F. U. Fenn, Animal Husbandry Department.)

Sooner Milo Equals Corn in Rapidity of Gain for Pigs

This station conducted tests to determine the feeding value of grain from Sooner milo, grain from a low prussic acid variety of amber sorghum developed by the South Dakota Agricultural Experiment Station and grain from ordinary Dakota amber sorghum as compared with yellow corn.

Forty summer pigs grown by the College Animal Husbandry Department were used. These were divided into four uniform lots of 10 pigs each and self-fed, free-choice, as follows:

Lot 1—Shelled corn, tankage, alfalfa hay, mineral mixture.
Lot 2—Ground Sooner milo grain, tankage, alfalfa hay, mineral mixture.
Lot 3—Ground grain from low prussic acid sorghum, tankage, alfalfa hay, mineral mixture.
Lot 4—Ground grain from ordinary Dakota amber sorghum, tankage, alfalfa hay, mineral mixture.

The pigs fed the Sooner milo made the fastest gains and those fed Dakota amber sorghum the slowest. There was very little difference be-
between the pigs fed the Sooner milo and those fed corn in feed required per hundred pounds gain. Those fed the milo required a little less grain but a little more tankage than those fed corn.

Both the low prussic acid sorghum and the Dakota amber sorghum were considerably lower in feed value than the corn and milo. The low prussic acid sorghum gave 75 percent the value of corn whereas the Dakota amber returned but 65 percent. The hogs fed on these amber sorghums, while making slower gains than the others, did put on an excellent market finish. (Project 27. Leader: Turner Wright, Animal Husbandry Department.)

Lightweight Barley Valuable for Fattening Pigs

The fourth in a series of tests—fattening fall pigs on South Dakota grains—was conducted during the winter and spring of 1939. Forty fall pigs raised by the College Animal Husbandry Department were divided into four uniform lots of 10 pigs each.

### Different Weight Barleys Were Checked Against Corn as Follows:

<table>
<thead>
<tr>
<th>Rations fed*</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelled yellow corn</td>
<td>Gr. heavy</td>
<td>Gr. medium</td>
<td>Gr. light</td>
<td></td>
</tr>
<tr>
<td>Tankage</td>
<td>wt. barley</td>
<td>wt. barley</td>
<td>wt. barley</td>
<td></td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>Alfalfa hay</td>
<td>Alfalfa hay</td>
<td>Alfalfa hay</td>
<td></td>
</tr>
</tbody>
</table>

| Average No. of days fed | 58 | 58 | 59 | 62 |
| Average initial weight per pig | 126.2 | 126.5 | 124.0 | 126.5 |
| Average final weight per pig | 237.8 | 236.7 | 235.7 | 236.6 |
| Total gain per pig | 111.6 | 110.2 | 111.8 | 110.1 |
| Feed consumed per 100 lbs. gain: | | | | |
| Grain | 332.4 | 326.3 | 368.8 | 362.7 |
| Tankage | 25.4 | 19.6 | 21.0 | 18.4 |
| Alfalfa hay | 2.15 | 1.5 | 1.7 | 1.9 |
| Mineral mixture | .9 | .9 | .9 | .9 |

* The test weights per bushel of the grains used were as follows: Yellow corn 55 pounds, heavyweight barley 47 pounds, mediumweight barley 38 pounds and lightweight barley 32 pounds.

All of the pigs used in this experiment made rapid, cheap gains, less than 400 pounds of feed being required for 100 pounds gain for every ration fed. The pigs fed heavyweight barley practically equalled those fed corn in rate of gain and made 100 pounds of gain on less feed. The lightweight barley again made a very favorable showing, indicating a relatively higher feeding value than often shown by market prices. (Project 24. Turner Wright, Animal Husbandry Department.)
Excellent Results From Fattening Pigs on Forage

Pork of excellent palatability and quality has been produced by pigs fed a ration of shelled corn and tankage while on alfalfa, sweet clover or rape pasture at the South Dakota Agricultural Experiment Station. No significant difference could be detected between the pork produced by the pasture lots and from pigs fed similarly on dry lot.

Three trials of this experiment have been conducted. In each trial four lots of 10 pigs each were fed to an individual weight of 225 pounds and then slaughtered under test in the college meat laboratory. The carcasses were graded and meat samples from each carcass were roasted and scored by a palatability committee. The project was planned and conducted according to procedures recommended by National Meat Investigations cooperators. (Project 50. Leaders: Turner Wright and F. U. Fenn, Animal Husbandry Department.)

Compare Lambs and Gummer Ewes for Fattening

In eastern South Dakota and in the irrigated sections of the state, sheep and lamb feeding is in general a profitable livestock enterprise. Lambs are bought by farmers from western producers at the end of the grazing season and fed during the fall and winter months. At the same time lambs are sold to the western producer, old ewes are culled out and sent to market. The low price that these ewes command on the market often attracts feeders.

The question has been asked the South Dakota Station numerous times as to the economy of feeding these aged, gummer western ewes in comparison with western lambs. Feeders also desire information on the
advisability of grinding the grain in the ration for gummer ewes. Producers and the meat trade have always been interested in knowing to what degree the quality of mutton is improved by feeding aged, gummer ewes. This experiment is being conducted to give South Dakota sheep feeders information on these specific sheep feeding problems.

At the end of one year’s work in feeding 50 head of western lambs and 100 head of gummer ewes the results indicate corn to be superior to barley as a fattening feed for both lambs and ewes. Grinding grain for aged, gummer ewes was not a profitable practice. The palatability committee rated mutton from finished gummer ewes surprisingly high and nearly comparable with lamb, whereas the mutton from similar ewes before fattening was much inferior.

**THE FEEDING TRIAL RESULTS WERE AS followS:**

<table>
<thead>
<tr>
<th>Feed required per 100 lbs. gain:</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>Grain</td>
<td>651.8</td>
<td>634.4</td>
<td>502.3</td>
<td>552.7</td>
<td>491.6</td>
<td>415.8</td>
</tr>
<tr>
<td>Wh. barley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr. barley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wh. corn</td>
<td>399.2</td>
<td>481.7</td>
<td>351.6</td>
<td>420.2</td>
<td>439.0</td>
<td>399.0</td>
</tr>
<tr>
<td>Gr. corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wh. barley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wh. corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit per head after deducting feed costs</td>
<td>$1.15</td>
<td>$0.99</td>
<td>$1.46</td>
<td>$1.18</td>
<td>$1.75</td>
<td>$1.97</td>
</tr>
</tbody>
</table>

(Proiect 78. Leaders: James Watson and F. U. Fenn, Animal Husbandry Department.)

**Test Rations for the Pregnant Ewe**

For the past three years the station has been conducting work on rations for the pregnant ewe with respect to the effect on the ewe, her fleece and her progeny. An effort has been made to determine if a wide or narrow nutritive ration is preferable. The final report will be based upon five years work, or at the conclusion of the experiment.

Fifty-five head of grade Hampshire ewes were bred to a purebred Hampshire ram for the 1939 lamb crop. These ewes were divided into five different lots of 11 head each and fed the following rations:

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

Each ewe was weighed when bred and a sample of her fleece clipped from the left shoulder, left side and left thigh. After lambing she was again weighed and fleece samples taken. The wool was submitted for analysis by a chemist and a fiber technician.
The progeny was weighed at birth and the condition noted. After birth the lambs were weighed and turned out on pasture. A daily feed record was kept. On July 1 the lambs were again weighed and determinations made to discover any effect of winter feeding on the condition or growth of the lamb during pasture season. (Project 54. Leader: J. W. Wilson, Animal Husbandry Department.)

Report Progress of No-Tail Breed of Sheep

For the last 24 years work has been going on at the South Dakota Agricultural Experiment Station toward the development of a no-tail breed of sheep under the supervision of Director Emeritus James W. Wilson. As far as it is known, it is the only flock of its kind in the world.

Ninety-nine ewes were mated to four different rams last December. Of the 91 lambs born, 35 had no tails, 24 had tails of an inch or less, 17 had tails between 1 and 2 inches, 5 between 2 and 3 and 6 between 3 and 4 inches. Only four carried tails over 4 inches in length. (Project 9. Leader: J. W. Wilson, Animal Husbandry Department.)

Livestock Research Work at Newell Field Station

Conduct Lamb Feeding Tests. Tests have been run at the Newell Station comparing important sheep feeds of the region as to rate and economy of gains and the quality of meat produced.

About 750 lambs, selected for uniformity in type, age, weight and grade are fed annually. The work is largely financed by the South Dakota Agricultural Experiment Station and operated by the Bureau of Plant Industry with the Bureau of Animal Industry assisting in the technical nutrition and husbandry phases.

Conduct Sheep Breeding Improvement Projects. Some worthy strains of Hampshire sheep have been developed of especial value for excellence of mutton form, rapid growth in the lambs and trueness to the practical and useful type. The work was started in 1923 when the Bureau of Animal Industry placed 20 purebred ewes on the Belle Fourche Field Station. Definite progress has been made in the improvement of the quality of wool. Fleece weights for the flock at Newell have averaged higher than other Hampshire flocks of the area.

Considerable work has been done with wool improvement. All fleeces are scored for fineness, character, density and face covering, color of fiber,
LAMBS ON FEED AT THE NEWELL STATION

At Newell, one of the largest experimental lamb feeding laboratories in the United States, over 750 lambs are fed annually. The work is carried on cooperatively by the South Dakota Agricultural Experiment Station and the Bureau of Animal Industry.

measurement for length of staple and weight of fleece. The data obtained have been used in planning the matings.

**Find Alfalfa and Sweet Clover Superior Sheep Pastures.** A distinct edge has been awarded alfalfa and sweet clover as pastures of high sheep-carrying capacity. Bloat on alfalfa has been infrequent and under proper management apparently is not a problem in the Newell area. Botulinus caused some losses on the sweet clover but not sufficiently to be recognized as a general problem to be charged to sweet clover as a sheep pasture.

**Investigate Date of Breeding Ewe Lambs.** Work at Newell indicates that ewe lambs may be bred at 9 or 10 months of age with a fair degree of success if they are well fed. This would necessitate including good alfalfa hay and barley in the ration. In the several years that the project has been conducted the ewes bred as lambs developed about as successfully as their sisters which were first bred at 18 or 19 months.

**Grade Carcasses in Meat Studies.** Grading data are being accumulated to determine the influence of various feeds on the finished lamb carcass. This work has been conducted in connection with the feeding project. Special studies have been made of the relationship of the carcass grades to rate of gain in weight, initial and final weights of the lambs, dressing percentages, carcass weights, market prices and the grades of the lambs on foot.

[23]
# Results of 1938-39 Lamb Feeding Experiments at Newell Field Station

Included in the feeding trials were six lots of 100 lambs each and one carload lot. The length of the feeding period was 128 days except for the carload lot which was 130 days.

