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Explanation of South Dakota Map on Cover

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

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

1. Corn, livestock feeding and dairying.
2. Corn transition, livestock feeding and dairying.
3. Small grain transition and general livestock production.
4. Small grain and general livestock production.
5. Grazing and production of feeder stock.
6. Diversification, grazing, feeding and dairying.
Farm Research
in
South Dakota

Fifty-Third 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 A. M. Eberle
Division of Agriculture
South Dakota State College

Dear Dean Eberle:

Submitted herewith is the fifty-third annual report of the South Dakota Agricultural Experiment Station for the fiscal year July 1, 1939 to June 30, 1940. As required by law the Experiment Station has arranged for its publication. John A. Rohlf, assistant station editor, has aided in editing the manuscript material and in arranging the make-up of the printed report.

In reporting the progress of the year’s research work, the reports have again been classified by subject matter. Those who may be interested in the work of any department will find an index on the opposite page which provides a ready reference to departmental activities.

Increased demands for additional research are being made upon the Experiment Station. We are endeavoring to meet them insofar as our funds and personnel will permit. The work of the County Land Use Planning Committees is emphasizing the need for a land and soil classification study. Such a study is recognized as essential if sound progress is to be made in planning for the welfare of South Dakota’s agriculture.

May we ask your earnest consideration of the problem of securing more full time research workers on the Experiment Station staff.

Respectfully submitted,

[Signature]

Director, Experiment Station
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The present fiscal year marked the passing of one of South Dakota’s staunchest agricultural research workers, Joseph Gladden Hutton. He, it was, who early appreciated our heritage from the soil; who decades ago fully realized what soil conservation meant to a permanent and prosperous agriculture for South Dakota; and who, in the early part of the century, impressed upon us the necessity for a detailed classification of our soils in order that we might build more soundly the economic and social structures of our South Dakota communities.

Under Professor Hutton’s guidance a detailed classification of our South Dakota soils was begun and carried to a completion in nine counties. To those of us who are privileged to live and work in South Dakota falls the task of carrying on this project to its ultimate completion in the state. Professor Hutton pointed the way—let us carry on.
Soils, Crops and Crop Breeding

Deep Plowing Increases Grain Yields

An experiment with plowing soils at different depths dating over a 24-year period has been summarized and results published in Station Bulletin No. 344 “Depth of Plowing and Crop Yields.” It compares total yields of plant growth from corn, winter wheat, oats and legumes and also yields of grain (or seed) from the same crops.

The conclusions of this experiment would indicate that:

1. Subsoiling does not result in an increase in crop yields. Such a result is in accord with experimental results reported by other stations.

2. Increases in total weight of corn were found to occur directly with increased depth of plowing to the maximum of 12 inches. Corn was the only crop where total weight increased significantly with increased depths of plowing.

3. The yield of corn in bushels per acre increased directly with depth of plowing up to 12 inches.

4. The yields of grain from winter wheat following corn in the rotation, and from oats following wheat, increased with substantial regularity with depth of plowing in preparation for corn. The seeming exception occurred with the plot prepared with no differential plowing—only disking and harrowing. The highest total yields of cereal grain were produced from plots with the deepest plowing.

5. The relationship between the total weight of legume seed and hay or seed alone and depth of plowing could not be definitely established. (Project 8. Leader: A. N. Hume, Agronomy Department.)

Nitrogen and Organic Matter Decline Under Cropping

The effect of crop production and the application of nitrogen, phosphorus and potash fertilizers on the nature and total quantity of plant food is under investigation. In the summer of 1939 the fertility plots

MANY ATTEND STATION’S AGRONOMY FIELD DAY

More than 120 members of the state and county crop improvement associations, county agents and others interested in crop improvement gathered at Brookings in July for the Stations’ agronomy field day.
were carefully sampled and the samples were preserved for analysis. The total nitrogen, nitrate nitrogen, total phosphorus, organic phosphorus and available phosphorus content of the soils from the various plots will be determined.

The results so far indicate a rapid decline in the soil nitrogen and soil organic matter as the result of cultivation and cropping of these plots.

The effect of cropping and fertilizer treatment on the mineral composition of the grains and forage from the plots will be determined by chemical analysis. (Project 3. Leader: Leo. F. Puhr, Agronomy Department.)

How Do Crop Residues Affect the Soil?
The rate of decomposition of leguminous and non-leguminous crop residues when incorporated with the soil were investigated by measuring the total amount of carbon dioxide evolved. Considerable differences were noted between the various treatments. At the present time the results are being analyzed by statistical methods. (Project 46. Leader: Leo F. Puhr, Agronomy Department.)

Corn Breeding Work Gains Momentum
From the past season’s studies on 768 combination double crosses, eight pure lines were selected for distribution, making single and double crosses. These eight pure lines are being further studied in combination double crosses, totaling 233 double-cross combinations. Likewise 45 of the combinations are being studied this year in the state hybrid yield plots.

This season several new combinations in single and double crosses will be combined in regard to the respective selection based on high and low pounds pull per plant. It has been found from past experiments that the isolation of lines which were selected on the basis of high pounds pull per plant appear to be superior in their respective combining qualities to those lines selected on relatively lower pounds pull per plant. The utility quality characters of both stalk and grain apparently are superior to those lines which were isolated for high pounds pull per plant.

The Station now has 330 convergent lines from 74 combined combinations isolated from 33 adapted varieties of the state. It is hoped to improve utility quality factors and combine them in fewer lines for the
development of superior hybrid corn in the state of South Dakota. These newer lines in the near future will be tested in their respective single and double cross combinations. (Project 66. Leader: C. J. Franzke, Agronomy Department.)

Develop High Protein Strain of Corn

BY LONG, continuous selection a strain of corn has been developed at the South Dakota Station that tested 22.3 percent protein in the 1939 crop (the normal protein percentage of corn being slightly under 10 percent). Seven lines of high protein selections all above 21 percent are being further studied for increased protein content. Ten lines slightly above eight percent protein are likewise being further studied for low protein content. From past experimental results, low protein strains appear to be higher in yielding ability in regard to pounds of grain produced per acre than the high protein strains.

The average protein content lines have been increased in relative proportion more than the low protein lines have been lowered. The reduction in the yielding ability of the high protein lines has been sufficient so that the production of protein per acre is approximately equal to that of the low protein strains. (Project 6. Leader: C. J. Franzke, Agronomy Department.)

Recommend Bindweed Control Practices

THE CONTROL of field bindweed by cropping systems and chemical treatments is being studied at the South Dakota Station. It has been found more practical to summer fallow badly infested field bindweed land one full season before seeding to a heavy rate of fall rye. The fallow practices should start approximately two to three weeks after the creepers have resumed growth in the spring or early summer. The length of time between fallows should be at least eight days after the first bindweeds have emerged from the previous fallow.

It is likewise found that a heavy stand of fall seeded rye is just about as effective as continued fallow provided one whole season of fallow has been practiced before seeding the fall rye. It has also been found that it is necessary to remove the rye crop from the land as soon as it has matured so as to resume the fallow practices the remainder of the season until time of reseeding fall rye.

Sodium chlorate appears to be the best chemical for bindweed control. The dry application is just as effective as the spray. For best results four pounds per square rod should be utilized in the dry method; three
pounds per square rod for spray. The treated area should be left undisturbed for at least one season after application except to treat the escaped plants any time after July of that season. The best time to apply sodium chlorate, whether dry or as a spray, is late summer and early fall. Sodium chlorate applied earlier in the season apparently is not as effective as the general kill in all cases has been lower.

Where moisture is more of a limiting factor there appears to be a residual effect on the land treated with sodium chlorate two or more years after the application. Much of the residual effect can be overcome by the application of barnyard manure. (Project 32. Leaders: C. J. Franzke and E. L. Erickson, Agronomy Department.)

Breed Forage Sorghums for Safer Livestock Feeds

The work on isolation of sorghum strains of low HCN content has been continued and out of several hundred strains analyzed, 17 were found to run from zero to 224 parts per million. These strains will be reselected this coming season for the low HCN factor. The strains which appear to have a very low percentage or no HCN continue to have a small percentage of plants which have a trace of HCN.

This past season mechanical injury also was applied on two high strains, 15-30-S and 19-30-S, under field conditions. The results indicate that mechanical injury slows up plant growth, thereby allowing the plants to reach and retain the maximum HCN content. These results have been summarized and will be published in the near future.

The influence of manure and no manure at varying soil moisture concentrations under greenhouse conditions were studied in a low and high HCN strain, 39-30-S and 19-30-S. The results indicate that barnyard manure applied under limited moisture conditions as well as under optimum and maximum moisture reduces the HCN content as compared with the no-treatment under similar moisture conditions.

The diurnal variation in HCN content in two high HCN strains were made at two intervals. The results indicate that the HCN content of sorghum plants apparently appears to be directly associated with the photosynthesis and that the results in comparing strains cannot be relied upon if sampled at different periods of the day. It also shows that there is apparent relationship between the photosynthetic properties and the metabolism of the plant. Further studies will be made on this particular phase. (Project 61. Leader: C. J. Franzke, Agronomy Department.)
Make Further Progress in Cereal Breeding

Hard red spring wheat. About 2000 lines, the progenies of 14 crosses, were under observation in segregating generations in the breeding nursery in 1939. Approximately 3000 lines are in the 1940 breeding nursery.

About 90 F4 lines of the crosses Thatcher x Hope, Rival x Thatcher, and Rival x Reward were bulked and advanced to preliminary rod-row yield trials in 1940. About 200 F5 lines of these crosses are still under observation in the breeding nursery in 1940. All of these lines have been selected for resistance to stem rust, leaf rust and bunt, and for earliness and other desirable characters.

Four crosses are in the F4 generation in 1940. Several promising lines have been isolated from a Hope x Ceres cross from which a high degree of disease resistance is obtainable. Selections earlier than either parent have been made. Of considerable interest are three crosses with Triumpho, an Argentine variety which has exhibited considerable tolerance to high temperatures and resistance to grasshoppers. From the cross, Thatcher x Triumpho, where both parents are very susceptible to leaf rust, leaf rust-resistant lines have been obtained as a result of what appears to be complementary factors for leaf-rust resistance. The moderate stem rust and bunt resistance of Thatcher apparently have not been exceeded in any of the lines. Good stem and leaf rust resistance has been obtained in lines from the cross Hope-Reliance-Prelude x Triumpho. However considerable difficulty has been encountered in crosses with Triumpho owing to the fact that this variety is susceptible to a number of diseases including the root rots. The remaining cross in F4, Hope-Reliance-Reward x Clarendon, has yielded lines which are early and stiff-strawed and which it is hoped will combine the drought-resistance and grasshopper resistance of Clarendon with the rust resistance of the Hope-Reliance-Reward parent.

The seven crosses in the F5 generation include two more crosses with Triumpho, namely Hope-Ceres x Triumpho and Hope-Reliance-Reward x Triumpho. Two drought-resistant Russian varieties, Caesium and Milturum, crossed with Hope-Reliance-Reward have yielded about 600 F3 lines under observation in 1940. Caesium and Milturum are extremely late and susceptible to the rusts so it will be impossible to evaluate their drought-resistance until the earlier lines derived from them can be studied under drought conditions. A very promising cross is Mercury x Hope-Reliance-Reward. Mercury is highly resistant to both rusts and to bunt while Hope-Reliance-Reward is early and has an excellent kernel type. Several F3 lines appear to be considerably superior to either parent. Two
other crosses in F₃, Hope-Reliance-Reward x Hope-Reliance-Prelude and Hope-Reliance-Reward x Hope-Ceres, are yielding early lines with high degrees of resistance to the rusts.

Rod-row nurseries and 1/66 acre plot trials including promising new varieties and standard varieties were grown on the experimental plots at Brookings, Highmore, Eureka, and Vivian.

**Hard Red Winter Wheat.** Five crosses of winter with spring wheat are being grown in bulk in the F₄ in 1940 for the purpose of transferring rust resistance from spring wheat to winter wheat. These crosses are Hope-Reward x Minard-Minhardi, Marquis-Kota-Hope x Minard-Minhardi, Marquis-Kota-Hope x Minhardi, Marquis-Kota-Hope x Minturki, and Double Cross-Hope x Minard-Minhardi. Selections for rust resistance are being made in 1940 and will be tested in 1941. Rod-row nurseries were grown at Brookings and Highmore.

**Durum Wheat.** No breeding work is currently in progress. However, several new strains developed recently are being tested in comparison with standard varieties in rod-row nurseries and 1/66 acre plots at Brookings, Highmore, and Vivian. Standard varieties are in 1/66 acre plot trials at Eureka.

**Rye.** The development of improved lines by inbreeding is being continued in a limited manner. Resistance to ergot, desirable plant and kernel types and yield are the chief objectives of the work.

**Barley.** Approximately 1000 lines from six crosses are being grown in 1940. About 90 F₄ lines of the crosses Atlas x Wisconsin 38 and Peatland x Dryland were bulked in 1939 and advanced to the rod-row Nursery in 1940. A number of F₅ lines of these crosses are still under observation in the breeding nursery in 1940. The lines from the latter cross

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**HARD RED SPRING WHEAT NURSERY EARLY IN THE SPRING**

All new grain varieties are thoroughly tested in the Station nurseries before they are released as recommended varieties.
all are resistant to stem rust. Earliness and high yield for central and western South Dakota are the chief object in these crosses.

The cross Lion-Manchuria x Peatland-Glabron was made for the purpose of combining earliness, high yield, stiff straw, and resistance to rust and other diseases into a desirable malting variety for eastern South Dakota. About 400 F₃ lines are being grown in 1940. Another cross of Spartan with Peatland-Glabron is expected to give early, stiff-strawed, rust-resistant selections.

Lion-Manchuria x Chevron is a cross grown in the F₂ generation in 1940 for the purpose of obtaining strains with the desirable characteristics of the Lion-Manchuria x Peatland-Glabron selections.

About 50 F₆ or F₇ Spartan x Ace selections are under observation for central and western South Dakota conditions. The inheritance and linkage relationships of several genetic characters also are being studied. Rod-row and 1/66 acre plot trials of barley were conducted at Brookings, Highmore, Eureka and Vivian.

Oats. Between 40 and 50 new recently developed strains were advanced to rod-row trials in 1940. These strains are resistant to stem rust and the smuts, and include about 10 new hulless strains. Two new strains, Markton-Iogold x Markton (F40) and Markton-Richland x Swedish Select-Kilby (F330-486), are being increased for distribution as new varieties to farmers in another year or two.

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

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

**Hard Red Spring Wheat.** Uniform Regional Rod-Row Nursery at Brookings, Uniform 1/66 acre Plot Trials at all Four Stations, Uniform Rust Nursery at Brookings.

**Hard Red Winter Wheat.** Uniform Winterhardiness Rod-Row Nursery and Supplementary Winterhardiness Nursery, both at Brookings.

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

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

**Flax.** Uniform Rod-row Nursery at Brookings. (Project 25. Leader: S. P. Swenson, Agronomy Department; Bureau of Plant Industry Cooperating.)
Continue Efforts to Improve Forage Crops

In cooperation with the Soil Conservation Service the dates of seeding (early spring, medium spring, late spring, early fall, and very late fall seeding) on 22 species and varieties of cultivated and native grasses are being studied.

In addition 127 species and varieties of grasses are being observed in an adaptation rod-row nursery and 24 native and cultivated grasses and 10 legumes are being studied in a variety test nursery. Three species of grasses seeded early spring, late spring, early fall, late fall, drilled and broadcast on different seed bed preparations likewise are well under way. Considerable information is being secured in regard to the method of seeding, seed bed preparations and dates of seeding.

Several hundred alfalfa plant selections are under observation in the breeding nursery. Selections will be made in 1940 and planted in plant rows in 1941. The Uniform Regional Alfalfa Yield Nursery also is being continued. Selections for more desirable forage types of sweet clover have been made. Among the most promising are some dwarf and semi-dwarf types isolated at this Station. The inheritance of pale yellow seed color is being studied in crosses with green-seeded and normal yellow-seeded strains.

It is rather difficult to secure stands of grasses and legumes due to seedling blight or root rot. Considerable work was carried on this past winter under greenhouse conditions, studying cropping systems, and native sod from different sections of the state. It appears that there is some relation to the cropping systems. It is also noted that the root rot disease infestations appear to be much heavier in the eastern section of the state than the western. A susceptibility study under greenhouse conditions on a badly infested soil is being made on seven legumes and nine grasses.

Seed and soil treatment in controlling these root rot diseases were studied the past season on crested wheat, Russian wild rye and brome grass. As the disease is a soil-borne organism, very little has been accomplished in controlling the loss of stands other than securing a higher percentage of emergence. These were also studied under greenhouse conditions. The result under greenhouse conditions was very similar to those under field conditions.

Considerable work is being carried on in selecting individual plants which appear to either have escaped or are resistant to root rots. These are being planted out under field conditions on badly infested soil for further study with the hope of building up strains more resistant to the root rots. (Project 74. Leaders: S. P. Swenson, C. J. Franzke, and E. L. Erickson, Agronomy Department.)
Manchuria Top Variety in Soybean Yields

Variety tests of soybeans with a view to finding which strains may be adapted to this region are being continued. Such tests have been under way in fact for 20 years or more and a good deal of selection work has been accomplished. The progress with selection was carried on largely by Matthew Fowlds, assistant agronomist, recently resigned.

A five-year test for the years 1935-39 placed the variety Manchuria at the top of the list for average yield of seed, yielding 11 bushels per acre. It yielded highest among the eight varieties tested, four years out of the five.

There was very little difference among the eight varieties from the standpoint of average yield of hay. Tests have been conducted in cooperation with the Bureau of Plant Industry for three successive years. This cooperation makes it possible to compare numerous introductions of soybeans brought in by the Bureau from various parts of the United States and the world.

It is part of the object of this cooperative test to find out varieties of soybeans which may be suitable to grow in comparatively northern latitudes for industrial purposes. It is generally recognized that soybeans are utilizible for scores of industrial purposes in addition to their use directly as feeds for livestock and for human food. The present utilization of soybeans for many purposes is on the increase. It is desirable to have information about this crop for South Dakota conditions in order to get a possible demand later on.

A number of the earlier varieties have given promise of being productive in these cooperative tests. Among them are certain edible garden varieties which have not been previously cultivated here. (Project C-2. Leader: A. N. Hume, Agronomy Department; Bureau of Agricultural Chemistry and Engineering and Bureau of Plant Industry Co-operating.)

Substations Report Experimental Progress

Projects at the experimental substations are intended to secure information about the best farm practices for the sections of South Dakota each represent.

At the Cottonwood substation grass nurseries have been continued as well as comparative yields of hay from small grain. One project has been installed to obtain comparative yields of corn and sorghum and also to learn whether either of these crops are injurious to land. Yields of wild hay will be studied in comparison with cultivated forage.
Experiments at the Vivian substation include tests of small grain varieties in a nursery. Variety tests of grasses indicate that Crested wheat grass is making especially successful growth in the present season. The seeding of corn and sorghum in alternate pairs of rows furnishes a demonstration of the greater resistance of sorghums against grasshoppers and other insects than corn. One of the finest windbreaks of considerable age in the West River area may be seen at Vivian. Hackberry is most successful species that has persisted for many years.

At the Highmore substation, a crop rotation has been arranged to compare the effect upon soil fertility of (1) plowing under all straw and fodder remaining after harvesting and threshing grain, and (2) returning the equivalent in stall manure after feeding the same amount of roughage to livestock. Such an experiment might be called a comparison of livestock and grain systems of farming and the results should be of interest to crop growers and livestock feeders alike. At Highmore it is evident that crested wheat grass seeded in the fall of the year has made better growth than spring seeding. Another factor in connection with the fall seeding likewise is the fact that seed which evidently failed to germinate immediately the first year of seeding came on and produced an appreciable crop in the following season or even the second season after seeding.

In cooperation with the Animal Husbandry Department, an experiment is under way at Highmore relative to pasturing low prussic acid sorghum with cattle in comparison with high prussic acid sorghum and a commercial variety. Over a period of years it is intended to develop sorghum varieties that are safe to use for pasture and forage so far as the content of prussic acid is concerned. Such varieties of sorghum will contribute largely to the stability of pasture and forage production in this area.

