Dear Dean A. M. Eberle:

This is the sixty-fifth annual report of the South Dakota State College Experiment Station. As in the reports for the past two years the quarterly issues of the South Dakota Farm and Home Research comprise the first 104 pages, while the succeeding pages present a brief statement of the research activities and results that were not presented in the Quarterly.

During the fiscal year ending June 30, 1952 there were five research projects completed. Research was started on 10 new problems, making a total of 118 active research projects at the year's close.

In the course of a year, problems of an emergency nature do arise. Within the past year these involved the storing and utilization of the soft corn, and how to contend most effectively with the new race of wheat rust, known as 15B. Both of these are reported herein. The use of antibiotics in rations for livestock and poultry was tested. A concrete block has been made from an aggregate developed from our South Dakota shales; this block is about half the weight of a standard block. One research activity that merits special mention is the sorghum breeding. By the use of colchicine the researchers have been able to juggle the chromosomes, so that the first generation of the new strain of sorghum transmits its new characteristics to succeeding generations of the plant. In other words, it becomes a "purebred" in a single year, instead of the usual five to six years required through crossing and selection.

Financial support is needed for the Station's projects that are now active. Operating costs continue to increase, so that the research now under way is costing more than anticipated. Added to this cost of operation is the necessity for funds with which to meet the necessary salary adjustments. The Station must be able to retain the services of the trained scientists who have become familiar with our South Dakota conditions and problems, and who are in the best position to serve the people of the state.

The Station staff joins me in expressing our appreciation for the interest and support accorded agricultural research in the state.

Respectfully submitted,

[Signature]

Director, Experiment Station
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What is the value of this year's corn crop which stands a good chance of being soft and wet? While the soft corn is not fit for man, it is fit for beast. In fact, as a livestock feed it is a lot better than most people think. Obviously, a pound of dry corn has considerably more value as a feed than a pound of soft corn containing anywhere from 30 to 40 percent moisture, but if you consider the two on a dry-matter basis then there is very little difference. Many of you are probably wondering what type of livestock you can feed soft corn to, how you may harvest it and store it, and what results you may expect of this soft corn when fed to various types of livestock.

Here is the way the South Dakota Agricultural Experiment Station handled their soft corn problem and the results they have obtained. The corn was picked in the usual way, though a somewhat higher percentage of husks remained on the ear than otherwise would be true had the corn been sound. It was brought in and dumped on the ground in a long pile and allowed to dry during the latter part of the fall. While most of this soft corn appeared black and spongy, no difficulty was experienced in getting the animals to eat it.
Twenty-eight head of yearling feeder steers were fed on trial from January 3 to June 25, 1951. The results of this comparison are given in Table 1. The shelled corn fed in Lot I contained 11 percent moisture; the matured ear corn fed in Lot II showed a 15 percent moisture test; and Lot III received soft ear corn which tested at 40 percent moisture. Cattle receiving the soft corn were the first to accept a full feed. Their daily gains continued to be slightly higher than those of the cattle getting matured shelled or ear corn. No harmful results were noticed from feeding moldy ears, and there was little or no difference in finish and bloom shown by the three lots of cattle. Buyers paid the same price for all lots, and carcass grades were the same.

As was found in preliminary studies, the feeding value of soft corn is equal to that of mature corn if calculated on a dry-matter basis.

<table>
<thead>
<tr>
<th>Lot Number and Ration</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each Lot on Feed for 173 Days</td>
<td>Shelled Corn Soybean Oilmeal</td>
<td>Hard Ear Corn Soybean Oilmeal</td>
<td>Soft Ear Corn Soybean Oilmeal</td>
</tr>
<tr>
<td>Number steers in lot</td>
<td>9</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Average weight per steer (lbs.)</td>
<td>857</td>
<td>854</td>
<td>862</td>
</tr>
<tr>
<td>Initial</td>
<td>1172</td>
<td>1175</td>
<td>1217</td>
</tr>
<tr>
<td>Total gain</td>
<td>315</td>
<td>321</td>
<td>355</td>
</tr>
<tr>
<td>Daily gain</td>
<td>1.82</td>
<td>1.86</td>
<td>2.05</td>
</tr>
<tr>
<td>Average daily ration (lbs.)</td>
<td>14.17</td>
<td>16.41</td>
<td>24.31</td>
</tr>
<tr>
<td>Shelled corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard ear corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft ear corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>0.86</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>6.58</td>
<td>6.91</td>
<td>6.60</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>0.78</td>
<td>0.78</td>
<td>0.78</td>
</tr>
<tr>
<td>Salt, bone meal, limestone, free choice</td>
<td>0.08</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Feed per cwt. gain (lbs.)</td>
<td>778.4</td>
<td>884.2</td>
<td>1184.2</td>
</tr>
<tr>
<td>Shelled corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard ear corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft ear corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>47.3</td>
<td>46.4</td>
<td>42.2</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>361.3</td>
<td>372.1</td>
<td>321.7</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>12.8</td>
<td>12.0</td>
<td>37.9</td>
</tr>
<tr>
<td>Salt</td>
<td>1.4</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Bone meal</td>
<td>2.4</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Selling price per cwt.</td>
<td>$35.50</td>
<td>$35.50</td>
<td>$35.50</td>
</tr>
<tr>
<td>Average carcass grade</td>
<td>Prime</td>
<td>Prime</td>
<td>Prime</td>
</tr>
</tbody>
</table>
STAY HEALTHY ON SOFT, MOLDY CORN

Last year's soft corn was compared to hard corn for fattening lambs in a feeding trial from April 27 to June 30, 1951. Twenty-four lambs were fed soft corn, 25 lambs were fed hard ear corn, and 25 lambs received shelled corn. Alfalfa hay was fed as the roughage. The results of this year's work are given in Table 2.

The lambs receiving soft ear corn did not make as good daily gains, and required much more corn than those receiving hard ear corn. This, in part at least, can be attributed to the fact that deterioration of the corn took place after the advent of warm weather in the spring. Thus, such corn would not be expected to have as much feed value when fed in late spring or early summer as when fed during the winter. In spite of these conditions, the lambs fed soft corn gained .32 pounds daily during the 64-day feeding period, while the lambs receiving hard ear corn gained .42 pounds during the same period.

These results indicate a deterioration of soft corn during warm weather when compared with the results reported in Circular 48 which were obtained by feeding soft corn in the winter months. In these winter-feeding trials, 100 pounds of hard corn were equal to 123 pounds of soft corn plus 9 pounds of alfalfa hay. On a dry-matter basis, the lambs fed soft corn required 473 pounds of corn plus 392 pounds of alfalfa hay for 100 pounds gain, while those fed hard corn required 479 pounds of corn plus 340 pounds of alfalfa hay.

Table 2. Soft Corn for Fattening Lambs, 1951

<table>
<thead>
<tr>
<th>Lot Number and Ration</th>
<th>Soft Ear Corn</th>
<th>Hard Ear Corn</th>
<th>Shelled Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alfalfa Hay</td>
<td>Alfalfa Hay</td>
<td>Soybean Meal</td>
</tr>
<tr>
<td></td>
<td>Soybean Meal</td>
<td>Soybean Meal</td>
<td></td>
</tr>
<tr>
<td>Each Lot on Feed for 64 Days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number lambs</td>
<td>24</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Average weight, lbs.</td>
<td>65.1</td>
<td>65.3</td>
<td>71.6</td>
</tr>
<tr>
<td>Average daily gain, lbs.</td>
<td>.32</td>
<td>.42</td>
<td>.39</td>
</tr>
</tbody>
</table>

Average daily ration, lbs.

| Corn                  | 2.86          | 2.38          | 1.76         |
| Alfalfa hay           | 1.66          | 1.59          | 1.60         |
| Soybean meal          | .23           | .24           | .18          |

Feed per cwt. gain, lbs.

| Corn                  | 908.3         | 569.5         | 457.8        |
| Alfalfa hay           | 528.3         | 380.0         | 414.8        |
| Soybean Meal          | .73           | .55           | .48          |
GOOD DAILY GAINS ON SOFT CORN

Since the publication of Circular 48 there was an additional feeding trial in the winter of 1946 in which soft corn was again fed to hogs.

The pigs in Lot I were self-fed a good grade of shelled corn which tested 19 percent moisture, 46.8 pounds per bushel and showed an estimated 7 to 9 percent damaged kernel. The corn fed in Lot II was of slightly better grade, testing 18.5 percent moisture and 47 pounds per bushel. As this was stored inside, the moisture content decreased somewhat during the progress of the experiment. Soft ear corn was fed to Lots III and IV, while Lot V was self-fed soft corn that had been dried in a commercial drier and shelled. It tested 12 percent moisture and 46.3 pounds per bushel.

All lots, with the exception of Lot IV, were self-fed a supplemental protein mixture consisting of 2 parts tankage, 1 part soybean meal and 1 part linseed meal, and a mineral mixture consisting of 2 parts steamed bone meal, 2 parts ground limestone and one part salt. The protein mixture fed to the pigs in Lot IV was limited each week to the amount consumed by the pigs in Lot I the week preceding. Good quality alfalfa hay was available at all times. Results of this trial are shown in Table 3.

Based on the results obtained in Lot I, the hard corn fed in Lot II had a feeding value of 88.5 cents a bushel (75 pounds). There was no significant difference between the two lots fed soft corn. The pigs in Lot V which were fed the dry shelled corn required considerably less feed per hundredweight of gain than did Lot I. This was especially true for protein feed.

The cost of feed per 100 pounds of gain in Lot V was the highest in the test due to the higher total cost of the corn. The original cost of this corn, which was bought later in the season than the corn fed the other lots, was $1.10 a hundredweight. (This corn tested 24 percent moisture as compared to 33.7 percent moisture for the corn fed the other lots.) The drying charge was 35 cents a bushel based on the amount of dried shelled corn returned. The shrinkage in the drying process plus the drying charge brought the total cost of this corn to $1.55 a bushel. With the hard corn used in Lot I at $1.03 a bushel, this dried corn was worth a $1.19 a bushel, based on the feed required to produce a hundred pounds of gain.

There was not much variation in the shrinkage from feed lot to market except for Lot III. It is difficult to understand why the pigs in this lot should have shrunk one percent more on the road to market than those in Lot IV. However, they showed practically one percent higher in dressing yield which compensated for the heavier loss.
### Table 3. Soft Corn Compared With Hard Corn for Fattening Pigs

<table>
<thead>
<tr>
<th>Lot Number and Ration</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Pigs in Each Lot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of days fed</td>
<td>82</td>
<td>86</td>
<td>86</td>
<td>86</td>
<td>79</td>
</tr>
<tr>
<td>Average initial weight per pigs, lbs.</td>
<td>118.8</td>
<td>119.7</td>
<td>117.8</td>
<td>118.1</td>
<td>118.1</td>
</tr>
<tr>
<td>Average final weight per pig, lbs.</td>
<td>277.33</td>
<td>272.6</td>
<td>268.8</td>
<td>271.33</td>
<td>285.2</td>
</tr>
<tr>
<td>Average daily gain per pig, lbs.</td>
<td>1.93</td>
<td>1.78</td>
<td>1.76</td>
<td>1.78</td>
<td>2.11</td>
</tr>
<tr>
<td>Feed per cwt. gain, lbs.</td>
<td></td>
<td></td>
<td>742.1</td>
<td>731.0</td>
<td>338.8</td>
</tr>
<tr>
<td>Corn</td>
<td>358.1</td>
<td>566.8</td>
<td>35.8</td>
<td>48.6</td>
<td>48.0</td>
</tr>
<tr>
<td>Protein</td>
<td>52.67</td>
<td>45.8</td>
<td>48.6</td>
<td>48.0</td>
<td>35.4</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>5.97</td>
<td>6.1</td>
<td>6.7</td>
<td>6.4</td>
<td>6.0</td>
</tr>
<tr>
<td>Mineral</td>
<td>.76</td>
<td>.72</td>
<td>.6</td>
<td>.78</td>
<td>.66</td>
</tr>
<tr>
<td>Total</td>
<td>417.40</td>
<td>619.42</td>
<td>798.0</td>
<td>787.18</td>
<td>380.86</td>
</tr>
<tr>
<td>Average daily ration per pig, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>6.92</td>
<td>10.08</td>
<td>13.03</td>
<td>13.0</td>
<td>7.16</td>
</tr>
<tr>
<td>Protein feed</td>
<td>1.01</td>
<td>.81</td>
<td>.85</td>
<td>.85</td>
<td>.75</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>.11</td>
<td>.11</td>
<td>.12</td>
<td>.13</td>
<td>.13</td>
</tr>
<tr>
<td>Mineral</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>Feed cost per cwt. of gain</td>
<td>$8.40</td>
<td>$9.13</td>
<td>$7.00</td>
<td>$7.89</td>
<td>$10.62</td>
</tr>
<tr>
<td>Percent shrink to market</td>
<td>1.93</td>
<td>2.08</td>
<td>3.06</td>
<td>2.61</td>
<td>2.08</td>
</tr>
<tr>
<td>Dressing percent, packer style</td>
<td>73.14</td>
<td>73.44</td>
<td>73.50</td>
<td>72.62</td>
<td>74.32</td>
</tr>
<tr>
<td>Carcass grade</td>
<td>Good to choice</td>
<td>Good</td>
<td>Good</td>
<td>Choice</td>
<td></td>
</tr>
</tbody>
</table>

#### Feed Prices

- Hard ear corn: $1.00 per bushel of 75 lbs.
- Hard shelled corn: $1.03 per bushel
- Soft ear corn: $.75 per cwt.
- Tankage: $76.00 per ton
- Soybean meal: $60.00 per ton
- Linseed meal: $55.00 per ton
- Alfalfa hay: $15.00 per ton
- Mineral mixture: $1.94 per cwt.
- Shelled corn (dried) fed in Lot V: $1.55 per bushel

Carcasses of hogs from Lots II and V graded choice; Lot I, good to choice; and Lots III and IV, good. There was more variation in finish between carcasses in both Lots III and IV than in other lots.