## Initial weight (Av)  
67.95  
99.05  
31.10  
24.30  
34.10  
288  
929  
493  
54  
963  
12  
9  

## Final weight (Av)  
67.35  
68.90  
33.75  
4.95  
98.90  
67.70  
290  
928  
929  
363  
316  
282  

## Gain per lamb  
31.10  
24.30  
33.75  
34.10  
29.45  
32.95  
30.10  
42.67  

## Average daily gain  
.243  
.190  
.264  
.266  
.230  
.257  
.235  
.328  

## Feed required per 100 lbs. gain:  
Shelled corn  
346  
377  
243  
264  
266  
316  
282  
363  

Barley  
316  
290  
304  
316  
282  
316  
304  
316  

Pressed pulp  
929  
928  
928  
928  
928  
928  
928  
928  

Molasses  
56  
54  
54  
54  
54  
54  
54  
54  

Bone meal  
7  
7  
7  
7  
7  
7  
7  
7  

Corn silage  
248  
267  
130  
130  
130  
130  
130  
130  

Alfalfa hay  
304  
304  
304  
304  
304  
304  
304  
304  

Shrink to Sioux City  
5.45  
3.75  
5.10  
5.10  
5.10  
5.10  
5.10  
5.10  

Cost of feed per 100 lbs. gain*  
$.80  
.61  
.88  
.82  
.01  
.69  
.43  
.34  

Profit per lamb  
.27  
—.33  
.57  
.62  
.37  
.90  
.93  
.128  

Dressing percent (Av)  
49.7  
49.0  
50.8  
50.8  
50.8  
50.8  
50.8  
50.8  

Cost of lambs was $6.50 cwt. & selling price $8.85 cwt. Value of feed based on following prices: Com, $1.15 cwt.; barley, $0.85 cwt.; alfalfa, $10.00 ton; pressed pulp, $0.75 ton; molasses, $1.20 ton; corn silage, $1.20 ton; bone meal, $3.20 cwt. Beet tops are figured at $0.50 per ton yield of beets.

* Includes cost of beet tops in lots where they were used.
Grazing Trials Measure Pasture Yields

Eleven years ago this station launched a series of trials designed to obtain data on such pasture plants as alfalfa, sudan grass and sweet clover. Because of the abnormally dry seasons, including several drouth years, the work has been extended in the hope of including one or more seasons in which moisture is not the limiting factor.

Again this past year (1938) insufficient moisture was a severe handicap. The plots seeded to alfalfa did not have a sufficient stand to even warrant pasturing and the cows were taken off the sweet clover plot the latter part of July.

**Summary of the 1938 Acre Yields**

<table>
<thead>
<tr>
<th>Pasture Plant</th>
<th>Cow Days* Pastured</th>
<th>Milk Produced Per Acre</th>
<th>Butterfat Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet clover</td>
<td>875</td>
<td>5955.8</td>
<td>223.0</td>
</tr>
<tr>
<td>Sudan grass</td>
<td>470</td>
<td>4137.5</td>
<td>138.7</td>
</tr>
<tr>
<td>Alfalfa (No Results—Insufficient Stand)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* By cow days is meant the number of days one cow was pastured. For instance if seven cows were pastured 20 days the total would be 140 days.

Considerable trouble with bloat was experienced on the sweet clover pasture around the first of June. The cows seemed to bloat during the early part of the evening. Gas samples were collected and the analysis indicated a content of 60 to 70 percent carbon dioxide and 12 to 14 percent methane. To date no trouble has been noted from sudan grass poisoning.

The work on bloat is being continued in the hope of finding the cause and possible remedy. With the danger of bloat threatening the dairyman who pastures sweet clover and alfalfa the value of these crops for grazing is greatly minimized. (Project 17. Leader: T. M. Olson, Dairy Department.)

Compare Fineness of Ground Oats for Dairy Cows

Work at the South Dakota Station relative to the effect of the fineness of grinding on the digestion coefficients of corn has been carried on pre-
viously. Similar studies have also been made on oats as it seemed quite possible that the results with grains protected by a heavy seed coat, or hull, might be different from those obtained from other grains such as corn. Results with oats have been obtained following a year's study. Digestion trials were used to measure the effects and value of grinding to various degrees of fineness in an effort to obtain more fundamental information on this point than is now available. Most of the studies reported previously have merely attempted to measure the results in terms of the effect on the amount of milk produced. Still other projects have dealt largely with the cost of grinding to various degrees of fineness.

It was found that the digestion coefficients for all the nutrients were higher for the whole ration when medium ground oats was used than when the oats was finely ground. The differences favoring the medium ground oats were still more pronounced when figured for the oats alone. This difference is just the reverse of the results for corn where the finely ground grain proved to be the best. In both cases the coefficients were much lower for the whole grains than for either kind of grinding except for fiber which was distinctly higher for the whole grains.

One Holstein, one Jersey and two Guernsey cows were used for this study. All the animals were in about the middle of their lactation periods so no great changes in the level of milk production were encountered. Each trial consisted of a 7-day preliminary period and a 14-day collection period. The four cows were run simultaneously on a sequence of trials where the ration contained oats prepared as follows: (1) medium oats, (2) finely ground oats, and (3) whole oats. A fourth trial was run in which the alfalfa hay part of the ration was fed alone to determine its digestibility.

It is known that changes in such factors as the nutritive ratio of the ration, the amount of fiber and the quantity of feed may alter the digestion coefficients. The rations were set up to avoid as many of these variables as possible. To accomplish this each cow was given a constant amount of a ration of alfalfa hay and oats, half and half by weight, throughout the entire series of trials, so that the only variable was the difference in the preparation of the oats.

The nutrient requirement of each animal was calculated from the weight and milk production records at the beginning of the experiment and was estimated for the end of the experiment by the use of normal lactation curves and usual weight changes. The average of these two sets of figures was used as the nutrient requirement of each cow for the entire ex-
experimental period, or about two months. The ration of half alfalfa hay and oats by weight had a nutritive ratio of 1:4.74 and when it was fed to supply the required total digestible nutrients the other nutrient requirements were nicely met except for an occasional slight excess of protein.

When the whole oats was being fed the feces were washed over a fine screen to see how many of the undigested oats could be recovered. The oats recovered represented from 11.6 to 19.9 percent of the intake. An analysis of the oats recovered from the feces failed to show any decided difference as compared with oats as fed. The whole corn recovered from the feces represented from 13.4 to 26.4 percent of the intake which is somewhat more than for the oats. This will account in part for the fact that the difference in digestibility between the ground corn and whole corn was somewhat greater than the difference between the ground and whole oats. (Project 56. Leaders: T.M.Olson and G.C.Wallis, Dairy Department.)

Discount Effect of Peppergrass on Milk Flavors

Considerable trouble with weedy flavors in milk and cream has been experienced by creamerymen and others buying and selling dairy products. These undesirable flavors have become increasingly worse during the drouth years. Wherever native pastures have lost out in their fight with the drouth, peppergrass has come in thickly. Naturally there were many who blamed peppergrass for the undesirable flavor in milk during the early pasture season.

In order to determine under experimental conditions whether peppergrass or some other weed was responsible for the undesirable flavor a project was submitted. The peppergrass was fed green, as dry hay and as seed.

After conducting a number of trials in which the peppergrass was hand picked and fed liberally to the cows in stanchions and samples of milk collected every 15 minutes, no definite weed flavor could be detected by four different tasters. Peppergrass was also pastured with no objectionable flavor to the milk.

Peppergrass cured as hay in June was fed in liberal quantities with no apparent ill effects. The same results were obtained when liberal amounts of finely ground peppergrass seed was fed under experimental conditions.

The data on all trials indicated that when peppergrass was pastured, fed green, fed as hay or as seed no objectionable weed flavor was discernable.

Whether the undesirable flavors will develop later in the butter can-
not be determined until the butter is held in storage for some time. The butter oil was analyzed for indol and skatol and the results seemed to indicate only slight increase in indol on progressive feeding of the green peppergrass. The work will be continued during May and the first half of June next year as this is the only time when the weeds give any trouble. (Project 75. Leader: T. M. Olson, Dairy Department.)

Can Weedy Cream Flavor Be Reduced Satisfactorily

Results obtained in preliminary trials indicate that the weedy flavor can be reduced, but only with rigorous treatment which imparts other objectionable flavors such as stale, neutralizer or chemical flavor.

The trials during the summer of 1938 involved four batches of weedy cream obtained directly from the creameries. The cream was obtained by grading a considerable number of lots on the receiving platform and selecting only those pronounced weedy by the operators. The lots obtained were divided into two portions and the various processes applied.

The processes tried on this cream were the use of sodium hypochlorite, high temperature, pasteurization, aeration over surface coolers and the addition of butter culture. (Project 63. Leader: D. H. Jacobsen, Dairy Department.)

Holding Cream Is Serious Small Creamery Problem

The problem of holding cream over Sundays in the average small creamery is a serious one when the operator is concerned with the maintenance of high standards of butter quality.

The problem was studied by dividing a vat of cream into three parts. One part was held raw in cans at 35 to 40 degrees F. for 40 hours and then pasteurized. Two of the lots were pasteurized immediately when received. One of these was cooled and churned immediately and the other held for 40 hours in cans at 35 to 40 degrees and then churned. Seventeen vats or 51 churnings of No. 1 grade cream have been studied for both fresh butter score and keeping quality.

The results of these preliminary trials indicated some advantage in holding cream raw for the 40-hour period over holding the pasteurized cream for the same length of time. Additional trials will be conducted to determine the bacteriological and chemical changes involved and to obtain additional data on cream of higher and lower quality. (Project 76. Leaders: D. H. Jacobsen and C. C. Totman, Dairy Department.)
Study Effect of Microorganisms on Butter

The station work during the year has been on two phases of this problem: (1) The identification of cultures of lipolytic (fat-splitting) and proteolytic (protein-digesting) bacteria, and (2) The effect of these types on the keeping quality of butter at different temperatures.

Additional investigations have been made into the characteristics of the 40 lipolytic and proteolytic cultures which have been isolated from defective butter. The practical angle of the studies has been emphasized in that the heat resistance and the proteolytic power of the cultures have been determined. The information obtained on these cultures appears to be extensive enough now to permit some classification and identification of the genera and species involved. It is hoped that identification of these 40 cultures involved will aid in solving the problem of keeping quality control by suggesting the processing methods necessary for their destruction.

The influence of lipolytic and proteolytic microorganisms on the flavor deterioration of butter at various temperatures has been studied on 29 churnings. This has been done to determine the cause of variation in the results of the “holding test” at room temperature. The keeping quality test at room temperature does not agree in every case with the keeping quality of butter at lower storage temperatures common in the butter industry.

The explanation appears to be that there are different kinds of microorganisms active in the butter at the different temperatures. (Project 48, Leader: D. H. Jacobsen, Dairy Department.)

Study Transmission of Vitamin D from Feed to Milk

Starting four years ago experiments have been run at the South Dakota Station comparing the dairy breeds in their ability to utilize the vitamin D in the feed for increasing the vitamin D of the milk produced.

The second pair of cows, a Holstein and a Jersey, completed their lactations during the year. They were fed the same amount of vitamin D daily throughout the lactation period by giving each cow 12 pounds of alfalfa hay. This provided each cow with 7500 International Units of vitamin D per day. Records were kept of the amount and fat percentage of the milk produced. At monthly intervals a three-to-six-day composite sample of butterfat was obtained from each animal for a vitamin D determination. To assist with interpreting probable differences in the vitamin
SEASONAL VARIATIONS IN VITAMIN D CONTENT OF MILK

The chart shows nearly four times as much vitamin D in milk during July as in April. The South Dakota Station is conducting work to determine the influence of feed on the vitamin D content of the milk.

D potency of the butterfat samples, composite blood plasma samples were taken from the two cows at the same time that the butterfat samples were saved in July and September, 1938. A morning and an afternoon sample was made up for each animal. As far as these two sets of observations are concerned there was no great difference between the vitamin D potency of the morning and the afternoon blood plasma samples, nor between the two breeds.