The Eureka substation furnishes an excellent demonstration of the apparent advantage of medium early planting of corn as compared with later planting. The experiment is not completed, but apparently early planted corn is able to take advantage of moisture in the early part of the season and produce more vigorous growth than later planted corn in this northern latitude even at some risk of frost. Another interesting experiment at Eureka is that with seeding three different kinds of grass with and without nurse crops. Preliminary indications are that the nurse crop (which consists of a light seeding of oats) apparently holds Russian thistles and other weeds measurably in check. The development of Eureka corn with ear-row selection and crossing is being continued. The variety known as Eureka has been successful not only in northern South Dakota but in other northern latitudes as Washington and Wyoming where short-season varieties are needed.
Study Selenium Content of Plants and Soils

For the second year, the selenium content of grasses and other range plants has been studied. A third year's work on this study is now underway, and until this is completed no definite conclusions can be reached concerning the study. The results on hand indicate that the selenium content of grasses and most of the other range plants studied decreased considerably with advancing stages of growth. Western wheat grass (Agropyron smithii) apparently absorbs more selenium from soils than do other common grasses which have been studied. Gum plant (Grindelia squarrosa), a plant which often contains relatively large amounts of selenium, has been found to increase in selenium with advancing stages of growth.

An attempt is being made to develop a practical method for determining available selenium in soils. Methods have been developed that have proved fairly accurate, but they are too difficult and require too much time to be of much practical value. The methods which are now being investigated are being checked by field studies.

Investigations of the chemical form of selenium in "converter" plants have not progressed to the point where it can be said definitely in what form the selenium occurs. Much of the selenium apparently is bound in the proteins of the plants. It appears quite likely, however, that the selenium occurs in the plants in more than one form. Acid hydrolysis of selenium cystine has been shown to cause decomposition of this compound. The same has been found for electrodialysis of the compound. On the basis of this, it has been considered essential that less drastic means of releasing the seleniferous compound from proteins and isolating it must be used. Enzymic hydrolysis is now being tried.

Since it was found that arsenic would counteract the toxic effects of selenium, certain arsenic studies were begun on rocks, soils, and plants. Although arsenic has been found to occur in most of the rocks and soils that were studied in greater amounts than does selenium, the plants growing in these rocks and soils usually contain much less arsenic than they do selenium. Most plants absorb only very small amounts of arsenic and it may be, therefore, that naturally occurring arsenic is of little benefit as concerns the counteracting of selenium poisoning. (Project 19. Leaders: A. L. Moxon and O. E. Olson, Station Chemistry Department.)

For selenium studies on livestock see pages 42 and 43.
Investigations of the Ephedra Plant Continued

This cooperative project with the Agronomy Department is concerned with the continuation of the original project relative to the introduction, acclimation, and cultivation methods best suited to the production of Ephedra sinica in South Dakota. In addition to the two phases of investigation cited in the 1939 report, namely: (1) Commercial possibilities, and (2) soil erosion control, it has been necessary to extend the investigation to include additional closely related studies. With the possibility of the plants being transplanted to places where stock might have access to them, it of necessity must be determined whether or not the material is a stock poison. Preliminary investigations with rabbits have indicated that it is a potent drug, and that additional research is needed in this field before the plants are too widely distributed.

Relative to its commercial possibilities, some constructive steps have been taken to insure the continued use of the crude drug. The monograph for the adoption of the crude drug into the official books was received and published in the bulletin of the National Formulary, Vol. VII, p. 297 (1939). In addition a year's work on the preparation and assay of the Fluidextract has been completed by a graduate student in the Division of Pharmacy. Its adoption will insure a market for the crude drug inasmuch as it can be prepared in no other way.

During 1939-40 a great increase in seed production was experienced. During the summer more than twice the amount of seed was collected and cleaned as compared to the previous year's yield. Additional plantings are now being made to increase the number of plants with which to continue the experiment.

Adverse weather conditions for starting young plants hampered the development of the plots at both the Highmore and Vivian substations. However, enough of the plants survived at the former station to enable samples of the stems to be taken for assay purposes last fall. These stems were selected plants and assayed 1.63 percent. These same plants should produce fruits and seeds this season with which to inaugurate additional studies into the effects of controlled pollination on the quality of the stems. Still another sample of stems was returned from the Murdo area which assayed 1.07 percent ephedrine. (Project 65. Leader: L. D. Hiner, Pharmacy Division.)
Sooner Milo Equals Corn for Fattening Pigs

Two years' trials conducted by the South Dakota Station would indicate that Sooner milo grain compares very favorably with shelled corn for fattening pigs when fed with protein supplements and minerals. It appears that this crop can well be used to replace corn in those sections of the state where corn is not so likely to produce as good a yield.

The primary object of this experiment was to determine the relative feeding values of the grain from Sooner milo, Low Prussic acid cane and Dakota Amber cane when supplemented with protein feeds and minerals for fattening pigs.

Forty thrifty fall pigs were divided as uniformly as possible into four lots of 10 pigs each in the recently concluded 1940 trials. The following rations were fed:

Lot 1—Shelled yellow corn.
Lot 2—Ground Sooner milo grain.
Lot 3—Ground Low Prussic Acid cane seed.
Lot 4—Ground Dakota amber cane seed.

In addition the pigs in all lots were fed tankage, alfalfa hay and a mineral mixture. All feeds were fed free choice method.

It was noticed soon after this year's experiment was started that the pigs fed the ground Sooner milo were making more rapid gains than the pigs in any of the other lots. They also showed a higher degree of finish and smoother hair from the end of the first three weeks of feeding until the final weight of 234.7 pounds average was reached.

A comparison of the amounts of feed required to produce 100 pounds of gain showed that the pigs fed the ground Sooner milo required less grain but slightly more tankage than those receiving shelled corn. When the cost of grinding the Sooner milo with the increased tankage requirements was considered the shelled corn and Sooner milo used in this feeding trial had practically the same feeding value for fattening pigs.

The ground seed from both the Low Prussic and Dakota Amber sorghums (which are saccharine varieties) gave considerably lower feeding values than shelled corn. The results would indicate, however, that where grain from the saccharine sorghums is produced, it can be utilized for swine feeding with fairly satisfactory results.

At the close of the feeding period, five hogs from each lot were slaughtered to determine if there was any tendency for the seed from
amber sorghums to produce dark colored meat. The hogs fed on the grain from the saccharine sorghums did not give as high dressing yields as those fed corn or Sooner milo. Neither were the carcasses quite so firm. However, the lean meat in the carcasses from the hogs fed the dark colored cane seed was no darker than the lean in the carcasses from the hogs fed shelled corn.

The hogs fed Sooner milo dressed slightly higher than those fed shelled corn and excelled in percentage of lean meat. Further feeding trials will have to be conducted, however, to determine if the higher percentage of lean to fat was due to the ration fed or to the individuality of the hogs in this particular lot. (Project 24. Leader: Turner Wright, Animal Husbandry Department.)

What Are the Best Rations for Pigs After Weaning?

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

For this first trial 100 thrifty spring pigs were divided into 10 uniform lots and self fed nine different feed combinations as follows:

- Lot 1—80 parts coarsely ground yellow corn, 20 parts of trio mixture No. 1.*
- Lot 2—80 parts coarsely ground yellow corn, 20 parts of trio mixture No. 2.†
- Lot 3—60 parts coarsely ground yellow corn, 20 parts standard wheat middlings, 20 parts trio mixture No. 2.
- Lot 4—60 parts coarsely ground yellow corn, 20 parts of ground oats, 20 parts trio mixture No. 2.
- Lot 5—80 parts coarsely ground yellow shelled corn, 20 parts of a protein mixture consisting of 35 parts tankage, 25 parts alfalfa meal, 25 parts soybean oil meal, and 15 parts dried skim milk.
- Lot 6—Shelled yellow corn; a protein mixture consisting of tankage 2 parts, and soybean meal 1 part, self fed; alfalfa hay, self fed.
- Lot 7—Same as Lot 2.
- Lot 8—Same as Lot 5 except dried buttermilk used instead of dried skim milk.
- Lot 9—80 parts coarsely ground yellow corn and 20 parts of a protein mixture consisting of 35 parts tankage, 25 parts soybean meal, 15 parts “Calf Manna,” and 25 parts alfalfa meal.
- Lot 10—60 parts coarsely ground yellow corn, 30 parts standard wheat middlings, 5 parts tankage, and 5 parts soybean meal; alfalfa hay, self fed.

After the pigs reached approximately 100 pounds average weight the ratio of trio mixtures to corn was changed to 88 parts corn and 12 parts trio mixture.

* Trio mixture No. 1 consisted of two parts tankage, one part linseed meal and one part alfalfa meal by weight.
† Trio mixture No. 2 consisted of two parts tankage, one part soybean meal and one part alfalfa meal by weight.

The mineral mixture was then made by mixing 40 pounds steamed bone meal, 40 pounds ground limestone and 20 pounds common salt. One pound of this mineral mixture was added to each 100 pounds of the feed mixture for all lots except Lots 6 and 10 which were self fed the same mineral mixture.

[18]
One severe case of lameness of a type sometimes called "High Stepping" developed in Lot 2. Two other mild cases of the same type of lameness developed near the close of the test. One of these was in Lot 3 and the other in Lot 5. The latter two pigs, however, did not become unthrifty and there was no appreciable lowering of the rate of gain. The pig in Lot 2, however, gained at a much slower rate than any of the other pigs in the lot save one which became decidedly unthrifty soon after the experiment was started. These were the only cases of this type of lameness which have occurred in the College herd of hogs in at least 12 years. Considerable trouble, however, has been experienced with pigs becoming unthrifty.

The pigs in Lots 3 and 4, fed wheat middlings and ground oats respectively, in combination with corn, made the most rapid gains with as low feed requirements as any of the pigs in the experiment.

One of the most noticeable differences was that the pigs self fed, free choice method, ate considerably less protein supplement than those fed the protein supplement mixed with the grain. Also the pigs self fed mineral ate only about one-third as much mineral as those fed mineral mixed with the grain. This would seem to indicate that one pound of mineral mixed with 100 pounds of grain is more than is needed in this locality especially as the pigs self fed the mineral used the grain fed just as efficiently as the pigs in any of the other lots.

This experiment is being repeated. (Project 85. Leader: Turner Wright, Animal Husbandry Department.)

Good Quality Pork Produced on Pasture

This project—effects of pasture on quality of pork—was temporarily discontinued during 1939-40 due to the inability to secure a stand of alfalfa and sweet clover for the pasture lots the previous year. However, the cooking and palatability tests on the smoked hams from the 1938-39 trial of this project were completed during the past year. A partial summary of the feeding data and of the cooking and palatability data was also made.

Results summarized to date indicate:

1. That pork of good quality and palatability was produced by growing fattening pigs self-fed, free choice, a ration of yellow shelled corn, tankage and minerals in dry lot or on alfalfa, sweet clover or rape pastures.

2. That no significant differences were noted between the quality and palatability of the pork produced in dry lot and that produced by the pigs allowed either of the aforementioned forage crops.
A fourth trial of this project is in progress at present. Four lots of growing fattening pigs of 10 head each, were started on feed June 14 in dry lot, alfalfa, sweet clover, oats and rape pastures, respectively, and fed similar rations as before. When these pigs reach market weight and finish of about 225 pounds, they will be slaughtered and the meat of each carcass will be graded in regard to quality and palatability factors as was done in the previous trials. (Project 50. Leaders: Turner Wright and F. U. Fenn, Animal Husbandry Department.)

Methods of Baby Beef Production Compared

South Dakota cattle producers have often expressed a desire to know if the growing out and fattening of beef calves at an early age as baby beeves would be a profitable enterprise under their conditions. They also wanted to know if satisfactory baby beeves can be produced from a herd of average grade beef cows and if it pays to feed grain in a creep to such calves while they are on pasture with their dams.

An experiment designed so as to answer these problems far the cattle producers was started at this Station early in 1938. A small breeding herd of 30 average red, white and roan farm cows was purchased locally from farmers early in 1938. A good type, purebred Shorthorn bull was also purchased to head this herd. However, since the cows were purchased as bred cows, the first crop of calves, produced and fed out in 1938 and 1939, were not sired by this bull. Also, it happened that six of the 1939 calves were sired by a neighbor's scrub bull.

The second trial of this project will soon be completed with the marketing of the remainder of the second crop of calves from the feedlot. The grazing period with the third crop of calves and their dams is in progress.

Results of the second trial were similar to those of the first year. The creep fed calves are reaching market weight and finish in the feed lot about a month sooner than the non-creep fed calves. However, it again appears doubtful if the creep feeding will prove economical, when followed by a long fattening period in the feed lot. Also, significant differences in the quality or palatability of the beef produced by creep fed and non-creep fed calves under these conditions have not been noted.

A very significant practical demonstration of the value of a good beef type purebred bull for siring baby beef calves from common, grade, dual-purpose cows was shown in the second trial this year. The six calves sired by a neighbor's scrub bull were definitely of poorer type at birth, as feeders at the close of the grazing period and as fat beeves at the close
DEMONSTRATE VALUE OF GOOD PUREBRED BEEF SIRE

Top: These calves were sired by a good, beef type purebred bull and were out of common cows.

Bottom: These calves were sired by a scrub bull and out of good cows. When marketed they averaged one full grade lower and sold for an average of 50 cents per hundredweight less than steers sired by the purebred bull.

of the fattening period, than the rest of the calves sired by the good, beef type purebred bull. They were also graded lower on foot at the market and their carcasses were graded lower in the packing house coolers due principally to their deficient conformation. They averaged fully one grade lower and sold for an average of about 50 cents less per hundred weight than the rest of the calves.

In the 1940 trial the 25 cows with calves have been divided into three groups for the summer grazing period instead of two as in previous years. Five of the cows will be kept in a separate pasture from their calves and the calves will be allowed to nurse only twice a day as a preliminary test of this method of management for handling baby beef calves. (Project 67. Leaders: I. B. Johnson and F. U. Fenn, Animal Husbandry Department.)

How Do Sorghum Grains Compare with Corn for Steers?

The bulk of the sorghum forage and much of the sorghum grain produced in South Dakota is fed to cattle. South Dakota cattle growers and feeders desire information in regard to the use and value of various types of South Dakota sorghums in cattle rations and in particular desire to know how it compares with corn. In view of this fact an experimental
cattle feeding project was started at this Station during the summer of 1939 to secure much needed information in regard to the use and value of various sorghums as cattle feeds in South Dakota.

Thirty head of good and choice grade two-year old Hereford feeder steers were bought during early August. These steers were allowed a fill and started on a dry feed of oats and prairie hay for a few days before being weighed for the 90-day feeding trial. They were also divided into three uniform lots of ten head each and started on the following rations:

Lot 1—Ground shelled corn, soybean oil meal and alfalfa hay.
Lot 2—Ground Sooner milo grain, soybean oil meal and alfalfa hay.
Lot 3—Ground Dakota Amber cane seed, soybean oil meal and alfalfa hay.

From the data obtained it was noted that the ground shelled corn produced faster and more economical gains than the ground Sooner milo grain and both of these were superior to the ground Dakota Amber cane seed in these respects. The corn fed steers returned a good profit at the prices prevailing at that time while a small profit was realized on the milo fed cattle and the cane fed cattle were fattened at a decided loss. The excessive amounts of Dakota Amber cane seed required to produce 100 pounds of gain in comparison to the amount of corn and milo grain that were required for an equal amount of gain on similar cattle fed under the same conditions, indicates that this type of sorghum grain is worth much less per pound as a cattle feed than either corn or milo.

THESE STEERS WERE FATTENED ON SOONER MILO GRAIN

Sooner milo grain, although not quite up to shelled corn in rate or economy of gain, has shown up well in feeding trials at the South Dakota Station. The tests indicate that Sooner milo may be used to advantage for fattening steers in areas not adapted to successful corn production.
Two growing fattening pigs followed the steers in each lot and the pork gains credited gave the corn lot a still greater advantage.

The dressing percent and carcass grades were obtained for each lot from the packers who purchased them. All of the carcasses from the steers in Lots 1 and 2 graded either good or choice. The carcass grade of the milo fed lot averaged slightly higher than that of corn fed lot. The average dressing percent for the two lots was identical at 59.8 percent. Lot 3 did not yield any choice grade carcasses and the average grade was fully one grade lower than the average of the other two lots. The dressing percent was also lower, being 58.1 percent. These data indicate that the Lot 3 cattle had not acquired satisfactory market finish during the feeding period as had the cattle in the other two lots.

An interesting observation was made when these carcasses were "ribbed down" or quartered in the coolers. The lean meat in the carcasses from the Lot 3 cattle, fed on the cane seed, had a dark, liver color instead of the bright, cherry red color which is desired. This observation has attracted considerable attention as a possible factor related to the cause of dark cutting beef—a problem that is being studied considerably by other Stations and research agencies at the present time.

These cattle were exhibited and a progress report given to several hundred livestock men who attended the Station Feeder’s Day in connection with the annual Farm and Home Week held a week before the close of this feeding trial last November. A great deal of interest was shown in the cattle and the results of the experiment.

A second feeding trial will be conducted in 1940, to see if similar results will be obtained. It is also hoped that sufficient Low Prussic cane seed can be obtained so that a fourth lot of cattle fed on this type of sorghum grain can be included in this next trial in order that similar information may be obtained for this popular type of sorghum that has been developed at this Station. (Project 90. Leaders: I. B. Johnson and F. U. Fenn, Animal Husbandry Department.)

Are Gummer Ewes or Lambs More Profitable to Feed?

Lamb and sheep feeding is generally a profitable livestock enterprise in eastern South Dakota and irrigated sections of western South Dakota. Western lambs bought direct from the western producer or on the central market is the most popular source of feeding lambs. The western producer markets his aged and gummer ewes about the same time that the lambs are marketed. The low price that these ewes command on the market often attracts feeders.

There is little available information on the comparison of economy of feeding western gummer ewes and western lambs. The South
Dakota Station has conducted feeding trials the past two years comparing the economy of feeding lambs and gummer ewes. Corn and barley as fattening feeds have been compared. Comparing ground and whole grain rations for gummer ewes is also a part of the trial. Information on the improvement of mutton of gummer ewes by fattening is being secured.

The Results of the Feeding Trials for the Past Two Years are as Follows:

<table>
<thead>
<tr>
<th></th>
<th>LOT I</th>
<th>LOT II</th>
<th>LOT III</th>
<th>LOT IV</th>
<th>LOT V</th>
<th>LOT VI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>96 Ewes</td>
<td>92 Ewes</td>
<td>96 Ewes</td>
<td>90 Ewes</td>
<td>94 Lambs</td>
<td>94 Lambs</td>
</tr>
<tr>
<td>Feed required per 100 lb. gain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>797.9</td>
<td>815.2</td>
<td>616.0</td>
<td>675.4</td>
<td>553.8</td>
<td>486.9</td>
</tr>
<tr>
<td>Wh. Barley*</td>
<td>Gr. Barley†</td>
<td>Wh. Corn</td>
<td>Gr. Corn</td>
<td>Wh. Barley</td>
<td>Wh. Corn</td>
<td></td>
</tr>
<tr>
<td>Alfalfa Hay</td>
<td>416.5</td>
<td>508.2</td>
<td>371.1</td>
<td>436.3</td>
<td>402.3</td>
<td>401.8</td>
</tr>
<tr>
<td>Profit or loss per head after deducting feed costs</td>
<td>$0.31</td>
<td>-$0.19</td>
<td>$0.63</td>
<td>$0.15</td>
<td>$0.97</td>
<td>$1.25</td>
</tr>
</tbody>
</table>

* Wh. Barley is whole barley.
† Gr. Barley is ground barley.

The results of two years trials of feeding 50 head of western lambs and 100 head of aged gummer western ewes indicate corn to be superior to barley as a fattening feed for both ewes and lambs. Grinding the grain ration for gummer ewes is not a profitable practice. A palatability committee rated mutton from finished gummer ewes surprisingly high and nearly comparable to lamb, whereas the mutton from similar ewes before fattening was much inferior. (Project 78. Leaders: James Watson and F. U. Fenn, Animal Husbandry Department.)