In this feeding test 100 pounds of hard ear corn was worth 130 pounds of soft ear corn plus 2½ pounds of protein feed.

**RESEARCH REVEALS THESE FACTS ABOUT FEEDING SOFT CORN**

1. Usually more return can be realized by feeding soft corn to cattle, lambs or pigs than by selling it as cash grain.
2. Soft ear corn can best be fed in the ear. If shelled or ground it tends to heat and mold more than when stored in the ear. It is best to feed it before warm weather in the spring, as deterioration sets in with the beginning of warm weather.
3. It can be utilized best by yearlings and mature cattle, followed in order by lambs, pigs, and steer calves.
4. The soft corn fed in these trials was palatable to cattle, sheep and hogs, and no bad effects were encountered in shifting steers or lambs from a full feed of soft corn to hard grain.
5. A greater amount of soft corn needs to be fed per head daily than is the case with hard ear corn to allow for the extra moisture which the soft corn contains. The feeding value of the soft corn fed in these studies was 82 percent the value of hard corn when fed to steers in the winter months and 75 percent for the entire feeding period; 76 percent for the winter months when fed to calves and 57 percent for the entire feeding period; and 76 percent for the entire feeding period when fed to growing-fattening pigs. When fed to lambs it had 78 percent of the value of hard corn.
One possible outlet for the dairy farmer with a quantity of soft corn on his hands, is to feed it to his cows. Experiments conducted two different years showed that dairy cows made efficient use of soft corn with no apparent adverse effects.

A comparison was made with hard corn of good quality having a moisture content of 15 percent. The amount of moisture in the soft corn varied somewhat with different lots, but the average for that used during the past winter season was 40 percent. This wet corn was stored outside, where it remained in a frozen condition, and it was brought into the barn in small quantities, sufficient for three or four days' requirements.

It was found necessary to thaw this frozen soft corn before it was ground in the hammer mill in which a one-half inch screen was used. Both the hard corn and soft corn were used as corn-and-cob meal and were mixed with the other feeds in the grain-concentrate ration at the time of grinding. Spoilage of the soft corn ration was avoided by preparing small amounts at a time.

The amount of soft corn used in the ration depended upon its moisture content. Since there was much more moisture in it than in hard corn, its feeding value per pound was much less. For example, in 100 pounds of hard corn containing 15 percent moisture there would be 85 pounds of dry feed, while in 100 pounds of soft corn with 40 percent moisture there would be only 60 pounds of dry feed. In these experiments the amount of soft corn used in the ration was calculated so that there would be the same amount of feed on the dry-weight basis as in the hard corn ration. The following examples are typical of the grain-concentrate rations:

<table>
<thead>
<tr>
<th>Item in Ration</th>
<th>Hard Corn lbs.</th>
<th>Soft Corn lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-and-cob-meal</td>
<td>700</td>
<td>1000</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Linseed meal</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Steamed bone meal</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Salt</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>1020</td>
<td>1320</td>
</tr>
</tbody>
</table>

Since there are 300 pounds more weight in this soft corn ration than in the one with hard corn due to the high moisture content in the soft corn, it is obvious that a greater amount of it would be required at each feeding to give the same quantity of feed on a dry-weight basis. In this case 1320 ÷ 1020 = 1.294, which means that for each pound of the hard corn ration it would be necessary to feed about 1.3 pounds of the soft corn ration.

In these trials the amount of grain-concentrate mixture fed was 1
pound for each 3 pounds of milk produced at the beginning of the experiment. For example, one of the cows was producing milk at the rate of about 60 pounds per day. Her daily ration was \(60 \div 3 = 20\) pounds of the mixture containing hard corn. When this cow was put on the soft corn ration, she was given \(20 \times 1.3 = 26\) pounds daily. In addition to this grain-concentrate mixture, all of the cows on these experiments were fed 1 pound of alfalfa-brome hay and 3 pounds corn silage for each 100 pounds of body weight.

Six Holstein cows were used in the trials conducted during February, March, and the first part of April 1951. These cows were selected with as much uniformity as possible with respect to age and stage of lactation. They were placed in two groups in order that one group would receive the soft corn ration and the other, the hard corn ration. These rations were given to the opposite group after the end of the first feeding period. A 10-day preliminary feeding period was used, followed by 30 days on the experiment; another 10-day preliminary period was used following the reversal, and then the final 30 days on the experiment.

According to the results obtained in these trials, the cows produced about 7 percent more milk while they were getting the hard corn ration than they did when they received the soft corn. A closer examination of the records indicates that this difference in production was probably not due to the feed, but rather to the fact that one of the cows had an attack of mastitis about the time she was changed from the hard corn ration to the soft corn. Her daily production dropped from 35.1 pounds of milk to 18 pounds, which was more than twice as much as was observed with any of the other cows. During the same period the body weight of this cow increased 160 pounds, which was about five times the average increase of the other cows. During the attack of mastitis this cow converted her grain into body weight instead of milk. If a normal 10 percent decrease in milk production is used for this cow for the second 30-day period instead of her actual production, and the production figures are again averaged, the cows on the hard corn ration produced only 0.5 percent more milk than they did when on the soft corn. This means that dairy cows can utilize soft corn very efficiently.

No digestive difficulties were observed at any time with any of the cows during the two different winter seasons when soft corn was fed. The experiment was started rather late in the winter the first year and the corn became very moldy.

Milk samples from each cow on the experiment were saved once each week and were examined for flavor and odor by at least two milk judges. In spite of the fact that some of the corn was moldy, no objectionable flavors or odors which could be attributed to feed were ever observed.

When soft corn is a problem, it can be fed to dairy cows with very satisfactory results. Precautions to be observed are (1) keep the corn frozen until it is to be ground into

Continued on page 11.
Late fall rains and heavy winter snows often add to the miseries of farm living in South Dakota. Troublesome as they seem at the time, however, they greatly increase the chances of getting a harvest the next year, especially in areas where rainfall is generally deficient.

A recent study of South Dakota precipitation and crop yields indicates that within the subhumid region of the Great Plains, this preseasonal rain and snow make a very significant contribution to grain production. In almost every area, the increase in yield of crops per inch of pre-seasonal precipitation was greater than the increase in yield per inch of rainfall received during the growing period.

However, in a part of the study not reported on here, it was evident that in areas receiving more than 11 inches of rainfall during the growing season, the pre-seasonal precipitation did not make any significant contribution toward crop yields. This emphasized the fact that in order for the study to have value, it must be restricted to these areas of limited rainfall where the average precipitation is barely sufficient to produce favorable yields.

Within this subhumid region, if the soil is well saturated at the start of the growing season, crops can draw on soil moisture during the intervals between rains. Because of this, good yields have frequently been produced in spite of rather scant seasonal rainfall.

Small Grain Yields and Precipitation Records Compared

Yields of spring wheat, oats and barley for 25 years, from 1923 to 1947, inclusive, were recorded. Yield data as reported by the South Dakota Crop and Livestock Reporting Service represented average yields for each county.

As the amount of precipitation varies over short distances, it was necessary to use precipitation figures from more than one U. S. weather station in each area, so that the moisture figures would be com-
parable to the average county yield figures.

Precipitation data were used on the crop-year basis from September 1 to July 31 of the following year. Since most small grains are harvested before the first of August, the precipitation for that month was not used. The crop year was broken down into two periods: September 1 to March 31, which is referred to as the preseasonal precipitation period, and April 1 to July 31 as the seasonal period. This makes it possible to compare and evaluate the relative contribution of the precipitation received during each period. It also enables one to make a preliminary estimate at seeding time of the probable yield for that year.

Area groupings of counties (Fig. 1) follow the agricultural areas as established by the State Experiment Station. In some cases, the established areas were divided into two or three sub-areas. All counties of the state except the Black Hills counties were used. Conditions vary too greatly within the Black Hills counties for precipitation to be a reliable indication of average yield. Then too, there is considerable irrigation within these counties which further limits the influence of precipitation on yields.

The average area yield in bushels of each grain studied, and the average inches of precipitation received in each precipitation period for the 25 years of the study are shown in Table 1. As precipitation increased from the western to the eastern part of the state, area yields increased accordingly.

The increase in yield per inch of preseasonal precipitation was great-
Table 1. Average Area Yield of Three Grain Crops and Precipitation in Inches for Thirteen Areas of South Dakota, 1923–1947

<table>
<thead>
<tr>
<th>Area</th>
<th>Spring Wheat Yields</th>
<th>Oats Yields</th>
<th>Barley Yields</th>
<th>Preseasonal Precipitation</th>
<th>Seasonal Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bu.</td>
<td>Bu.</td>
<td>Bu.</td>
<td>Inches</td>
<td>Inches</td>
</tr>
<tr>
<td>II A</td>
<td>8.3</td>
<td>16.4</td>
<td>13.0</td>
<td>4.83</td>
<td>9.07</td>
</tr>
<tr>
<td>II B</td>
<td>8.6</td>
<td>15.5</td>
<td>13.1</td>
<td>4.80</td>
<td>9.25</td>
</tr>
<tr>
<td>II C</td>
<td>8.1</td>
<td>15.5</td>
<td>13.1</td>
<td>5.52</td>
<td>8.82</td>
</tr>
<tr>
<td>III A</td>
<td>8.2</td>
<td>18.2</td>
<td>12.8</td>
<td>4.70</td>
<td>8.94</td>
</tr>
<tr>
<td>III B</td>
<td>8.1</td>
<td>20.1</td>
<td>13.4</td>
<td>5.22</td>
<td>9.89</td>
</tr>
<tr>
<td>IV A</td>
<td>9.0</td>
<td>20.5</td>
<td>13.9</td>
<td>6.22</td>
<td>10.05</td>
</tr>
<tr>
<td>IV B</td>
<td>10.2</td>
<td>24.0</td>
<td>16.7</td>
<td>6.35</td>
<td>10.80</td>
</tr>
<tr>
<td>V</td>
<td>11.1</td>
<td>27.7</td>
<td>19.2</td>
<td>6.76</td>
<td>10.98</td>
</tr>
<tr>
<td>VI A</td>
<td>9.5</td>
<td>18.4</td>
<td>15.4</td>
<td>5.82</td>
<td>10.08</td>
</tr>
<tr>
<td>VI B</td>
<td>8.7</td>
<td>18.1</td>
<td>14.1</td>
<td>5.68</td>
<td>9.71</td>
</tr>
<tr>
<td>VII A</td>
<td>9.7</td>
<td>21.4</td>
<td>16.5</td>
<td>7.44</td>
<td>11.22</td>
</tr>
<tr>
<td>VII B</td>
<td>11.0</td>
<td>24.5</td>
<td>18.5</td>
<td>7.78</td>
<td>11.38</td>
</tr>
<tr>
<td>VIII</td>
<td>13.0</td>
<td>29.6</td>
<td>23.5</td>
<td>8.50</td>
<td>12.03</td>
</tr>
</tbody>
</table>

More Than 4 Inches of Preseasonal Rainfall Needed to Break Even

Wheat yields reported yearly for Areas III B and IV A, located in the north central part of the state, are listed in Table 3. These yields are grouped by the different amounts of preseasonal precipitation received each year for the 25 years of the study. It has been estimated that a yield of 10 bushels of wheat per acre is required to allow reasonable returns to the operator for his labor and expense in producing it. There were nine years when less than 4 inches of preseasonal precipitation were received. The average yield of these nine years was 3.7 bushels. Whenever the preseasonal precipitation was below 4 inches, the yield was less than 10 bushels.

When 4 to 6 inches of preseasonal precipitation were received, the average yield was 8 bushels, and in 8 out of 20 times, yields were above 10 bushels. When 6 to 8 inches of preseasonal precipitation were received, the average advanced to 10.3 bushels per acre. In 9 out of 17 cases in this group, yields were
Table 3. Yield of Wheat by Different Amounts of Precipitation in Inches Areas III B and IV A, South Dakota 1923–1947

<table>
<thead>
<tr>
<th>Preseasonal Precipitation—Inches</th>
<th>Under 4”</th>
<th>4”-4.99”</th>
<th>6”-7.99” and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total yield</td>
<td>33.7</td>
<td>159.6</td>
<td>175.0</td>
</tr>
<tr>
<td>Average yield</td>
<td>3.7</td>
<td>8.0</td>
<td>10.3</td>
</tr>
<tr>
<td>No. in group</td>
<td>9</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

Above 10 bushels and in only 4 were they below 8 bushels. When 8 inches or more preseasonal precipitation were received, the average yield was 14.5 bushels, and no case was reported with a yield below 10 bushels.

A Chance to Adjust Plans

Since this study applies to average conditions for each area under consideration, care should be exercised not to use this method in an attempt to predict (or anticipate) expected yields for individual fields. Soil moisture in an individual field may vary greatly from average county or area conditions. To what extent it may be possible to test individual fields for available moisture and then estimate probable yields remains to be determined. From the relationships shown in Table 3, it would appear that relatively greater risks are assumed by Great Plains farmers when they put seed into soil that is excessively dry. While it sometimes happens that a deficiency of moisture at seeding time is made up during the growing season, it is the exception rather than the general rule within this subhumid area.

Adjustment of the farming program of the farmer to correspond with climatic conditions each year would help to reduce losses from seeding and harvesting crops that do not pay production costs. This study might also serve as a basis for a crop insurance program through defining risks of crop production. (Project 157. Leader: Ray F. Pengra, Agricultural Economics Dept.)

Feeding Soft Corn to Livestock

The ration, (2) prepare only a few days supply at a time and (3) calculate the amount needed in the ration, based on the dry matter it contains.

There is a possibility that corn in the state this year will contain more moisture than the soft corn used in these trials. Consequently, it may not have the same feeding value that has been experienced in these trials.