For these two months the butterfat potencies averaged practically the same as the potency per quart of milk was in proportion to the fat percentage of the milk. However, the preliminary figures indicate that from month to month for the entire year the butterfat from the Holstein will probably be a little less potent than the Jersey. Differences in milk flow will also have to be considered in making final interpretations.

The result of this year's work indicates the importance of having blood plasma samples taken simultaneously with the butterfat samples throughout the entire lactation. This will be carried out on the next pair of animals to be run on this experiment as provided for in the original project statement. (Project 47. Leader: G. C. Wallis, Dairy Department.)

Vitamin D Deficiency Studies in Dairy Cows

The blood chemistry studies, mineral balance trials and observations as to the physical condition of the cows on this experiment are being continued as before with additional observations being added.

A dry farrow cow has now been on the vitamin D deficient ration for 19 months with no external evidences of deficiency symptoms. The mineral balance trials show that she is starting to lose calcium and phosphorus from her body. Slight declines in blood plasma calcium and phos-
phorus have also been noted. Another cow on the same ration but receiv-
ing a cod-liver oil concentrate as a vitamin D supplement was apparently
normal throughout the year thus indicating that the experimental ration
is complete except for the vitamin D.

Two other cows became depleted of vitamin D during the winter in-
stead of last summer as was hoped. One of these was given substantial in-
creases in the mineral intake but her condition was not improved. She
became suddenly worse, was unable to get up, gave birth to an 8-months’
fetus, and died a few days later. Inspection revealed both the incisor and
molar teeth were extremely loose which suggested possible vitamin C de-
ficiency complications as this ration furnished little or no vitamin C. Al-
though cattle are not supposed to require food sources of vitamin C it was
decided to test the blood, urine and milk of these animals for evidence of
vitamin C reserves as several years on this ration would constitute a very
severe test of the animal’s ability to maintain herself without appreciable
food sources. These tests are now being made.

The other depleted animal was given alfalfa hay as a source of vitamin
D, but either the requirements were higher than anticipated or the cow
was in a more critical condition than was expected; she failed to recover.
The calcium and phosphorus of the blood plasma showed moderate in-
creases indicating some action of the vitamin D in the hay. Blood plasma
samples were taken for vitamin D assay when the symptoms were most
severe and again after about three weeks of hay feeding. When these
assays are completed they may supply direct evidence as to the appearance
of vitamin D in the blood stream. A post mortem examination indicated
very severe arthritic conditions in the joints, with eroded areas on the ar-
ticulating surfaces, and considerable pus, clotted blood and necrotic
tissue around the hip joints in particular, resulting evidently from the
severe inflammation.

One animal was added to the group on this experiment. She freshened
about January 1 and it is hoped that she will become depleted of vitamin
D during the summer so that the ability of mature cows to use the anti-
rachitic effects of sunshine may be studied in some detail. Mineral balance
trials, blood chemistry determinations, the vitamin D content of blood
plasma and butterfat, etc., will be determined before and after sunshine
exposure. (Project 55. Leader: G. C. Wallis, Dairy Department.)

Influence of Roughage on Vitamin D Potency of Milk

A SCIENTIFIC ARTICLE presenting certain technical aspects of this inves-
tigation which was mentioned in last year’s report has been prepared and
accepted for publication in the *Journal of Dairy Science* under the title, "The Vitamin D of Alfalfa and Prairie Hay and its Utilization by Dairy Cows." This is in addition to the Station Bulletin (321) and the article in the *Journal of Agricultural Research* which have already been published to present other phases of this investigation.

During the past year another sample of alfalfa hay which was graded U. S. No. 1 has been separated into leaves and stems and these two portions assayed for vitamin D. On this sample the leaves contained 1.22 International Units of vitamin D per gram and the stems only 0.29 units. The leaves were therefore 4.21 times as potent as the stems. While the leaf to stem relationship is similar to that obtained on the first sample of alfalfa hay the potencies are much lower as the leaves from the first sample of hay contained 10.45 International Units of vitamin D per gram and the stems 1.72 units.

These results together with the increasing amount of evidence pointing to the importance of the vitamins in roughages for the adequate nutrition of dairy cattle suggest the need for further studies along this line. It is proposed to revise this project to include a study of the factors affecting the vitamin D content of roughages with special reference to vitamins A and D. Studies to indicate the variations in vitamin content of the different kinds of roughages and of different samples of the same kind of roughage as they are customarily handled and used would probably make a logical starting point. (Project 41. Leader: G. C. Wallis, Dairy Department.)
THE CHENOPODIUM PLANT IS A LUSTY GROWER

Both sheep and hogs have been used in testing the worm expelling properties of chenopodium. Preliminary results indicate it may be used as a forage crop to eliminate worms and reduce feed costs.

Livestock Diseases and Parasites

Test Chenopodium for Worm Expelling Properties

In 1928 this station started a study of the properties and uses of oil of chenopodium and chenopodium plants for the treatment of worms in swine and sheep.

At this time the following objectives were outlined: (1) To increase the anthelmintic (worm expelling) properties by breeding of improved strains, (2) To study the anthelmintic values of the oil by actual experimental work with swine and sheep, (3) To study the value of the chenopodium plant as a forage crop, and (4) To study the value of cured chenopodium plant when incorporated in feed mixtures.
Like some plant breeding work progress has been slow and little positive information has been obtained. Preliminary results seem to indicate that chenopodium plants may be used as a forage crop for hogs to eliminate worms and reduce grain and supplements required for 100 pounds gain. Other findings will later be forthcoming with sheep and poultry.

**HOGS:** Four lots of hogs were used in the 1938-39 tests. In general, the results were in line with experiments of previous years.

### Feed Requirements Were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Wormed with Chenopodium</th>
<th>Chenopodium Pasture alternated with rape and oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>341</td>
<td>373</td>
<td>338</td>
</tr>
<tr>
<td>Tankage</td>
<td>32</td>
<td>29</td>
<td>28</td>
</tr>
</tbody>
</table>

These feed requirements were remarkably low for all lots, considering the wormy, runty condition of the pigs at the beginning of the experiment. The only significant difference was a slightly higher feed requirement for the pigs that were wormed.

**LAMBS:** Two lots of wormy lambs were placed on experiment. The first lot, in addition to being decidedly wormy, also had lung worms. The lung worms caused all but five of the lambs to die within two weeks after starting the experiment. Consequently no results were obtained. The second lot of lambs were also very wormy but the majority of them had coccidiosis. Due to the coccidia, they were in a run-down condition and several died. The results obtained would not give a true picture of what to expect from wormy lambs not infected with coccidia.

This year, wormy lambs free from coccidia and lung worms will be used. (Project 20. Leaders: Floyd LeBlanc, Division of Pharmacy; Turner Wright and James Watson, Animal Husbandry Department.)

**Seek More Satisfactory Hemorrhagic Immunizing Agent**

The work on bacterins prepared in various ways as immunizing agents against hemorrhagic septicemia was continued this year in the Veterinary Department. A bacterin that gave the best results so far was one made as follows: Organisms of hemorrhagic septicemia (Buffalo strain) were grown in a medium consisting of 1 part normal rabbit serum and 3 parts brain heart infusion for 48 hours. The whole culture was then treated with formalin and the organisms killed.
Rabbits were given two doses of 2cc each at five day intervals. Fifteen days after the last injection of bacterin the rabbits were then given 0.1 cc. of virulent bouillon culture of hemorrhagic septicemia organisms. Of all the rabbits so treated 50 percent lived and 50 percent died.

Rabbits given the same dosage of commercial bacterin and aggressin when injected with 0.1 cc. of virulent culture (Buffalo strain) all died. Considering the virulence of the Buffalo strain this is a severe test.

A bacterin prepared with the addition of normal rabbit serum to the bouillon in cultural preparation of the bacterin, greatly increases its immunizing power over bacterins prepared without the addition of serum. (Project 11. Leader: J. B. Taylor, Veterinary Department.)

Selenium Poisoning or “Alkali Disease” Studies

The term “alkali disease” is a misnomer which has been applied to a livestock disturbance of the semi-arid Great Plains of the United States. The early settlers adopted the term because some of them suspected that the alkali (high salt) waters of the semi-arid area caused the disease, and others associated it with alkali seeps and alkali spots in the soil.

Research work carried out by South Dakota Agricultural Experiment Station in 1912-13 definitely proved that the alkali waters were not the cause of the disease but the name has remained.

Hogs, cattle, horses and chickens are all affected by the disease. Hogs seems to react most easily, sloughing the hair and hoofs very readily when given feeds produced in selenium areas. Cattle and horses lose their hoofs and hair in much the same manner, but more slowly, due no doubt to the greater size of the animal.

The Toxicity of Selenium to Animals. Considerable progress has been made in determining the toxicity of different forms of selenium. Selenium cystine (the amino acid with the sulphur replaced by selenium) has been prepared by Dr. Arne Fredga of Uppsala University, Uppsala, Sweden and sent to this laboratory for bioassay. The selenium in selenium cystine is almost as toxic as the selenium in the inorganic compounds $\text{Na}_2\text{SeO}_3$ and $\text{Na}_2\text{SeO}_4$ and the selenium as it occurs in seleniferous grains. Even though attempts to isolate selenium cystine from seleniferous grains have failed the possibility remains that at least a part of the selenium in the grains is in the form of this amino acid.

Work is underway to determine the forms and toxicities of selenium in various grasses and converter plants. There have been indications that the selenium in grasses is not as toxic as the selenium in grains.
A RESULT OF GRAZING IN SELENIUM AREAS
Showing the separation of the hoof from the foot of a horse which died after it had grazed on an affected ranch for eight weeks.

Work on the prevention of selenium poisoning by feeding arsenic has continued. Excellent results have been obtained with rats and dogs and experiments are underway with pigs. A knowledge of the mechanism of the reactions between selenium and arsenic in the animal body may lead to the discovery of some substance other than arsenic which will counteract the toxic properties of selenium.

PROPER USE OF SELENIFEROUS LAND. Forty head of steers have been bought for the grazing experiments on the seleniferous Reed Ranch southeast of Pierre. The steers have been divided into four lots of 10 head each as follows: 1. One-half normal grazing load, 2. Normal grazing load, 3. Twice normal load and 4. Twice normal load plus mineral additions.

Periodic weight checks and blood analyses are being made to determine the relative effects of overgrazing and sparse grazing. It is planned these tests will be continued over a three-year period. (Project 19. Leaders: A. L. Moxon and O. E. Olson, Station Chemistry Department: Bureau of Agricultural Economics.)
Poultry Production

Test Oats and Millet Grain Value in Poultry Rations

The production of proso millet in South Dakota is increasing, largely because this grain is drought-resistant and yields well under South Dakota conditions. There have been practically no experiments conducted by other stations on the utilization of millets in the various types of poultry rations.

During the past year, various combinations of Red Proso millet with either wheat, oats or barley have been tested in starting mash mixtures. Other commonly available ingredients used with these grains include meat and bone scraps, dried buttermilk, alfalfa leaf meal and cod-liver oil. Equal parts (37 percent each) of proso with either barley, oats or wheat have proved very satisfactory combinations.

The growing rations which resulted in good growth utilize 52 percent of either oats or Red Proso with either or both of these grains kept before the birds in hoppers. The growth was not quite so good when oats were used in the mash and fed as the only grain.

The laying rations tested include combinations of 30 percent of ground wheat or oats with 44 percent of either Red or White Proso millet, with millet kept before the birds as the only grain.