Seek Improved Rations for the Pregnant Ewe

Fifty grade Hampshire ewes were divided into five lots of 10 head each and bred to a purebred Hampshire ram in the fourth year's experiment to determine the best rations for pregnant ewes.

The rations for the ewes during the period of gestation were as follows:

Lot 1—Shelled corn and alfalfa hay.
Lot 2—Shelled corn and wild hay.
Lot 5—Cottonseed cake and alfalfa hay.

Lot 3—Oats and wild hay.
Lot 4—Oats and alfalfa hay.
ANNUAL FEEDER'S DAY HELD IN NOVEMBER

During Farm and Home Week the Station Animal Husbandry Department holds its annual Feeder’s Day. An estimated 500 stockmen and farmers attended the 1939 event and listened to Station workers tell of their feeding research projects.

Samples of wool for chemical analysis were taken from three different parts of the body, namely, the shoulder, side, and thigh when the ewe was bred and again after she lambed. The lambs were weighed, measured and described as to their condition when one day old.

There were 57 lambs in the 1938-39 test. These were weighed individually on July 26 and put on a pasture consisting of rape, oats and sudan grass. At the end of 60 days the lambs were again weighed, since the pasture was rapidly becoming depleted on account of shortage of rain.

The average gain per head daily for the 57 head of lambs was .31 of a pound. The lambs in Lot 3 gained .34, Lot 1 .33, Lot 5 .32, Lot 2 .30, and Lot 4 .28 of a pound. Lots 2 and 4 with 13 and 14 lambs raised topped the other three lots which had 10 head each. To date, conclusions have not been made as to the superiority of one ration over another. (Project 54. Leader: J. W. Wilson, Animal Husbandry Department.)

Report Progress in Notail Sheep Development

The object of this experiment is to develop, if possible, a breed of sheep without tails. For the 1940 lambs four different rams were used. Each of these rams was selected because of its individuality and breeding. The ewe flock consisted of no-tailed and short tailed ewes.

In Lot 1 the ewes were bred to the yearling ram No. 5758. This ram was used because he possessed characters desired for body and wool improvement. He sired 34 lambs, 21 of which had no tails and the other
13 had tails ranging in length from ¼ to 2½ inches with an average length of 1.05 inches.

In Lot 2 ram No. 5766 was used. He sired 39 lambs of which 8 had no tails, 15 out of crossbred Southdown ewes with tails ranging from ½ to 4 inches with an average of 3.11 inches. The remaining 16 lambs, out of no-tailed and short tailed ewes, had tails ranging from ½ to 3 inches with an average of 1.48 inches.

In Lot 3 ram No. 5854 was used and sired 20 lambs of which 8 had no tails. Seven were out of crossbred Southdown ewes and had tails ranging from ½ to 4 inches in length with an average of 2.71 inches. The other five lambs were out of no tailed and short tailed ewes and the length of tail varied from 1 to 2½ inches with an average length of 1.2 inches.

In Lot 4 ram No. 4989, a crossbred Southdown and Notail, was used on six ewes of the same breeding with the result that one of the ewes, 5320, had a lamb without a tail. The five other lambs had tails ranging from two to six inches with an average of 4.9 inches.

Indications are that two crosses of the Notail breed on a down breed are necessary to reduce the tail length so lambs will not have to be docked. A progress report of the development of the Notail breed was published during the year in Station Circular 28. (Project 9. Leader J. W. Wilson, Animal Husbandry Department.)

How Much Livestock Can Our Grasslands Carry?

There is a necessity of a grazing capacity inventory in South Dakota to be used as a basis for agricultural planning, arriving at land values, leasing and rental fees and for use in livestock improvement programs and farm and ranch management practices. Such an inventory is available from the U. S. Forest Service and the Soil Conservation Service for the western portion and in some of the counties in the eastern portion of the state. The South Dakota Agricultural Experiment Station is conducting a study of the carrying capacities of representative ranges and pastures in the eastern portion of the state where no previous work has been conducted. Upon completion of this study a grazing capacity map of the state will be published. (Project 97. Leaders: I. B. Johnson and James Watson, Animal Husbandry Department.)
Survey Sheep Versus Hogs on Irrigated Farms

The objectives of this study were (1) to determine the factors which have brought about the distinct drift from hog production to sheep production and feeding, and (2) to develop some recommendations for better utilization of livestock on irrigated farms in order to increase farm incomes.

Among operators the following reasons for the trend in the direction of sheep production are common: (1) Sheep utilize a higher proportion of roughages and crop residues, and require less grain than do hogs. (2) Quicker returns on investment from sheep; fed lambs are salable at end of 90 days. Wool and lamb crop bring double income from same investment. (3) Sheep require less labor and less special equipment. (4) Sheep diseases and infections are considered a less serious hazard.

There are indications that both efficiency and incomes can be increased as follows: (1) Further improving the quality of breeding stock, particularly in the case of sheep; (2) better methods of handling flocks on summer range are needed; (3) operators stand to increase income by adding feeder pig production. Relatively high grain yields on irrigated land, favorable climate, and possibility of growing alfalfa to advantage lead to the conclusion that decreases in hog numbers may have been carried too far.

There is need for further research to determine probable costs of pig production. Such research should be conducted in cooperation with the Federal Station at Newell, South Dakota. (Project 91. Leaders, Max Myers, Agricultural Economics Department and Turner Wright, Animal Husbandry Department.)

Livestock Research Work at Newell Field Station

The experiments with sheep at the Field Station, Newell, South Dakota, involve the cooperation of the South Dakota Experiment Station and the United States Department of Agriculture through their Bureau of Plant Industry—the bureau operating the field station and assuming the major responsibility for the work—and the Bureau of Animal Industry which serves in an advisory capacity for the technical phases of sheep husbandry.

Sheep Breeding. During the fiscal year ending June 30, 1940, the sheep husbandry experiments have included activities in the breeding of Hampshire and Corriedale sheep; the feeding of range lambs to a market finish; pasture studies with ewes and lambs; a study of the influence of having the first breeding of Hampshire ewes occur at the early
age of 9 or 10 months; studies of fleeces of wool for weight, length of
staple, fineness, character, density and color of fiber; studies of the
grades of lambs as feeders and as finished lambs, and the grades of
their carcasses at the livestock market in Sioux City, Iowa, where their
carcasses have been graded by the Agricultural Marketing Service, U. S.
Department of Agriculture.

During the past year the South Dakota Station acquired from the
Bureau of Animal Industry its best purebred registered Corriedale
sheep of the Beltsville Research Center, Beltsville, Maryland, and placed
them at the Belle Fourche Field Station. These included 3 rams, 27
ewes of breeding age, and 6 ewe lambs. In the spring of 1940 the fleeces
of these Corriedales were very attractive, clean and light shrinking,
dicating the possibility of producing excellent wool with Corriedales un-
der such conditions as prevail at the Newell Field Station. The average
weights and lengths of staple of the fleeces of these Corriedale sheep
as compared with those of the well bred and well grown purebred regis-
tered Hampshire sheep at the Newell Station are shown in the follow-
ing table:

<table>
<thead>
<tr>
<th>Breed</th>
<th>Sex</th>
<th>Number of Fleeces</th>
<th>Average Fl. Weight</th>
<th>Average Length of Staple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corriedale</td>
<td>Rams</td>
<td>3</td>
<td>14.20</td>
<td>8.47</td>
</tr>
<tr>
<td>Hampshire</td>
<td>Rams</td>
<td>5</td>
<td>8.72</td>
<td>7.38</td>
</tr>
<tr>
<td>Corriedale</td>
<td>Ewes</td>
<td>32</td>
<td>10.93</td>
<td>8.79</td>
</tr>
<tr>
<td>Hampshire</td>
<td>Ewes</td>
<td>150</td>
<td>7.44</td>
<td>7.61</td>
</tr>
</tbody>
</table>

These data indicate the advantage of Corriedales for wool produc-
tion under irrigation farming conditions of western South Dakota and
suggest the possibility of their usefulness for improving the wool produc-
tion of sheep on the ranges of that region. Further studies of these
wools and of Corriedales are required for adequate determination of
Corriedale sheep and their wool growing advantages in that region.

These Corriedale sheep have fleeces that are strictly pure white, with-
out any black or dark colored fibers. The 294 Hampshire sheep and
lambs on hand early in June 1940 were carefully examined for color of
wool fiber in their fleeces and 261 of them were free from dark or black
fibers in the bodies of their fleeces, 21 had very slight occurrence of
dark fiber, 7 were troubled by such off-colored fibers to a medium de-
gree, while 5 were carrying enough black fibers in their fleeces to justify
the discarding of them from the breeding flock of purebred Hampshires.
These Hampshire sheep are averaging very good for mutton confor-
tion and rapid growth of lambs. Their fleeces are good for Hampshires
and they have been improved over the past 17 years, during which these Hampshires or their ancestors, have been in these breeding experiments, but further improvement can and should be made.

**Ewe Lambs Versus Yearling Ewes.** During the lambing seasons of 1938 and 1939 the Hampshire ewe lambs that were scheduled to give birth to lambs resulting from their being bred at the age of about 9 or 10 months failed in all cases to give birth to lambs at that time. They had been fed on cane hay, beet pulp and barley during and following their ewe lamb breeding season, and they were evidently thereby retarded in their necessary development for normal conception. Last winter the Hampshire ewe lambs that were bred at 9 to 10 months of age were fed alfalfa hay instead of cane hay and many of them lambed in the spring of 1940. This result suggests the need of a good legume hay or its equivalent in order to succeed in having Hampshire ewe lambs breed early enough to bring their first lamb crop when they are 14 to 15 months old. Here is a problem in physiological and nutrition research that needs thorough investigation before there can be a complete understanding of the underlying principles involved.

**Sheep Feeding.** Seven lots of 100 range lambs per lot were fed last winter for a period of 119 days. The rations of the different lots were as follows:

<table>
<thead>
<tr>
<th>Lot</th>
<th>Ration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shelled corn and alfalfa hay.</td>
</tr>
<tr>
<td>2</td>
<td>Shelled corn, corn silage and alfalfa hay.</td>
</tr>
<tr>
<td>3</td>
<td>Shelled corn, pressed beet pulp and alfalfa hay.</td>
</tr>
<tr>
<td>4</td>
<td>Shelled corn, pressed beet pulp, beet tops and alfalfa hay.</td>
</tr>
<tr>
<td>5</td>
<td>Barley, beet molasses, pressed beet pulp and alfalfa hay.</td>
</tr>
<tr>
<td>6</td>
<td>Barley, beet molasses, pressed beet pulp, beet tops and alfalfa hay.</td>
</tr>
<tr>
<td>7</td>
<td>Barley, beet molasses, pressed beet pulp, beet tops, bone meal and alfalfa hay.</td>
</tr>
</tbody>
</table>

At the ruling prices for lambs and feed the selling prices per 100 pounds live weight of the lambs, when finished, that were necessary to pay the costs of feed, interest, death losses, freight and marketing were, by lots, $9.35, $9.35, $9.10, $9.05, $9.45, $9.20, and $9.20 respectively, for lots 1 to 7 inclusive.

It will be noted that the $9.05 for lot 4 was the lowest price required to break even and therefore the most economical. Lot 3 was second in low cost, lots 6 and 7 tied for third place, lots 1 and 2 for fourth, and lot 5 was in fifth place or the most expensive, indicating the need for beet tops when feeding lambs molasses with barley, pressed beet pulp and alfalfa hay. However, these results suggest that the most efficient ration of the seven rations tested was shelled corn, pressed beet pulp, beet tops and alfalfa hay. A comparison of lots 6 and 7 shows no advantage to the feeding of bone meal to these lambs.
Sweet Clover Leads in Pasture Trials

This project has been active for 12 pasture seasons. Each year insufficient moisture has been a limiting factor. Although very good results have been obtained during this period, it is felt that normal moisture would materially increase the productive value of these pastures, as well as their relative importance. It is also possible that with greater moisture conditions, other problems would arise that would in part or wholly, nullify the added advantage of increased moisture.

The following results were obtained from the pasture plots during the 1939 grazing season:

<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>500</td>
<td>4525</td>
<td>158</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>576</td>
<td>3901</td>
<td>140</td>
</tr>
<tr>
<td>Sudan Grass</td>
<td>480</td>
<td>3446</td>
<td>144</td>
</tr>
</tbody>
</table>

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

The 10-year average production for these pasture crops per acre as reported in Station Bulletin 324 is:

<table>
<thead>
<tr>
<th>Alfalfa Milk B. Fat</th>
<th>Sweet Clover Milk B. Fat</th>
<th>Sudan Grass Milk</th>
<th>Sudan Grass B. Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>3307.99 135.54</td>
<td>3668.59 146.68</td>
<td>2766.58 109.95</td>
<td></td>
</tr>
</tbody>
</table>

Bloat in Dairy Cattle. During the year considerable work has been done in determining the kind of gases present in the rumen of bovine. Samples of gas have been secured from bloated cows, cows which have died from bloat, slaughtered cows on dry feed and grass fed cows. Samples of gas from various varieties of legumes and non-legumes fermented under laboratory conditions have also been analyzed. Approximately 90 samples have been analyzed to date. No satisfactory quantitative procedure has been found for determining hydrogen sulphide in small quantities.

The rumen gas was found to contain carbon dioxide, and methane in appreciable percentages, and carbon monoxide and hydrogen sulphide in small but discernible percentages. The two latter gases are highly toxic when present in the systemic blood in small percentages.

The pressure exerted in the rumen due to the gases, has also been measured by a manometer, by means of a small trocar inserted into the
MEASURE PRESSURE EXERTED IN RUMEN DURING BLOAT

By means of a small trocar inserted into the rumen of bloated animals the pressure exerted in the rumen due to the gases present has been measured by the manometer shown in the accompanying picture.

rumen. Samples of blood from the jugular vein have been drawn for gas determinations. A sufficient number of samples have not as yet been secured to report results.

It is anticipated that these trials will determine the types and percentages of gases present in the rumen under winter and summer feeding conditions. The plan of procedure also hopes to determine whether the cause of death from bloat is due to the pressure exerted by the gases, or due to the toxicity of the gases.

It is apparent that the latter information is essential to the solution of the problem. That is, the cause of death from bloat must be determined before a remedy can be sought. (Project 17. Leader: T. M. Olson, Dairy Department; Veterinary Department cooperating.)
Test Legume-Sorghum Silage for Dairy Cows

The planting of sorghum has increased very materially in the past five years in South Dakota. Alfalfa grows readily, and with adequate moisture this crop will be grown in abundance. If in addition to its value as a dry roughage it can also be used as silage its value for livestock feeding can be greatly enhanced.

Alfalfa has been ensiled successfully by using molasses. The plan of this project is to use the sweet sorghums in place of molasses. In addition to the nutritive value of sorghum it will also provide food for acid producing bacteria and thus preserve the alfalfa.

One trial has been conducted in which a hundred ton silo was filled with sorghum and alfalfa in approximately equal parts by weight. Because of lack of moisture and the intense heat the alfalfa was lower in moisture than desired. Three samples of alfalfa taken directly after mowing contained an average of 54.52 percent moisture. The sorghum contained 75.33 percent moisture. No water was added, and no difficulty occurred in the ensiling process although it is thought a more desirable silage would result if the alfalfa was greener than that ensiled. The mixture fermented and although it did not have so distinct an acid aroma as good corn silage, this fact might be due to the rather mature and dry condition of the alfalfa used.

When the silage was fed to 22 cows, no difference in palatability could be observed between the alfalfa-sorghum silage and the corn silage. Samples for analyses were taken when the two silos were about half fed out. The Station Chemist reported the following:

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>Ash</th>
<th>Ether Extract</th>
<th>Protein</th>
<th>Moisture Free Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td></td>
<td>Percent</td>
<td>Percent</td>
<td>Crude Fiber</td>
</tr>
<tr>
<td>Sorghum-alfalfa silage</td>
<td>55.72</td>
<td>6.71</td>
<td>2.76</td>
<td>14.01</td>
<td>29.92</td>
</tr>
<tr>
<td>Corn silage</td>
<td>63.08</td>
<td>6.37</td>
<td>2.45</td>
<td>9.29</td>
<td>21.50</td>
</tr>
</tbody>
</table>

Both silages were lower in moisture than good silage should be. The analyses of corn silages reported in Morrison’s Feeds and Feeding ranges from 70.8 percent for well matured corn to 80.6 percent for immature corn, in moisture.

In the feeding trial in which corn silage was compared to the alfalfa sorghum silage, 22 cows were used on 30 day reversal plan. The first year’s results were as follows:

<table>
<thead>
<tr>
<th>Silage</th>
<th>First 30 Days Milk</th>
<th>Second 30 Days Milk</th>
<th>Total Milk</th>
<th>Butterfat</th>
<th>Total Butterfat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>9384.1</td>
<td>413.13</td>
<td>357.57</td>
<td>18,634.1</td>
<td>770.7</td>
</tr>
<tr>
<td>Legume-Sorghum</td>
<td>10,056.3</td>
<td>410.3</td>
<td>320.46</td>
<td>17,496.6</td>
<td>730.48</td>
</tr>
</tbody>
</table>

[32]
There was a decrease of 1944.1 pounds of milk and 92.67 pounds of fat respectively when the cows were changed from corn silage to sorghum-alfalfa silage, and a decrease of 806.3 pounds of milk and 52.73 pounds of fat when the cows were changed from sorghum-alfalfa silage to corn silage.

The decrease in milk and fat was more pronounced when the cows were shifted from the corn silage to the alfalfa-sorghum silage than when the reverse shift was made.

The data from this trial would seem to indicate therefore that the corn silage was slightly superior in nutritive value for milk cows. However it is necessary to repeat these trials several times in order to iron out the variable factor or differences in persistency of production and other individual factors of the cows used. In the first trial two cows accounted for much of the decrease in milk and fat production when the cows were shifted from sorghum-alfalfa silage to corn silage. (Project 89. Leader: T. M. Olson, Dairy Department.)

Is Grain Digestibility Affected by Fineness of Grinding?

The cost of grinding grain increases rapidly with increasing degrees of fineness to which the grain is ground. Unless the nutrients available to the animal increase proportionately faster than the cost it would be unprofitable to grind grains finely for dairy cows. Since there is but little definite information available as to the effect of the fineness of grinding grain on its digestibility these trials were set up to get further evidence on this problem. Two grains, corn and oats, have been studied so far. A group of four cows was used in a series of digestion trials for each grain. The rations consisted of half alfalfa hay and half of the grain being studied. The only difference in the ration from trial to trial was the difference in the degree of fineness of grinding of the grain. This past year the tabulations and calculations made in connection with these trials have all been rechecked and the summaries are ready for final evaluation. (Project 56. Leaders: T. M. Olson and G. C. Wallis, Dairy Department.)

Does Fineness of Grinding Grain Affect Milk Production?

Experimental work at the Texas and Indiana Stations indicate higher production from medium than from finely ground grain. The data in Project 56 of the South Dakota Station indicate a higher coefficient of digestion for the finely ground corn. The cause for the lower production on the grain ration with a higher coefficient of digestion, requires an explanation. This project was set up to find the answer to this question.
Four heavy producing cows were placed in the experimental barn and fed a balanced ration of alfalfa hay and a grain mixture of equal parts by weight of corn and oats. Two cows received the finely ground grain mixture, and two cows the coarsely ground grain mixture for a 30-day period. For the second 30-day period the groups of cows were reversed. For the third 30-day period the groups were on the same type of grain ration as the first.

The finely ground grains were put through a 1/16 inch hammer mill screen and the coarsely ground through a ¾ inch screen.

Fourteen-day digestion trials were conducted in the regular way during the latter part of each period. The cows were weighed at 10-day periods, and 10-day composite milk samples were taken.

The two cows on the finely ground grain produced 1596.5 pounds of milk the first 30 days. The second 30-day period when they were on medium ground grain the two cows produced 1534.4 pounds of milk, a decrease of 62.1 pounds. When the two cows were again placed on the finely ground grain they produced 1446.5 pounds of milk, or a decrease of 87.9 pounds of milk. The two cows on the medium ground grain produced 1930 pounds of milk the first 30-day period. When these cows were placed on the finely ground grain they produced 1820.8, or a decrease of 109.2 pounds of milk. When these cows were again placed on the medium ground grain they produced 1770.5 pounds of milk or a decrease of 50.3 pounds compared to the preceding 30 days. These data would seem to indicate that the medium ground grain was vastly superior to the finely ground grain in maintaining the milk flow. However one trial is not sufficient on which to base such a conclusion. It is possible that some other unknown factor may have entered the picture to produce the difference, although not discernible to those in charge of the project.