(continued from page 7)

Range sheepmen, depending on sheep for a livelihood, value any winter feeding program according to its cost as compared to net returns.

On western South Dakota ranches many ewes are wintered on the range with little supplemental feed. Some bred ewes are fed small amounts of grain or high protein supplements in addition to range hay. A few sheep ranchers feed liberal concentrate allowances in the belief that an increased yield of wool, and larger lambs at weaning time will more than pay for the increased cost of winter feeding.

Maximum profits from sheep depend upon ewes producing a large lamb crop and a heavy fleece. Also of importance to the sheep producer will be the necessity of providing a winter ration that will allow the ewe to maintain her body weight, as well as allow her to provide for the requirements of the lamb she carries through the winter.

Greater net returns from sheep can usually be expected when the normal winter roughage allowance is supplemented with a feed providing extra protein. However, the amount of supplemental feed required, and the level at which the greatest net returns are obtained are problems facing every range sheepman.

Feeding Plan Outlined

Feeding trials at the Newell Field Station the winter of 1945-46 indicated that in terms of ewe gains during the winter, and lambs and wool produced, a daily allowance of 2.5 pounds native wheatgrass hay supplemented with 1 pound alfalfa hay, was equivalent to feeding 3.5 pounds of alfalfa per head daily. In addition, it seemed necessary to learn what other supplemental feed might be required to increase production.

Barley was a suitable grain supplement and was grown in the area, making its use practical for all producers. Feeding barley at two different levels, in addition to the hay ration, was compared to feeding none. Other trials at the Newell Station have indicated the value of
using chopped hay as compared to long hay for feeding lambs. Since there was no evidence concerning the comparative values of chopped or long hay for wintering bred ewes, this comparison was also made. The feeding plan is outlined in Table 1.

Winter treatment according to this feeding plan was carried on in cooperation with the Newell Station during 1946-47, 1947-48 and 1949-50. Experimental feeding began about December 5. For the 12 lots, 240 good quality bred range ewes were equally divided. Five rams were used for breeding the ewes during November each year, and an equal number of ewes was bred to each ram. During the breeding season, all ewes were fed alike an allowance of 1 pound of alfalfa hay and 2.5 pounds native wheatgrass hay. Running water, salt and a 2:2:1 mineral mixture of ground lime stone, steamed bone meal, and salt were available at all times.

Table 1. Feeding Plan (Average Daily Ration per Ewe)

<table>
<thead>
<tr>
<th>Lot</th>
<th>Alfalfa—3.5 lbs. daily</th>
<th>Alfalfa—1.0 lb. daily</th>
<th>Alfalfa—3.5 lbs. daily</th>
<th>Alfalfa—1.0 lb. daily</th>
<th>Alfalfa—3.5 lbs. daily</th>
<th>Alfalfa—1.0 lb. daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Barley Fed</td>
<td>Lot 1</td>
<td>Lot 2</td>
<td>Lot 3</td>
<td>Lot 4</td>
<td>Lot 5</td>
<td>Lot 6</td>
</tr>
<tr>
<td>Long hay</td>
<td>Same hay as Lot 1</td>
<td>Same hay as Lot 2</td>
<td>Same hay as Lot 3</td>
<td>Same hay as Lot 4</td>
<td>Same hay as Lot 1</td>
<td>Same hay as Lot 2</td>
</tr>
<tr>
<td>Chopped hay</td>
<td>Lot 7</td>
<td>Lot 8</td>
<td>Lot 9</td>
<td>Lot 10</td>
<td>Lot 11</td>
<td>Lot 12</td>
</tr>
<tr>
<td></td>
<td>Same hay as Lot 3</td>
<td>Same hay as Lot 4</td>
<td>Same hay as Lot 1</td>
<td>Same hay as Lot 2</td>
<td>Same hay as Lot 3</td>
<td>Same hay as Lot 4</td>
</tr>
</tbody>
</table>

Table 2. Three-Year Average Performance By Lot

<table>
<thead>
<tr>
<th>Lot number</th>
<th>No Barley</th>
<th>½ lb. Barley per Head Daily Last 50 Days of Gestation</th>
<th>½ lb. Barley the Last 50 Days of Gestation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alfalfa 1</td>
<td>Alfalfa 2</td>
<td>Alfalfa 3</td>
</tr>
<tr>
<td>Av. number ewes</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Losses—av. number</td>
<td>1.3</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Av. gain per ewe</td>
<td>7.4</td>
<td>12.3</td>
<td>13.4</td>
</tr>
<tr>
<td>Percent ewes lambing</td>
<td>78.3</td>
<td>76.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Number of lambs born</td>
<td>20.0</td>
<td>20.7</td>
<td>22.3</td>
</tr>
<tr>
<td>Percent lambs born</td>
<td>100.0</td>
<td>103.3</td>
<td>111.7</td>
</tr>
<tr>
<td>Av. birth weight per lamb</td>
<td>9.7</td>
<td>9.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Av. weaning weight per lamb</td>
<td>76.8</td>
<td>76.0</td>
<td>76.5</td>
</tr>
<tr>
<td>Av. fleece weight per lamb</td>
<td>83.3</td>
<td>73.3</td>
<td>88.3</td>
</tr>
<tr>
<td>Av. feed cost per ewe*</td>
<td>$3.94</td>
<td>$3.84</td>
<td>$4.40</td>
</tr>
</tbody>
</table>

*Average prices of feed: Alfalfa at $25.30 per ton; Native hay at $27.63 per ton; Barley at $0.96 per bushel; Salt at $1.35 per hundred and mineral mix at $5.45 per hundred. Chopping of hay cost $0.001 per pound.
Ewes were weighed off experimental treatment April 1, or when the first lambs were born, whichever was earlier. Ewes and lambs were moved to summer range at the Antelope Range Field Station as soon as the range was in condition to be grazed, usually about May 1. Shearing occurred about June 15 each year, and lambs were weaned off the range about October 1.

The three-winter average performance by treatment is presented Table 2. In order that the treatment of the 12 lots is clear, it may be necessary to refer to the feeding plan in Table 1. For simplicity, when describing the hays fed, reference will be made to mixed hay rather than native hay supplemented by alfalfa. In general, comparisons made are for all ewes fed alfalfa or long hay, or each of the levels of barley, whatever the case may be.

Ewe Gains Affected Most By Treatment

It will be noted that differences in ewe gains between lots are much greater than differences in lamb birth and weaning weights, and ewe fleece weights. The weight of the ewe herself was affected more by the treatment than was her production of lamb and wool. When considering the requirements of the lamb that the ewe carried during the winter, it is apparent that ewes in Lots 1 and 5 actually lost body weight, as there was not a sufficient gain to allow the ewe to maintain her body weight. However, the treatment was not so deficient that there was a noticeable reduction in birth weights of lambs or ewe fleece weights as compared to the other treatments. This suggests that ewes receiving no barley still had hay rations of sufficient quality to meet their needs without harm to the ewe.

Ewes in Lots 2, 3, 4, 6, and 7 just about maintained actual body weight while also providing for the lamb. Treatment for Lots 8, 9, 10, 11, and 12 may have provided more nutrients than were necessary for top production. These data concerning ewe gains, when considered with lamb and fleece weights suggest that a good quality hay allowance plus (in this case) 1/3 pound barley the latter third of gestation, may be sufficient for economical production. On the other hand, ewe gain may be important as it affects the ewe’s ability to provide milk for her lamb up to weaning time.

Ewe gains may be of only secondary importance except for possible permanent harm done by the ewe by excessively deficient rations. If, when the ewe goes on range, there is plenty of forage, she may be able to maintain herself regardless of winter treatment and demands of the lamb.

Lamb Birth Weights Compared

When no barley or 1/3 pound of barley was fed, there was about 0.2 pound difference in birth weight in favor of lambs from ewes fed the 1/3 pound of barley. Lambs from ewes fed 1/3 plus 2/3 pound of barley were an additional 0.4 pound heavier at birth than lambs from ewes fed no barley.

Chopped hay appeared to be more advantageous than long hay in lamb birth weights for the lots of ewes fed the two levels of barley. In
both groups of lots, lambs from ewes fed chopped hay were 0.3 to 0.6 pound heavier at birth than lambs from ewes fed long hay. However, when no barley was fed there were no differences due to feeding the ewes chopped hay as compared to long hay.

In lots where no barley was fed, lambs from ewes fed alfalfa averaged 0.7 to 0.8 pound heavier at birth than lambs from ewes fed mixed hay. In the eight lots receiving barley, feeding alfalfa or mixed hay appeared to have little effect on lamb birth weights. As has already been pointed out, in the lots fed barley the differences in birth weights were apparently due to whether the hay fed was long or chopped.

**Lamb Weaning Weights Only Slightly Affected by Ewe's Ration**

There appears to have been no constant relationship between weight of lambs at birth and at weaning. That is, the heaviest lambs at birth were not necessarily the heaviest at weaning. Further, when comparing the three groups of lots on the basis of the amount of barley fed, there was more difference within the groups than between them. Especially is this true of the two groups of lots to which barley was fed. Weaning weights of lambs appear to have been only slightly affected by the rations fed to the ewes which produced them. Under extremely adverse range conditions we might expect that ewes coming out of the winter with actual body gains, will do a better job of suckling their lambs. That effect is only slightly indicated in these data by the weaning weights.

**Ewe Fleece Weights Heaviest Under Chopped Hay Ration**

Pounds of fleece at shearing time are of great economic importance to the producer. He is interested in winter treatment of his ewes which can help produce heavier fleeces. Feeding no barley to one group of lots, and at two levels to two groups produced no essential differences in fleece weights. This means, that as far as the fleece is concerned, there was no value in feeding barley in addition to the hay ration.

In the lots which received no barley supplement, the ewes fed mixed hay produced fleeces 0.3 pounds heavier than ewes which received alfalfa hay alone. Of the lots fed 1/3 pound barley, only those getting chopped mixed hay produced heavier fleeces. Among the lots fed 1/3 plus 2/3 pound barley the heaviest fleeces were produced by ewes getting chopped mixed hay. These data again indicate the value of chopping at least as expressed by pounds of fleece. Ewes fed chopped hay consistently produced slightly heavier fleeces than ewes fed long hay.

**Little Effect on Percent of Lambs Born and Weaned**

There apparently was little effect from these treatments on percent of lambs born or weaned. Breeding occurred prior to beginning of experimental feeding so that differences should possibly not be expected. Lot 6, of course, stands out in the data for percent lambs born and weaned. However, the percentages are so much different from lots treated in a similar manner, that the variation appears to be quite independent of treatment. There was also no agreement with Lots 2 and 9.
which were fed the same hay but different amounts of barley.

The data show no significant increase in percent of lambs born or weaned from any treatment or combination of treatments.

**Average Costs and Net Returns Per Ewe Figured**

Feeds rather easily available to the sheep rancher in west central South Dakota were used for this experiment because of the relative costs involved. Hauling charges for both hay and barley, and charges for chopping the hay were taken into consideration.

The data showed consistently that it cost more to feed straight alfalfa, to add barley to the ration, and to chop the hay than it did to feed mixed long hay. But, where costs were higher, net returns were not always less. Actually there were no consistently higher net returns for any type of treatment such as for ewes fed chopped hay or alfalfa alone or long or mixed hay. However, all ewes fed the higher level of barley produced slightly greater average net returns than all ewes fed no barley, while ewes fed the lower level of barley, with the exception of Lot 6, made the least average net returns.

The percent of lambs weaned is more important than any treatment, as it affected returns in pounds of lamb and wool. That relationship is strongest for Lot 6, but is rather consistent for Lots 1, 3, 10, 11, and so on. Even with the observed differences in pounds of lamb and wool produced, there appears to be little relationship between them and net returns. Actually, numbers of lambs produced were more important. This lack of agreement between production, except for numbers, and net returns suggests that the treatments were not severe enough. All treatments used were adequate for profitable production.

**These Are the Conclusions Reached**

1. Ewes fed alfalfa hay, either long or chopped, produced slightly more pounds of lambs and fleece than ewes fed mixed hay. However, ewes fed mixed hay tended to maintain body weight better than ewes fed alfalfa alone.

2. Adding barley to all hay rations increased lamb and wool production. However, feeding barley at the higher level increased production of lamb and wool only slightly more than did the lower level of barley.

3. Feeding chopped hay produced the greatest favorable differences in pounds of lamb and wool.

4. Because of the small differences in average net returns between ewes fed no barley as compared to the higher level of barley, there appeared to be no real advantage in adding barley. Likewise substantial increases in average net returns were not shown by ewes fed chopped hay.

5. There was little difference in average net returns from ewes fed alfalfa as compared to mixed hay. Therefore, since no range sheepman has, or would buy, sufficient alfalfa for the entire hay ration, it appears that profitable production is possible by supplementing winter range or native hay with at least a pound per head daily of alfalfa. (Project 159. Leaders: J. W. McCarty, Animal Husbandry Dept.; and Harry E. Weakly, Supt., Newell.)
Men and Land

By Max Myers

A rather pessimistic idea, often heard nowadays, that it is almost impossible for a young person to get established in farming in these high priced times has been modified by a study by the Agricultural Economics department.

This study indicates that it would be more correct to say that it is difficult for a young man to obtain control of the rather large amount of capital required to get a start in farming; but that under present conditions, once he has taken this step he can go ahead toward success in farming and in farm ownership more rapidly than has been possible in most periods of our history.

The oft-told tale from pioneer days of the newly married couple who settled on a homestead given to them by the government, with worldly goods consisting of a team and wagon, a plow and a cow given to them by the parents, and were thereby set up in farming, requires some further explanation. The tale usually does not mention the 30 or 40 years of near-poverty and hard work before that start in farming developed into the actual operation of an adequate farm unit which would provide a satisfactory level of living for the family. Today, the arrangements for the start in farming probably are more complex and difficult, but the farm family life is
likely to be much more satisfactory.