These experiments show how large percentages of millet may be satisfactorily utilized in combination with other cereal grains for the growth and egg production of chickens. (Project 40. Leaders: W. E. Poley, Poultry Department and A. L. Moxon, Station Chemistry Department.)

Study Selenium Grains for the Growing Chick

In portions of some western counties of the state a good chicken cannot be grown, believed to be due to an "alkalied" condition of the grain grown in that area.

This station organized a project to determine if the grain fed was actually responsible for the condition and what grains gave the most serious trouble. The following procedure was used:

Starting mash mixtures containing 72 percent of ground wheat in addition to 16 percent meat and bone scraps, 8 percent dried buttermilk, 3 percent alfalfa leaf meal and 0.5 percent each of salt and cod-liver oil were fed to chicks during the first eight weeks. Different ratios of wheat con-
taining selenium, and wheat containing no selenium were tested. The results indicate that a ration containing 14 parts per million of selenium is very definitely toxic. Chicks can apparently grow satisfactorily when the ration includes about 5 parts per million of selenium.

From these experiments and from a chemical analysis showing the amount of selenium present in wheat, it is possible to formulate rations to utilize this grain satisfactorily for growing chicks. (Project 28. Leaders: W. E. Poley, Poultry Department, and A. L. Moxon, Station Chemistry Department.)

Do Our Common Grain Varieties Affect Carcass Quality?

Because of the importance of South Dakota in the production of cereal grains at low cost, the work on this project has been confined to a study of the effects of corn, wheat and barley upon poultry meat quality. During the past year, data, which had been secured previously, involving physical and chemical measurements of dressed fryers and roasters were analyzed and treated statistically. In general, the birds receiving barley were not as fat and well-finished as those receiving either corn or wheat.

Special attention has been directed toward the development of suitable physical methods of measuring the amount of meat on a dressed carcass as correlated with certain body measurements. At present, the U. S. grades of dressed poultry are based upon weights and visual examination of the carcass. This method of grading is objectionable because there is often considerable difference of opinion, and there is no satisfactory way of predicting the dressing and drawing percentage of a bird. In addition, it is difficult to estimate the amount of edible meat on the carcass.

An instrument has been made for determining the breast angle, which will give some indication of breast fleshing. The objective is to obtain some measurements which may be correlated to grades, and that this device will be of use to the research worker and also be helpful in commercial grading. (Project 52. Leader: W. E. Poley, Poultry Department.)

Compare High and Low Grades of Grain for Poultry

Inasmuch as there is considerable variation in the test weight per bushel of cereal grains produced in South Dakota these experiments were organized to compare the nutritive values of the lower grades of corn, wheat and barley with the higher grades of these grains.

The experiments showed that in starting and growing rations, the lower grades of corn, wheat and barley were equally as good for growth as
the higher grades of these grains. However, for laying rations, the lower grades were not quite so good as higher grades for the production of eggs. It should be emphasized that this study did not involve diseased or moldy grains. Further work is necessary before definite conclusions can be reached.

From the results secured to date, it can be recommended, that for certain starting and growing rations properly supplemented, lower grades of grain may be utilized, while the higher grades of grain may be marketed at better prices. (Project 53. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

What Grain is Best for Turkey Production?

The availability and price of corn, wheat, barley and oats vary considerably from year to year, depending upon locations and crop conditions. The purpose of this experiment was to determine how large percentages of either of these grains could be satisfactorily utilized in turkey rations.

There were no appreciable differences in the rate of growth when turkeys received either corn, wheat, oats or barley in growing and finishing rations used in 1938.

When judged by the amount of feed required to produce a unit of gain in weight, wheat was practically equal to corn. Compared with yellow corn, wheat had 99.0 percent, barley 98.0 percent and oats 89.3 percent the feeding value of corn in the growing rations studied. In the finishing rations tested during the last two years, wheat had a value of 101, barley 87.7 and oats 96.2 percent compared with corn with a value of 100.
Based upon feed requirements per unit of gain in weight, a table has been made up giving the monetary values of wheat, barley and oats per bushel, compared with an equivalent value for yellow corn. This is published in Station Bulletin 330.

Turkeys produced on rations composed principally of either wheat, barley or oats were graded equally as high as those receiving yellow corn. The color of the dressed carcasses of turkeys receiving cereal grains other than yellow corn was more uniform and preferred by the grader.

These findings make it possible to select those grains which will produce turkeys at the lowest possible cost without affecting either the rate of growth or market quality. (Project 44. Leader: W. E. Poley, Poultry Department.)

Turkey Egg Hatchability Is Being Studied

The Northwest has become an important center of turkey production, with probabilities of considerable further growth. California and Texas have been important sources of hatching eggs. There is however, considerable interest in maintaining breeding stock and producing hatching eggs in South Dakota, Minnesota, North Dakota and other neighboring states in preference to having hatching eggs shipped in.

The experiments conducted on this project were for the purpose of studying the problems of reproduction in South Dakota. Low fertility and hatchability have been experienced with the station turkey breeding flock for several years, even though different strains have been used. During the winter months, all turkeys were subjected to all-night lights. Some lots of turkeys were maintained out-of-doors in yards with shelters, while other lots were kept inside both with and without heat. With some lots, the grain was kept before the birds with mash, while with other lots the grain consumption was limited and the mash kept before the birds.

Egg production was higher and fertility lower with the turkeys kept inside when compared to those outside, while there were no appreciable differences in the hatchability of fertile eggs from January to April.

Mash mixtures utilizing soybean oil meal and larger percentages of milk products were used after April, when all birds were allowed outside yards and alfalfa range. The results of these tests are not yet available.

These experiments indicate very definitely that there are many problems involved in getting good fertility and hatchability under climatic conditions which exist in the Northwest. There has been very little re-
search done on these problems and, at the present time, there is a great need for a broader research program to assist in the solution of these problems. (Project 39. Leader: W. E. Poley, Poultry Department.)

Rammed Earth in Poultry House Construction

Previous experiments involving the study of rammed earth for laying houses have proved this to be very satisfactory and, in fact, superior to wood in maintaining proper temperature conditions during the winter and summer months. Because of these desirable qualities, a brooder house was constructed by the members of the Department of Agricultural Engineering for the purpose of determining whether rammed earth would be satisfactory for chick brooding.

Efforts have been made to develop satisfactory hot water heating systems for a rammed earth brooder house and a frame brooder house of approximately the same inside dimensions. The purpose was to provide the same conditions of heating in both houses, after which tests will be conducted to determine the comparative fuel requirements of both brooder houses as well as the adaptability of these houses to chick brooding. (Project 35. Leaders: W. E. Poley, Poultry Department and R. L. Patty, Agricultural Engineering Department.)
Fruits and Vegetables

Fruit Breeding Experimental Work

About 6,000 seedlings from the Horticulture Department's breeding experiments are ready to transplant to a permanent position in the orchard for subsequent fruiting. In general the aim is to obtain long winter keeping apples, for more dwarf growth for more convenient spraying, than the standard apples. Apples with red flowers and red flesh have been produced and transplanted ready for fruiting.

Eight new varieties of fruits were offered for the first time in the spring of 1939. The list includes four pears, three apples and one plum.

Pears: Hybrids of Siberian and West European pears.
- Yermak—A remarkable tree; shows pear hardiness and resistance to blight. Excellent quality of fruit.
- Finsib—The flesh is juicy and the quality excellent.
- Tanya—Is a red, late keeping pear of medium size and good quality. It is hardy and blight resistant.
- Selenga—The fruit is of excellent quality, the tree is productive and blight resistant.

Crab Apples: All hybrids of the indigenous American apple.
- Wiyuta—This fruit when cooked is a great improvement over the Nevis wild crab.
- Watopa—The tree is very productive; the fruit is an all-the-year keeper and when cooked the flavor is mildly acid to neutral.
- Watonda—The tree is very productive; the fruit is a good keeper and when cooked the flavor is mild.

A low-headed fruit tree for South Dakota

This type tree is a good bearer, less wind-resistant, shades the ground and reduces labor requirements for spraying and picking.
Plums: Koto—The tree is very productive; the fruit is firm and delicious. (Project 1. Leader: N. E. Hansen, Horticulture Department.)

Breeding Triploid Apples from Tetraploids and Diploids.
Triploid apples contain a higher vitamin C percentage than the ordinary diploid apples, according to European research, especially in England and Sweden. Consequently, there is a demand for more triploid apples. Previously they had been of unknown accidental origin but now they can be produced by crossing a tetraploid on a diploid.

Professor Hansen’s Kola crab apple, the first tetraploid (with 68 chromosomes, double the usual diploid number), continues to attract attention in several countries. They offer a chance to originate many triploid apples (51 chromosomes). Recent cytological study in Sweden and England indicates triploid apples contain more vitamins than ordinary apples. The station is also getting entirely new types of apples of great value for the open prairie. These smaller trees are heavy annual bearers with good fruit that will keep a year. (Project 59. Leader: N. E. Hansen, Horticulture Department.)

Breeding Hardy Apricots with Sweet Kernels. Hardy apricots brought by N. E. Hansen from Manchuria in 1924 have fruited and 12 have been named. Many crosses were made the past year with standard apricots. Fifteen hundred seedling apricots were set out for fruit the spring of 1939. (Project 58. Leader: N. E. Hansen, Horticulture Department.)

A Genetic Study of Hardy Double Roses. The purpose is to breed hardy roses for the prairie Northwest that will be hardy without covering or winter protection and as free from thorns as possible. Four double roses were named and sent out the spring of 1938. An importation of over 300 roses from Germany was made in the spring of 1939, mostly rare varieties old and new for breeding experiments.

In 1938 the work in producing thornless double roses was continued. Much seed was obtained from the pollination of many thousands of flowers. A large collection of standard varieties was grown in tubs. This permits work with varieties that bloom far apart and they may be put in the cellar over winter. In the spring of 1939 over 1,200 roses were placed in tubs be-
sides thousands of roses in the field. Many promising selections were made from the seedlings and placed in propagation. (Project 2. Leader: N. E. Hansen, Horticulture Department.)

**The Genetics of Hardy Thornless Rose Stocks.** In clearing 20 acres of rose seedlings in 1932 in the State Rose Garden at Sioux Falls and at State College, a few 100 percent thornless rose plants were selected for further work. Both leaves and wood are smooth. These were introduced in 1936. The flowers are single, pink, fragrant. The abundant red rosehips in autumn and winter are noteworthy. These plants are of sturdy upright habit and are now being crossed with many large double-flowered varieties in other colors. In their present condition they are pleasing ornamental shrubs that will endure 50 below zero Fahrenheit without protection, and which may be found useful by the rose breeders in eliminating thorns.

Further progress is reported with the 100 percent Thornless Roses in South Dakota Bulletin No. 309. The flowers are single and pink. In 1937 out of 11,053 seedlings of these 100 percent thornless roses, 613 seedlings or about 5 1/2 percent were entirely smooth even the first year from seed. The hope is to make this character come true to seed and that it will be a dominant homozygote in hybridization with standard double roses. (Project 23. Leader: N. E. Hansen, Horticulture Department.)

**Sweet, Firm-Fleshed Tomatoes With a Minimum of Seeds.**

The production of sweet, firm-fleshed tomatoes with a minimum of seeds has made it necessary to determine just what are the factors that produce sweetness in tomatoes. Tomatoes may be sweet because they lack acidity and have a fair proportion of sugar, or they may be sweet because they have a high percent of sugar and relatively lower amount of acid. The pH and total titratable acidity of many named varieties and of many hybrids has been determined in an effort to learn just how these characters are inherited. The ascorbic acid content of named varieties and hybrids has been determined to show how this character is inherited and what effect ascorbic acid (vitamin C) has on the sweetness of tomatoes.