When the data from the digestion trials are compiled these may also shed further light on the results. The analyses on the digestion trials have recently been reported by the Station Chemist and some time will be necessary before the computations can be made.

This project will be repeated, at least once. If the results check with those of the first trial no further trials should be necessary. (Project 88. Leader: T. M. Olson, Dairy Department.)

Continue Study of Peppergrass on Milk Flavors

A series of feeding trials have been conducted on green peppergrass, peppergrass hay, peppergrass seed and peppergrass pasture to determine if any or all these forms of peppergrass is responsible for undesirable flavors in milk and cream.

Various quantities of green peppergrass have been fed. The green
peppergrass has been force fed and fed liberally in stanchions. In the earlier trials the peppergrass was secured on the College farm. In later trials the peppergrass was secured from the southern, central, and northern counties in western South Dakota. This peppergrass was chopped fine and force fed after the morning milking. Samples of milk were taken at hourly intervals from 8 a.m. to 5 p.m. Varying quantities of peppergrass were fed to the cows, that is, low producing cows were fed large quantities of peppergrass and high producing cows low quantities of peppergrass. In other trials the procedure was reversed, the purpose being to note the relationship of quantity of weeds to the quantity of milk produced.

The reason for securing peppergrass from different sections of the state was to note the effects of the different species on the flavor of milk. Other plants such as French weed, wild onion and rye pasture were also used in feeding trials, largely to identify the flavor and its persistency when fed in varying quantities and stages of development.

The species of peppergrass found growing in the western part of South Dakota, is shorter, less leafy but relatively higher in seeds than that grown on the College farm. In the trials with peppergrass from western South Dakota, the data indicate that when sufficient quantity is fed a pronounced flavor in the milk results. The flavor persists from four to seven hours depending on the amount of peppergrass fed and the quantity of milk produced by the cow receiving the peppergrass. The flavor in the butter from peppergrass-fed-cows was not as readily discernible as the flavors resulting from French weed and wild onions.

The work on this project also seems to indicate that the individuality of the cow is a factor. Some cows seem to transmit the weed flavor to their milk more readily than others. The work will be continued until sufficient data have been accumulated, with varying quantities of peppergrass grown and fed under varying conditions of soil, moisture and stages of maturity of the plant, to warrant definite conclusions. (Project 75. Leader: T. M. Olson, Dairy Department.)

Vitamin D in Roughage Influences Content in Milk

The importance of the vitamin content of roughages in the proper nutrition of dairy cattle becomes more apparent as the results of experimental work accumulate. The work of this experiment has demonstrated that vitamin D potency of the milk produced by dairy cows increases as the vitamin content of the roughage consumed increases. Further work on this experiment is being directed toward a study of the factors concerned in determining the vitamin potency of roughages.
A third sample of alfalfa hay has been divided into leaves and stems and these portions have been analyzed separately for their vitamin D content. While these results are not complete, the preliminary values indicate that the leaves will again be found to be four to five times as potent in this factor as the stems.

Since roughages also furnish important amounts of vitamin A for meeting the nutritive requirements of dairy cattle and for increasing the concentration of this factor in the milk this project is being revised to include simultaneous studies of the vitamin D and vitamin A potency of the same sample of roughage. Some information is available as to the effects of different curing processes on the vitamin D potency of hay and other studies deal with factors affecting the vitamin A activity of hay samples. These studies indicate that to some extent the methods of curing which tend to increase the vitamin D potency may in some cases be responsible for decreasing the vitamin A content.

Up to the present time very few experiments have been reported where both vitamins have been studied on the same sample of hay to see what may be done about maintaining a high potency of both factors in the same sample. With the idea of getting more information on this particular point 13 samples of alfalfa hay of known curing history were collected last fall. Vitamin A determinations have already been made on these samples and the vitamin D assays are now under way.

As fast as facilities are available simultaneous determinations of the vitamin A and D content of other kinds of roughage will be studied. Various methods of curing will be used in an effort to get more complete information about the factors affecting the vitamin content of South Dakota roughages to the end that nutritional deficiencies and their deleterious effects on the profitableness of dairying may be avoided. (Project 41. Leader: G. C. Wallis, Dairy Department.)

**Make Breed Comparison of Vitamin D in Milk**

In this experiment two breeds of dairy cattle are being studied to determine breed differences in the vitamin D content of the milk produced. To accomplish this an animal from each breed is given the same amount of vitamin D by feeding them equal amounts of alfalfa hay as their only source of this factor. The daily vitamin D intake is calculated after first determining the vitamin D content of the hay being fed. The same level of hay feeding is continued throughout the lactation. A three to five day composite sample of butterfat is collected at monthly intervals from each animal for vitamin D assay.

In each comparison a Holstein cow giving a larger amount of lower
testing milk is compared with a Jersey cow giving a smaller amount of higher testing milk. The relative efficiency of the two breeds in utilizing food sources of vitamin D for increasing the amount of this important human food factor in milk will be demonstrated. Information should also be obtained which will indicate whether the vitamin D is secreted in proportion to the fat percentage of the milk or in proportion to the quantity of milk produced.

The vitamin D tests on the butterfat samples for the second pair of animals have now been completed but a few of them will have to be re-checked before a final summary for this pair can be made.

A third pair of cows has been run on this project during the past winter. The butterfat samples were collected at monthly intervals throughout the entire lactation period. This year blood samples also were secured at the time the butterfat samples were saved to see if there is a breed difference in the concentration of vitamin D in the blood stream which might be used to explain differences in the potency of the fat or milk samples from the two breeds.

Rats are being used for determining the vitamin D potency of the blood plasma and butterfat samples. Since large quantities of fat have to be fed daily in making these tests there is a possibility that this in itself may interfere with the mineral metabolism of the rats and thus affect the vitamin D determination. In attempting to prove the reliability of the vitamin D testing method some differences have been found in the effect of different fats and oils on the accuracy of the test. The present indications are, however, that a slight modification in the mineral component of the diet used for the rats during the test period will prove satisfactory for making an accurate determination of the vitamin D in butterfat.

The monthly blood and butterfat samples from the third pair of cows are now being assayed for vitamin D. These results will be completed and carefully studied before starting more cows on this experiment. (Project 47. Leader: G. C. Wallis, Dairy Department.)

Dairy Cows Have Definite Vitamin D Requirements

Investigations on this experiment have already established the fact that dairy cows have a specific vitamin D requirement which must be met if normal health and body functioning are to be maintained on mature individuals. Just how much of this information will be directly applicable to mature animals of other species remains to be seen. The general principles will be very useful in directing similar studies on other species of farm animals and also in helping to solve important problems in human nutrition.
BEFORE AND AFTER VITAMIN D DEPLETION

Left: This is an experimental cow, known in the laboratory as 6E, before she was placed on the vitamin D deficient ration.

Right: The same cow after being on the vitamin D deficient ration for nearly a year. Note especially the humped back, the springing forward of the knees, the rough coat of hair and listless expression of the eyes. A few days after this picture was taken she went down, unable to rise.

A more detailed study is now being made of the various factors contributing to the development of a vitamin D deficiency and of the exact effects of such a deficiency on the health and efficiency of the animal. Among these factors may be listed such items as the influence of the amount of milk produced on the development of vitamin D deficiency symptoms, the relation of the calcium and phosphorus (mineral) intake, the effectiveness of sunshine as a preventive and curative agent, the quantitative requirements for vitamin D, usable sources of this factor, the effect of a deficiency on the breeding efficiency of the herd, on fetal development of the calf, and other such items.

Evidence is already beginning to accumulate on some of the topics indicated above. Some information as to the vitamin D requirements was obtained by feeding a limited amount of alfalfa hay of known vitamin D content to a vitamin D deficient animal. The improvement in her condition indicated that alfalfa hay provided a usable source of vitamin D for dairy cows. Another deficient animal was turned out into November and December sunshine to note any possible antirachitic effects of sunshine at this season of the year when its antirachitic action is at a minimum. Winter sunshine proved to be more effective than is sometimes supposed as this cow showed a definite gradual improvement in her condition. Her appetite and physical condition improved, the level of calcium and inorganic phosphorus in the blood plasma returned to normal and there was an increase in the amount of vitamin D in the blood plasma. Samples of butterfat were saved before and after sunshine exposure and these are now being tested for their vitamin D content.

Cows giving larger amounts of milk have been found to develop deficiency symptoms sooner than those giving a smaller amount. Observations made during the past year indicate that eventually dry, farrow
animals may show the effects of a vitamin D deficiency. One such animal began to show mild but definite indications of deficiency symptoms after 30 months on this experiment. Unfortunately she turned positive to the test for tuberculosis and had to be sold. Two new cows have been added to the experiment and are being fed twice the normal calcium and phosphorus requirement to study the relation of the mineral intake to the development of a vitamin D deficiency in dairy cows.

Observations are being extended to note other possible effects on the animals of a deficiency of vitamin D. For the last two years the magnesium content of the blood plasma has been determined along with the calcium and inorganic phosphorus determinations. These studies indicate that the concentration of magnesium in the blood plasma remains at normal levels even though there are wide fluctuations in the calcium and inorganic phosphorus components. Various factors related to the breeding efficiency of the animals are also being studied such as the number of calves born, their physical condition, evidence of the degree of mineralization of the bones of the calf at time of birth, the regularity of the estrus cycle (heat periods) of the cows and other such factors.

The development of loose teeth and a certain sponginess and atrophy of the gum tissue in certain of these animals indicated that some of the symptoms associated with this study of vitamin D deficiency may possibly have been due to an accompanying vitamin C deficiency. Although cattle are not supposed to require a food source of vitamin C it was decided to study the problem carefully since these animals had been on a ration for three or four years which was low in vitamin C as well as vitamin D. Such a long period of time constituted a more severe test for the requirement of vitamin C in the ration than has usually been made in studies of the vitamin C requirement of dairy cows.

For the past year determinations of vitamin C in the blood and milk from these experimental cows have been made at monthly intervals for comparison with similar determinations on cows in the regular dairy herd which were getting liberal amounts of vitamin C in their ration especially during the summer pasture season. Pasture grass is a good source of vitamin C. It was found that the concentration of vitamin C in the blood stream and in the milk produced by the experimental cows was fully as great as for the regular herd cows, which proves that the experimental cows did not have a vitamin C deficiency but that the observed symptoms were due to the vitamin D deficiency. The information supports the view that cattle can synthesize their own vitamin C and are not dependent upon a food source for this factor.

Although there is at present only a limited amount of information about many of the factors briefly discussed as contributing to the develop-
ment of vitamin D deficiency symptoms and as to the total effects of such a deficiency on the health of the animal, plans are being made to find definite answers to these questions so dependable suggestions can be made for maintaining the health and efficiency of the dairy herd and thus make possible more economical and profitable production (Project 55. Leader: G. C. Wallis, Dairy Department.)

How Can Weedy Cream Flavors in Butter Be Reduced?

The greatest problem in this work appears to be the difference of the flavors included by cream buyers under the description "weedy." Visits to creameries have shown a wide variety of flavors present in the cans sorted out as weedy. Many of the lots examined have had definite deterioration flavors which may have either accentuated the flavor or even covered it up. The plan for further work therefore is to include more samples of cream of known source.

During the early summer of 1939 a series of 12 churnings were made from cream of various degrees and kinds of weedy flavor. Some of it was pronounced weedy by cream buyers at the receiving station and other lots were from experimental lots produced by feeding weeds to cows in the station herd.

The processing trials carried on to date have shown promising results especially with cream with onion and peppergrass flavors. The treatment of French weed cream and cream of mixed flavors as obtained from stations showed little improvement.

The project is being continued to include more trials with cream of known background. (Project 63. Leader: D. H. Jacobsen, Dairy Department.)

What Is the Best Method of Holding Cream?

Preliminary results of holding tests would indicate that cream could be held over a Sunday or holiday in either the raw or pasteurized condition for periods as long as 48 hours without significantly lowering the quality of butter made from it.

The study has been continued this past year with 18 vats or 54 churnings of "first grade cream." Each vat is divided into three lots, one of which is pasteurized and churned fresh, one is pasteurized and held 48 hours and churned and a third held raw 48 hours and then pasteurized and churned. Twenty-pound tubs of the resulting butter have been scored by federal-state butter graders both when fresh and after holding for six weeks, three months and five months.
Analyses have been made for differences in lipolytic and proteolytic bacteria and also yeast and mold content of the cream and butter to determine the influence of holding methods on the microbiological changes in cream. Counts have also been made on the butter when fresh and at each stage in the holding period to study the causes in deterioration resulting from the various cream holding methods. The pH and the salt content of the butter have also been determined.

The experiment is still in progress and only a part of the butter has been given the final or five months score. In the first series of 27 churnings on which the data is compiled the keeping quality of butter was very good with all three methods. Little difference was noted in the quality butter resulting from the different methods of handling cream either when fresh or after storage.

Additional churnings are planned to study the effect of butter culture in "first grade" cream and also a series using "second grade" cream. (Project 76. Leader: D. H. Jacobsen, Dairy Department.)

**Holding Temperature Important in Butter Flavor**

Butter held at temperatures of 5 to 15 degrees centigrade is particularly susceptible to cheesy and rancid flavors, a preliminary examination of the results of this project would indicate. The multiplication of the lipolytic and proteolytic organisms has been observed to be most important at these temperatures because they become proportionately more numerous, that is, they become a greater part of the total count. It has also been noted that the same organisms often possess both lipolytic and proteolytic properties.

Additional studies of the heat resistant of the isolated lipolytic and proteolytic cultures have been made and are being continued to determine the limits of safety in setting cream pasteurization conditions. (Project 48. Leader: D. H. Jacobsen, Dairy Department.)
Can Selenium Poisoning of Livestock Be Checked?

During the past year the work of the Station Chemistry Department on the selenium problem has been largely confined to studies of preventive and control measures. Work on the preventive action of arsenic in selenium poisoning has been conducted on white rats and dogs in the laboratory and then on hogs and range cattle. Arsenic, when supplied at the rate of 5 parts per million in the drinking water, has successfully prevented the toxic action of 12 parts per million of selenium in the rations for rats, dogs and hogs. One dog has been kept continuously on a diet containing 12 parts per million of selenium and 5 parts per million of arsenic in the drinking water for a period of 20 months with no apparent ill effects from either element. Litter mates of this dog, kept on the same diet but receiving no arsenic in their drinking water, were all dead within five months time.

Sodium arsenate was found to be equally as effective as sodium arsenite in counteracting the toxicity of selenium to rats, but the arsenic sulfides (As$_2$S$_2$ and As$_2$S$_3$) were found to be ineffective. The arsenite was found to be effective whether the selenium was fed as seleniferous wheat, sodium selenite, or selenium-cystine. Arsenic as sodium arsenite was effective in treating rats which had been on a seleniferous diet for a period of 20 days, but it was of little value after 30 days.

Encouraging results have been obtained by feeding 10 parts per million of arsenic in the salt of steers grazing on a seleniferous range.* Those steers receiving the arsenic in their salt made better gains and fewer of them showed the cracked hoofs, lameness and other symptoms associated with the selenium poisoning than did the animals which received no arsenic.

The influence of arsenic upon the toxicity of selenium brings up the problem of the arsenic content of seleniferous vegetation and the effect of this arsenic upon the toxicity of the vegetation. Analyses of a large number of seleniferous geological sections and soils indicate that in general they contain more arsenic than selenium, but that the arsenic is less readily available to plants than selenium. Some seleniferous vegetation, however, contains sufficient arsenic to counteract the toxicity of the sel-

* This range study made possible through the cooperation of the Soil Conservation Service.
enium present in it. Work is now being done to determine whether the arsenic in plants is in a chemical form that will be effective in this respect.

The observation that high protein (casein) diets are effective in counteracting the toxicity of selenium has been confirmed by Smith of the United States Public Health Service and by Gortner of the University of Michigan. At present the South Dakota Station is investigating the possibility that commercial protein feeds might be of value in preventing the toxic action of selenium to livestock and poultry. Such feeds could then be readily used by livestock feeders.

Studies initiated to determine whether bromobenzene would form selenium analogues of p-bromophenyl mercapturic acid when administered to a selenized animal revealed that the bromobenzene caused a great increase in the rate of selenium excretion. The first trials were made on laboratory animals and the results were so promising that the work was carried on with steers on a seleniferous range. Within four or five days after the administration of the bromobenzene to selenized steers the selenium content of the blood decreased from about 3.0 parts per million to less than 0.25 parts per million. The selenium content of the urine increased simultaneously from about 0.25 to 2.5-3.0 parts per million. Similar results were obtained on a severely selenized horse with apparent alleviation of the symptoms.

Bromobenzene has been used in the treatment of some human cases of selenium poisoning with encouraging results.

In connection with selenium studies on range cattle, the selenium content of several common range plants at various stages in their growth is being studied. With the exception of highly seleniferous plants, the general tendency is for a decrease in selenium content at later stages of growth. This decrease is sometimes quite rapid. The reason for the high selenium content of young plants and lower selenium content of mature plants has not been established.

The chemical form of selenium in “converter” (highly seleniferous) plants is being studied. Studies to date indicate that the selenium in these plants occurs largely in two chemical forms. However, further work must be done to establish this.

The selenium content of the vegetation on 10 fenced plots has been followed for two years, and the soils from these plots are being used for studies on the availability of the selenium in these soils to plants. With the methods developed thus far a fairly accurate index of the availability of the selenium in a soil can be determined, but the method must be refined and simplified before it can be of much practical value.

In the work of the selenium project a total of 2688 samples were
analyzed for selenium. (Project 19. Leaders: A. L. Moxon and O. E. Olson, Station Chemistry Department; Veterinary, Agronomy and Animal Husbandry Departments Cooperating.) For selenium studies on plants and soils see page 15.

Test Immunizing Agents for Hemorrhagic Septicemia

Immunizing of rabbits with commercial bacterins and bacterins prepared at the Station Veterinary Department was continued this year. In the work of immunizing rabbits with commercial bacterins and aggressins in the years previous, it was found that all rabbits injected with two doses of commercial bacterins and aggressins failed to survive when given 1/10cc of virulent culture of Pasteurella (Buffalo strain) 15 days after the last immunizing dose of bacterin and aggressin.

With a bacterin prepared in the Station Veterinary laboratory made by growing Pasteurella (Buffalo strain) for 48 hours in a media consisting of ⅓ normal rabbit serum and brain heart infusion and killing the organisms with formalin, it was possible to immunize 50 percent of the rabbits.

For the past two years one commercial laboratory has put out a new bacterin for hemorrhagic septicemia. This was tested along with the bacterin prepared at the Station laboratory. The results were as follows: Bacterin prepared at Station laboratory 50 percent immunized. New bacterin prepared by commercial firm 33.3 percent immunized. Two percent of the rabbits died of shock from injection of the commercial bacterin. (Project 11. Leader: J. B. Taylor, Veterinary Department.)

Will Chenopodium Eradicate Worms in Lambs?

A practically universal problem that confronts the sheep producer and feeder is internal parasites. The usual method of treatment is drenching the sheep with a copper sulfate-nicotine sulfate solution. This requires fasting the sheep for 24 hours and considerable work in giving the correct dosages as the copper sulfate-nicotine sulfate solution is poisonous when too large amounts are given.

A small supply of chopped chenopodium remaining from the previous year’s work was available to add to the creep fed ration fed the college purebred lambs. This mixture consisted of 20 parts of chopped chenopodium and 80 parts of regular grain ration.

At numerous times during the summer samples of feces from the lambs showing evidence of worm infestation were examined. However, from the results of these examinations it was evident that the lambs were not in a wormy condition. As a consequence none of these lambs had to be treated with the usual copper sulfate-nicotine sulfate solution.
This was unusual because under comparable conditions in previous years it was found necessary to treat the lambs several times during the summer. It is evident that the chenopodium fed was at least partly responsible for the eradication of the parasites usually present.