From a detailed study of the tenure experiences, in 1947 and again in 1950, of about 250 farm families in South Dakota, a better idea has been obtained about the ways in which they gained the use and ownership of land.

**Most Lifetime Farmers Become Owners**

Most of the farmers interviewed who stayed in farming during their lifetime became owners of farm land and held on to that land. In the 1947 survey of 144 cases, the proportion that became and remained owners of farm land was more than 80 percent. In the 1950 survey of 100 farmers the proportion was above 75 percent. Most of these farmed through the depression and drought years of the '30s. These case histories did not show stories of easy success. They were stories of hard work and plenty of troubles, but they did show the attainment of farm ownership by those who went after it.

The evidence furnished to us by these people fails to support some of the ideas commonly held about land tenure and modifies other ideas on the subject. For example, it indicates as has already been mentioned that the farm tenure situation is not as unfavorable as people have said it is, if measured by the objective of the attainment of farm ownership by operating farmers. There is evidence also that the so-called "agricultural ladder" (route to farm ownership) of "farm boy—hired man—tenant-owner" no longer represents the route to farm success for the majority of farm people—if it ever did.

**Growing Up on Farm Best Route to Farm Ownership**

There are numerous routes or "ladders" by which farm people progress up the occupational and tenure climbs. However, the routes which include the position of hired man on a farm have had less travel in recent years than in the past. The most traveled route used by the people interviewed was that which involved being raised on a farm, working on the home farm as a young single man, sometimes on a share deal, and then advancing to farm operatorship usually at the time of marriage. About half of those who followed this route were able to start farming as owners of land and about half as tenants.

The next most traveled route was very similar to the one just mentioned, but the young men started farming one or more years before marrying. Of this group a larger proportion started as tenants than as owners. This may reflect merely the fact that both land and diamonds cost dollars and that those who had some capital were able to take the double jump into farm operation and matrimony, whereas those who had less capital had to choose at the start between the farm business and the wife.

**Non-Farm Wages Supply Capital**

Another frequently used route to farm operatorship and ownership was one where the farm boy went into non-farm work for wages, or into business off the farm for a relatively short period to acquire the initial capital to start in farming. This reflected the fact that non-farm wages tended to be somewhat high-
er than those paid hired men on farms, and that some people felt this provided them a way to gain capital for farming more rapidly. The use of this method seems to be increasing.

There was much variation in the number of years spent on the different occupational and tenure levels. However, most young farmers struck out on their own between the ages of 21 and 26. Those who started as single men tended to do so at an earlier age, and more often as tenants, than those who worked at home until marriage.

**Little Family Assistance Received**

The majority of the farmers interviewed did not report receiving family assistance toward the purchase of farms. Most of the land was acquired from non-relatives and most of the land which had been relinquished had gone to non-relatives. However, there were some indications that the amount of family aid toward getting started in farming and purchasing land is increasing at least in times of high price level.

**Other Aspects Considered**

There were no indications in the sample of farm people that nationality or religion or war-time military experience affected the progress toward farm ownership in any way. The samples were not large enough to permit thorough study of the effect of varying amounts of educational experience. An attempt was made to measure the relationship between the various stages in the family cycle and the rate at which the farmers acquired land, but if an effect is present, it is obscured by the much more dominant influence of changing price levels.

The findings of this study seem to indicate that the tenure situation is somewhat less dark than has been pictured. We have had enough farmers in the state, and those who stayed in farming worked up to ownership.

This does not mean that there are no tenure problems. It does infer that emphasis should be shifted away from a lament over the failure of farmers to attain ownership and toward some of the other problems, such as:

1. How to help those relatively few operators who do not attain ownership even though they put in almost a lifetime at farming.
2. How to insure that the better qualified young individuals remain in farming.
3. How to help them to help themselves toward an earlier control of enough capital to permit efficient farming and farm ownership.
4. How to prevent the price of the farm from being subtracted from the level of living of the farm family.
5. How to have continuous and efficient farm production during shifts in ownership or operatorship.

Such problems will provide farm families and farm tenure specialists something to think about for many years. (Project 166. Agricultural Economics.)
There have been reports of very poor hatches of turkey poults in certain restricted areas of South Dakota that were believed to be due to selenium poisoning. Although the probabilities of encountering selenium toxicities with turkeys are limited to cases where grain is used which contains upwards of 20 parts per million (ppm) of selenium, it nevertheless would be highly desirable to have a cure or a preventative for such difficulties. The selenium content of grains will vary depending upon the type of soil and the season in which the grains are grown.

“Andy Gump” Appearance Produced by Selenium

To distinguish poor hatches due to selenium poisoning from other poor hatches of turkey poults, there are two rather specific symptoms. Depending on the level of selenium in the turkey breeder diet, the symptoms will vary from wiry or bristly down on otherwise normal poults (Bronze poults may appear quite a bit blacker than normal) to dead embryos which are abnormally developed — more specifically, having an “Andy Gump” appearance. This is typified by dead embryos showing a short lower beak or no beak at all. Besides having wiry down, the dead embryos may show...
other abnormalities such as no toe, a reversed hock joint, or a wingless condition.

The problem of finding a means of control for selenium poisoning in turkeys was studied with Broad Breasted Bronze turkey hens raised at the State College Experiment Station. Preliminary studies, conducted to determine how much selenium would be required to produce poisoning, had indicated that 9 ppm produced a wiry condition and poults which do not live, whereas levels of selenium from 13 to 15 ppm caused most embryos to develop the "Andy Gump" condition, and all embryos to die before hatching time. The tolerance levels are therefore considerably higher for turkeys than for chickens, since 5 ppm is detrimental to chickens.

**Arsenic Standard Means of Control**

Preliminary efforts at control showed that potassium iodide was ineffective in counteracting the toxic effects of selenium. The standard means of controlling selenium poisoning in livestock has been to include arsenic with the salt. It had been found that arsenic included in the drinking water would prevent toxic symptoms that chickens would ordinarily exhibit when receiving a diet containing poisonous levels of selenium.

Two trials with turkey hens were conducted to determine whether arsenic could be added to the feed and thus overcome selenium toxicity. The first trial involved feeding seleniferous grains to produce the symptoms of poisoning, and then adding arsenic to the diet to determine its effectiveness as a cure. The second trial involved the addition of arsenic first and seleniferous grains later in a prevention-type test.

Twelve hens with one tom were used in each trial, and during each study, 25 hens with two toms served as a control pen. The control pen, during the entire course of the trial, and the experimental pen, except when seleniferous grains were used, received the same all-mash diet.

Trapnests were used and eggs were set for pedigree hatching each week of the trial. The eggs were candled to determine fertility, and all hatchability results reported were based on the percent of fertile eggs which hatched.

**Arsenic Not a Cure**

The results of the first trial are given in Table 1. It will be noted that although the control pen performed somewhat better than the treated pen, there was really no great change in performance due to climatic, incubator, or other environmental conditions. Within three to six days after seleniferous corn was added to the diet, the eggs that were produced showed the effects of selenium poisoning, producing the typical wiry down and "Andy
Table 1. Effect of Arsenic Addition to a Turkey Breeder Diet* Containing Seleniferous Corn on Hatchability of Fertile Eggs

<table>
<thead>
<tr>
<th>Dietary Schedule</th>
<th>Week of Trial</th>
<th>Treated Pen Percent Hatchability</th>
<th>Control Pen Percent Hatchability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal grains</td>
<td>5-8 inc.</td>
<td>64</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>9-12 inc.</td>
<td>69</td>
<td>84</td>
</tr>
<tr>
<td>Seleniferous corn†</td>
<td>13</td>
<td>36</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>5</td>
<td>83</td>
</tr>
<tr>
<td>Seleniferous corn plus arsenic‡</td>
<td>15</td>
<td>3</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>8</td>
<td>77</td>
</tr>
<tr>
<td>Normal grains plus arsenic‡</td>
<td>17</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>90</td>
<td>—</td>
</tr>
<tr>
<td>Normal grains</td>
<td>19-21 inc.</td>
<td>49</td>
<td>—</td>
</tr>
</tbody>
</table>

*The diet contained grains and by-products, 79%; meat scraps, 5%; soybean meal, 5%; dried buttermilk, 5%; alfalfa meal, 3%; steamed bone meal, 2%; salt (containing iodine and manganese) 1/2%; fish oil (300 D-750 A) 1/2%; and riboflavin, 0.4 mg. per pound of diet.
†Selenium content of diet 15 ppm, seleniferous corn replaced normal grains in the diet at a 50% level.
‡Arsenic content of diet 15 ppm as sodium arsenite.

Gump" conditions. Hatchability of fertile eggs was reduced to almost zero within two weeks, and was not materially improved by the addition of arsenic to the feed. The 5, 3 and 8 percent figures were obtained by including poults that appeared normal except for having dark wiry down. Only when the seleniferous corn was removed from the diet of the hens was hatchability improved. After about four to six days on normal grains, the hens laid eggs that produced normal poults.

**Arsenic Not a Preventive**

The results of the second trial are given in Table 2. Arsenic alone appeared to reduce the hatchability of fertile eggs somewhat, and apparently it did not protect the turkeys from selenium poisoning, although there is a slight possibility that a small degree of protection was afforded. Hatchability did not drop to 5 percent in two weeks as it had done in the previous study without arsenic in the feed. However, a drop in egg production accompanied the reduction in hatchability in the second study, which may account, in part, for the apparent difference. Recovery, nevertheless, was not quite as rapid in the second study which provides some evidence that arsenic aided recovery in the first study.

Table 2. Effect of Addition of Seleniferous Corn to a Turkey Breeder Diet* Containing Arsenic on Hatchability of Fertile Eggs

<table>
<thead>
<tr>
<th>Dietary Schedule</th>
<th>Week of Trial</th>
<th>Treated Pen Percent Hatchability</th>
<th>Control Pen Percent Hatchability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal grains</td>
<td>5-8 inc.</td>
<td>78</td>
<td>68</td>
</tr>
<tr>
<td>Arsenic†</td>
<td>9</td>
<td>67</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>68</td>
<td>60</td>
</tr>
<tr>
<td>Arsenic and seleniferous corn‡</td>
<td>11</td>
<td>52</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>21</td>
<td>64</td>
</tr>
<tr>
<td>Seleniferous corn‡</td>
<td>13</td>
<td>0</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>Normal grains</td>
<td>15</td>
<td>8</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>76</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>74</td>
<td>—</td>
</tr>
</tbody>
</table>

*Same diet as for Table 1.
†Arsenic content of diet 15 ppm as sodium arsenite.
‡Selenium content of diet 15 ppm, seleniferous corn replaced normal grains in the diet at a 50 percent level.

Continued on page 24
VACCINATION AND BLOOD TESTS

For Fowl Cholera

By T. A. Dorsey

An increase in fowl cholera outbreaks occurs in late summer and fall. In 1950, approximately 50 percent of the total number of outbreaks diagnosed were in the months of August, September and October. This seasonal increase can be explained, at least in part, by the fact that contacts of young birds with "carriers" in the adult flock are more frequent at that time of year. This should emphasize the importance of isolation from the adult flock and the exercising of good sanitary practices as control measures.

Judging from diagnoses by the Veterinary department, fowl cholera must be considered one of the most serious infectious diseases of poultry in this area. The incidence of the disease was higher in 1950, with 105 diagnoses as compared to 66 in 1949.

In recent years, the death loss from fowl cholera in acute outbreaks is being reduced by administering certain of the "sulfa" drugs in the mash or drinking water. It has been the experience in many outbreaks where such treatment was used that losses again occurred following the treatment. In more chronic outbreaks, the rate of deaths is often not materially affected by "sulfa" treatment.

Because of the importance of fowl cholera in poultry flocks of South Dakota, and the inadequate means of control for all outbreaks, experimental work is being conducted towards prevention of the disease.

Two plans of procedure being investigated are:
1. The development of a blood test capable of detecting "carrier" birds so that they might be removed from the flocks.
2. The production of improved immunizing agents for vaccination.

Two Chief Types of Causative Organism Found

The cause of fowl cholera is the bacterium, Pasteurella multica. There are some differences in the strains of the organism isolated from affected birds. In a study of 66 isolated strains from outbreaks in this area, two chief types were found. Fifty-seven (86.5 percent) were Type I and nine (13.5 percent) were Type II depending upon their ability to ferment arabinose, dulcitol and xylose in broth cultures. As will be pointed out, the type of bacteria should be considered in the production of a testing antigen or an immunizing agent.

Blood Test Developed

An agglutination test is used for the detection of infected or "carrier" individuals as a control measure for several infectious diseases, including pullorum disease of poultry. This is a test for agglutinins or anti-
bodies in the blood as a result of infection or exposure to the disease agent. The testing agent, or antigen, is a suspension of organisms of the disease.

Antigens prepared from fowl cholera organisms have been produced which give promising results when used on birds experimentally infected with fowl cholera. Birds that had been infected with a Type I strain reacted when tested with a Type I antigen, but reactions were not obtained with a Type II antigen.

Three Immunization Trials Conducted

Attempts to immunize chickens against fowl cholera as a method of prevention have been made with varying degrees of success since the days of Pasteur. Very often, vaccination of flocks with commercial bacterins has not given a degree of immunity sufficient to protect against infection.

Three trials have been conducted where the chickens were challenged by injection of fowl cholera organisms into the muscles after having been vaccinated with differently prepared bacterins. In these trials, a whole culture bacterin produced a considerably higher resistance to infection than did either a commercial bacterin or a chick embryo vaccine. The mortality rates in the chickens vaccinated with whole culture bacterin, when exposed to experimental infection, was from 6 percent to 39 percent. The mortality in the chickens not immunized, which served as controls for the trials, was from 65 percent to 100 percent. When a whole culture bacterin prepared from a Type II strain of Pasteurella multocida was used for vaccination, and the challenge infection was a Type I strain, little, if any, protection was noted.