Approximately 129 primitive species and varieties of tomatoes from South America, Mexico and Europe have been tried the past year to determine if they possess factors for firmness and sweetness of flesh that are not possessed by the named American varieties. Several of the best primitive varieties have been selected this past year for further investigation.
It has been impossible to divorce drouth resistance of the seedlings from the project because often the resistance to drouth and disease is the controlling factor in determining whether the seedling is a success. (Project 49. Leader: L. L. Davis, Horticulture Department.)

The Development of Hybrid Drouth-Resistant Sweet Corn. The 1938 season marked the beginning of work on a hybrid drouth-resistant sweet corn. Of the 871 samples planted in 1938 but 460 were selected for continued investigation. Elimination was made on the basis of field records and observations. The yield, resistance to drouth, date of flowering, growth habits, date of maturing and length of time over which the corn remained suitable for use were important factors in making selections.

A selfing plot of one acre was started in 1938. These inbred lines are being carried through the 1939 season with no elimination. It is the plan to give major emphasis to selection of lines suitable for home gardens and to some extent for commercial canning. The length of the picking season will be important in making this selection. This season six acres are planted to field trials in addition to the selfing plot of one acre. Of the 460 samples planted there probably will be selected only about one-third for work next season. The inbred samples will be carefully observed for the development of different lines. (Project 68. Leader: S. A. McCrory, Horticulture Department.)

Tree Growth as Affected by a Cover Crop Since the tree growth as affected by a cover crop project started July 1, 1938, little significant data has been obtained to date. The results for the 21 plots relative to a system of soil management seems to be the same. Data indicating the organic content of the soil, the moisture content of the soil, nitrate nitrogen, total nitrogen and pH indicates at this date the initial condition of the plots. (Project 77. Leaders: L. L. Davis, Horticulture Department.)
STUDY BLISTER BEETLE AND GRASSHOPPER HABITS

With the aid of experimental cages, workers in the Entomology Department are able to determine the life cycles of the blister beetles and grasshoppers, and something about their food habits and preferences.

Crop Insects

Find Red Mites Do Not Kill Adult Grasshoppers

Much controversy has existed regarding the effect of the red mite, *Euthrombidium trigonom* (Hermann), upon grasshoppers. In attempting to secure an accurate answer to this question and obtain additional information pertaining to the mite, the station conducted an intensive study this past year with many important findings being made.

Contrary to many opinions the mites do not kill adult grasshoppers. During the larval stage the mite lives on the hopper, sucking only enough body fluid for existence but never enough to harm its host. Then during the nymph and adult stages the mite lives by feeding upon grasshopper eggs. If present in sufficient numbers on the body and wings they have been known to impede migration but their main source of damage is in the eating of eggs.

In the investigational work 50 male and 50 female mites were reared from egg to maturity with written descriptions secured of all stages from...
egg, through larva, nymph and adult. The reproductive rates, the days required for incubation, for passing through the larval and nymphal stages and preoviposition period of the adult were determined. The seasonal cycle and the number of generations per year were also studied.

The habits of the mites were studied, the effect of the larvae when parasitizing grasshoppers and the effect of the feeding activities of the nymphs and adult mites upon grasshopper eggs. Work was started in learning the names of the species of grasshoppers that become infested with mites and the degree of infestation. The abundance of the mites in various representative areas in South Dakota was also studied.

**Analyze Grasshopper Baits:** An analysis of poison bait samples obtained from five different mixing stations was made. Large variations in the amount of sodium arsenite per given weight of bait were found to exist. Some samples contained very small and insufficient amounts of sodium arsenite while others contained a superabundance of the poison. Efforts were made to determine the cause for the variations with the purpose of having the troubles corrected.

Experiments were conducted to determine the effect of rains in varying quantities upon poison bait. Studies thus far indicate that the sodium arsenite clings to the bait remarkably well.

Experiments were made to determine what effect rains and sprinkling with water would have upon garden produce when such gardens are treated with grasshopper poison bait with amounts as should be used for control of grasshoppers under field conditions. No sodium arsenite was found upon the underground portion of radishes, onions, beets, parsnips or other vegetables, even though the gardens were baited five times during the growing season. (Project 18. Leader: H. C. Severin, Entomology Department.)

**Beetle Larvae Important Natural Grasshopper Enemy**

As long as South Dakota has grasshoppers, so shall they have blister beetles, because blister beetles, although chiefly vegetarian in the adult stage, in their larval stage feed upon grasshopper eggs and in so doing act as one of the important natural enemies of the grasshopper. In some localized areas grasshopper eggs have been reduced to negligible numbers by the beetle larvae. On the other hand, very severe damage was done by the beetles to gardens, sweet clover, alfalfa, sugar beets, trees and shrubs.

This past year new methods of rearing blister beetles through their life cycles were set up and much information was obtained concerning seven
important species. Such information covered chiefly the life cycles of the species, seasonal cycles, host plants of the adults, larval and pupal stages, eggs and reproduction rates. Considerable work was also done in the matter of control of the adult beetles.

Additional information was gathered concerning the distribution of the various species of the beetles over the state of South Dakota and some information was recorded regarding the natural food plants of the beetles. A study was made of the damage done by the adult beetles and the beneficial work of the grub stages. Studies were also made of the relative abundance of the grubs in fields of grain infested with grasshopper eggs in different quantities per unit of space. (Project 14. Leaders: W. R. Horsfall and N. P. Larson, Entomology Department.)
A study of earth construction in our southwestern states including Nevada, southern California, Arizona, New Mexico and southern Colorado was made during the past year. Samples of old and new adobe brick were taken from the buildings in which they had been used. The history of the older earth walls generally indicated their quality and a laboratory analysis of the soil used in the brick gave an excellent answer as to the kind of soil favorable for adobe walls.

It was found that, contrary to the general opinion and writings to date, good natural adobe soils are not heavy clay soils. They are not even average clay soils but will contain from 50 percent to 70 percent total sand by hydrometer analysis. The best and most durable adobe brick in the entire country was found in Austin, Nevada—a mountain region. This soil tested 72.6 percent sand, 13.4 percent silt, 14 percent clay and had 14.4 percent colloids. Owing to the bonding quality of the silt and clay this soil could be made into adobe brick and handled with this high percentage of sand. Generally more clay and less sand is required for adobe brick. Complete analyses have been made of 40 of these samples to date.

In the study of protective coverings for earth wall, 200 lineal feet have been covered with experimental plaster panels. Asphalt emulsions, when used as an admixture to dagga plaster composed of sand and clay only, showed very favorable results in a small 3 by 10 foot panel put on two years ago. A large panel 9 by 10 feet was put on for a follow up check. A dagga plaster mortar with an admixture of 10 percent of Portland cement likewise showed favorable results and a similar large panel of the mortar was put on during the year.

AN EXPERIMENTAL RAMMED EARTH WALL

This wall has been divided into 28 experimental paint panels. The paints were applied at different periods, in different weight and number of coats and over different priming coats.
Build Potato Warehouse: A small experimental potato warehouse built with earth walls was finished during the year. The earth walls are 20 inches thick. A flat masonry roof utilizing the "pre-cast tile beam floor" design was constructed on this building. The earth walls extended four feet below grade but rested on a strong concrete footing. This building affords a study of pise material for building foundations of flat masonry roof construction and of earth walls for frost-proof potato storage in winter. The Horticulture Department will cooperate in the testing of this building for root storage purposes.

Mechanical rammers were assembled and set-up and used inside the laboratory during the year. They will be used in the building of pise walls outside during the coming year.

In cooperation with the College Poultry Department a stationary chick brooder house with 14-inch rammed earth walls and a special type of multiple heater and hover is being studied. The earth walls have proven very favorable for this purpose but the special heater system is not yet satisfactorily arranged. (Project 22. Leaders: R. L. Patty, H. M. Crothers and H. H. DeLong, Agricultural Engineering Department.)

Protective Covering and the Life of Steel Fence Posts

A comparison of the durability of galvanized steel posts versus painted steel posts for farm fence is being made in this study. Three different oil paints have been used in comparing their favorability for this purpose in addition to the above study. Inspection during the year showed little change since a year ago in the original galvanized and painted posts. The galvanized posts show a bare trace of failure after 14 years of service. The paint on the painted posts failed completely in seven years.

Metallic zinc paint has proven superior in durability and in spreading quality to the lead paints for this purpose. All paints that were replaced by brushing have proven much superior to the original paint on the posts. (Project 15. Leader: R. L. Patty, Agricultural Engineering Department.)

Investigate Use of Rubber on Farm Vehicles

This station project was planned to investigate new uses for rubber tired vehicles for farm work. The first part of the project deals with specialized trailers, feed carts and push carts, while the second part will deal with the two-wheeled and four-wheeled automobile and tractor trailer.

A brooder house moving trailer has been designed and tested by moving more than 50 poultry and hog brooder houses. Some minor weak-
nesses of the original design have been located and the plan changed to strengthen these points. The mover takes much of the druggery out of moving the houses, saves the houses from wracking and twisting and saves plots and yards from being cut up by the building skids.

A low platform, four-wheeled feed and water trailer has been built in cooperation with the Animal Husbandry Department for the purpose of saving time and labor in dispersing feed and water to individually located hog colonies. This same trailer can be modified to make a low platform vehicle for moving machinery.

A series of four push carts have been built, all rubber tired, and these will be tested as to their draft with as many steel wheeled carts. Tire sizes from those of 6—16 to those of bicycle wheels are being tested. Size of wheel diameter is being studied, as well as the effect of tire inflation on the draft of the carts. Draft of the carts is also to be tested on concrete floors, gravel and dirt surfaces and floors covered with straw or litter. (Project 73. Leader: H. H. DeLong, Agricultural Engineering Department.)

Study Hitches for Tractors and Large Horse Teams

The study of the effects of moisture on the strength and physical properties of woods commonly used in eveners and singletrees continued, using oak, hickory, ash and fir lumber for test samples. The maximum amount of moisture which each of the varieties of woods would absorb was determined and breaking tests run on these samples.

The recording drawbar dynamometer has been changed somewhat and has been used in testing the draft of plows and duckfoot cultivators. A timing device was made which marks the chart every five seconds. An hydraulic oil pump was installed between the compression cylinder and indicator to replenish the oil which may leak out past the packing. Several trials were run to test the accuracy of the chart drive mechanism and to arrive at the proper conversion factor to use in making the horsepower calculation from the chart. The cart, made from bicycle wheels, which carries the dynamometer, is proving rather light and the carriage and mounting may be redesigned. (Project 34. Leaders: D. E. Wiant, R. L. Patty and H. H. DeLong, Agricultural Engineering Department.)
Home Economics

Study Effect of Freezing Meat on Vitamin B₁

A biological study of fresh and frozen lamb muscle tissue and organs has been made by the Home Economics Department for the purpose of determining the effect of freezing and storage on their Vitamin B₁ content.

The lambs were furnished by the College Animal Husbandry Department with a local refrigerator locker company providing the locker space. The lambs were slaughtered weekly. A portion of the tissues was tested in the fresh state and corresponding amounts frozen at a temperature of -4 degrees and placed in the lockers and held at 10 to 12 degrees F. for a period of three months.