In the fall of 1939 fifty-six crossbred lambs were obtained to further test the use of chenopodium as an eradicator of internal parasites in feeding lambs. All were treated in such a manner as to insure a heavy infestation of worms and divided into four lots as follows:

Lot 1—Treated with copper sulfate-nicotine sulfate solution and fed alfalfa, chenopodium and corn.
Lot 2—Not treated but fed alfalfa, chenopodium and corn.
Lot 3—Treated with copper sulfate-nicotine sulfate and fed alfalfa and corn.
Lot 4—Not treated and fed alfalfa and corn.

The chenopodium plant and alfalfa were chopped and fed in the proportion of 20 parts of chenopodium and 80 parts of alfalfa. The corn was fed whole. The lambs had free access to roughage, water and salt at all times.

The following results were obtained:

<table>
<thead>
<tr>
<th></th>
<th>Lot 1 14 lambs</th>
<th>Lot 2 13 lambs</th>
<th>Lot 3 14 lambs</th>
<th>Lot 4 14 lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days fed</td>
<td>56</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>Initial wt. (av. per hd.)</td>
<td>62.64</td>
<td>61.65</td>
<td>62.61</td>
<td>62.61</td>
</tr>
<tr>
<td>Final wt. (av. per hd.)</td>
<td>88.11</td>
<td>87.47</td>
<td>85.52</td>
<td>85.59</td>
</tr>
<tr>
<td>Av. daily gain</td>
<td>.51</td>
<td>.52</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Feed per 100 lbs. gain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>348.5</td>
<td>349.0</td>
<td>382.2</td>
<td>368.1</td>
</tr>
<tr>
<td>Chenopodium</td>
<td>58.3</td>
<td>65.3</td>
<td>261.3</td>
<td>319.2</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>233.1</td>
<td>261.3</td>
<td>319.2</td>
<td>336.6</td>
</tr>
<tr>
<td>Feed cost per 100 lbs. gain*</td>
<td>3.85</td>
<td>4.00</td>
<td>4.23</td>
<td>4.19</td>
</tr>
<tr>
<td>Number of lambs showing no worm infestation at end of trial</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Estimated number of worm eggs at the end of trial for every 1,000 present at beginning</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>16</td>
</tr>
</tbody>
</table>

* Chopped chenopodium, $8.50 per ton; chopped alfalfa, $8.50 per ton; corn .42c per bu.

From the results of the four lots in this trial it was found that the addition of chopped chenopodium plant gave more economical gains probably due to the reduced worm infestation. The chenopodium replaced more than its weight of alfalfa and reduced the amount of corn consumed. Lots receiving chenopodium showed a marked reduction in worm infestation over the lots not receiving the treatment.

Work is being continued toward developing a hardy plant that will yield a high quality oil and will mature from seeds sown directly in the field. Chenopodium plants were set out at the Highmore Substation in June. Although late for transplanting and the fact that grasshoppers were
bad the plants did very well. It is planned to establish similar plots at both
Highmore and Vivian. (Project 20. Leaders: Floyd J. LeBlanc, Pharmacy
Division; Turner Wright and James Watson, Animal Husbandry De-
partment; Veterinary Department Cooperating.)

Is Oat Hay at Times a Poisonous Feed?

During the summer of 1939 a survey of a portion of Western South Da-
kota was made in an effort to establish with some degree of accuracy the
number of losses that have resulted from oat hay poisoning. Since it is
impossible to verify reports from years back that cattle have died as a
result of eating oat hay, no definite statement can be made as to the
actual number of losses. However, the number of oat hay poisoning
cases, that have been reported and quite well verified, warranted the
initiation of a project to study methods of prevention.

The reduction of nitrate nitrogen (the toxic principle of poisonous
oat hay) to nitrite nitrogen has been studied. Apparently the conditions
found optimum for this reduction (by in vitro studies) are much like the
conditions existing in the rumen of the cow. The process is apparently
bacterial, and B. subtilis probably is the most important organism con-
cerned in it. Below a pH of 5.0 the reduction process is considerably re-
tarded. The optimum pH for rapid reduction is above 6.5. The rumen
contents of cattle and sheep have been taken from some slaughtered
animals and pH determinations have been made on them. The similar-
ity between the pH values obtained for the cattle and sheep makes it
appear quite unlikely that this factor is responsible for the fact that sheep
apparently are not poisoned by the toxic oat hay.

Preliminary studies have indicated that plants other than oat hay
may contain high concentrations of nitrate nitrogen. This is especially
true of pigweeds (Amaranthus retroflexus L.). Further studies on this
problem have been planned.

Greenhouse studies have been under way to determine the reason for
the accumulation of nitrate nitrogen in toxic oat hays. It is of interest
that no plants of low nitrate content have as yet been grown in the green-
house. It appears that some factor is operating in the greenhouse to pro-
duce plants of high nitrate content. It may be the same factor that is
active under field conditions. Small animal and in vitro studies are being
made in an effort to find antidotes which will be usable. (Project 87.
Leaders: A. L. Moxon and O. E. Olson, Station Chemistry Department;
Veterinary Department Cooperating.)
INTERIOR VIEW OF ONE OF THE EXPERIMENTAL LAYING PENS

The bases used by the Station in making comparisons among grain values include rate of egg production and rate of growth. In this manner the value of the grain in starting, growing and laying rations can be checked.

Poultry Production

Oats and Millet Good Poultry Feeds

Proso millet and oats are important grains which are adapted to South Dakota conditions. Proso millet is becoming increasingly popular because good yields have been obtained during relatively dry seasons. Very little work has been reported by other stations on the value of millet in rations for chickens.

Experiments extending over a period of five years and involving several thousand chickens of different ages have been completed. The feeding value of red and white proso millet was found to be approximately 95 to 100 percent that of oats or corn when used in the starting, growing and laying rations tested. The bases for comparing values included rate of growth and rate of egg production.

The feeding value (number of pounds of feed required to produce a pound of gain in weight) of oats when used in the simple rations tested was determined at about 100 percent the value of yellow corn or proso in starting rations. In growing rations, oats had about 80 percent the feeding value of proso or yellow corn. In laying rations, about the same amount of oats as yellow corn was required to produce a dozen eggs.

Practical growing rations recommended include a mash mixture of 150 pounds of ground wheat, 70 pounds of meat and bone scraps, 15 pounds of alfalfa leaf meal and 5 pounds of salt—total 240 pounds. This mixture may be added to 260 pounds of either ground red or ground white proso millet or the same amount of ground oats. The whole grain part of the ration may include either red or white proso millet or oats, or
a combination of these grains. Most any of the cereal grains, except rye, would be satisfactory to use with the mash mixture containing either millet or oats.

The results of the experiments conducted are reported in detail in Station Bulletin No. 337, "Proso Millet and Oats In Poultry Rations," which also includes recommendations for the use of millet and oats in different types of poultry rations. (Project 40. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

How Much Selenium Can a Chick Use?

There are some areas in South Dakota where it is very difficult to grow healthy chickens because of the selenium which has been found in the cereal grains produced.

In order to determine how much of these affected grains could be satisfactorily used in poultry rations, samples of corn, wheat and barley were obtained from seleniferous areas and the selenium content determined. These grains were used in all-mash starting and laying rations. Levels of 0, 2, 5, 8, 10 and 14 parts per million were used in starting rations, and levels of 0, 2 and 4 parts per million were used in laying rations.

From the results of the experiments conducted, it is recommended that starting and growing rations contain not more than 5 parts per million of selenium. Although satisfactory growth was obtained from hatching time until the birds were 24 weeks of age when the rations contained as much as 8 parts per million of selenium, the lower level of selenium is recommended to allow for a margin of safety. When the ration contained 10 parts per million of selenium, growth was slower and when 14 parts per million were included growth was severely reduced and there was a high mortality.

The laying rations fed included levels of 0, 2 and 4 parts per million of selenium. These levels were not high enough to reduce production and hatchability, neither was the health affected. The rate of growth of the chicks hatched from the hens receiving 4 parts per million was retarded somewhat. Previous experiments had shown that when laying rations included more than 5 p.p.m. of selenium the hatchability was reduced.

These experiments indicate the advisability of thoroughly mixing each lot of affected grain to be used for poultry feeding and having a sample analyzed by the Station Chemistry Department for selenium content. When the amount of selenium is determined, it will then be possible to formulate rations to satisfactorily utilize affected grains without jeopardizing the health of the birds. (Project 28. Leaders: W. E. Poley and W. O. Wilson, Poultry Department; A. L. Moxon, Station Chemistry Department; Veterinary Department Cooperating.)
Low Grade Cereals Used Successfully

There is a wide variation in the test weight per bushel of cereal grains produced in South Dakota. Some seasons there are considerable quantities of corn, wheat and barley which are of low grade and have comparatively little market value.

Each of three grades of Trebi barley, having test weights of 41\(\frac{1}{2}\), 38 and 36\(\frac{1}{2}\) pounds per bushel, was used in growing rations to make up 52 percent of the mash mixture. The other ingredients of the mash included 30 percent ground wheat, 14 percent meat and bone scraps, 3 percent alfalfa leaf meal and 1 percent salt. The same grade as used in the mash was also kept in hoppers before the birds. Equally good growth was obtained on each of the three grades of grain which were fed to Rhode Island Red pullets during the age period 9 to 20 weeks. For egg production the mash mixture included 30 percent ground wheat, 10 percent meat and bone scraps, 5 percent each of dried buttermilk and alfalfa leaf meal and 1 percent of salt, in addition to 49 percent of either high or low grade barley. Only the highest and lowest grades of barley were used in this experiment. An average of 117 eggs was produced by the birds receiving the better grade of barley, while an average of 102 eggs was produced per bird receiving the lowest grade of barley during the 40-week test period. In the experiments that were conducted during the previous year, 102 eggs were produced by the birds receiving high grade barley and 116 eggs were produced by those receiving the low grade barley. Considering both years' results, it appears that the use of low grade barley resulted in practically as good production as when a higher grade of barley was fed.

Each of three grades of Mindum wheat with test weights of 58\(\frac{1}{2}\), 52\(\frac{1}{2}\) and 50 pounds per bushel was used in growing and laying rations. The same grade that was used in the mash was also kept in hoppers before the birds. The growing mash included 64 percent of the wheat to be tested in addition to 20 percent ground oats, 10 percent meat and bone scraps, 5 percent alfalfa leaf meal and 1 percent salt. The same grade as included in the mash was also kept before the birds in hoppers. The rations were fed over a period when the birds were 9 to 20 weeks of age. Slightly better growth was secured with the highest grade of wheat. During the previous year, there were no practical differences in the amount of growth secured. The same rations as used during the growing period were also used for the laying period except that 5 percent of dried buttermilk was used to replace an equal amount of wheat. In addition, 30 percent of ground oats was used instead of 20 percent. There were small differences in egg production favoring the better grades of
wheat. It is doubtful, however, whether the differences obtained are sufficiently large to warrant the use of the best grade of wheat. Further work will answer this question.

Other laying rations tested included high and low grade yellow dent corn. The composition of the rations used was similar to that of the laying rations containing wheat. The test weight of the high grade corn was 54 pounds, while the lower grade corn weighed 50 pounds per bushel. The low grade of corn included a much higher percentage of shrunk and damaged kernels compared to the higher grade of corn. These differences are not adequately shown by a comparison of the test weights. Somewhat better egg production was obtained with the higher grade of corn. More work is necessary before definite conclusions can be made. (Project 53. Leaders: W. E. Poley and W. O. Wilson, Poultry Department; Station Chemistry Department Cooperating.)

Wheat up to Corn for Poultry Meat 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 it was found that wheat produced as good quality meat as yellow corn.

Other investigations have included studies of different methods of measuring poultry carcass quality. This work is especially significant in view of the fact that both live and dressed poultry are graded on the basis of observations, and different grader's opinions vary as to the proper grade classification.

Grade standards of poultry should be based upon certain carcass measurements which are closely associated with the amount of flesh and fat present. The past year's work has been directed toward finding a more accurate method of estimating the amount of fat and total edible meat on the carcass of dressed roasters.

The results indicate a significant correlation (+.517) between the thickness of fat under the skin on the back of the neck and the percentage of fat in the total edible meat on the carcass. Thus, in selecting birds, the thickness of the neck feather tract with its subcutaneous fat makes a good guide as to the amount of fattening.

An instrument was devised for measuring the fullness of breast fleshing which in turn is closely associated with the amount of edible meat on the carcass. Several of the body measurements taken were found reliable in predicting the amount of flesh and fat present. (Project 52. Leaders: W. O. Wilson, Poultry Department, R. L. Dolecek, Physics Department, and W. E. Poley, Poultry Department.)
Turkeys Do Well on Sorghums and Millets

The production of sorghums in South Dakota has made rapid growth during the past few years. The substitution of sorghums for other grains which are well established poultry feeds creates a problem, since there is comparatively little information on the feeding value of grain and forage sorghums compared with corn.

Turkey production has also increased considerably in recent years. This is perhaps due to the fact that turkeys are well adapted to South Dakota's climatic conditions and they have proved to be a good source of cash income.

Experiments dealing with the utilization of milo, feterita and cane were started in 1939. The objectives were to determine whether or not it would be practical to pasture these grains when practically mature instead of harvesting them and feeding them in hoppers. Red proso millet because of its adaptability to South Dakota conditions and because of its early maturing quality was also used in these experiments.

In August one group of 8-week-old turkeys was allowed to first pasture the proso millet for about 6 weeks. These turkeys were also fed a balanced mash mixture consisting of ground yellow corn 46 percent, pulverized oats 30 percent, meat and bone scraps 18 percent, dried buttermilk 5 percent and salt 1 percent. No additional whole grain was given. Two other groups were reared on sudan grass range and were given the same mash as the first group received. One of these groups was given proso millet in hoppers while the third group was fed cracked yellow corn. The last two groups were kept on the same range until marketed. No changes were made in the ration fed the third group. At the end of about six weeks, when most of the proso millet pasture was used, each group was weighed and the turkeys receiving proso millet either as pasture or in hoppers were found to have made as good growth as those receiving corn.

The turkeys receiving millet pasture were then transferred to milo pasture, and milo was substituted for proso millet in hoppers for the second group of turkeys. A feeding period of about five weeks proved that milo when fed either as pasture or in hoppers resulted in practically as good growth as when yellow corn was fed in hoppers.

The two groups of turkeys were transferred to an amber cane feeding period which extended for two weeks. The turkeys did not grow so well as the corn-fed birds when cane was either pastured or fed in hoppers. The amount of pasture was limited and this necessarily shortened the feeding period. The feeding period was too short to warrant conclusions.
The two groups of turkeys were finally changed to feterita. The group which previously had been allowed to pasture the other grains was given feterita pasture, and the second group was fed feterita in hoppers. The yield of this grain was very low and it was necessary to supplement the pasture with the hopper-feeding of feterita. The rate of growth of both groups receiving feterita was equally as good as that of the turkeys receiving yellow corn. More tests are necessary before conclusions can be drawn. (Project 79. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

Are Vitamin A Supplements Needed for Turkeys?

Green range conditions are often poor in some sections of South Dakota. In addition cereal grains deficient in vitamin A are frequently used for feeding. Since yellow corn and green feed are the principal sources of this vitamin, it frequently happens that both these feeds are not available for turkeys. The purpose of these experiments was to determine whether vitamin A deficiency symptoms would appear under certain conditions.

Four lots of 60 turkeys each were confined to one-quarter acre yards for the entire growing period from 8 weeks of age until 26 weeks, when they were marketed (November 6). The green range consisted of a mixture of grasses consisting mostly of Brome grass and some Kentucky Blue grass. When the turkeys were allowed access to this grass, it was practically matured. By the time the birds were 20 weeks of age, most of the green range either had been used or dried up and trampled down. All lots received the same basal mash mixture composed of 15 percent each of wheat bran and middlings, 18 percent of meat and bone scraps, 5 percent of dried buttermilk and 1 percent of salt. Forty-six percent of ground yellow corn was added to the basal mash mixture for one lot. The second lot received 36 percent of yellow corn and 10 percent alfalfa leaf meal. The third lot received 46 percent of white corn, while the fourth lot received 36 percent of white corn and 10 percent of alfalfa leaf meal was added to the basal mash. Whole yellow corn was kept before the birds in the first two lots, while whole white corn was fed to the two last lots as the only scratch grain.

There were no differences in growth which would indicate vitamin A deficiency, nor were there any other deficiency symptoms among the different lots.

The necessity of adding alfalfa leaf meal was also tested, using ground wheat and oats instead of corn, and it was found that growth was slightly better among the toms receiving mash containing 10 per-
LITTLE DANGER OF VITAMIN A DEFICIENCY IN TURKEYS

Turkeys were fed yellow corn—vitamin A rich—and white corn—vitamin A deficient—to determine if there would be any differences in growth or other vitamin A deficiency symptoms. Pictured are these pens. No differences in growth or other symptoms were found.

It would appear from these experiments that with these rations containing milk and a limited amount of green range it is unnecessary to add alfalfa leaf meal to the mash unless, of course, there was no green range, in which case other sources of green feed should be provided. (Project 44. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

Soybean Meal Improves Turkey Egg Hatchability

The west North Central area 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 and adjoining states in preference to having eggs purchased from other sections of the country.

The experiments conducted on this project were for the purpose of studying different factors affecting egg production, fertility and hatchability. Low fertility and hatchability have been experienced with the
Station turkey breeding flock for several years, even though different strains of Bronze turkeys were used and rations recognized to be balanced were fed.

During the winter months of the past year, all turkeys were subjected to all-night lights. Some of the turkeys were allowed to run out-of-doors with enclosed shelters for housing, while other lots were confined to unheated poultry houses. Other lots were provided with enough heat to keep the inside temperature above freezing.

An average of about 26 eggs was laid during the winter period from January 5 to April 5 by the birds confined to houses, while the birds which were not confined produced only an average of about six eggs each for the same period and much more feed was required per bird.

An average of about 7.3 poults per bird was produced during the winter period for the confined birds, while an average of about 2.25 poults was produced by each of the breeders allowed to run out-of-doors.

It was found that by feeding plenty of liquid buttermilk production could be increased by an average of 4.2 eggs per bird, and the average number of poults produced per hen was increased from 1.8 to 4.3 poults for the winter period.

In the experiments conducted during the spring, all birds had access to outside yards. Alfalfa range was available after May 1. The test extended from April to June, and indicated that better hatchability could be secured by using 10 percent of soybean oil meal in the breeder mash. This confirms the results obtained during the previous year. These experiments are not yet completed. (Project 39. Leaders: W. E. Poley and W. O. Wilson, Poultry Department.)

Interest in Rammed Earth Poultry Houses Grows

The value of rammed earth in poultry house construction has been previously established by experiments conducted at this Station.

During the past year, inside temperatures have been taken in a comparison of the amount of coal required by two brooder houses, one of which was made of rammed earth and the other was a frame house. These tests are not yet completed.

A third rammed earth poultry house has been constructed on the poultry farm by the members of the Agricultural Engineering Department and further observations will be made of temperature and humidity conditions. (Project 35. Leaders: W. E. Poley and W. O. Wilson, Poultry Department and R. L. Patty, Agricultural Engineering Department.)
Fruits and Vegetables

Report Further Fruit Breeding Progress

Many acres of seedling fruits have been grown since the work was started in 1895. The improvement in size and quality of each plant generation by hybridization and selection is greater year by year.

PEARS. For many years hybridization of the native pear of East Siberia and North China with standard cultivated pears has been tried. Several have already been named and further progress is noted this year. Several new seedlings bore a heavy crop of fruit, excellent in quality and of good commercial size. The trees are free from fire-blight in an orchard in which fire-blight occurs. The size and high quality of the standard pears of western Europe can be combined in large measure with hardiness and immunity to fire-blight of the pears of east Siberia and north China.

CRABAPPLES. Out of thousands of hybrids of the Siberian crab, Pyrus baccata, with the standard tame apple, produced here and elsewhere, the limits of variation begin to appear. It is difficult to tell whether these hybrids are crabs or tame apples, as some are too large for a crab and too small for an apple. In order to obtain larger size, a multitude of back-crosses with the standard apples have been produced here, in other states and in Canada. The third back-cross at Ottawa gave full apple size. Whether the hardiness of the Siberian crab can be combined with the large size of the standard apple, or whether the hardiness will be intermediate, must be determined.