Field Trials Will Follow Up Experimental Trials

The experimental trials involving blood testing and vaccination are of a preliminary nature. Field trials will need to be conducted to determine whether “carrier” birds can be detected with the experimental antigen, and whether fowl cholera outbreaks can be prevented or checked by the whole culture bacterin. (Project 141. Leaders: T. A. Dorsey, G. S. Harshfield, Veterinary Dept.)

Arsenic Fails to Control

Selenium poisoning in turkeys was not prevented by feeding arsenic at levels approximately equivalent to the selenium content, fed either as a cure or a preventative. Some protection may have been afforded by arsenic in these trials, but more work should be done to find a satisfactory means of overcoming selenium poisoning under these conditions. It should be emphasized that chickens are more susceptible to selenium poisoning than turkeys. However, adding arsenic to the water will counteract the toxic effects chickens exhibit. (Project 28. C. W. Carlson and Wm. Kohlmeyer, Poultry Department; and A. L. Moxon, Chemistry Department.)
MARKETING AND PROCESSING METHODS

Affect Butter Quality

By Ernest Feder and D. F. Breazeale

Butter manufacturing has remained the major dairy industry in South Dakota. The bulk of butter in the state is produced from cream separated at the farm, and cream sales, though declining in amount, account for approximately 70 percent of the total South Dakota milk production (Figs. 1 and 2).

About 80 percent of the butter produced in the state is shipped to other markets where it is in competition with other butter and other spreads, indicating the importance of quality control for satisfactory marketing.

Information on some of the factors affecting the quality of South Dakota butter has been obtained by several surveys which were part of a North Central Regional Research study or were conducted in cooperation with the State Department of Agriculture and the State Chemist at Vermillion.

A sample of 21 creameries based on size and ownership in South Dakota was selected as part of a regional survey. A federal grader visited each of these plants once in the spring and once in the summer of 1950. He graded all churnings of the butter on hand at the time of his visit, according to the federal standards for U. S. creamery butter. These grades are AA or 93 score, A or 92 score, B or 90 score, C or 89 score and CG (cooking grade). An effort was made to time these trips when a considerable quantity of butter would be available, and a total of 343,646 pounds of butter was represented in these 1950 gradings.

Size of Plant and Season of Year Influence Grades

Results of these gradings show that 81 percent of the butter was B grade and 19 percent C grade, with the larger plants manufacturing a somewhat higher percentage of B grade than the smaller plants (Table 1).

The summer grading resulted in a greater proportion of lower grade butter than the spring grading, in all sizes of creameries. However, the differences were not as great as might well be expected for a normal season, since summer temperatures in South Dakota were unusually low in 1950.
Important changes have taken place in the dairy industry during the past few years. From 1940 to 1949, total milk production in the U.S. increased from 110 to 119 billion pounds. There has been a shift from the sale of farm-separated cream to the sale of whole milk. In 1940, 30 percent of the milk produced was sold by farmers in the form of cream while in 1949 only 17 percent was sold in this form. The amount of milk sold to plants and dealers as whole milk increased from 43 to 61 percent. In contrast to the national trend, milk production in South Dakota decreased sharply, but cream sales remained around 70 percent.

Also, cooperative creameries produced a slightly higher proportion of higher grade butter than independently owned plants (including centralizer plants). This is not shown in the table.

Flavor and Aroma Chief Factors in Determining Butter Grades
Butter grades are determined chiefly by the kind and intensity of the predominating flavor and aroma observed by the grader. Other factors considered are defects in body and texture, color and salt, but these were of little significance in the survey. Between 70 and 90 percent of the B grade butter was characterized by "definitely old cream" or "definitely acidy" flavors. The principal flavors in the samples of C grade were "definitely stale" and "definitely metallic."

The occurrence of "metallic" or "utensil" flavors in butter, of which about 10 percent was found in 1950, can probably be attributed to the prolonged contact of the cream with cans having rust spots. The 1950 survey shows that butter with this flavor was manufactured by creameries which obtained their cream supply mainly from cream stations, through door delivery, or direct rail shippers. Plants where no metallic flavored butter was found, obtained their supply mainly through farm truck routes. There did not seem to be any relation between the observed sanitation procedures or the condition of the processing equipment of the plants and the occurrence of these flavors.

The greatest proportion of cream was marketed through cream sta-
tions with truck routes being next in importance. The creameries obtaining their supply of cream by farm truck routes appear to have a somewhat greater control over freshness of cream than plants receiving their supply by other methods (Table 2).

Methods of Collecting Cream Affect Quality of Butter

In 1950, plants collecting more than 50 percent of their cream by farm truck routes produced 94 percent grade B butter (Table 3). The proportion of grade B butter was considerably lower for plants using mainly other methods of collection. This is not conclusive evidence that farm truck routes are always conducive to higher grade butter, since other important factors have not been accounted for, such as, grading of cream, and processing methods at the plants. But control over the age of cream, such as is afforded by regular routes, is one of the important factors in the production of higher quality butter.

In this connection it is interesting to note that the cooperative plants included in the 1950 survey received 55 percent of their cream from truck routes, the remainder through other methods of supply. The independents received 4 percent of their cream by truck routes. Cooperatives received 4 percent and independents 73 percent of their supply through cream stations.

<table>
<thead>
<tr>
<th>Plants Producing</th>
<th>No. of Plants in Sample</th>
<th>No. of Churnings Graded</th>
<th>Total Weight in Graded Churnings</th>
<th>% of U. S. &quot;B&quot; Grade</th>
<th>% of U. S. &quot;C&quot; Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000,000 lbs. and over</td>
<td>4*</td>
<td>80</td>
<td>106,461</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>500,000 to 999,999 lbs.</td>
<td>5</td>
<td>96</td>
<td>122,157</td>
<td>81</td>
<td>19</td>
</tr>
<tr>
<td>Less than 500,000 lbs.</td>
<td>12</td>
<td>116</td>
<td>115,028</td>
<td>74</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>21*</td>
<td>292</td>
<td>343,646</td>
<td>81</td>
<td>19</td>
</tr>
</tbody>
</table>

*One large plant did not cooperate in the summer grading

| Plants Producing | No. of Plants in Sample | Total lbs. of Butterfat Purchased | % of Butterfat Received Through Truck Route Stations Door Delivery Direct Rail |
|------------------|------------------------|----------------------------------|----------------------------------|---------------------|---------------------|
| 1,000,000 lbs. and over | 3* | 4,011,910 | 24 | 64 | 6 | 6 |
| 500,000 to 999,999 lbs. | 5 | 2,832,260 | 17 | 29 | 39 | 15 |
| Under 500,000 lbs. | 12 | 2,137,462 | 37 | 36 | 27 | 8 |
| Total | 20* | 8,981,632 | 25 | 46 | 21 | 8 |

*One large plant did not cooperate in the survey

<table>
<thead>
<tr>
<th>Major Method of Cream Receipts</th>
<th>No. of Plants in Sample</th>
<th>Total Butter Produced</th>
<th>% of U. S. &quot;B&quot; Grade</th>
<th>% of U. S. &quot;C&quot; Grade</th>
<th>% of Cream Receipts</th>
</tr>
</thead>
<tbody>
<tr>
<td>By truck route</td>
<td>7</td>
<td>79,706</td>
<td>94</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>By stations</td>
<td>8</td>
<td>192,750</td>
<td>78</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>By door delivery</td>
<td>5</td>
<td>60,664</td>
<td>73</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>333,120</td>
<td>81</td>
<td>19</td>
<td>94</td>
</tr>
</tbody>
</table>

*Major = receiving 50% or more of the cream by one method
Relationships Between Butter Grades and Chemical Tests Explained

As a food product, butter must comply with state and federal regulations with respect to butterfat content and freedom from adulteration. Butter and cream are considered adulterated under federal laws, if they consist in whole or in part of any filthy, putrid or decomposed substance, or are otherwise unfit for food, or are processed under insanitary conditions. The use of decomposed cream in the manufacturing of butter lowers its grade, and also confronts a plant with the danger of its output being seized by the authorities with resulting fines and loss of butter.

The W.I.A. test (water insoluble acids) is a chemical analysis which the authorities may use to determine the degree of decomposition which the cream has undergone prior to its manufacture into butter. As cream becomes older, decomposition sets in and progresses, depending chiefly upon the temperature at which the cream is held, and the W.I.A. content rises. It is generally considered that samples of butter with a W.I.A. content over 400 are made from cream unfit for human consumption.

Butter Samples Tested

To obtain more information on the characteristics of butter with respect to relationships between fat acidity, pH of the butter, W.I.A. and grades, 368 samples collected by the South Dakota Dairy Inspectors and representing about 200,000 pounds of butter, were analyzed at the Station Dairy department and

<table>
<thead>
<tr>
<th>Grades and Periods</th>
<th>No. of samples</th>
<th>Av. pH*</th>
<th>Av. F.A.t</th>
<th>Av. WIA§</th>
<th>High pH</th>
<th>Low pH</th>
<th>High F.A.</th>
<th>Low F.A.</th>
<th>High WIA</th>
<th>Low WIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 1950</td>
<td>3</td>
<td>6.96</td>
<td>0.63</td>
<td>151</td>
<td>7.18</td>
<td>.76</td>
<td>.57</td>
<td>226</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>May—June 1951</td>
<td>3</td>
<td>6.83</td>
<td>0.69</td>
<td>112</td>
<td>6.92</td>
<td>.68</td>
<td>.80</td>
<td>.59</td>
<td>179</td>
<td>77</td>
</tr>
<tr>
<td>August 1951</td>
<td></td>
<td>6.89</td>
<td>0.66</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total or Average</td>
<td>6</td>
<td>6.89</td>
<td>0.66</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Grade B</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 1950</td>
<td>52</td>
<td>6.88</td>
<td>0.86</td>
<td>207</td>
<td>7.75</td>
<td>4.48</td>
<td>1.31</td>
<td>.32</td>
<td>422</td>
<td>79</td>
</tr>
<tr>
<td>May—June 1951</td>
<td>122</td>
<td>6.79</td>
<td>0.73</td>
<td>114</td>
<td>7.90</td>
<td>5.05</td>
<td>1.52</td>
<td>.18</td>
<td>375</td>
<td>42</td>
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<tr>
<td>August 1951</td>
<td>84</td>
<td>6.91</td>
<td>0.85</td>
<td>207</td>
<td>8.02</td>
<td>5.40</td>
<td>1.66</td>
<td>.35</td>
<td>423</td>
<td>73</td>
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<tr>
<td>Total or Average</td>
<td>258</td>
<td>6.85</td>
<td>0.79</td>
<td>163</td>
<td></td>
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</tr>
<tr>
<td>Grade C</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>July 1950</td>
<td>37</td>
<td>7.04</td>
<td>0.82</td>
<td>209</td>
<td>8.17</td>
<td>5.37</td>
<td>1.67</td>
<td>.31</td>
<td>416</td>
<td>79</td>
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<tr>
<td>May—June 1951</td>
<td>23</td>
<td>6.75</td>
<td>0.86</td>
<td>141</td>
<td>7.79</td>
<td>5.90</td>
<td>1.53</td>
<td>.32</td>
<td>285</td>
<td>37</td>
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<tr>
<td>August 1951</td>
<td>32</td>
<td>6.60</td>
<td>1.23</td>
<td>310</td>
<td>7.75</td>
<td>5.23</td>
<td>2.24</td>
<td>.74</td>
<td>539</td>
<td>110</td>
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<td>92</td>
<td>6.82</td>
<td>0.97</td>
<td>227</td>
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<tr>
<td>Grade CG</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>July 1950</td>
<td>5</td>
<td>7.02</td>
<td>0.94</td>
<td>242</td>
<td>7.88</td>
<td>6.47</td>
<td>1.24</td>
<td>.47</td>
<td>295</td>
<td>171</td>
</tr>
<tr>
<td>May—June 1951</td>
<td>3</td>
<td>6.23</td>
<td>1.43</td>
<td>262</td>
<td>6.33</td>
<td>6.03</td>
<td>2.29</td>
<td>.77</td>
<td>467</td>
<td>83</td>
</tr>
<tr>
<td>August 1951</td>
<td>4</td>
<td>7.00</td>
<td>0.80</td>
<td>251</td>
<td>8.02</td>
<td>6.22</td>
<td>1.13</td>
<td>.32</td>
<td>291</td>
<td>171</td>
</tr>
<tr>
<td>Total or Average</td>
<td>12</td>
<td>6.82</td>
<td>1.01</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>368</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*pH of butter serum (active acidity)
†F.A. = Fat acidity (ml. 0.1 N KOH per 10 g. fat)
§WIA = mg. of water insoluble acids per 100 g. fat
at the State Chemist's laboratory in a joint venture. To obtain data of most value to the butter industry, a fairly high proportion of lowest grade butter samples was obtained. Table 4 shows the results in condensed form.

(1) There were 11 samples exceeding a W.I.A. test of 400.

(2) A significant relationship exists between the amount of fat acidity and the W.I.A. content within each grade. High fat acidity will normally correspond to a high W.I.A. content. Since the W.I.A. test is an expensive and time consuming test, the comparatively simple fat acidity test will give an indication as to the probable result of the W.I.A. test.

(3) One might assume that the fat acidity and the W.I.A. content of butter would increase as the grade of butter declines. On the whole, it was found that this was so; but there were important exceptions to this rule. The average fat acidity and W.I.A. content in grade C butter was higher than in grade B butter for all samples combined. When the weather was cool and apparently favorable for higher quality butter, such as July 1950 and May and June 1951, the samples showed lower values of fat acidity and W.I.A. than when the weather was warmer (August 1951), and there was little difference between grades B and C, except for August 1951.