Although the experimental data is not sufficient to warrant definite conclusions, it does indicate that freezing and subsequent storage for a period of three months does not materially affect the Vitamin B₁ content of lamb muscle tissue and organs. The Home Economics Department also cooperated with the Animal Husbandry Department in their studies of the factors influencing the quality and palatability of meats. (Project 57. Leaders: Minerva Kellogg and Edith Pierson, Home Economics Department.)

Fiber Diameter of Wool Shows Breed Variation

A statistical study of wool fiber diameter relationships from five breeds of sheep raised in South Dakota was conducted during the past year. The breeds used were Hampshire, Rambouillet, Shropshire, Southdown and an experimental hybrid. Wide variations in wool fiber diameter were found between sheep within a breed, and in most instances, between breeds.

The contour ratios were found, in general, to be higher than the ratio of 1:1.2 given by Barker for the ideal fiber. In more than one-half of the cases fiber contour was found to increase positively as fiber diameter of the various portions of a single fleece increased. Within a breed the lowest contour ratios were not necessarily found for those fleeces having the smallest diameters. In three of the breeds a majority of the fleeces showed increasing standard deviation as the contour increased. In the other two breeds no relationships were found.
CONDUCT ANALYSIS OF WOOL FLANNEL FABRICS

Laboratory workers analyze wool fabrics manufactured from different grades of South Dakota wool.

Calculations were made of the number of fibers necessary to measure to secure the same error for the breed, using the hybrid shoulder measurements as an example. It was found that the fibers necessary would decrease rapidly if the number of sheep were increased.

A further study dealing with the relationship between the fiber diameter and fiber contour at various points along the fiber length is being made.

ANALYZE FLANNEL FABRICS: The analysis of wool flannel fabrics manufactured from different grades of wool fiber is now in progress. For the purpose of this project four fabrics composed of different percentages of virgin and reworked wool have been manufactured by a textile institute. Rambouillet wool from the station was used as the source of virgin wool and clippings from pastel wool sweaters used as a source of reworked wool.

The physical properties of the virgin and reworked wool fiber have been determined and samples of the fabrics as woven and after dry-cleaning and pressing for 15, 30 and 45 times have been prepared for the determination of the physical characteristics of the fabrics. Work on this project will be continued through the coming year. (Project 26. Leader: Barbara Bailey, Home Economics Department.)
Farm Income and Community Welfare

Study Farm Management in Central South Dakota

Heavy farm mortgage delinquency and foreclosures, high tax delinquency and relief expenditures in the central South Dakota area, roughly referred to as lying between the James and Missouri rivers prompted the organization of a project last year.

A study was undertaken to analyze some of the climatic and economic factors affecting the area in an attempt to determine the size and type of farm unit most adapted to survive drouth years and periods of low prices.

Data has been obtained from selected areas in Beadle, Hyde and Douglas counties by field enumerators. Work is now being done on tabulating, summarizing and analyzing the material obtained. Preliminary findings in Beadle county would indicate a tendency to increase size of operating unit with 480 acres probably being the minimum size of farm which will support an average family in the area.

The Bureau of Agricultural Economics cooperated in furnishing technical and clerical help and Works Progress Administration workers were employed clerically following completion of the field work. (Project 71. Leader: Aaron G. Nelson, Agricultural Economics Department: Bureau of Agricultural Economics.)

Western Counties Assume Ownership of Much Land

A bulletin on the research project "County Land Management in Northwestern South Dakota" was published in September, 1938 on data collected in the range area. The study established the fact that counties in western South Dakota have assumed the ownership of large areas of land in recent years. Together, four counties in the northwestern area own more than a million acres of land. Approximately 70 percent of this land is leased to farm or ranch operators.

Only a small percentage of these county holdings can be sold to private buyers at the present time. To date, the estimated total of county land sales in the eight counties amounts to about one-tenth of the present holdings. The cost of acquiring tax title is sufficient to prevent counties
from taking tax title to much of the land, even though the land is delin-
quent four years.

Some of the recommendations included in the bulletin are: The state
should withdraw levies and specify in detail the method of managing
county lands, since each land has a particular type of problem, and coun-
ties should draw their leases in such a manner as to establish more perma-
nent operating units on their land. This would include long-term leases
or continuing leases with provisions for preventing overgrazing and abuse.

The state legislature in enacting their law on “County Land Adminis-
tration and Management” acted upon many of the recommendations made
as a result of the research carried on in the land economics field. (Project
31. Leaders: R. J. Penn and C. W. Loomer, Agricultural Economics De-
partment.)

Cooperatives Aid to South Dakota Agriculture

SOUTH DAKOTA farmers have realized that the marketing of their pro-
ducts and the purchasing of their supplies is almost as vital to them as the
production of those products. One of the types of business organization
upon which the farmer has called to do his marketing is the cooperative.
As a result many cooperatives have been established.

Some have served their period of usefulness and have ceased opera-
tions; others are just beginning their jobs. In April a bulletin was pub-
lished on “Cooperatives in South Dakota” designed to bring together
some of the information which might aid those individuals interested in
cooperatives. Some of the more significant facts were:

1. There are 354 cooperative associations in South Dakota, including 203
elevators, 51 oil stations, 40 creameries, 18 stores, 14 livestock shipping associa-
tions, 12 cream stations, 8 lumber associations and 8 miscellaneous associations.

2. There were 71,000 membership in cooperative associations in South Da-
kota. The cooperatives have a total number of 124,000 patrons.

3. Farmers marketed cooperatively 19½ million dollars worth of commod-
ities and purchased a little over 7 million dollars worth of supplies.

4. There are a few associations in which the ownership and control are being
removed from those who patronize the association. One hundred twenty associa-
tions required members to be producers, 17 required the stock of ineligible mem-
bers to be purchased or converted into voting stock and 90 percent of the voting
stock was owned by producers in 116 associations.

5. Despite the fact that 1936 was a difficult year for agriculture, the coopera-
tive associations of the State made a total net profit of $800,000; and $500,000
of these earnings were returned to member patrons. (Project 62. Leaders: L. M.
Brown and R. J. Penn, Agricultural Economics Department.)
Ranchers Favor AAA Experimental Range Program

Both the evidence obtained from study of representative ranches and the opinions of ranch operators indicated that the AAA Experimental Range Program is better suited than the North Central Region Range Conservation Program to the needs of ranches of a size and type common to South Dakota conditions.

Thirty-six ranchers, 18 in Jones county and 18 in surrounding areas, were interviewed in connection with the survey work conducted during May and June, 1939. The study was initiated for the purpose of comparing the accomplishments of the Jones County Experimental Range Program and the North Central Region Range Program and determining how each might be improved or revised.

Variations between Jones county and adjoining counties in the amount of rainfall, the degree of stocking, and the amount of free range land available make it difficult to obtain adequate comparisons of carrying capacities, grass conditions, and the results of deferred grazing under the Jones County Experimental Range Program and the North Central Region Range Program. However, the opinions of the ranchers interviewed, both in and out of Jones county, the quality of water facilities obtained and the conclusions of the fieldmen all favored the experimental over the regional program. (Project C-10. Leaders Max Myers, Agricultural Economics Department; James Watson, Animal Husbandry Department; Henry Holzman, Extension Service; cooperating with the Bureau of Agricultural Economics and Agricultural Adjustment Administration.)

Survey Shows Reduction in Mortgage Indebtedness

The annual survey of farm mortgage foreclosures showed a considerable reduction in the total mortgage indebtedness between 1930-35 in the five counties surveyed.

Of the counties studied—Turner, Brookings, Clark, Hyde and Haakon—the smallest reduction was found in Haakon. The debt per acre of mortgaged land decreased in all five counties and foreclosures were smaller than in the five previous years. The Federal Land Bank increased its proportion of loans in all the counties.

Farm Credit data have been assembled and are being tabulated as part of the Central South Dakota Project and more complete data are being secured from the Ranch and Wheat area cooperators.
The agricultural credit project was started in 1925. (Project 13. Leader: Gabriel Lundy, Agricultural Economics Department.)

Study Ranch Management in Northwest South Dakota

Ranch records from nine years work in the northwest South Dakota area are being summarized and analyzed and a comprehensive report with recommendations will be completed during the fiscal year 1939-40.

This project is organized similar to the wheat area study with ranchers cooperating. During the past year two trips were made to cooperating ranchers in Perkins, Harding, Butte and Meade counties securing data regarding the operation, organization and management of these ranches.

The 15 records have been summarized and analyzed for 1938 and 19 cooperators are in the project for 1939. A brief analysis was taken to each of the ranchers when they were visited in the spring of 1939. Quite a number of operators in this area have expressed the desire to organize a farm and ranch management association.

Preliminary analysis of the ranch records for the past several years seems to indicate that the principal factor in the success of the leading ranches was keeping operating costs at a minimum. It is significant that, in the range area, taxes are much higher than rental rates. Consequently, land ownership has decreased noticeably. Due to unfavorable seasons, cropping has decreased and there has been a shift to forage and drought-resistant crops. On the whole, however, the livestock ranchers seem to have weathered the unfavorable years more successfully than the grain farmers. (Project 30. Leaders: Aaron G. Nelson and Max Myers, Agricultural Economics Department.)

A RANCH SCENE IN NORTHWEST SOUTH DAKOTA
Experiment Station workers have analyzed ranch records for nine years work in this area. By keeping operating costs at a minimum many ranchers have been able to overcome the handicap of low prices and unfavorable cropping years.
Publish Work on Farm Tenancy and Leasing

In the course of work on the Farm and Ranch management studies, considerable need arose for more information on tenancy and leasing. As a result of findings in the project work, a circular on “Farm Tenancy in South Dakota,” was prepared by H. P. Hanson.

In addition, a manuscript on “Leases and Leasing for South Dakota” with improved lease forms, was written by H. P. Hanson and Max Myers and published by the Extension Service as Circular 383.

Analyze Cooperative Grain Elevators

A detailed analysis of 75 cooperative elevators was again made last year in cooperation with the Farm Credit Administration with the aim of helping the associations maintain reasonable stability in their organizations.

Comparative balance sheets and standards of performance have been returned to each elevator for the last two years. After the collection of the material for 1939 and its summarization, a publication on cooperative elevators in South Dakota is contemplated. (Project 60. Leaders: L. M. Brown, R. J. Penn and Gabriel Lundy, Agricultural Economics Department.)

Study Farm Practices in Wheat Producing Areas

This station started a project in 1931 designed to determine the best and most profitable farm management practices in the wheat producing areas of South Dakota through analysis of operator’s record books and subsequent recommended procedures.

The cooperation of farmers in seven north central counties was solicited during this past year, 52 records were summarized and approximately 65 farmers have been cooperating for 1939.

During the past year the usual two visits to each farm were made to secure data relating to their organization, operation and management; to give the farmers a brief analysis of former studies which have been carried on, and to replace cooperators who, for various reasons, dropped from the project.

Indications are that the shift in the type of crops being grown is still taking place. Farmers are planting more feed crops such as feed grains,
cane, sudan and millet to assure themselves of livestock feed. There are only a few cooperators where wheat is the principal crop and source of income. In 1938 three planted no wheat whatever. (Project 29. Leaders: Aaron G. Nelson and Max Myers, Agricultural Economics Department.)

Correlate South Dakota Prices and Production

South Dakota farm prices have been assembled and index numbers computed for publication in the monthly outlook this past year. Dr. T. H. Cox served only a portion of the year, departing on leave of absence in September 1938. (Project 12. Leader: W. H. Peterson, Agricultural Economics Department.)