BUSHCHERRIES. The work in improving the South Dakota Native sandcherry, Prunus hesseyi, began in 1895 and now is well along in the second million seedlings covering 14 generations. This selected strain is now called the Hansen Bushcherry. In 1938 and 1939 about one thousand plants out of 35 acres of seedlings marked for further propagation.

In selection, the weight of 100 ripe cherries is determined, then the fruit is pitted and the ratio is determined between the weight of 100 pits and 100 ripe fruits. The size of the pit is decreasing each generation; in some the size is less than one-fourth of the original size. The usual color of the fruit is black but many good yellow-fruited seedlings have appeared. In 1938 the first breaks into red fruits were noted. They are budded on native plum, but it is the plan to breed them true to seed as rapidly as possible.

PEARS. Hardy, and fire-blight resistant in South Dakota.

OKOLO—The clear, light-yellow, juicy pear, is a fair sized fruit and has high productive quality.

SUNGARI—The Sungari pear has a fairly large fruit of a clear yellow color with excellent table or cooking qualities.

ILYA—A summer table or cooking pear with juicy, tender flesh qualities.

[55]
Crabapples. Hardy, heavy-fruiting varieties with a pleasant taste.

K.EO—The bright red fruit is crisp, pleasant, juicy and acid. It stands up well, a characteristic derived from Anur crabs.

Eda—The red fruit is pleasant, subacid, much like Jonathon, one of its parents, and unusually heavy for its size.

Apples: Large, red-striped apples combine hardiness and productivity.

Selma—This red-striped fruit, three inches and over in size, makes a nice apple for family use.

Nebo—The fruit, red-striped or splashed, is pleasantly subacid and cooks up into excellent sauce. It is over three inches in size.

Bushcherries: Improved native fruit, hardy-large-sized.

Checkpa—The large, black fruits make excellent sauce. It is the best of the bushcherries. The Checkpa is a heavy producer with small pits.

Kasota—The Kasota bushcherry is second only to Checkpa. It has large, black fruit of good quality.

For a complete description and pedigree of the above fruits, see “New Hardy Fruits for the Northwest,” South Dakota Experiment Station Bulletin No. 339, 1940. (Project 1. Leader: N. E. Hansen, Horticulture Department.)

Study Genetics of Hardy Double Roses

The work of crossing roses in the field was continued on a large scale the past year. About 500 tubbed roses were forced during the winter and much hybrid seed was obtained.

Yawa Rose—A hybrid of Anci Bohm (a red multiflora from Czecho-Slovakia) x Rosa blanda pollen of Bemidji, Minnesota. (Yawa: the Sioux Indian word for “esteem.”) This is not a Pax rose, although it is a sister to Pax Iola, reported in South Dakota Experiment Station Bulletin 339, as the main stem is thorny, especially near the base. The side shoots are smooth or nearly so. It is a tall, wide-spreading open-habit pillar rose with 9-foot stems; blooming in June and early July. The flowers are a delightful light coral pink, quite double, 58 petals, flowers fragrant, two inches across, in clusters from 4 to 12, on the side shoots with 8 to 12 inch stems. Apparently no seed hips are formed, indicating that in such combinations the Pax or thornless character must be obtained in the first cross. (Project 2. Leader: N. E. Hansen, Horticulture Department.)

Seek Hardy Thornless Rose Stocks

Selections from many thousands of thornless seedlings of the northern Rosa blanda have been made on the basis of freedom from bristles on the rachis or midrib of the leaves so that the plants are 100 percent smooth. Some plants sucker more freely than others and thus are often undesirable as stock. The present commercial rose stocks are not satisfactory here in the Prairie Northwest as the present rose stocks winter-kill. Many flowers have been crossed with other species to give greater hybrid vigor. The problem is of commercial importance as over 25 million roses are budded every year by American nurserymen. (Project 23. Leader: N. E. Hansen, Horticulture Department.)
Breed for Sweet Tomatoes With a Minimum of Seeds

Out of tomato plants representing 136 different crosses of named varieties and United States Department of Agriculture Bureau of Plant Introductions strains, 123 field selections were made in the growing season of 1939.

Fifty field selections were finally kept while the balance was discarded because they did not yield at least 16 pounds of ripe, salable, disease-free fruit per plant, or the vitamin C content was very low, or the sugar-acid ratio did not make acceptable flavored fruit. Of these, 7 selections were F3, 26 selections were F2 and 17 selections were F1. Many seedlings yielded more than 20 pounds of fruit per plant. One seedling yielded 32 pounds per plant. Vitamin C content varied from .110 mg. per gram to .299 mg. per gram of fruit.

The ground work for future breeding for high vitamin C content has now been laid. The selections of last season and 100 new crosses were planted this season—1940. (Project 49. Leader: L. L. Davis, Horticulture Department.)

Breeding of Hardy Apricots with Sweet Kernels Progresses

The Manchu apricots introduced from the Harbin region of North China bear good fruit and are both winter hardy and drought resistant. They are now in extensive commercial propagation in many states. Pollen of the choicest apricots grown in California was received last year and used to pollinate these named Manchurian apricots. The hybrid seed was planted this spring. About 10 acres of open-pollinated seedling selections were also planted. (Project 58. Leader: N. E. Hansen, Horticultural Department.)

Develop Triploid Apples from Tetraploids and Diploids

This project consists in originating triploid apples, with 51 chromosomes, by crossing the tetraploid apples, 68 chromosomes, with standard diploid apples, containing 34 chromosomes. The first tetraploid apples are the Kola, Tipi, Zapta and Shoko. Many different combinations are being made every spring. Many seedlings are coming on for fruiting. (Project 59. Leader: N. E. Hansen, Horticulture Department.)

Seek a Hybrid Drought Resistant Sweet Corn

The work done with sweet corn is preliminary to the actual breeding of drought resistant hybrids. An inbreeding plot of one acre and a six-acre plot of hybrids and open-pollinated varieties were planted. Droutht re-
sistance could not be estimated under field conditions since lack of mois-
ture was not a limiting factor in 1939. Artificial means of determining
drought resistance were attempted by the “pulling test” and by subject-
ing three-weeks-old potted seedlings to oven temperatures. A temperature
of 50 degrees C for 5 hours was the maximum any could survive. Most
of them were destroyed at a lower temperature. Samples used for pulling
showed much variation in their resistance.

In the variety and hybrid trial plot, yield was one of the factors con-
sidered important as a basis for rating a sample. The greatest yield was
made by an early hybrid. Varieties maturing in 20 days or less after tassel-
ing averaged 3626 pounds of husked corn per acre, while those requiring
35 days or more averaged 3613 pounds per acre. In general, something
was sacrificed in yield for earliness in maturity. All varities maturing in
a relatively short time after tasseling had many tillers, but not all varieties
having many tillers had a short period of time between tasseling and
and maturing. In no case did a variety, having few tillers, reach an edible
stage in a short time after tasseling.

An attempt was made to group the varieties into 5 classes, according
to quality. The Department of Home Economics cooperated with this
phase of the work. The blanching in hot water before freezing, as well
as the cooking process, caused great vitamin C loss. There was consider-
able variation between varieties in the vitamin C content, and there are
indications that some varieties retain their vitamin C content better than
others. (Project 68. Leader: S. A. McCrory, Horticulture Department.)

New Work on Trees and Shrubs Promising

Three lots of Manchurian walnut, *Juglans mandshurica*, seedlings
grown from seed obtained west of Harbin, Manchuria, came through the
winter in fine condition. They give promise of adding to the Station’s
collection of walnuts, as the black walnut, only native *Juglans*, is not too
hardy in the northern part of the state. Twelve other lots of seed of *Jug-
lans*, including *regia*, *cordiforms* and *mandshurica*, were received this
spring. A portion have already germinated while the balance will not
germinate until next year.

A number of tender and hardy perennials were received from the
Bureau of Plant Introductions and are being tested. Seed of a number of
species of honeysuckle were recently obtained from Ottawa, Canada.
Twenty-two species and varieties of *Paeonia* were obtained from Switzer-
land and will be tried out. One-hundred and twenty varieties of French
lilacs were received from the Canadian Experiment Station at Morden,
Manitoba, and are being tried out. (Leader: L. L. Davis, Horticulture
Department.)
Is Tree Growth Affected by a Cover Crop?

The data for two years have been obtained which indicates rather definite trends but should not be considered final. Plots were cultivated throughout the growing season, in the fall, and other plots were not cultivated. The weeds in those plots cultivated in the fall or not cultivated at all were cut several times during the growing season. Differences in tree growth in the various plots are apparent. Soil differences, as noted in change of pH, organic matter, nitrate nitrogen and total nitrogen are being noted. (Project 77. Leader: L. L. Davis, Horticulture Department.)

Station Cooperates in Vegetable Trials

A variety trial project in cooperation with the Connecticut Agricultural Experiment Station has been carried on since 1937. Last season, beans, beets, carrots, peas and peppers were planted at the local station. Bountiful and Plentiful green beans came into production and con...
continued to produce over identical periods—July 6 to July 21. Production was much greater with Bountiful, being almost twice as great as the yield of Plentiful. The pods were very similar in shape except that Bountiful produces a slightly wider pod. Plentiful averaged 6.8 beans per pod as against 6 for Bountiful.

Gilbo, Glacier and Laxton’s Progress peas were planted in uniform rows 50 feet long. Glacier produced 9684 grams, Gilbo 4723 grams and Laxton’s Progress 4073 grams of shelled peas per 50 rows. Glacier came into production June 26 and continued until July 21 which was three days longer than Laxton’s Progress and 9 days longer than Gilbo. Gilbo produced twice as many pods per vine as Laxton’s Progress and 35 percent more than Glacier.

Nantes E3a and Nantes E3 carrots produced well under local conditions and were quite similar in most respects. Nantes E3 was a little longer and inclined to taper slightly more than Nantes E3a.

Wonder and Detroit Dark Red beets were both low in quality and productiveness. Top growth was good but in other respects they were so low in quality as to be classed as a failure.

King of the North, Windsor A and California Wonder Peppers were compared as to yield, average weight per fruit, shape, wall-thickness and dimension. They all produced well.

The complete summary of these trials is included in the report of Vegetable Variety and Strain Trials 1939, University of Connecticut, Storrs, Conn. (Leader: S. A. McCrory, Horticulture Department.)
Crop Insects

Test Electrocutors for Grasshopper Destruction

Is it feasible to use electrocutors for the destruction of grasshoppers?

Extensive experimental work by the Station Entomology Department, cooperating with the Agricultural Engineering Department, would indicate that it is not. The electrocutors were neither practical nor efficient to use.

Several serious objections were encountered in the electrocutors, some of which are:

1. The electrocutors burned foliage severely and burned dry vegetation readily.
2. When a grasshopper, piece of vegetation or other material came in contact with any of the wires of the grid, the remainder of the grid shorted and remained so until the objects were removed from the wires or became desiccated.
3. When a current above 10 or 15 milliamperes was used the grid became exceedingly dangerous to the operator. Such a current may prove fatal to man should he come in contact with it.
4. Grasshoppers apparently are highly resistant to the effect of even such electric shocks which could readily prove fatal to man.

Drawings illustrating all stages of the life cycle of the grasshopper mite have been completed.

Further investigations during the past year have shown the Melanoplus confusus (Say), the confused grasshopper, winters over in the egg stage in South Dakota. However, the eggs of this species of grasshopper hatch extremely early and, therefore, this hopper is one of the earliest to mature. During the past eight years the confused grasshopper has become an important economic species in South Dakota. (Project 18. Leader: H. C. Severin, Entomology Department.)

Blister Beetle Control Work Continues

A survey of blister beetle control measures made by the South Dakota Station showed that more than a half-dozen common methods were being used in this state. The information gained during the present year shows the barium fluosilicate dust recommended in the past to be as effective as any other method, but in some cases it was found lacking in efficiency. This ineffectiveness may be correlated with the time at which the material was applied.

Several hundred blister beetle specimens were collected and labeled as to locality and host upon which they were taken. These were added
BLISTER BEETLE DESTRUCTION

This potato plant has been heavily damaged by the Immaculate Blister Beetle.

to the collection already built. In the life history studies, the eggs and immature forms of several species were obtained for study.

While some of the experimental work was conducted at or near Brookings, most of the control work was carried on in the irrigated district in the western part of the state, in the vicinity of Spearfish and Belle Fourche.

A Station Bulletin, No. 340, “Blister Beetles and Their Control” was published during the year by G. I. Gilbertson and W. R. Horsfall, former project leaders. (Project 14. Leader: N. P. Larson, Entomology Department.)

Does Tillage Seriously Affect Grasshopper Populations?

In order to obtain more information regarding the effect of different tillage practices upon grasshopper populations the Station Entomology Department started a study of this problem in the fall of 1939.

Arrangements were made with the Soil Conservation Service in the Winner and Hecla districts for carrying out tillage practices to be tested in the destruction of grasshopper eggs and young grasshoppers. These included: Fall discing, fall plowing, fall cut-away discing, cut-away discing, regular listing, double discing, duck-foot type sub-surface cultivating and spring listing. These experimental areas were set up on farms of soil conservation cooperators and tillage practices followed under the direction of the Station.

In addition to the tillage experiments, an egg survey was conducted in the Winner and Huron areas from the standpoint of strip cropping practices. The survey in this, the first year, can be expected to give no more than an indication of the tendencies on the part of the grasshoppers to deposit their eggs or not to deposit them in or along the edges of the strips. This particular study must be conducted over a period of several years before definite statements relative to these tendencies could be made. (Project 86. Leader: G. B. Spawn, Entomology Department.)

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THE “A” TYPE HOUSEMOVER IN ACTION

This device designed by the Agricultural Engineering Department carries the building easily without racking it and without cutting up yards and lanes. Such ease of moving small buildings suggests improved livestock and poultry sanitation practices.

Farm Engineering

Is Rubber Feasible on Farm Vehicles?

The first part of this project dealing with small rubber-tired farm carts and trailers, was completed during the year and the results and plans of the carts and trailers are published in Station Bulletin No. 333.

The following is a list of vehicles made and now in use to determine their actual life and usefulness:

- One “A” type brooder and farrowing house mover.
- One “B” type brooder and farrowing house mover.
- Three silage carts with various types of wheels.
- One light utility cart for farmyard work.
- One 4-wheel feed and water trailer for use with scattered hog houses and yards.

A detailed study was made of wheel diameters, steel vs rubber tires, tire sizes and tire inflation as they effect farm carts carrying very light loads. Draft tests of the carts are under all of these variations, and made on (1) smooth hard surfaces, (2) soft fine dry dirt tracks, (3) coarse gravel tracks, and (4) hay covered board tracks were made. The complete results of these trials are recorded and summarized in Bulletin No. 333.

The type “A” brooder and farrowing house mover is being used at every opportunity possible. A few weaknesses have appeared and parts have been strengthened. The type “B” brooder house mover is a variation of the first plan and is made for one man to operate. All lifting of buildings in loading is done with a large jack.
Plans have been drawn and prepared for distribution of a rubber tired farm wagon of the type used at the Station. This type utilizes used rear axles from light passenger cars. (Project 73. Leader: H. H. DeLong, Agricultural Engineering Department.)

**Redesign Horse-Drawn Equipment for Tractors**

Methods of hitching two horse-drawn grain binders behind the farm tractor were designed by the Agricultural Engineering Department with the idea of helping farmers use the machines they already own. A simple hitch requiring only two chains was finally developed.

An old horse-drawn binder was rebuilt into a windrower for small grain. The platform was changed to the opposite side of the bull wheel in order to allow the combine pick-up to work from the outside of the field toward the center.

A four-row corn cultivator and hitch was designed for the farm tractor from old two-row horse-drawn cultivators with satisfactory results. Details of the above are given in Station circular No. 30. (Project 34. Leaders: L. F. Larsen, H. H. DeLong and R. L. Patty, Agricultural Engineering Department.)

**Rammed Earth Studies Continue**

A study of earth walls and their adaptability to climates of extreme seasonal temperatures is being made. The past year’s investigations included a foundation study to determine the resistance of rammed earth walls to soil water under foundation wall conditions, development and trials with compressed air rammers for building walls, the building of rammed earth poultry house walls for testing mechanical rammers and for securing figures on the comparative speed of hand ramming versus mechanical ramming, and protective coverings for rammed earth walls.

A tank-like structure, 5’ x 10’ x 30”, was built of rammed earth in the laboratory. It was filled with loose dirt thoroughly soaked with water at intermittent intervals to produce conditions comparable to those a foundation must resist. Three different sections of the tank walls were built of different kinds of soil—high quality, low quality and medium. Inspection holes extending half way through the wall were provided. No definite reports can be made for some time.

Covering studies were largely limited to paints during the past year. Thirty-two panels were set up including lead oil paints, cold water paints, cement paints and asphalt emulsion paints. This is the ninth year of experimental work on coverings and a Station Bulletin, No. 336, was published in May entitled “Paints and Plasters for Rammed Earth Walls.”
Three compressed-air mechanical rammers have been assembled and tried out under different power, speed and varying conditions. Compressors tried varied in capacity from 6.6 cubic feet of air per minute to 16.3 cubic feet per minute. The smallest compressor that was found practical for driving a single rammer has a capacity of 16.3 cubic feet per minute, and requires a 3-horse electric motor at 450 r.p.m. This compressor will cost $212. If form bolts could be eliminated so as not to interfere with the rammer, this outfit would be too small. A square aluminum head $2\frac{3}{4}'' \times 2\frac{3}{4}''$ was found best for the rammer head.

Rammed earth walls for a poultry house 20' x 60' were built in which a special study was made of the comparative speed of building walls by hand and with a mechanical rammer. Man-hour time figures were also recorded in this comparison. (Project 22. Leaders: R. L. Patty, H. M. Crothers and H. H. DeLong, Agricultural Engineering Department.)

Station Tests Galvanized-Painted Steel Posts

A study is being made to determine if galvanized steel fence posts are a better investment than painted steel posts. The same brand and type of steel posts were used and were built into a fence in 1925. After 15 years the galvanized coat shows fine, although close inspection shows definite points of rust developing. They have had no treatment of any kind and from the road their appearance is excellent.

The original painted posts are perfectly black with rust, that is, those that were left for checks. Most of the painted posts were repainted after eight years. Different paints (of the same color) were used and metallic zinc paint is showing definitely superior to lead paints. After seven years the metallic zinc paint is intact while all others are failing and fading. (Project 15. Leader: R. L. Patty, Agricultural Engineering Department.)

Test Hard Surfaced Floors for Farm Poultry Houses

A project was started this year to study floors for farm poultry houses. Five different hard surfaced floors were built in a 10-pen poultry house during the year and three small experimental floors were built outside. These floors will, of course, be inspected regularly and five additional ones built this coming year. The floors built were cinder concrete, cement-sawdust concrete, common concrete, asphalt oil-gravel and tar oil-gravel. These floors are 6 x 16 feet. Methods of construction were a part of this study as well as the quality of the floor. It was found entirely possible to mix the "black-top" oil gravel floor material in a concrete mixer by add-
ing the oil to the gravel in the mixer first and then adding the clay. Twenty percent of clay was added to the gravel for the “black-top” floors. No report will be available on these floors for some time. (Project 83. Leaders: R. L. Patty and L. F. Larsen, Agricultural Engineering Department.)

Can Mechanical Injury to Barley Be Prevented?

The study of the machinery involved in the handling of malting barley was carried on by the North Dakota, South Dakota and Minnesota stations with the Northwest Crop Investment Association and the Federal Grain Supervision aiding. The purpose of the study was to determine the causes of injury to barley kernels which results in lower grades and lower prices for the grain.

Several days were spent during harvest and threshing season for the purpose of observing different combines. Fifteen combines were observed as well as seven threshers. Samples of barley were taken from each machine at a given setting. Cylinder speeds, concave setting and other adjustments concerned were recorded. Weather conditions, crop yields, etc. were also reported.

Each sample was then carefully examined and the damaged kernels counted. The count was also made by the Federal Grain Supervision. A summary of the results seems to indicate that close concave setting was the most serious cause of injured barley. High cylinder speeds also had a tendency to crack the kernels, but to a lesser degree. Other variable factors may have a definite bearing, but variable factors must be controlled more closely if accurate results are to be obtained.