It may be tentatively concluded that differences in grades, based mainly on predominating flavors, in many cases do not correspond to appreciable differences in fat acidities or W.I.A. values.

(4) Does the degree of neutralization, as measured by the pH of the butter, affect its W.I.A. test? Analysis showed that when the pH of the butter was within a range of 6.8 and 7.0, which is usually considered most desirable from the standpoint of good manufacturing, there was no correlation between pH and the W.I.A. test. However as the pH decreased from 6.8, the W.I.A. values increased significantly. This general trend is shown in Fig. 3. These lower pH values indicate that the cream was under-neutralized, and under-neutralization tends to increase the W.I.A. and fat acidity values.

Processors are therefore urged to control cream neutralization very carefully in order that the pH of the butter will be in the range of 6.8 to 7.0 or as close to this as possible. This careful control of neutralization will not only help to minimize the possibility of having excessive W.I.A. values, but also will definitely aid in the manufacture of high quality butter. (Project 201. Leaders: Ernest Feder, Agricultural Economics, D. F. Breazeale, Dairy.)

These remarks refer only to grades B and C since not enough samples could be collected of the other grades.

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Fig. 3. Trend of average pH values and corresponding average W.I.A. and F.A. values.
By Lillian Lund, Ethel L. Phelps, and Helen Ward Norton

Blending remanufactured wool with new wool has been a widespread practice for many years. The Wool Products Labeling Act, which became effective in 1941, requires that labels must indicate percentages of new and remanufactured wool present in any wool product. If the consumer does not know what effect such blending may have on the serviceability of the product, it is difficult for him to decide which product will be best suited to his particular needs.

In order to determine the effects upon the serviceability of wool flannels of various combinations of new and reused wool, a cooperative investigation was undertaken by the South Dakota and Minnesota experiment stations. The study also was designed to measure some of the physical changes which might result from dry cleaning and aging as well as from wear.

Wool Fibers Measured

Since the fundamental differences between fabrics are influenced by their fiber content, the two groups of fibers were studied. Length measurements showed that the new wool fiber was approximately one-half inch longer than the reused fiber. Moreover, the new wool contained more than twice as many fibers which were three inches or more in length. The new wool fibers were finer, the average diameter being 23 microns for the new wool and 30 for the reused wool, and showed considerably less variation in diameter measurements than did the reused wool fibers.

One of several experimental skirts worn by college girls in testing the wear-life of a wool flannel fabric containing reused wool.
WILL IT WEAR?

During the process of remanufacture, fabrics and yarns are torn apart in order to yield a mass of fiber which can be reused. In this process many fibers are damaged, a common evidence of which is splintered ends. The ends of fibers from both the new and the reused wool were examined under the microscope for damage. On this basis they were classified into groups which varied from fibers showing no damage to those with severely splintered ends. The general tendency was for somewhat greater damage to be observed in the reused wool fibers.

Less Stretch and Strength in Yarn of Reused Wool

In manufacturing the yarn from fiber, every effort was made to produce yarns which were alike. Nevertheless yarn measurements indicated that the additions of reused wool tended to result in yarns of decreasing size. Yarn strength measurements showed that an increase in the amount of reused wool resulted in lower yarn strength. Apparently new wool not only provides more strength, but it also imparts greater elongation to the yarn.

Yarn Woven Into Five Fabrics

The yarns were woven into flannels with specified fiber content as shown below:
- 100 percent new wool
- 75 percent new wool plus 25 percent reused wool
- 50 percent new wool plus 50 percent reused wool
- 25 percent new wool plus 75 percent reused wool

A. Flannel made from 100 percent new wool.
B. Flannel made from 50 percent new wool and 50 percent reused wool.
C. Flannel made from 100 percent reused wool.
100 percent reused wool
These experimental fabrics were woven with an even twill weave, weighed 11 to 12 ounces per linear yard in the 54-inch width, and were similar to a commercial flannel of comparable kind and weight.

For convenient identification, each fabric was numbered according to the percentage of its new wool content; that is, the flannel which contained 100 percent new wool was numbered “100” and that containing 0 percent, “0.”

The five fabrics were made into plain, four-gore skirts which were worn by students (Fig. 1). Three skirts from each of the first four fabrics were worn 1000 hours; three, 2000 hours; and three, 3000 hours. Fabric No. 0 was not subjected to 3000 hours of wear since yardage was available for only six garments.

Each wearer kept a record of hours of wear, amount of pressing, evidences of wear and damage, and type of activity. After 200 hours of wear each garment was returned to the laboratory for inspection, dry cleaning and repair.

Differences in the Unworn Fabrics
Every effort was made to produce five flannels which would vary only in fiber content. All were dyed navy blue. Nevertheless, it was possible to distinguish between them visually and by feel. The differences between new and reused wool fiber mentioned above were probably responsible for these variations. The all new wool fabric No. 100 produced a soft, smooth fabric, with a close, even weave. With each addition of reused fiber the fabric became harsher to the touch and the weave more irregular. Fabric No. 0 was quite harsh, markedly irregular in weave, and showed thin spots interspersed with thickly matted areas (Fig. 2).

Differences also were shown by laboratory measurements on the new (unworn) fabrics. Weight, strength and elongation tended to decrease as the proportion of reused wool increased (Table 1).

Aging or storage always is involved in a study of wear. However, results from this investigation indicated that only minor changes occurred during storage without wear.

Dry cleaning caused some shrinking and some stretching. In numerous cases these changes were less marked for the fabrics with larger proportions of reused wool.

Table 1. Values for Fabric Properties of Wool Flannels When New and After Wear

<table>
<thead>
<tr>
<th>Fabric No.</th>
<th>Weight per Square Yard</th>
<th>Strength in Pounds</th>
<th>Elongation in Percent</th>
<th>Bursting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in Ounces</td>
<td>Warp</td>
<td>Filling</td>
<td>Breaking</td>
</tr>
<tr>
<td>100 New</td>
<td>9.3</td>
<td>32.6</td>
<td>17.6</td>
<td>63.7</td>
</tr>
<tr>
<td>Worn 3000 hrs.</td>
<td>9.1</td>
<td>32.4</td>
<td>17.3</td>
<td>59.7</td>
</tr>
<tr>
<td>75 New</td>
<td>9.0</td>
<td>23.2</td>
<td>12.2</td>
<td>49.6</td>
</tr>
<tr>
<td>Worn 3000 hrs.</td>
<td>8.6</td>
<td>22.6</td>
<td>11.1</td>
<td>42.6</td>
</tr>
<tr>
<td>50 New</td>
<td>9.0</td>
<td>20.4</td>
<td>12.3</td>
<td>47.3</td>
</tr>
<tr>
<td>Worn 3000 hrs.</td>
<td>8.4</td>
<td>20.8</td>
<td>11.0</td>
<td>39.9</td>
</tr>
<tr>
<td>25 New</td>
<td>8.8</td>
<td>17.6</td>
<td>10.9</td>
<td>42.0</td>
</tr>
<tr>
<td>Worn 3000 hrs.</td>
<td>8.2</td>
<td>16.5</td>
<td>9.0</td>
<td>31.7</td>
</tr>
<tr>
<td>0 New</td>
<td>7.8</td>
<td>14.4</td>
<td>7.5</td>
<td>32.8</td>
</tr>
<tr>
<td>Worn 2000 hrs.</td>
<td>6.5</td>
<td>11.0</td>
<td>5.5</td>
<td>18.4</td>
</tr>
</tbody>
</table>
Differences in the Worn Fabrics

Common experience has demonstrated that wear will cause changes in fabric properties. In this connection it must be remembered that manufacturing processes and the uses to which the fabric is subjected cause permanent changes also in the fiber properties. These may detract from the serviceability of the fabric and account for some of the differences observed.

Measurements made on these fabrics have shown that many such changes occurred during the wear life of the flannels. As wear with dry cleaning continued there was a slight shrinking, or pulling together of the yarns. This tendency was not shown in the fabrics containing all reused wool. Here the trend was in the opposite direction since the fabric tended to stretch. Losses in thickness were observed when the percentage of reused wool exceeded 50 percent. All of the fabrics decreased in weight during the wear periods, the losses becoming larger as the amount of new wool was decreased and the amount of reused wool proportionately increased. Such differences in weight could result in a material becoming threadbare and less apt to hold its shape.

Strength losses often are used to portray the effects of wear. When a garment is worn, strain may occur across the shoulders, on the sleeves, or wherever there is pull in one direction. This type of strain can be measured in the laboratory by applying a force to one end of a strip of fabric and increasing the force until the fabric breaks. Such force is measured in pounds and is called the breaking strength of the fabric.

Comparing the breaking strength of the unworn fabrics with that of the fabrics which were worn, those materials made of all reused wool lost much more strength than did those containing new wool (Table 1).

Another type of force to which fabrics may be subjected is bursting force such as might occur at the elbows or the knees of a garment. Such strain may be measured by clamping a sample tightly into a machine and forcing a steel ball up against the fabric, continuing to apply pressure until the ball ruptures the cloth. This also is measured in pounds, and is called bursting strength.

Losses in bursting strength of the flannels were greater than losses in breaking strength, varying from four pounds for fabric No. 100 to 20 pounds for fabric No. 0. It is interesting to note that the 4-pound loss in bursting strength occurred after 3000 hours of wear for fabric No. 100, whereas the 20-pound loss occurred after No. 0 had been worn only 2000 hours. Fabric No. 100, which contained all new wool, showed remarkably little change as the result of being worn and dry cleaned for the three wear periods.

All of the skirts were still wearable at the end of the final wear period, but most of them were at a point where they probably would have been discarded for their shabby appearance under normal circumstances. Many of the waist bands had holes in them where they had been fastened; and one skirt of fabric No. 0 needed a new waist band before the end of the second wear period.

Continued on page 35
SOUTH DAKOTA Barley

HIGH IN PROTEIN

By A. W. Halverson

Of the large acreage of barley grown in South Dakota, a considerable portion reaches industrial outlets (brewing industry), but a much larger proportion is used for feeding purposes by farmers and feeders throughout the state.

There is a tendency for South Dakota barley to be too high in protein to suit brewing requirements. Evidently the environmental factors characteristic of this area sometimes promote excessive protein content in barley varieties which are normally considered to be of moderate protein content. Drought conditions during the midsummer growing season cause the grain kernels to shrivel and result in abnormally high protein content.

The logical solution to the production of more suitable malting barley for South Dakota appears to be continued development of low-protein, early-maturing, disease-resistant varieties. On the other hand, attention to the continued development of high protein varieties which possess high yield and disease resistant characteristics is also warranted. Using a high protein barley as a livestock feed is practical primarily because protein supplement requirements are reduced to a minimum. The amount of protein supplement (concentrate) required to make a balanced ration is much less when the basic grain is a high protein grain.

A quantitative study of the protein fractions in malting and feeding barley varieties was carried out in a cooperative project between the Experiment Station Chemistry and Agronomy departments.

The fractions studied were salt-soluble protein, alcohol-soluble protein and insoluble protein. The samples analyzed represented Feebar, Odessa and Plains barley (1950 crop) grown on experimental plots in several different areas of the state. Odessa is a malting-type barley of well-established reputation,
while Plains and Feebar are newly developed varieties that hold promise of being popular feed-type barleys. Plains is considered to have a medium protein content. Feebar is a high protein variety.

Environmental Factors Affect Protein Content

The data already obtained in the current barley protein study are important. The results show a definite relationship between protein composition and total protein content. Changes in the total protein content of barley samples cause regular and comparable changes in the protein fraction percentages of different varieties (6-row type).

Wide variations in the protein content of both low- and high-protein types of barley emphasize that environmental factors may obscure varietal characters such as protein level to a significant extent. The results further indicate that as much as 50 percent of the variation in the protein content of barley samples (Feebar) can be caused by environmental factors which interfere with normal kernel development and thus cause shriveled grain of higher protein content to result. Plains barley was outstanding in that high protein levels were attained in well-developed grain kernels (non-shriveled). A combination of high protein and early maturity characters is no doubt responsible for the ability of the Plains variety to attain good yields of feed-type grain even when grown in drier areas.

Further study of the protein composition of malting and feeding barleys together with evaluation of the effect of environmental factors upon protein composition will greatly help the plant breeder to select varieties for feeding or for malting. An adequate understanding of the differences in nutritive value between low- and high-protein barley will also be of great importance. (Project 195. Leaders: A. W. Halverson, A. L. Moxon, Station Chem.; J. E. Grafius, Agronomy.)

Reused Wool, Will it Wear?

It was not possible to keep a record of the number of hours the skirts actually were exposed to sunlight. However, samples of new fabric were exposed to light in a Fade-Ometer to simulate the effect of sunlight. Results indicated that breaking strength values tended to decrease after each period of exposure, and that these decreases were larger for the fabrics with increasing amounts of reused wool.

The serviceability to be expected from reused wool is dependent largely upon the amount of new wool which may be mixed with it. Results of the research conducted at the two stations indicate that, although a fabric made of new wool will be superior in serviceability, the consumer might expect reasonably good service from fabrics containing not more than 50 percent of reused wool. Increasing proportions of the reused fiber will result in a marked decline in serviceability. (Project 140. Leaders: Lillian O. Lund, Home Economics Department, in cooperation with Ethel L. Phelps, Minnesota Ag. Expt. Sta.)

Continued from page 33
Nine stages of growth of Moore barley treated in 1950. The yield in bushels per acre is given for each stage. The yield from untreated, weed-free plots was 34.4 bushels per acre, identical to that of the plots treated in the eighth stage of growth, showing that the application of 2,4-D at this stage of growth did not have an adverse effect upon barley yields.

By LYLE A. DERSCHEID

Spraying a field of barley or oats with 2,4-D kills the broadleaved weeds, but what does it do to the crop? Though barley and oats are generally tolerant to small dosages, it was found at the South Dakota Agricultural Experiment Station that there are certain stages when spraying with 2,4-D will cause definite reductions in yield.