State and Local Tax Study Project Inactive

Although the taxation study as an independent project has been held in abeyance, the past year data have been assembled on the cost of township government in the area covered by the Central South Dakota project, No. 71. (Project 42. Leaders: R. B. Westbrook and R. J. Penn, Agricultural Economics Department.)

Out of State Farm Population Movement Declines

Although the mobility of the farm population during recent years has been a matter of public concern, the Experiment Station study reveals that the movement of farmers out of South Dakota has passed its peak, the loss for 1937 being an estimated 16,100 persons while for the past year, 1938, the loss was reported as an estimated 3,800 persons. This change is apparent from the total estimated farm population figures as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Estimated Farm Population</th>
<th>Net Change Gain or Loss</th>
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<tbody>
<tr>
<td>January 1, 1937</td>
<td>327,800</td>
<td>16,100</td>
</tr>
<tr>
<td>January 1, 1938</td>
<td>311,700</td>
<td>-16,100</td>
</tr>
<tr>
<td>January 1, 1939</td>
<td>307,900</td>
<td>-3,800</td>
</tr>
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</table>

It is further estimated that the birth rate of farm population for the year 1938, was 20.8 per 1,000, while the death rate was 6.2 per 1,000. This birth rate is slightly higher and the death rate is slightly lower than for the preceding year, 1937.

A reduction in the movement to other states is apparent. Along with this is the interesting comment from a similar study in California that the number of incoming migrants "in need of manual employment" was less
than during 1936 and 1937. During 1938, persons who moved from South Dakota farms to other states most frequently selected Minnesota, Iowa, Nebraska, California and North Dakota, all but one of which are bordering states; but in 1937 a larger proportion of these migrants out of the state had gone to the Pacific Coast—Washington, Oregon and California being among the five states most frequently mentioned.

Of those persons immigrating into South Dakota from other states, the largest number continued to come from adjoining states. The border counties of the state account for a major share of the immigration. Much of the significance of this movement is consequently lost because of the possibility that it represents movement from farm to farm within communities although a state boundary may have been crossed. (Project 70. Leader: W. F. Kumlien, Rural Sociology Department: Bureau of Agricultural Economics.)

Study Standard of Living in Farm Security Loan Cases

A study of the standard of living levels of Farm Security standard loan cases, based upon an analysis of 1086 standard loan cases of the FSA and its predecessor, the Resettlement Administration, was made in 21 counties in South Dakota during the years 1936, 1937 and 1938.

The records of these standard loan cases were secured from the county offices of the Farm Security Administration. No names were used throughout the study, and great care was exercised in having all records checked and approved by the FSA officials before they were tabulated. A "standard loan" case, as used by the Farm Security Administration, is a loan made for the purpose of rehabilitating a farm unit. It is obvious that these cases would consist of low-income groups who are responsible for repaying the loan but who need a long-time payment plan worked out at a low rate of interest. In these cases the loan was not given as a lump sum to the borrower but for purposes such as repairs, new buildings and equipment and livestock.

The study has been made to compare the standard of living of such a subrepresentative group with the standard of living of a representative group found in a previous Standard of Living study. The field work in connection with this study is now complete but there are still a few tabulations to be made and it is, therefore, too early to draw conclusions or to make a digest of the findings. It is hoped to have the preliminary mimeographed circular prepared in the near future. (Project 69. Leader W. F. Kumlien, Rural Sociology Department.)
The percentages of the 1045 open-country families in six selected counties of South Dakota with various home conveniences as indicated by the standard of living studies by the South Dakota Agricultural Experiment Station.
This map illustrates the decrease in South Dakota’s population over the 1930-35 period by counties. Samplings since 1935 have indicated a similar downturn.

South Dakota May Have Reached Peak Population

A bulletin published in graphic form entitled “Basic Trends of Social Change in South Dakota,” disclosed that it is entirely possible that South Dakota’s peak population was reached in 1930. Between 1930-35 a loss was registered and sample studies have indicated a similar downturn since that time.

The study, one of those conducted under the social history of the state program, was divided into 10 parts: history of settlement, growth of population, nativity of population, interstate immigration, age composition, sex composition, births and deaths, foreign immigration and estimating future trends.

The population of the state is unmistakably taking on the earmarks of an older state with a lessening proportion of children, expanding proportion of old folks and an increase in percentage of population which is South Dakota born, according to the conclusions.

It is recommended that considerable attention be given to the problems arising from a stationary population and measures advanced to cope with them. It should not be concluded, however, that a declining population means a decadent future. (Project 64. Leader: W. F. Kumlien, Rural Sociology Department.)
Farm Families Not a Dependent Child Problem

Child dependency arising from a loss of a parent's support is more a town than a farm problem in South Dakota. While a majority of all citizens are on farms, only about one-fifth of the children dependent on relief because of the loss of a parent are farm children. More farm families are capable of self-support under favorable conditions, as they contain more able-bodied men and women.

The problem of aid to dependent children made a complicated study. It was found that the amount of assistance required to the family in a year varies from less than $25 to more than $1000; that a dependent child may live with one parent or in a family of 10 and many families have able-bodied men entirely capable of self-support.

The settlements, from 50 persons up, were set off from the farm areas. The occupational division between farm and non-farm people proved more significant than that between “rural” and “urban” with the division at 2,500 people. The largest share of the cost arises in the settlements, the open country being relatively free of the problem, with about one-fourth of the total expenditures as against more than half the state population.

Future trends are shown to depend very much on economic conditions, there being no obvious reason why a large proportion in town or country cannot become self-supporting. In fact, the many changes in relief demands of particular households during the year indicates that the amount of dependency is very responsive to economic conditions. The impression to be had from the survey is that a minority of broken-home children would require extensive aid wherever there is a strong demand for labor both in town and country.

On the other hand a relief demand so sensitive to changes in private fortunes is likely to fluctuate violently from time to time and to bear unequally on different areas. Sources of public relief that produces the same amount from year to year cannot meet such demands. (Project 72. Leader: R. L. Woolbert, Rural Sociology Department.)
Cooperative Project Agreements With Federal Agencies

The following are the cooperative research project agreements which were in force during the year with federal agencies.

AGRICULTURAL ADJUSTMENT ADMINISTRATION

1. Cooperative Western Range Survey Within “WRS” Region G (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas). (Agricultural Economics Department: Agricultural Adjustment Administration, Forest Service and the Bureau of Agricultural Economics.) (a) To coordinate and round out the range survey work of the various cooperating agencies so as to secure uniformity of procedure, method analysis, results so that all data collected, irrespective of agency, may be fitted into the general territorial survey. (b) To determine the location, extent, type and composition of plant cover and grazing capacity of lands within the area in a form that will lend itself to the determination of essential management and betterment practices in the development and administration of conservation programs. (Project C-5.)

2. Comparison of the Agricultural Adjustment Administration Experimental Range Program, and the North Central Range Program in Jones County, South Dakota. (Agricultural Economics Department: Agricultural Adjustment Administration, Extension Service and Bureau of Agricultural Economics.) To determine the accomplishments of the Experimental Range Program in promoting the long time objective of soil and range conservation and the economic use of agricultural resources, to compare the experimental program with the North Central Range Program and to secure such information as might be used in revising and improving subsequent range conservation programs. (Project C-10.)

A statement setting forth the comparative results of the AAA Experimental Range Program and the North Central Program will be found on page 56.

BUREAU OF AGRICULTURAL ECONOMICS

1. Annual Change in Population in South Dakota. (Rural Sociology Department: Bureau of Agricultural Economics.) 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. (Project C-7.)

2. Adjustment of Agriculture to Environment in Central South Dakota. (Agricultural Economics Department: Bureau of Agricultural Economics.) 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. (C-8.)

3. To Determine the Proper Utilization of Seleniferous Land. (Experiment Station Chemistry Department: Bureau of Agricultural Economics.) To furnish information which will be helpful in planning the future economical use of seleniferous land. (Project C-11.)

A summary of this work will be found on page 36.

4. Cooperative Work in Agricultural Land Use Planning. (South Dakota Experiment Station: Bureau of Agricultural Economics.) 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 operating 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. (Project C-12.)

BUREAU OF AGRICULTURAL ECONOMICS AND BUREAU OF DAIRY INDUSTRY

1. Input as Related to Output in Milk Production. (Dairy Department: Bureau of Agricultural Economics and Bureau of Dairy Industry.) (a) To test the application of the principal of increasing and diminishing returns to the milk producer, (b) To extend the present knowledge of the fundamental relationship between rate and method of feeding different feeds and milk production of dairy cattle, and (c) To make information available in a form which will permit the determination of the most economical rate of feeding under various price conditions. (Project C-4.)

[65]
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: Bureau of Animal Industry.) To study the improvement of swine through breeding methods. (Project C-6.)

2. Improvement 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, New Jersey: Bureau of Animal Industry.) 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: Bureau of Plant Industry and Bureau of Animal Industry.) 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. (Project C-1.)

A summary of this work will be found on page 22.

BUREAU OF CHEMISTRY AND SOILS

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: Bureau of Chemistry and Soils.) To obtain through basic research facts and materials applicable to the utilization of the soybean and soybean products and to develop methods whereby these facts and materials may be utilized to the benefit of agriculture. (Project C-2.)
1. Soil Erosion Control in South Dakota. (Agricultural Experiment Station: Soil Conservation Service.) 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. (Project C-3.)

Farming to hold the rain where it falls reduces soil loss and increases soil moisture.
### Active Research Projects

Chronologically Numbered July 1, 1938

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Fund</th>
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<tbody>
<tr>
<td>1</td>
<td>Fruit Breeding.</td>
<td>Adams, State Exp.</td>
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<tr>
<td>2</td>
<td>Rose Breeding For Hardiness.</td>
<td>Hatch</td>
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<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>
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<td></td>
<td>No report this year</td>
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<td>4</td>
<td>Grain and Livestock Systems. (Crop Rotation and Application of Phosphorus and Potassium)</td>
<td>Hatch</td>
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<td>5</td>
<td>Oat Breeding.</td>
<td>Hatch</td>
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<tr>
<td>6</td>
<td>Corn Breeding for High and Low Protein.</td>
<td>State Bankhead Jones</td>
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<td>Hatch, Station Local</td>
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<tr>
<td>7</td>
<td>Manure, Phosphate and Limestone Trials.</td>
<td>Hatch</td>
</tr>
<tr>
<td>8</td>
<td>Depth of Tillage.</td>
<td>Hatch</td>
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<tr>
<td>9</td>
<td>Development of No-tail Breed of Sheep.</td>
<td>State Exp.</td>
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<tr>
<td>10</td>
<td>Breeding Forage Crops (Alfalfa and Sweet Clover).</td>
<td>Hatch</td>
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<tr>
<td>11</td>
<td>A Study in the Development of New Vaccines in the Immunization of Animals against Hemorrhagic Septicemia.</td>
<td>Adams</td>
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<tr>
<td>12</td>
<td>The Correlation between South Dakota Prices and Production.</td>
<td>Purnell</td>
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<tr>
<td>13</td>
<td>Study of Credit Needs of South Dakota Agriculture and Agencies Serving It.</td>
<td>Purnell</td>
</tr>
<tr>
<td>14</td>
<td>A Study of the Blister Beetles of Economic Importance in South Dakota Including their Identification, Distribution, Feeding Habits and Control.</td>
<td>Adams</td>
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<tr>
<td>15</td>
<td>The Comparative Length of Service of Galvanized Steel Posts and Painted Steel Posts.</td>
<td>Station Local</td>
</tr>
<tr>
<td>16</td>
<td>Winter Rations for Brood Sows.</td>
<td>Station Local</td>
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<tr>
<td></td>
<td>No report this year</td>
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<tr>
<td>17</td>
<td>A Comparison of Sweet Clover, Alfalfa, and Sudan Grass Pastures under South Dakota Conditions, and Permanent Pasture Mixtures.</td>
<td>Purnell</td>
</tr>
<tr>
<td>18</td>
<td>The Grasshoppers of South Dakota and Their Control.</td>
<td>Adams</td>
</tr>
<tr>
<td>19</td>
<td>Chemical Forms of Selenium in Soils and Plants and Toxicity to Animals Including Proper Use in Grazing.</td>
<td>Purnell</td>
</tr>
</tbody>
</table>


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.