Another phase of the project was a study of the grain blower which is occasionally used for elevating grains in this region, to see if it’s use might be responsible for part of the injury to the kernels. Nineteen trials were run at varying speeds and moisture contents. No serious damage was done to barley when run at the recommended speeds. Excessive speeds or running the blower empty caused some mechanical injury. (Project 84. Leaders: H. H. DeLong and L. F. Larsen, Agricultural Engineering Department.)
Addition of Reworked Wool Decreases Fabric Strength

In order to determine the relative merits of new and reworked wool fiber, four blends were manufactured into flannel fabrics. These blends were as follows:

- Fabric I, 100 percent virgin wool;
- Fabric II, 75 percent virgin wool and 25 percent reworked wool;
- Fabric III, 50 percent virgin wool and 50 percent reworked wool;
- Fabric IV, 25 percent virgin wool and 75 percent reworked wool.

Samples of each of the fabrics were dry cleaned and pressed for 15, 30 and 45 times and the results of laboratory physical and chemical tests were compared with these properties of the fabrics before treatment.

It was found that using identical manufacturing process, increasing proportions of reworked fiber resulted in lighter weight fabrics, probably due to the fact that the reworked fiber was shorter, resulting in more spinning waste.

The ash content of the fabrics increased with dry cleaning and pressing, the total nitrogen content increased appreciably between 15 and 30 dry cleanings, while no change due to treatment was noted in sulfur content. The increase in ash probably resulted from deposition of metallic substances from the dry cleaning agent and equipment used, but no explanation can be made of the increase in nitrogen.

The application of statistical methods to the measurements of fabric strength and elongation before breaking led to the following conclusions: (1) Blending new and reworked wool in varying proportions and subjecting them to identical manufacturing processes resulted in fabrics of different properties regardless of the dry cleaning and pressing given them; (2) the treatments to which the blends were subjected were significantly different; and (3) in most tests of strength and elongation the blends did not react similarly to dry cleaning and pressing.

When the actual strength and elongation figures were studied it was evident that increasing proportions of reworked wool resulted in decreasing strength, and, in most instances, in decreasing elongation. Dry cleaning and pressing increased strength in some instances and decreased it in others.

In conclusion, it should be emphasized that the results indicated here are applicable only in predicting the effects of blending in new and reworked fiber having the properties found for the fiber used in this study. A detailed report of this study is in preparation for publication.

A study of sampling in cross-section measurements of wool fibers has
been conducted during the present fiscal year. Fiber diameter and contour (circularity) were measured at three locations along the fiber length at each of three locations on nine fleeces of a single breed. Because of the variations found among sheep, locations on the fleece, and positions measured in the fiber, it was concluded that procedure in sampling would depend largely on the application to be made of the resulting data. A complete statistical report based on this study has been prepared for publication. (Project 26. Leader: Barbara Bailey, Home Economics Department.)

Does Quick Freezing of Meat Affect Its Vitamins?

The introduction and the rapid increase in the number of refrigerated locker plants in South Dakota, as well as other parts of the country, has raised the question of the effect of freezing on the nutritive value, particularly the vitamin content, of frozen foods. In order to obtain at least a partial answer to that question, a study of the effect of freezing on the vitamin \( B_1 \) content of lamb tissues and organs has been in progress for two years.

Samples of lamb muscle, tongue, heart, kidney and liver were supplied weekly during the experimental period by the Animal Husbandry Department. Each sample was divided into two portions, one of which was frozen at -4 degrees F and stored for three months in a refrigerated locker at 10 to 12 degrees F. Using a biological method, the amounts of vitamin \( B_1 \) present in both the fresh and frozen tissues were estimated.

From the results it was evident that the organ meats—liver, heart and kidney—are considerably richer in vitamin \( B_1 \) than are either muscle or tongue. Although some loss of vitamin \( B_1 \) is indicated, only in the case of tongue was this loss found to be statistically significant. Thus, on the whole, the conclusion that the vitamin \( B_1 \) content of meats is not materially altered by freezing and subsequent storage in a refrigerated locker would appear to be justified. A more detailed report of this experimental work is being prepared for publication.

The Home Economics Department has again cooperated with the Animal Husbandry Department in their studies of the factors affecting the quality and palatability of meats. Cooking and palatability tests on frozen sweet corn were likewise made for the Horticulture Department. (Project 57. Leaders: Lida M. Burrill and Edith M. Pierson, Home Economics Department.)
Farm Income
and Community Welfare

480 Acres—Minimum Size Farm for Beadle County

The most important factor to consider in farming in Central South Dakota is the climate. Frequent and wide variation in precipitation is the major factor affecting the prosperity of agriculture in this area. Precipitation varies greatly from year to year and also from period to period. It is not uncommon to have two or more successive years of extremely low or high precipitation. It is, therefore, necessary that the farm be organized in such a way that it is capable of contraction during adverse periods and yet capable of expansion rapid enough to take advantage of periods of more favorable production. A major problem in this connection is to avoid land speculation and over-capitalization in good years and keep capital investment in line with long-time production capabilities of the land. A farm organization combining livestock and cash grain production appears to be the best adapted to the area. Such a system should include livestock enterprises which could be expanded or contracted to conform with the feed supplies available. Cattle and hogs appear to meet these requirements. Individual operators may find it to their advantage to have a combined cattle and sheep enterprise or to substitute turkeys for chickens or part of the hogs.

Livestock enterprises may increase the drouth hazards unless they are planned to meet the wide variations of crop production. Farm operators should follow a policy of starting each winter with a two-year supply of feed for all livestock except hogs and turkeys. Reserve feed for hogs and turkeys need not be carried if breeding stock is kept according to the number of hogs or turkeys that can be raised with the grain on hand at breeding time.

In the Beadle County area a farm of 480 acres (rented basis) appears to be the minimum size that will provide a very conservative standard of living for an average farm family in this area. Since this is the minimum and not the optimum size of farm, the amount of capital which might be accumulated on such a farm would be very small. A larger farm would be needed by an average family who expects to have more than a very moderate standard of living or expects to retire debts very rapidly. An operator buying a farm and attempting to make payments on it would also need more than 480 acres. For a further discussion of these topics, see South Dakota Station Bulletin, No. 341, "Planning Minimum Size
Farms for the Beadle County Area in Central South Dakota,” by James L. Paschal, Aaron G. Nelson and Olav Rogeness.

Preliminary findings in the Hyde County area indicate that the minimum acreage that will support an average family varies from 640 to around 3,000 acres, depending upon the type of farming or ranching practiced.

In connection with this project, data which will be useful in research and county agricultural planning, has been collected and summarized for the counties in Central South Dakota. (Project 71. Leader: Aaron G. Nelson, Agricultural Economics Department; Bureau of Agricultural Economics Cooperating.)

Livestock Is Important Even in Wheat Area

AFTER obtaining farm business records for 10 years from seven north-central counties, a comprehensive bulletin, No. 343, entitled “Farm Performance in North Central South Dakota” was prepared and is now available for distribution.

This area is suited in many ways to the production of good quality wheat. It has in the past produced about one-third of South Dakota’s wheat, the state producing 3.5 percent of the United States total wheat crop. One limitation to wheat production in this area is that there is a tendency for larger crops in years when other parts of the nation produce larger crops, which results in lowered prices. When prices are high, the wheat farmer here usually produces a crop which is below normal.

A total of 165 operators in this area kept farm business records, some keeping them for only one year while others kept them for the entire ten-year period. A total of 620 records were secured over the period.

The average size of farms studied was 887 acres, probably slightly larger than the average for the area, and the farms studied showed an increase in size during the period. These units averaged 63 percent crop-land and 19.4 percent wheat acreage. Slightly less than half the land was owned and the rest was leased. An average of 54.6 animal units of livestock was kept per farm per year; 59.3 percent of this total was cattle. Livestock numbers fluctuated greatly. The average net worth per farm was $13,086. Net worths decreased somewhat during the 10 years.

There were 30 farm business records in the study that were kept continuously for eight years. These records were arrayed according to their financial standing. It was found that the 10 farms in the high income group were appreciably larger in acreage, carried more livestock and, consequently had cash receipts nearly twice that of the 10 farms in the low income group.

The high income farms had relatively more pasture and hayland

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acres and relatively less crop land. A larger proportion of their crop acres was devoted to feed crops, row crops, legumes and a smaller proportion to wheat and fallow. It is reasonable to assume that larger farms with more livestock and less cash crops, might be one method of withstanding the brunt of drought and depression in years to come. (Project 29. Leaders: Aaron G. Nelson and Max Myers, Agricultural Economics Department.)

Study Ranch Management in Northwest South Dakota

This project was set up to secure continuous records of ranch management over a period of 10 years. The project is now in the tenth year and plans are to publish a complete report with recommendations during the fiscal year 1940-41. This report will contain data on trends and practices in ranch management in the area including ownership and rental practices, number and kinds of livestock kept, average cost of production per animal unit and the average selling price received by operators. The distribution of capital investment and how this affects profits will also be presented. Available information concerning best crop and livestock practices of the area will be correlated and summarized. (Project 30. Leaders: Aaron G. Nelson and Max Myers, Agricultural Economics Department.)

Station Aids in County Land Use Planning

Contributions of the Station Departments to county agricultural land use planning have been: (1) Assistance of an advisory nature in directing research and (2) actual research in certain counties and the entire state.

Taxation studies have been conducted in Hand and Kingsbury Counties in cooperation with the local land use planning groups. These studies were of a survey nature, the principal object being to determine what are the most acute local taxation problems. The principal problems in Hand County appear to be a heavy tax burden brought about by too great a discrepancy between the cost of the school system and tax-paying ability, and a problem of inequality in assessment due to lack of adequate land classification. A portion of the data gathered in this study was published in the "Hand County Land Use Planning Report." The remainder has been prepared and presented to the planning committee in chart form. The data concerning Kingsbury County has been prepared in chart form.

A township in Marshall County was selected and a study is in progress concerning taxation as applied to a school district which has lost a large portion of its land to a government agency.
Studies in prices of South Dakota farm products have been carried on by W. H. Peterson, assistant economist. His forecast on the effect of the war is that a repetition of World War practices in expanding the cash grain acreage is not advisable. The general conclusions from a study of the purchasing power of the nine most important agricultural commodities in South Dakota from 1890 to 1939 is that the purchasing power of sheep, cattle and hogs was considerably higher on the average than that of wheat, rye, oats, barley, flax and corn. (Project 92. Leaders: Gabriel Lundy, Agricultural Economics Department; Louis E. Joy, cooperative employee, South Dakota Station and Bureau of Agricultural Economics.)

**Study Social Conditions.** A research program which included a survey by communities of social conditions related to land use planning in Hand County, South Dakota was launched by the Rural Sociology Department in September, 1939.

Among the questions to be answered were these:

1. What are the trends of community organization?
2. What do people themselves think of the condition of their institutions?
3. Are new communities being built over the old structures?
4. What sort of picture of communities would evolve if certain basic factors such as trading areas, nationality, church affiliation were used as measuring devices to delineate community boundaries?

The social committee was provided with maps with which to report the location of social institutions, the location of families, and on which it might trace areas of common interest as affected by religious affiliations and nationality backgrounds. As township reports were received from the committeemen, separate maps were made for the county for each factor. Finally a composite map was made which included all of the factors. These maps were continually subject to the criticism of committee members, and many of them were seen at their own homes or Miller, or correspondence was carried on with them.

The objective of the study, of course, was to point out the areas of common interest. Project 95. Leader: W. F. Kumlien, Rural Sociology Department; Bureau of Agricultural Economics Cooperating.)

**Can Rural Zoning Aid Better Land Use Planning?**

The people in Corson county, South Dakota, are interested in rural zoning as a method by which they may stabilize the type of agriculture they feel is desirable. They have requested the South Dakota Station to investigate the practicability of applying rural zoning ordinances in Corson County. Results from this investigation should be applicable to
many other areas of western South Dakota and the Great Plains. The two problems to which this investigation was directed were: First, whether rural zoning could guide future settlement in such a way as to increase the efficiency of public expenditure, such as for roads and schools; and second, whether rural zoning could prevent the recurrence of cash crop farming in areas primarily suited for livestock production.

The analysis indicates that rural zoning has some application in the Great Plains environment of Corson County, particularly in guiding population into communities where public services can be furnished more efficiently. Preventing the return of cash crop farming by rural zoning does not appear desirable in Corson County because a major portion of the area is public land not affected by a zoning ordinance. The public land owning agencies can prevent the return of cash crop farming through their management policies if the local people so demand. In addition, the supplementary relationship between crop and grazing use makes crop land necessary for the full use of grazing land. To restrict cash crop production as a major enterprise and still permit crop production to supplement ranching units would require the zoning ordinance to place restrictions on the percentage of the operating unit in crop. The administration of a rural zoning ordinance with restrictions of operating units limits its use.

The report of this investigation is in manuscript form and will be published as Station Bulletin No. 345 "Rural Zoning in South Dakota" during the coming year. (Project 93. Leaders: R. J. Penn, Agricultural Economics Department; Wayne C. Clark, cooperative employee, South Dakota Station and Bureau of Agricultural Economics.)

Can Administration of State Public Lands Be Improved?

There are a large number of public agencies owning land in South Dakota. These Federal, State and local agencies do not all have the same objectives in managing their lands nor do they follow the same procedure. The administration of publicly-owned land can be an important factor in the readjustment of agriculture and local government to meet the physical conditions of the State. The public land administration project was inaugurated to summarize the land management policies of the several public agencies, and to determine how these policies fit the needs of the people living on the land both as to their operating units and their local government.

Inventories of publicly owned land have been made in Marshall, Tripp, Meade and Corson Counties. Summaries of the policies of a few public agencies have been completed.
When admitted into the Union, South Dakota received 3,417,922 acres of land from the Federal Government, 576,949 acres of which had been sold for more than 17 million dollars by June 30, 1938 and the proceeds placed in what is called the Permanent School Fund. This money is loaned through county commissioners to individuals and political subdivisions and the income therefrom apportioned to the schools of the state for support. More than 41 million dollars has been so apportioned since statehood.

Suggested changes that might tend to alleviate management problems of the Department of School and Public Lands and the Permanent School Fund include a flexible interest rate for the use of Fund money; future investment of more Fund money in bonds; apportionment for school support according to contribution and financial need; a more detailed accounting system in the Department of School and Public Lands; the sale of school lands at their market value; the election of the Commissioner of School and Public Lands on a non-partisan ballot; and a more detailed classification of school lands as to productive capacity and value. Circular 29, "How Should The Permanent School Fund Be Managed?" (Project 94. Leaders: R. J. Penn and Oral A. Holm, Agricultural Economics Department; Bureau of Agricultural Economics Cooperating.)

Operating Economics of Cooperative Elevators Studied

A detailed business analysis of 75 cooperative elevators has been completed for the third year. The aim of this survey was to establish business standards which the elevator managers and boards of directors could use as a guide in their operations. Each year a business analysis including comparative balance sheets, analysis sheets, and yardsticks of performance were returned to the management.

One of the specific problems studied was the effect that the handling of sidelines had on income. Many farmers elevators had increased the number of sidelines handled in order to bolster income which had declined because of adverse conditions. However, it was found that a majority of the associations did not receive the margins on sidelines that they had expected—in fact, the addition of sidelines to the elevator business in many cases did not increase the total income but reduced it.

Changes in state and federal cooperative laws and changes in the requirements for income tax exemption have made it necessary for many of the present associations to reorganize. Information on different methods of reorganizing and how to meet income tax regulations has been
sent to the farmers’ elevators that were interested. Also detailed plans for reorganization were sent to those that specifically asked for assistance.

The three-years’ material has been analyzed, tabulated and summarized, and is now being incorporated into a manuscript to be prepared for publication. It is hoped that the results of this study will aid those interested in cooperative grain marketing. (Project 60: Leader, L. M. Brown, Agricultural Economics Department; Farm Credit Administration Cooperating.)

### Analyze Local and State Taxes

In the taxation study, attention was largely given to new problems. Such new problems as have received attention were selected on the basis of a survey recently made in approximately 50 counties of South Dakota. The possibility of economizing in public expenditures by reorganizing the boundaries of local civil units of government is under study. Increasing tax delinquency calls attention to the need for resurveying assessed valuation of agricultural land with a view to making adjustments which will relieve such land from overburdensome taxation. The predominating aim in all cases is to analyze tax organization and operation in order that underlying ills may be determined and possible remedies indicated. (Project 42. Leader: Norris J. Anderson, Agricultural Economics Department.)

### Farm Mortgage Foreclosures Decrease

Farm mortgage foreclosures in South Dakota during 1939 were slightly fewer than in 1938, according to reports received from county registers of deeds. In 1939 there were 1776 foreclosures involving 432,451 acres of farm land. This is a reduction from 1894 foreclosures on 472,669 acres in 1938. Some counties, nevertheless, showed increases in foreclosures. The largest of these increases were in the northern part of the east river area. A mimeographed report will soon be available. (Project 13. Leader: Gabriel Lundy, Agricultural Economics Department.)

### Analyze Problems of Marketing Poultry Products

Because of the innumerable problems connected with the marketing of poultry products, the Agricultural Economics Department in cooperation with the Poultry Department instituted a project last year to secure information concerning the present methods of marketing poultry products in South Dakota.
The purpose of this project is two-fold: First, to establish standards of performance for cooperative organizations to guide them in their business practices and to acquaint them with marketing methods of similar organizations; and second, to analyze the general poultry marketing situation which will require a study of sample trade areas. This will include independent and privately-owned businesses along with cooperative associations.

Data were gathered from all cooperative associations in the state that handled poultry or eggs. This information will be used as background material—the first step in studying more difficult problems. It was found that cooperative associations handle only a very small portion of the total state volume. Thus, a general analysis of poultry marketing will be required. (Project 80: Leader, L. M. Brown, Agricultural Economics Department, in cooperation with the Poultry Department.)

**Can Creameries Improve Marketing Practices?**

Frequent requests by men in the creamery business resulted in a project started last year to study the marketing of dairy products by cooperative associations. The purpose of this study is to acquaint management and membership with the methods used by other associations and set up standards of performance that will aid them in their work. For instance, one of the most timely problems deals with the collection of butterfat—methods of collection and methods of payment.

Data were gathered last year from all cooperative creameries and is being tabulated and summarized so that comparisons and business analyses can be made for each association. This material with information on how the various associations market their products will be incorporated into a bulletin this next fiscal year. (Project 81: Leader, L. M. Brown, Agricultural Economics Department, in cooperation with the Dairy Department.)

**How Do Freezer Locker Plants Operate?**

The increasing importance of freezer locker plants in the handling and marketing of food products was responsible for this study being started last year. As the freezer locker plants are a relatively new influence in the marketing of agricultural products, it is hoped that this influence can be analyzed. Also, it is hoped that information necessary to supply farm groups and others that are interested will be obtained.

It was not possible to begin the actual field work, but the necessary preliminary steps were taken. The locker plant managers have indicated their wish for the study and have assured us of their cooperation.
schedules have been prepared and the actual field work of contacting the freezer locker managers will start soon. Project 82: Leader; L. M. Brown, Agricultural Economics Department, in cooperation with the Animal Husbandry Department.)

State Migration Definitely Slowed Up

A study conducted by the Station indicates that migration, both in and out of the state, has slowed up. During the past decade there has been an unusual amount of migration taking place. Only a few counties actually increased in population and most of that increase came within the larger cities and towns over 1,000. Preliminary figures indicate that fully 90 percent of the farm townships have declined in population. However, recent estimates of the farm population movement in and out of the state would support the belief that there is a tendency toward a stabilization of population. (Project 70. Leader: W. F. Kumlien, Rural Sociology Department; Bureau of Agricultural Economics Cooperating.)

Work on Social Change Continues

The second and third bulletins of the projected series of bulletins on “Basic Trends of Social Change in South Dakota” have been published during the current year. This study deals with basic trends which have taken place during South Dakota’s first 50 years of statehood, namely from 1889-1939. Because of the Federal Census being on a decennial basis, the study has covered the data from 1890-1940 respectively.

The first bulletin carried the subtitle “Public Health Facilities.”