The effect of 2,4-D on these crops was studied to determine (1) whether different varieties were affected the same way by 2,4-D, (2) whether reduced yield or abnormalities brought about by spraying with 2,4-D were transmitted to the next generation, and also (3) how and why 2,4-D causes yield reduction.

Nine varieties of barley and 10 varieties of oats were tested in three years (1947, 1948, and 1949). Barley varieties tested were Spartan, Plains, Feebar, Kindred, Odessa, Manchuria and Wisconsin 38. Oat varieties were Brunker, Trojan, Richland, Vikota, Tama, Mindo, Clinton, Marion and Bonda. In addition, Tregal barley was treated in 1947 and Moore barley and Andrew oats in 1949.
Yields Reduced When Treated with Ester of 2,4-D

All farmers who have used 2,4-D realize that there are three general forms of this herbicide - ester, amine, and sodium salt. These three forms do not necessarily have the same effect on crops or weeds. Therefore, all three forms were used in the tests. The 2,4-D was applied when the grain was in four stages of growth (seedling, fully tillered, heading and milk).

Yields of barley and oats were consistently reduced by treatment with the ester at the first three stages of growth (seedling, tillered,
and heading). In barley the reduction in yield was greatest when treated at the seedling and heading stages, but there was a slight reduction when treated at the fully tillered stage. The yield of oats was reduced 15 to 20 percent when treated at the seedling stage and 5 to 10 percent at the fully tillered and heading stages.

The amine and sodium salt forms of 2,4-D reduced barley yields slightly at the critical seedling and heading stages, but did not consistently affect the yield of oats.

Count Leaves to Determine When to Spray

The end of the susceptible seedling period can be determined more accurately by counting the leaves than by the height of the plant. Even though an early variety and a late variety were grown under two distinctly different sets of growing conditions, by the time the fifth leaf was expanded tillers were no longer being formed, and heads were starting to form (inside the plant). At this stage, the two seedling leaves had dried up and almost disappeared on some plants. The plants were 8 inches tall in 1949 and 12 inches tall in 1950. This indicates that the stage of growth can be determined more accurately by counting the number of leaves than by measuring plant height.

Some Varieties More Susceptible

Wisconsin 38 was definitely more susceptible to 2,4-D than the other barley varieties tested. Moore was tested only one year, but in that year it was also more susceptible than the other varieties.

In the oat test plots, Marion, Mindo, Clinton, Andrew and
Boncla, in that order, were more susceptible to 2,4-D than the other five. Whenever the yield was reduced, it was found that the number of seeds per head was reduced, but seed weight, number of heads and viability (ability to grow and develop) were not affected.

**Effect of 2,4-D Not Transmitted to Progeny**

When barley and oats were treated at the seedling (5-leaf) stage with the ester of 2,4-D, the yield was always reduced. Seeds from these treated plots and from untreated plots were planted and yields were taken on the progeny of both. The barley varieties grown in 1948 were tested in 1949, and the barley and oat varieties grown in 1949 were tested in 1950. It was shown that the reduction in yield caused by the application of 2,4-D was not transmitted to the succeeding generation through the seed.

Abnormal heads of barley, caused by treatment with 2,4-D, were threshed and the seed was planted. Since no abnormalities were observed on the progeny of malformed plants, it was concluded that these abnormalities were not transmitted to the next generation through the seed.

**How Does 2,4-D Reduce Barley Yields?**

An early and a late variety of barley were treated with 2,4-D at nine stages of growth during two years. Plains was used as the early variety each year. Wisconsin 38 was used as the late variety in 1949, but Moore was substituted for it in 1950. The 2,4-D was applied at 3-day intervals beginning at the 4- to 5-leaf stage. Each time 2,4-D was...
applied, the growing point was removed from some plants in order to determine the exact stage of growth that was treated. Yield, seed-weight and number of heads were determined at harvest time and the number of seeds per head was calculated.

In 1950, spaced plants of both varieties were treated each time that the other plots were treated, in order that the yield per plant and the number of tillers could more easily be determined. The first treatment in 1950 was applied when Moore had only four leaves. This treatment caused a large reduction in yield and also caused a reduction in the number of tillers on spaced plants.

Growing Conditions Affect Response to 2,4-D

The warm, dry conditions of 1949 were conducive to a slow growth rate and the rapid formation of heads. The head was formed in a very short time on any one stem and the heads of all main stems were formed over a short interval. The same was true for tillers. The application of 2,4-D during the time that heads were being formed caused large reductions in yield and increased the number of abnormal heads. Under these same conditions there was a period between the time that heads were being formed in the main stem and the time that they were formed in the tillers. The application of 2,4-D during this period did not materially affect yield or cause any malformed heads.

The cool growing conditions of 1950 were conducive to rapid growth and slow head formation. Heads were formed more slowly and in fewer stems at any given time. Consequently, no single application of 2,4-D would affect so many growing points and give such large reductions in yield or so many head abnormalities as in the previous season. On the other hand, the overlapping of head formation in main stems and tillers gave a long period (12-16 days) of moderate yield reduction.

Spray Barley in Second and Fourth Periods of Growth

The results of the three experiments show that the growing period of barley can be divided into four developmental periods — each responding in a different way to 2,4-D. The four periods are: (1) a susceptible period beginning when the grain comes up and ending at the 5-leaf stage, (2) a relatively tolerant period between the 5-leaf stage and the early boot stage, (3) a second susceptible period from pre-heading to late heading and, (4) a resistant period after the grain is in the milk.

During the latter part of the first (seedling) period, the application of 2,4-D stopped the formation of tillers. When the number of tillers was decreased, the number of heads was less and consequently the yield was greatly reduced.

In the second period (between 5-leaf and early boot stages) the application of 2,4-D affected the formation of the head. The number of seeds per head was reduced, yield was depressed and the number of head abnormalities increased. The severity of this injury was propor-
tional to the number of heads being formed when the 2,4-D was applied.

In a dry year the application of 2,4-D at the time that heads were being formed caused large reductions in yield and many abnormal heads. It did not materially affect yields or cause malformed heads when applied after heads were formed in the main culm, but before they started to form in the tillers.

In a wet year the application of 2,4-D caused a small yield reduction and few head malformations over a two-week period. Since 2,4-D would have to be applied during a short interval when many heads were being formed in order to cause a large reduction in yield, this second period is considered to be relatively tolerant. Any reduction in yield is generally offset by advantages gained in control of weeds.

In the third (heading) period, 2,4-D consistently caused large yield reductions due to a decrease in the number of seeds and this period is therefore, considered to be susceptible.

The application of 2,4-D during the fourth (milk or post-heading) period does not reduce yields and does not cause head abnormalities.

Oats follow the same general pattern, but results for definite stages of growth have not yet been determined. (Project 82. Leader: Lyle A. Derscheid, Agronomy Dept.)

Head abnormalities found on Plains barley when treated with ester form of 2,4-D at time heads were being formed. Yield is decreased in proportion to the number of head abnormalities.
By C. W. Carlson and Wm. Kohlmeyer

During the growing season for turkeys, new-crop oats are a relatively plentiful and economical cereal in South Dakota. In view of this, a series of feeding trials was conducted to determine to what extent oats could be used in the turkey growing ration as a replacement for corn. The results suggest that turkeys can consume a great amount of oats, and therefore a great amount of fiber without being retarded in growth. It would also seem that replacing corn in the diet with oats will not hamper the development of the birds.

Trials Substitute Oats for Corn

All stock used for the trials was from the same strain, a medium-sized Broad Breasted Bronze, bred at the South Dakota Agricultural Experiment Station for the past several years.

The turkeys were placed on green range at approximately 11 weeks of age and were fed a control diet until the start of each trial. Free access to oyster shells and granite grit was provided. The number of turkeys varied from 60 to 90 birds of mixed sex per pen. Individual weights were taken at intervals of four weeks maximum, and feed consumption records were also kept for each period.

The first three trials, in 1946, 1947, and 1948, were conducted with a free-choice system of feeding mash and a grain mixture. In the experiments of 1946 and 1947 the grain mixture consisted of equal parts oats and corn; the oats level was increased in the mash by replacing the corn. In 1948 the oats level was increased 67 1/2 percent for one pen. For this pen the grain mixture was also altered to one-fourth corn to three-fourths oats. It will be noted in Table 1 that the actual levels of oats consumed did not markedly differ from the calculated levels.

In the last three trials, conducted in 1949, 1950 and 1951, only an all-mash diet was used. In these experiments, the level of oats in the diet was increased from a 10 percent level to an 80 percent level, the 80 percent level meaning that oats completely replaced corn in the diet (Table 1).

Weights and Rate of Growth Not Affected by Level of Oats Used

The results on final body weights are given in Tables 2 and 3. It will be noted that the age at termination for the trials in 1946 and 1947 was 26 weeks, whereas the age at term-
Rape was used as a forage crop in these trials.

mination for the other trials was 28 weeks. The data show that there is no definite trend in final weight differences for either the males or females.

Examination of data available, but not given here, for earlier weight periods shows that the rates of growth were not affected by the levels of oats used in the diets. The turkeys on the lower levels of oats did not grow any faster and reach market size any sooner than the birds on higher level of oats.

Difference Lies in Feed Efficiency

The difference in high and low level of oats in the diet, lies in the feed efficiency. Figures for the entire period for which records were

### Table 1. Calculated and Actual Level of Oats in the Turkey Diets*

<table>
<thead>
<tr>
<th>Calculated Oats Level</th>
<th>Actual Oats Level Consumed</th>
<th>1946</th>
<th>1947</th>
<th>1948</th>
<th>1949</th>
<th>1950</th>
<th>1951</th>
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<tbody>
<tr>
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<tr>
<td>40</td>
<td></td>
<td>36.6</td>
<td>39.4</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>45</td>
<td></td>
<td>43.2</td>
<td>45.0</td>
<td>45.7</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
<td>50</td>
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<tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>60</td>
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<tr>
<td>67 1/2</td>
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<td>70.1</td>
<td></td>
<td>67 1/2</td>
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<td></td>
<td></td>
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<td>80</td>
</tr>
</tbody>
</table>

*These diets consisted of approximately 80% of corn and/or oats, 10% soybean meal, 5% meat scraps, 2% dried buttermilk, 2% alfalfa meal, and 1% salt. In 1930, the soybean meal and alfalfa meal were changed to 7% and 4% respectively, and 5% of steamed bone meal was added. In 1951, 5%, wheat bran and 5%, standard wheat middlings were used in place of 10% of the corn, except for the 80% oats diet where the wheat by-products were not used. Niacin was added to this diet at 6 m/g. The soybean meal in this trial was varied from 5 to 8% in keeping the calculated protein level constant at 16%.

†In this diet only the oats content in the mash was increased; the grain mixture being constant at 50% oats to 50% corn.

‡In this trial the grain mixture was altered to one-fourth corn to three-fourths oats.
available are shown in Table 4. The length of time and period involved, shown at the head of the columns, indicate why the figures for 1949 are high and therefore show a poorer efficiency. This is due to the fact that there is a reduced efficiency at the older ages when the growth rate is slowed down. Those for 1946 and 1947 are low, showing a better efficiency in feed conversion.

It will be noted that for the years 1946, 1947 and 1948, in which the free-choice system of feeding was used, there is no definite trend in the efficiency of feed conversion. On all-mash feeding, it appears that better efficiency is obtained on the lower levels of oats feeding. It is difficult to tell from this just at what level feed efficiency was reduced.

Corn Supplies One Third More Calories Than Oats

Examination of feed efficiency as related to calculated available energy allows for a more definite conclusion. The data, as shown in Table 5, indicate that about 850 calories of available energy per pound of diet are required for maximum feed efficiency. There is just a hint that higher energy levels may be somewhat more efficient; however, the irregularity shown by the 859-calorie diet for 1949 is difficult to interpret.

In general, as the oats increased, replacing corn, the calorie value of the diet decreased, since corn supplies about one-third more calories than oats. Slight variation in diets between years makes for considerable variation in calorie content.
Table 4. Feed Efficiency—Pounds of Feed Per Pound of Gain

<table>
<thead>
<tr>
<th>Oats Level %</th>
<th>12-25</th>
<th>Weeks of Trial*</th>
<th>16-28</th>
<th>20-28†</th>
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<tr>
<td>10</td>
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<td>45</td>
<td>5.66</td>
<td>5.42</td>
<td>6.75</td>
<td>8.50</td>
<td>6.44</td>
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<tr>
<td>50</td>
<td>5.39</td>
<td>5.46</td>
<td>7.15</td>
<td>10.36</td>
<td>6.08</td>
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<td>55</td>
<td>5.47</td>
<td>5.57</td>
<td>6.61</td>
<td>9.39</td>
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<tr>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.74</td>
</tr>
<tr>
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<td>70</td>
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<td>6.79</td>
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<tr>
<td>80</td>
<td></td>
<td></td>
<td>6.73</td>
<td>6.88</td>
<td></td>
</tr>
</tbody>
</table>

*Refers to the age of the turkeys at the beginning and end of the feeding trials.
†These were older birds at the start of the trial, and therefore show a reduced feed efficiency as indicated by the higher figures.

Low Cost of Oats Makes Up for Small Loss in Feed Efficiency

Maximum feed efficiency was achieved when the diet contained 847 calories of available energy per pound, with the oats level at 50 percent and the fiber content at about 8 percent. If this maximum feed efficiency level is compared to the 80 percent oats level in the diet, with a fiber content of 11 percent and the available calories at 720 per pound, a loss of 10 to 15 percent in feed efficiency occurs (Table 5). But this loss is of no great concern to the South Dakota farmer if he can bring his turkeys to market as fast with a high level of comparatively cheap oats as with a high level of costly corn. This will be true as long as new-crop oats remain relatively cheap compared to held-over corn.