27. Fattening Summer Pigs on South Dakota Grains.


32. Weed Control.

33. Some Routine Tests for Garget or Mastitis in Cows' Milk.

No report this year

34. Field Hitches for Tractors and Big Horse Teams.

35. Rammed Earth Poultry Houses.

36. Project Completed.

37. Project Completed.

38. Feeding Grains Affected with Ergot.

No report this year

39. A Study of Turkey Egg Hatchability.

40. Value of Oats and Millets in Laying Rations for Pullets.

41. Influence of Roughage on the Vitamin D Potency of Milk.

42. A Study of Local and State Taxes in South Dakota.

43. Tankage as Protein Supplement for Fattening Baby Beeves.
44. The Utilization of Yellow Corn, Wheat, Barley and Oats in Starting and Growing Rations for Turkeys.

45. South Dakota Cropping Systems: Computation and Tabulation of Existing Acreage of State Crops by Counties within Soil Areas of South Dakota; Proposing Definite Changes in said Existing Acreages, Based on Results of Previous Crop Rotation Experiments.

No report this year


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 Microorganisms and the Development of Specific Flavor Defects in Butter.

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


51. Project Completed.

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.

57. Vitamin Content of Lamb Tissues and Organs.

58. Breeding Hardy Apricots with Sweet Kernels.

59. Breeding Triploid 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.
61. Occurrence of Forage Poisoning of Livestock with Special Reference to Cyanide (Prussic Acid) in Various Species of Sorghum. Purnell
62. Survey of Farmers’ Cooperative Associations in South Dakota. Purnell
63. A Study of the Methods of Handling Weedy Cream with the Purpose of Reducing the Grassy and Weedy Flavors in Butter. Hatch
64. A Social History of Population Settlement in South Dakota. Purnell
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 the Marginal Lands in Western South Dakota. Purnell
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. Adams Federal
67. Methods of Baby Beef Production. Purnell
68. The Development of Hybrid Drouth-Resistant Sweet Corn. Fed’l and State Bankhead Jones
69. Standard of Living Levels of Farm Security Standard Loan Cases. Purnell
70. Annual Change in Population in South Dakota. Purnell
71. Agricultural Adjustment to Environment in Central South Dakota. Purnell
72. Survey of Dependent Children in South Dakota. Purnell
73. Use of Rubber on Farm Vehicles. Purnell
74. The Breeding and Improvement of Forage Crops. Federal Bankhead Jones
75. The Effect of Peppergrass on Flavor of Milk and Cream and Products Made Therefrom. Purnell
76. The Influence of Various Methods on Holding Cream on Butter Quality. Hatch
77. Tree Growth as Affected by a Cover Crop. Federal Bankhead Jones
78. Comparison of Economy of Feeding Western Gummer Ewes and Western Lambs. State Bankhead Jones
79. The Utilization of Grain and Forage Sorghums and Proso Millets in Growing and Finishing Turkeys. No report this year

[71]
The South Dakota Board of Regents

HONORABLE EDWARD PRCHAL...........................................Burke
HONORABLE E. M. MUMFORD........................................Howard
HONORABLE MRS. E. R. DOERING..................................Parkston
HONORABLE FRANK CUNDILL.........................................Firesteel
HONORABLE F. H. VAN TASSELL.....................................Iroquois

Experiment Station Staff

EXECUTIVE

Edward Prchal............................................................Regent Member
E. M. Mumford..............................................................Regent Member
Charles W. Pugsley, B.S., D.Agr......................................President of College
C. Larsen, B.S.A., M.S......................................................Dean of Agriculture
I. B. Johnson, B.S.A., M.Agr.............................................Director
J. W. Wilson, B.S.A., M.S.A., LL.D.....................................Director Emeritus
A. N. Hume, B.S.A., M.S., Ph.D..........................................Supt. Sub-Stations
R. A. Larson.................................................................Treasurer
Loren E. Donelson, B.S., M.S...........................................Editor
Phyllis C. Wendell........................................................Secretary

AGRICULTURAL ECONOMICS

Gabriel Lundy, B.S., M.S..............................................Agricultural Economist
R. J. Penn, B.E............................................................Assistant
Aaron G. Nelson, B.S., M.S............................................Assistant
W. H. Peterson, B.S., M.S...............................................Assistant
L. M. Brown, B.S., M.S..................................................Assistant
Max Myers, B.S............................................................Assistant

AGRICULTURAL ENGINEERING

R. L. Patty, B.Di., B.S. in A.E.........................................Agricultural Engineer
H. M. Crothers, B.S., E.E., Ph.D........................................Associate
H. DeLong, B.S.A., B.S. in A.E.........................................Assistant
Elbert Snethen, B.S.A. in A.E...........................................Assistant

AGRONOMY

A. N. Hume, B.S.A., M.S., Ph.D......................................Agronomist
J. G. Hutton, B.S., M.S...................................................Associate
S. P. Swenson, B.S., M.S., Ph.D.......................................Assistant
M. Fowlds, B.S............................................................Assistant
C. J. Franzke, B.S........................................................Assistant
ANIMAL HUSBANDRY

I. B. JOHNSON, B.S.A., M.Agr........................................Animal Husbandman
J. W. WILSON, B.S.A., M.S.A., LL.D................................Associate
TURNER WRIGHT, B.S....................................................Associate
F. U. FENN, B.S., M.S......................................................Assistant
J. C. WATSON, B.S..........................................................Assistant

CHEMISTRY

A. L. MOXON, B.S., M.S............................................Chemist
O. E. OLSON, B.S., M.S.............................................Analyst

DAIRY HUSBANDRY

T. M. OLSON, B.S., M.S.A........................................Dairy Husbandman
D. H. JACOBSEN, B.S., M.S., PH.D............................Assistant
G. C. WALLIS, B.S., M.S., PH.D.................................Assistant

ENTOMOLOGY

H. C. SEVERIN, B.A., M.A........................................Entomologist
N. P. LARSON, B.S., M.S...........................................Assistant

HOME ECONOMICS

EDITH M. PIERSON, B.S., M.S..................................Home Economist
BARBARA BAILEY, B.S., M.S..................................Assistant
MINERVA KELLOGG, B.S., M.S., PH.D.........................Assistant

HORTICULTURE

L. L. DAVIS, B.S., M.S............................................Horticulturist
N. E. HANSEN, B.S., M.S., SC.D.........................Horticulturist Emeritus
S. A. McCORY, B.S., M.A........................................Assistant

PHARMACY

F. J. LEBLANC, PH.C., B.S., M.S..............................Pharmaceutical Chemist
L. D. HINER, B.S., M.S., PH.D...............................Pharmacologist

POULTRY

W. E. POLEY, B.S., M.S., PH.D.................................Poultry Husbandman
W. O. WILSON, B.S., M.S........................................Assistant

RURAL SOCIOLOGY

W. F. KUMLIEN, B.A., M.S., M.S.A...........................Rural Sociologist
R. L. WOOLBERT, A.B., A.M., PH.D........................Assistant

VETERINARY

J. B. TAYLOR, D.V.M............................................Veterinarian
Changes in Station Staff During the Year

RESIGNATIONS

W. R. HORSFALL, Assistant Entomologist........................................... Sept. 1938
C. E. HOXIE, Assistant Horticulturist............................................. Sept. 1938
J. P. JOHANSEN, Associate Rural Sociologist..................................... Sept. 1938
W. McMartin, Assistant Economist................................................... Sept. 1938
D. E. WIANT, Assistant Agricultural Engineer.................................... Jan. 1939
R. B. WESTBROOK, Assistant Economist........................................... Feb. 1939
H. P. HANSON, Assistant Economist................................................. Feb. 1939
T. HILLARD COX, Associate Economist............................................. June 1939

APPOINTMENTS

PHYLLIS C. WENDELL, Secretary.......................................................... July 1938
S. A. McCrory, Assistant Horticulturist............................................ Sept. 1938
MAX MYERS, Assistant Economist....................................................... Sept. 1938
R. L. WOOLBERT, Assistant Rural Sociologist..................................... Sept. 1938
N. P. LARSON, Assistant Entomologist............................................... Oct. 1938
W. H. PETERSON, Assistant Economist............................................... Oct. 1938
ELBERT SNETHEN, Assistant Agricultural Engineer................................ Jan. 1939
AARON G. NELSON, Assistant Economist............................................ Mar. 1939

LEAVES OF ABSENCE

T. HILLARD COX, Associate Economist............................................. Sept. 1938-Sept. 1939
LEO F. PUCH, Assistant Agronomist................................................. Oct. 1938-Feb. 1940
A. L. MOXON, Chemist................................................................. Nov. 1938-Jan. 1939
MINERVA KELLOGG, Assistant Home Economist................................... May 1939-May 1940
Publications

During the period July 1, 1938 to June 30, 1939, the South Dakota Agricultural Experiment Station published six new bulletins. Starting a new series of publications covering the more scientific phases of agriculture, two technical bulletins were released. Two new circulars were also published.

BULLETINS

326 County Land Management in Northwestern South Dakota by R. J. Penn and C. W. Loomer.
328 Cooperatives in South Dakota by R. J. Penn and L. M. Brown.
331 Factors Affecting the Composition of Milk by D. H. Jacobsen and G. C. Wallis.

TECHNICAL BULLETINS

1 A Study of Sorghum with Reference to the Content of HCN by C. J. Franzke, Leo F. Puhr and A. N. Hume.
2 Selenium in Rocks, Soil and Plants by A. L. Moxon, O. E. Olson and Walter V. Searight.

CIRCULARS

24 Business Activity in South Dakota by T. Hillard Cox.
25 Farm Tenancy in South Dakota by H. P. Hanson.

Journal Articles by Staff Members

AGRICULTURAL ENGINEERING


AGRONOMY

ANIMAL HUSBANDRY


STATION CHEMISTRY


DAIRY


HOME ECONOMICS


PHARMACY


POULTRY


## Financial Statement - Agricultural Research Funds

### Receipts

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### Expenditures

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### Totals

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### Receipts

**Financial Statement - Agricultural Research Funds**

July 1, 1938 to June 30, 1939

**Federal Research Funds**

**State Research Funds**

**Totals**

**Receipts**

**Expenditures**

**Totals**

**Appropriations**

**Revised**

*Bankhead Hortonline Sue-Popular Pluicoe*
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<th>Item</th>
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\* State Funds Appropriated and Used for Sub-Station Work

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† 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.

‡ $4,859.25 of the $8,880.07 represents the balance on hand in the Newell Field Station fund at the beginning of the year.

§ $4,237.82 of the $8,980.78 represents the balance on hand in the Newell Field Station fund at the close of the year.

$ $7,730.67 of the $8,360.59 received from Sale of Produce represents produce sold from Newell Field Station.