Some of the more important conclusions arrived at in this study were:

1. South Dakota has a high average length of life. This is due largely to our low death rate, which in turn is based upon a number of other factors such as our decreasing infant mortality rate, the favorable age distribution of our population, the non-industrialization of the state, and the lack of overcrowded conditions.

2. There seems to be a slow trend towards public health facilities replacing those operating under private auspices. This has been accelerated to some extent by the drought and depression period where many people have required some public assistance in obtaining medical services.

3. The functions of the State Board of Health are becoming of increasing importance. County nurses, county health units, supervision of sanitation and water supplies, control of epidemics, and various child health services are all becoming increasingly important.

4. When looked at from the state as a whole, the main hospital problem is not to add to the number, but to improve the quality and completeness of service rendered by those already in existence and to educate more people to the idea of hospitalization.
5. The trend towards a decrease in professional health personnel in the state need not be considered alarming. Improved transportation and the tendency for country patients to call at the doctor's office, rather than calling him to their home, has made it possible for him to serve a larger number of patients.

6. There are many groups of various kinds in the state that will doubtless organize themselves into health associations in the near future. The mainspring of such a movement will be partly reducing health costs and partly an expression of greater interest in public health matters.

The second bulletin, No. 338, published during the year carried the title, "Education in Transition." A summary of this publication disclosed that:

1. There has been a consistently increasing emphasis on education during the entire period of the state's history. Both the compulsory school age and attendance requirements have been raised. While not required, there has been a considerable increase in nursery school and kindergarten attendance as well as in various adult education agencies.

2. A beginning has already been made toward centralization which is resulting in fewer but better schools. As the school population declines further this tendency will become more marked.

3. The qualifications of teaching personnel have been progressively raised since the early years of the state. As the future demand for rural school teachers becomes less, it is likely that the same trend for higher qualifications will continue.

4. There is a marked tendency toward more practical curricula in the present day public school systems. This is particularly evidenced by the increase in vocational courses on both a secondary school and college level. Vocational agriculture and homemaking, as well as various types of commercial courses, have been introduced into a large number of public high schools. This appears to be a permanent trend in secondary education.

5. In proportion to the total population, those enumerated in the school census, or persons 6-20 years of age, have rapidly declined since the peak period in the early twenties. There has been, however, a consistent increase from 1890-1940 in the proportion of persons of school age actually attending school.

6. School costs per pupil have risen because of increased demands for an enriched curriculum and for better school plants and equipment. Since the number of elementary school pupils are declining the cost per pupil will continue to rise unless the number of schools are reduced and the systems are more centralized. (Project 64. Leader: W. F. Kumlien, Rural Sociology Department.)

Complete Study of Dependent Child Problem

A study of dependent children in South Dakota was undertaken in the spring of 1938 by the South Dakota Station because of the current interest of relief authorities, particularly the Social Security Commission and the Work Projects Administration, in the welfare of broken-home children. The study was completed during the past year and a Station Bulletin, No. 332, entitled "Dependent Children in South Dakota" was published.
Some of the principle findings were as follows:

1. Dependent children are defined by the United States Social Security act as including all children under 16 on relief who have lost the care or support of a parent by the death, continued absence, or incapacity of a parent, and reside with their families. Children under 18 may, in 1940, be regarded as dependent if in school.

2. This state-wide survey of the year July 1, 1937, through June 30, 1938, shows that during the year 13,098 children were dependent as defined. They resided in 5,772 households which contained a total of 25,654 persons.

3. The cost of state cooperation with the United States Social Security board in an Aid to Dependent Children's program must be estimated from existing outlays by the various relief agencies, not from the number of dependent children. This is because the amount of relief per person during a year varies greatly between households.

4. During the survey year $1,668,077 in relief went into the dependent children's households. This includes all relief that can be stated in money from any public source for any person in the household.

5. The federal contribution was $1,015,717; the counties', $613,576; and the state's, $38,784. In percentages the distribution among the three governments was 60.9, 36.8 and 2.3.

6. Allowing each child an equal share of the total relief and every head of a household a one-half share, the portion assignable by law and custom to care of the children would be about 62 percent, or $1,049,460.

7. County government through the mothers' pension system and county commissioner's relief apparently contributed for the children between $368,146 and $490,861. The other half-million dollars or more of relief to the children came almost entirely from federal relief agencies.

8. A study of the number of dependent children in relation to the number of adults in the homes shows that special children's aid is quite appropriate to one large class; inappropriate to another. The unemployment of adults able to give both care and support has put many broken-home children on relief whose needs can be met better by work relief or farm relief.

9. For such reasons, and others, a state program for the year would not have required the full $1,050,000. From $700,000 to $787,500 for an ADC program is the estimate, which can be stated as about $750,000. The cost to state and county government would then be about $375,000.

10. Some time is required to develop an ADC program, particularly if it is to be done carefully. To reach a maximum state expenditure of $375,000 in the third year, the state might reasonably spend $150,000 the first year and $250,000 the second.

11. Under the one-third federal aid law then in effect the counties and the state would have had to add a sum of from $9,139 to $131,854 in order to have a complete program. Under the present "fifty-fifty" law, an additional $6,854 might have been required, or $115,861 saved to county and state government, depending upon the estimate used. A saving would be most likely.

12. The total rural population of the state occasioned a cost of only 63 cents per capita while the population of incorporated places had a cost of $2.84 per person of their general populations. Three out of four dollars were spent in settlements, which contained about 40 percent of the people of the state. (Project 72. Leader: R. L. Woolbert, Rural Sociology Department.)

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,
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, livestock, etc.

This study has now been completed and the findings issued in a special mimeographed circular of 43 pages as of February, 1940. The circular is entitled, "The Standard of Living of Farm Security Clients in South Dakota."

A brief digest of the main conclusions of the publication follows:

1. Insofar as possible the results of this study of a low income group have been compared with the results of a study made in 1935 of a more representative South Dakota group.
2. Households in the 1936-38 study differed from those included in the 1935 study in the following respects: The families were slightly larger; the education of both the head and the homemaker was higher; the number of males of working age were fewer in the tenant families; and the male heads were much younger.
3. A comparison with both the 1935 study and the 1930 census has revealed that the 1936-38 study dealt with a low income group.
4. Sources of cash income for those included in the 1936-38 study were principally grain and dairy products. Private employment, emergency grants, relief and WPA employment were responsible for only a small proportion of the income received by standard loan clients.
5. The factors which apparently affected the net cash income in the 1935 survey seemed also to have been operative in the 1936-38 study.
6. Families in the 1936-38 study spent considerably less than those included in the 1935 study. The amount spent for food and clothing by those in the 1936-38 study was a much larger proportion of the total family living expense than in the 1935 study. This is to be expected in a low income group when it is compared with a more normal sample of the population.
7. The owners spent the largest share of their farm operating expense for taxes, insurance and interest on old debts, while the tenants spent the largest proportion of their farm operating expense for various miscellaneous items such as twine, threshing expense, veterinary expense, tractor fuel and silo filling. The operating expenses of the owners was much greater than that of the tenants.
8. Livestock was the largest item of capital goods to be purchased during the year by both owners and tenants. The next largest item for both was payment on old debts.
9. Although the owners had larger liabilities than the tenants they also had the greater net worth. The owners had the largest total debt, but the tenants had the largest debt in comparison to their assets.
10. By far the largest proportion of the farm operators in the 1936-38 survey operated farms of less than the average size for their respective counties. (Project 69. Leader: W. F. Kumljen, Rural Sociology Department.)
Cooperative Project Agreements With Federal Agencies

Certain federal agencies or bureaus are cooperating with the Agricultural Experiment Station in conducting research on specified agricultural problems in the state. A brief report of such cooperative research projects follows.

BUREAU OF AGRICULTURAL ECONOMICS

1. Annual Change in Population in South Dakota (Rural Sociology Department). To estimate from a selected sample the number of persons living on farms in South Dakota, the number of births and deaths in the farm population and the number of persons who moved from farms. Additional studies were made of out-of-the state movements. A report of the year's work accomplished on this project will be found on page 77. (Project C-7.)

2. Adjustment of Agriculture to Environment in Central South Dakota (Agricultural Economics Department). To analyze the present agricultural conditions in Central South Dakota in relation to environment and to try to determine the adjustments necessary to place agriculture in this area on a more stable basis. A report of the year's work accomplished on this project will be found on page 69. (Project C-8.)

3. Cooperative Work in Agricultural Land Use Planning (South Dakota Experiment Station). To develop an agricultural land use program, in which will be correlated the suggestions and work of farmers, the State Agricultural Extension Service, the Experiment Station, the Bureau of Agricultural Economics and the action agencies of the United States Department of Agriculture. In this project all the above mentioned agencies may make the greatest and most effective contribution to agricultural adjustment, conservation, crop insurance, farm forestry, flood control, land retirement, rehabilitation and water utilization. Consideration will be given the land use implications of community facilities, credit, marketing, public finance, land taxation, tenancy and transportation. A report of the year's work accomplished on the project will be found on page 71. (Project C-12.)

4. Rural Zoning as a Method of Controlling Land Use, Location of Settlement, and Local Government Costs in Corson County, a Marginal Farming Area (Agricultural Economics Department). To determine whether rural zoning would be a practical method of controlling the use of land in a semiarid area used for dry farming and grazing. Also to
determine the possibility of controlling settlement and reducing public costs through rural zoning. The results obtained from the study are briefly stated on page 72. (Project C-13.)

5. *A Study of the Management of Publicly-Owned Lands in South Dakota, Including a Determination of Programs and Policies, Land Use Adjustments and Directional Measures Desirable for Such Lands* (Agricultural Economics Department). (a.) To determine the amount, location and use of land in South Dakota which is controlled and managed by public agencies—federal, state and county, (b.) To investigate the management policies of the county, state and federal agencies which control substantial amounts of land in South Dakota or in problem areas requiring major adjustment, (c.) To study the possibility of coordinating the management policies of various public agencies as a means of land use adjustment in problem areas, and (d.) To determine the programs and policies, land use adjustments and directional measures which are desirable for such publicly-owned lands. The year’s work is summarized on page 73. (Project C-14.)

**BUREAU OF AGRICULTURAL ECONOMICS AND BUREAU OF DAIRY INDUSTRY**

1. *Input as Related to Output in Milk Production* (Dairy Department). (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.)

**BUREAU OF ANIMAL INDUSTRY**

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

2. *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 and New Jersey). To study the improvement of viability in poultry. (Project C-9.)
BUREAU OF ANIMAL INDUSTRY AND BUREAU OF PLANT INDUSTRY

1. The Maintenance and Operation of a Cooperative Field Station on the Belle Fourche Reclamation Project Near Newell (Animal Husbandry Department). The object of the major project is to study problems pertaining to the sheep industry under conditions of irrigation farming, relative to (1) sheep breeding, (2) sheep feeding, (3) sheep pasture utilization and management, (4) lamb production, and (5) wool production. In 1932 a project was started on grain rations for pigs on pasture. A summary of this work will be found on page 27. (Project C-1.)

BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING AND BUREAU OF PLANT INDUSTRY

1. Cooperative Research into the Laws and Principles Underlying Industrial Utilization of the Soybean and Soybean Products (Agricultural Experiment Stations of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio and Wisconsin). To obtain through basic research facts and materials applicable to the utilization of the soybean and soybean products and to develop methods whereby these facts and materials may be utilized to the benefit of agriculture. A report of the Station's activities on this project is found on page 13. (Project C-2.)

SOIL CONSERVATION SERVICE AND BUREAU OF PLANT INDUSTRY

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

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

Grass clippings are being made over the state, particularly in the western part, to determine the volume by weight of forage produced per unit density of the various native grasses. Sufficient data are not yet available to give the different grasses a definite rating. (Project C-16.)

SOIL CONSERVATION SERVICE

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

In the Winner-Dixon area on the heavy residual soil and fairly steep slopes, contour stripped fields of Sooner Milo produced an average yield of 24.2 bushels per acre, while the average yield of Sooner Milo on block-farmed fields was 18.2 bushels per acre. In addition to obtaining higher yields, there is a substantial saving of soil from both wind and water erosion.

At both the Huron and Winner-Dixon projects pasture contour furrows have decreased run-off water and increased the amount of water that penetrates into the soil, especially on pastures having a thin vegetative cover. Generally speaking, this has resulted in an increase in the growth of vegetation, especially adjacent to the furrows, which has remained green for a longer period than vegetation in similar pastures not furrowed. In the Winner-Dixon area small type (lister) furrows constructed in 1936 are nearly silted full, while the larger (grader) type constructed in the same year are still very effective for water conservation.

Studies made in the Winner-Dixon and Huron areas show strip cropping to be effective and economical in controlling soil drifting, especially when used with a tillage system which maintains crop residues at or near the surface of the ground.

Terraces on the Winner-Dixon area have been generally effective in controlling water erosion and are valuable guide lines for contour farming. With the steep slopes and tight soil conditions existing in the area, terraces should be constructed on a gradient to facilitate drainage of excess water accumulations.

Tree and shrub plantings made during 1936 in the Huron area are beginning to show some influence in controlling wind erosion and in protecting adjacent crops. Woody vegetation planted in gullies and around small reservoirs has not only proven effective for desilting and for water erosion control, but has also provided a splendid habitat for wild life. (Project C-3.)

2. To Determine the Proper Utilization of Seleniferous Land (Experiment Station Chemistry Department). To furnish information which will be helpful in planning the future economical use of seleniferous land. A summary of this work will be found on page 42. (Project C-11.)
3. Soil and Water Conservation Research on Pasture and Cultivated Lands in South Dakota (Agronomy Department). (a) To determine methods of reducing wind and water erosion and effecting water conservation through re-establishing vegetative covers of grasses or shrubs upon eroded agricultural and pasture land, (b) To determine the relative efficiency of different types of tillage equipment for contour cultivation to aid in erosion control and to find the best methods to handle residues to reduce water and wind erosion, (c) To develop methods of spreading and utilizing flood waters, and to determine the possibility of retaining rains of varying degrees of intensity upon the land, so as to reduce soil and water loss and develop a better vegetative plant cover for erosion control.

Actual field susceptibility to wind erosion will be quantitatively measured by the use of a wind tunnel. Effect upon soil structure of these treatments will be determined by aggregate analysis. The effect various amounts of crop residue have on total soil moisture stored will be measured. (Project C-15.)

Active Research Projects

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13. Study of Credit Needs of South Dakota Agriculture and Agencies Serving It.  
15. The Comparative Length of Service of Galvanized Steel Posts and Painted Steel Posts. (Completed.)  
16. Winter Rations for Brood Sows. (Completed.)  
18. The Grasshoppers of South Dakota and Their Control.  
19. Chemical Forms of Selenium in Soils and Plants and Toxicity to Animals Including Proper Use in Grazing.  
22. The Genetics of Hardy Thornless Rose Stocks.  
23. Fattening Fall Pigs on South Dakota Grains.  
24. 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.  
26. Fattening Summer Pigs on South Dakota Grains. (Completed.)  
27. Studies of the Nutrition of the Growing Chick (Alkali Disease).  
29. Cattle Ranch Management in Northwestern South Dakota.  
30. A Study of Land Valuation in Typical Areas in South Dakota. (Completed.)  
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32. Some Routine Tests for Garget or Mastitis in Cow's Milk. No report this year  
33. Field Hitches for Tractors and Big Horse Teams.  
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38. Feeding Grains Affected with Ergot. (Dormant until grain affected with ergot can be obtained.)

39. A Study of Turkey Egg Hatchability.

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

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

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

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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.


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.  

62. A Study of the Methods of Handling Weedy Cream with the Purpose of Reducing the Grassy and Weedy Flavors in Butter.  


64. 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.  

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


67. The Development of Hybrid Drouth-Resistant Sweet Corn.  

68. Standard of Living Levels of Farm Security Standard Loan Cases. (Completed.)  

69. Annual Change in Population in South Dakota.  

70. Agricultural Adjustment to Environment in Central South Dakota.  

71. Survey of Dependent Children in South Dakota. (Completed.)  

72. Use of Rubber on Farm Vehicles.  

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

75. The Influence of Various Methods of Holding Cream on Butter Quality.  

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

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80. Analysis of the Marketing of Poultry Products in South Dakota.
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83. Farm Building Floors—Material and Construction.
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86. Tillage and Its Effect Upon Grasshopper Populations; Strip Farming and Grasshopper Populations.
87. Oat Hay Poisoning.
88. The Effect of Fine and Medium Grinding of Grain on Milk Production.
89. The Feeding Value of Sorghum-Legume Silage, Compared to Corn Silage.
90. The Grain from Sorghums Versus Corn for Fattening Steers.
91. Comparative Advantage of Certain Classes of Livestock in the Irrigated Area of Butte County, South Dakota.
92. Economic Phase of Agricultural Land Use Planning in South Dakota.
93. Rural Zoning as a Method of Controlling Land Use, Location of Settlement, and Local Government Costs in Corson County, a Marginal Farming Area.
95. A Survey by Communities of Social Conditions Related to Land Use Planning in Hand County, South Dakota.
96. The Influence of Feeding and Management Upon the Fertility and Hatchability of Turkey Eggs.
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TURNER WRIGHT, B.S.———Associate
F. U. PENN, 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.A., 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
GERALD B. SPAWN, B.S., M.S.———Assistant

HOME ECONOMICS
EDITH M. PIERSO, B.S., M.S.———Home Economist
BARBARA BAILEY, B.S., M.S.———Assistant
LIDA M. BURRI, B.S., M.S.———Assistant

HORTICULTURE
L. L. DAVIS, B.S., M.S.———Horticulturist
N. E. HANSEN, B.S., M.S., Sc.D.———Horticulturist Emeritus
S. A. MCCRORY, B.S., M.A.———Assistant

PHARMACY
F. J. LEBLANC, Ph.C., B.S., M.S., Ph.D.———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
R. L. DOLECER, A.B., M.A., Ph.D.———Physicist

RURAL SOCIOLOGY
W. F. KUMLIN, B.A., M.S., M.S.A.———Rural Sociologist
R. L. WOOLBERT, A.B., A.M., Ph.D.———Assistant

[90]
Journal Articles by Staff Members

AGRICULTURAL ENGINEERING


STATION CHEMISTRY


DAIRY


HOME ECONOMICS


HORTICULTURE


POULTRY


[92]
Publications

During the period July 1, 1939 to June 30, 1940, the South Dakota Agricultural Experiment Station published the annual report, 13 bulletins of the popular series and 4 circulars. In addition there were approximately one hundred stories sent to the daily and weekly newspapers in the state concerning research work at the South Dakota Station.

**BULLETINS**

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<td>Homemade Rubber Tired Carts and Trailers by Henry H. DeLong.</td>
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<td>Capon Production in South Dakota by W. E. Poley.</td>
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<td>Planning Minimum Sized Farms for the Beadle County Area in South Dakota by J. L. Paschal, Aaron G. Nelson and Olav Rogeness.</td>
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<td>342</td>
<td>Spring Wheat Varieties in South Dakota by S. P. Swenson.</td>
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<td>Farm Performance in North Central South Dakota by Max Myers.</td>
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<td>Remodeling Farm Machinery for Tractor Farming by L. F. Larsen.</td>
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## Financial Statement—Agricultural Research Funds
### July 1, 1939 to June 30, 1940

### RECEIPTS

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### EXPENDITURES

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### STATE RESEARCH FUNDS

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* State Funds Appropriated and Used for Sub-Station Work

Appropriations:
- COTTONWOOD: $450.00
- EUREKA: $450.00
- HIGHMORE: $450.00
- VIVIAN: $450.00
- NEWELL: $500.00
- TOTAL: $2300.00

How the Funds Were Used:
- Salaries and Labor: 239.00
- Scientific Supplies: 35.60
- Feeding Stuffs: 495.00
- Communications: 1.00
- Equipment: 174.40
- TOTALS: $2300.00

† 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.
‡ $4,237.82 of the $8,980.78 represents the balance on hand in the Newell Field Station fund at the beginning of the year.
§ $8,565.55 of the $9,004.42 received from Sale of Produce represents produce sold from Newell Field Station.
¶ $3732.85 of the $8,854.72 represents the balance on hand in the Newell Field Station fund at the close of the year.