(Project 52. Leaders C. W. Carlson, Wm. Kohlmeyer, Poultry Department; A. L. Moxon, Station Chemistry Department.)

Table 5. Effect of Available Dietary Energy on Feed Efficiency

<table>
<thead>
<tr>
<th>Calories per Lb.*</th>
<th>Oats Level %</th>
<th>Fiber Content %</th>
<th>1949</th>
<th>1950</th>
<th>1951</th>
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<tr>
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<tr>
<td>880</td>
<td>45</td>
<td>6.9</td>
<td>8.50</td>
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<td>859</td>
<td>50</td>
<td>7.4</td>
<td>10.36</td>
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<td>847</td>
<td>50</td>
<td>8.1</td>
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<td>6.08</td>
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<tr>
<td>838</td>
<td>55</td>
<td>7.9</td>
<td>9.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>816</td>
<td>40*</td>
<td>8.2</td>
<td></td>
<td></td>
<td>6.44</td>
</tr>
<tr>
<td>806</td>
<td>60</td>
<td>9.1</td>
<td></td>
<td>6.74</td>
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</tr>
<tr>
<td>786</td>
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<td>9.2</td>
<td>11.15</td>
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<td></td>
</tr>
<tr>
<td>767</td>
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<td>720</td>
<td>80</td>
<td>11.6</td>
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<td>6.88</td>
</tr>
</tbody>
</table>

*Available energy content was calculated for the total ration, and the apparent discrepancies are due to the change of supplements between years.
During the first warm days of spring, the heel flies begin egg laying. In attempting to avoid the flies, the cattle run wildly about the pasture or range. The eggs are glued to the hair, preferably on the lower part of the legs and flanks of the host animals. After about a week, the eggs hatch into small larvae which make their way down the hair and burrow through the skin.

By W. L. Berndt and H. C. Severin

Economic losses in the United States caused by cattle grubs and heel flies have been estimated at 150 million dollars per year. The average rancher usually does not realize that he is paying his share of this loss. The most apparent loss to a rancher is noted in the spring when the heel flies become active. Cattle attempting to avoid the egg-laying heel flies may stampede through fences. More often they run into brush, or seek shelter in water or in the barns and spend the greater portion of a day in such places instead of grazing.

The packer experiences considerable loss when carcasses come through the plant with the backs and loins covered with a mass of yellowish matter and grubs. This entire mass, plus much of the surrounding flesh, must be trimmed away leaving the backs and loins badly gouged. Since nearly all the trimming is done over the loin, and this is a highly valuable portion of the beef animal, naturally a packer is concerned when too much trimming must be done.

Besides ruining choice cuts of meats, grub holes are made in the back portion of the hide which is the most desirable portion for leather. Any hide with more than five grub holes is classed as "grubby" and brings a lower price from the tanner.

These losses suffered by packers and manufacturers are passed back to the producer in the form of lower prices for his cattle.

Two Kinds of Cattle Grubs

In South Dakota there are two species of heel flies which attack cattle, the common heel fly (Hypoderma lineatum) and the northern heel fly (Hypoderma bovis.) The habits of these two species differ somewhat. (For a detailed account of life cycles and seasonal histories, see Farm and Home Research, Vol. 1, No. 2, pp. 43-45.) During the latter part of December or the fore part of January, the larvae of the common grub usually begin to appear under the skin on the backs of
cattle; in the case of the northern grub, the larvae do not begin to appear until March. Grubs may be found under the skin on the backs of livestock from late in December into early June in South Dakota. Emergence of the flies begins with the first warm days of spring.

**Rotenone Kills Grubs**

At the present time the only insecticide known to kill cattle grubs effectively and safely is rotenone. In applying rotenone to the backs of cattle, three methods may be employed, power spraying, hand dusting and hand washing.

In power spraying, 7½ pounds of powder containing 5 percent rotenone per 100 gallons of water is used. This material is applied at a pressure of 400 to 600 pounds per square inch in a narrow driving stream rather than as a mist or fog. The spray nozzles should have discs that have at least a 5/64-inch aperture. Nozzles should be operated about 18 inches from the back of the animal, and care should be taken to cover thoroughly an area of about 10 inches on each side of the spine from the shoulders to the base of the tail. Usually 100 gallons of spray is sufficient to treat 100 to 150 head of cattle.

A dry dust containing one part of 5 percent rotenone plus two parts of some inert carrier such as tripoli earth or pyrophyllite may be used to destroy cattle grubs. Many commercial dusts are available on the market all mixed and ready for use. These usually are labeled as containing 1.67 percent rotenone.

The dry dust should be applied by means of a shaker can or jar. (An effective shaker can be made from a quart or pint fruit jar fitted with a lid in which 10 or 12 holes have been punched with a 10-penny nail.) About three ounces of dust should be applied to the back of each animal and rubbed in well with the finger tips with a rotary motion. Some people prefer to use a stiff brush, but, unless the brush is kept clean, it will soon foul with loose hair and become ineffective.

A method fast coming into popularity is the hand washing method. Twelve ounces of 5 percent rotenone is stirred into one gallon of warm water along with one-third of a cup of granulated laundry soap. A pint to a quart of this mixture is poured slowly on the back of the animal and thoroughly scrubbed into the hair coat with a stiff, long-bristled brush. One of the better brushes sells in the hardware stores as a cream can brush. Water may be heated alongside the holding chute with a wood fire, camp stove, or a weed burner. A stove used to heat branding irons makes a very effective heater for water. The hand washing operation avoids the unpleasantness of breathing the dust which is often very irritating to many people.

**Number of Treatments**

The number of treatments per year that should be given cattle varies somewhat. In general, grubs appear in the backs of cattle from January to June with a separate peak of abundance for each species. The first treatment should be timed to come about one month after the first grubs appear. Subsequent treatments should be made at
monthly intervals until no new grubs make their appearance.

**Area Control Important**

One of the most important phases of the grub control project was to set up two experimental control areas in South Dakota to determine whether such areas could be freed of cattle grubs through practical control measures; or, if this were not possible, to reduce the population of grubs to such numbers that they would be of minor importance. Accordingly, the Hughes and Meade County grub control areas were established.

The Hughes County area was organized in 1948 and covered about a township. There were 37 cooperators in the area and from 2500 to 3000 cattle were treated at that time. In 1951 the area was expanded to 12 townships with 144 cooperators, and 19,000 head of cattle were treated. In this year, three townships in Hyde County were added to the Hughes County control area. This addition accounted for the principal expansion in 1951.

Herds located in the center of the Hughes County control area, in which the cattle had been treated for four years, showed a 92 percent reduction of grubs as compared with cattle outside of the area.

The Meade County area was also organized in 1948 and covered about 1½ townships. There were 20 cooperators in the area and 1800 to 2000 cattle were treated. The area remained unchanged in 1949 and 1950 with the same number of cooperators and the same number of cattle being treated. In 1951 this area was expanded to 5½ townships, the cooperators increased to 37, and the cattle treated, to 4000 head.

In the Meade County control area, centrally located herds showed a reduction of 67 percent below untreated herds immediately outside of the area. Herds located on or near the edges of the two areas showed a reduction of grub infestation below untreated herds, but the percent of reduction of grubs here was not as large as it was in the center of the areas.

**Spraying and Washing Methods Prove Effective**

Spraying and washing are the two more popular and effective methods of treating cattle for grub control in South Dakota. About 75 to 85 percent of the third stage grubs were killed by spraying, 85 to 90 percent by washing, while dusting killed only 68 to 70 percent.

Spraying is popular with the rancher who runs a large herd. Washing is more popular with the small operator, because it has the advantage of low cost investment, but it has a disadvantage in that the operation requires more labor. Dusting is more popular with the dairy operators, but it has the disadvantage of being unpleasant to use and, in addition, it results in the lowest rate of grub kill.

Through experimentation it was learned that grub control programs on an area basis reduce grub populations. It is advisable to obtain close to 100 percent cooperation of all the cattle owners in an area in order to get the maximum control benefits. (Project 163, Cooperative. Leaders: J. A. Lofgren, W. L. Berndt, P. H. Kohler, Entomology-Zoology; I. H. Roberts, USDA-BAI.)
Recent POPULATION CHANGES IN SOUTH DAKOTA

By JOHN P. JOHANSEN

Both pre-school children and elderly persons are increasing in numbers in South Dakota.

Many small towns and villages accepted with dismay and disbelief the 1950 census figures which showed that their population had decreased. Counting the new housing and new businesses, they had expected that they would hold their own.

Some population facts have specific legal significance. In South Dakota, cities and towns are classified by law according to the number of their inhabitants. Federal and state aid is allotted on a population basis. School officials are keenly interested in the new tide of youngsters in many urban communities and are also concerned about the continued decreases in rural areas. In fact, all types of business, professional and government services are dependent upon a fairly stable sustaining population.

It is far from sufficient, however, to know merely the number of individuals who live in a given area. Population changes are very complex. They affect not only the number of inhabitants of a given area but also their characteristics with regard to sex, age, nativity and race or other traits. Births increase and deaths decrease the total count. People move from one place to another. They change their marital status, their occupation, their residence. The passing of time in itself means that the people are older.
Net Migration of 79,000 Persons From the State

The simple question: "Did South Dakota gain or lose population from 1940 to 1950?" would have to be answered with two apparently contradictory statements (1) that the state had 9,779 more inhabitants on April 1, 1950 than it had 10 years before; and (2) that the state lost 79,000 persons by net migration during these 10 years (Table 1).

South Dakota did not hold its own from 1940 to 1950. It had a deficit of 79,000 persons because of greater migration from the state than to it. Many more than that number left the state but others came in their place so that the net movement balanced at that figure.

Natural increase is the excess of births over deaths. In 1948, it amounted to 10,599 persons. It was estimated to be 89,000 persons for the whole decade. Therefore, if no migration had taken place the state should have had 89,000 inhabitants more in 1950 than in 1940. The actual increase was only 9,779 persons. It follows that the state lost about 79,000 persons through migration.

But all of the surrounding states suffered a similar fate. North Dakota was one of the four states in the nation (along with Arkansas, Mississippi, and Oklahoma) which had an actual loss of population from 1940 to 1950. But what is perhaps even more arresting and thought-provoking is the fact that a net migration of 202,000 persons occurred from the wealthy agricultural and industrial state of Iowa.

Now the migration of youth in pursuit of opportunity is a time-honored American tradition. It has one distinct consequence: It leaves the old folks at home.

South Dakota's Population Is Aging Rapidly

Although it is only 63 years ago since South Dakota was admitted to the Union as a young, buoyant frontier state, it has now, because of the continued "export" of its youth, a larger proportion of aged in its population than has the nation as a whole. The comparative figures were 8.5 percent for South Dakota and 8.2 percent for the United States.

Table 1. Natural Increase of Population and Net Migration from 1940 to 1950 in South Dakota and Surrounding States

<table>
<thead>
<tr>
<th>State</th>
<th>Population 1940</th>
<th>Population 1950</th>
<th>Increase Decrease Number</th>
<th>Natural Increase Number</th>
<th>Net Migration Number % of 1940 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Dakota</td>
<td>642,961</td>
<td>652,740</td>
<td>9,779</td>
<td>89,000</td>
<td>-79,000</td>
</tr>
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<td>North Dakota</td>
<td>641,935</td>
<td>619,636</td>
<td>-22,299</td>
<td>98,000</td>
<td>-121,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>2,792,300</td>
<td>2,982,483</td>
<td>190,183</td>
<td>361,000</td>
<td>-171,000</td>
</tr>
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<td>Iowa</td>
<td>2,538,268</td>
<td>2,621,073</td>
<td>82,805</td>
<td>284,000</td>
<td>-202,000</td>
</tr>
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<td>Nebraska</td>
<td>1,315,834</td>
<td>1,325,510</td>
<td>9,676</td>
<td>146,000</td>
<td>-136,000</td>
</tr>
<tr>
<td>Wyoming</td>
<td>250,742</td>
<td>290,529</td>
<td>39,787</td>
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<td>-1,000</td>
</tr>
<tr>
<td>Montana</td>
<td>559,456</td>
<td>591,024</td>
<td>31,568</td>
<td>72,000</td>
<td>-40,000</td>
</tr>
</tbody>
</table>

This aging of the whole population is a gradual, unspectacular change which affects the whole economy and the social institutions of the state. The age of those at the helm colors the outlook and limits the energy and enterprise of business and industry. Larger numbers of farm operators and farm homemakers are of advanced years. Families are older and smaller. There are fewer children under 21 at home.

Robert Browning was an inveterate optimist when he said:

"Grow old along with me
The best is yet to be
The last for which the first was made."

Not many accumulate the means of carefree retirement in Florida or California. Old age brings in its wake a host of problems: chronic illness, frail health, mental infirmity, widowhood and bereavement, retirement, social insecurity, and general dependency upon others.

Fewer Youths From 15 to 24 Years of Age

Several important points are indicated by the data in Table 2. The state as a whole experienced great increases: (1) in children under 5 years (32.4 percent), and (2) in elderly and aged persons 65 years and over (24.4 percent). But most age groups from 5 to 55 years show decreases.

The census counted 18,382 fewer youths from 15 to 24 years of age, a decline of 15.4 percent. In this age group, however, the urban areas gained 22.1 percent; the rural-nonfarm lost 17.2 percent; and the rural-farm areas lost 33.4 percent. One rural-farm youth is gone for every two who are now there.
Increases of Children Under 5 Years

In the age group of children under 5 there were some striking changes. In urban areas there was an increase of 97.1 percent; in the rural-nonfarm classification the increase was 29.7 percent; but in the rural-farm area, the increase was only 5.7 percent from 1940 to 1950. This increase of children under 5 years is due to the extraordinary rise of the birth rate. In 1950, the provisional number of births was 18,532. This was the largest number on record but it may be exceeded in 1951. An even more important point is that the urban birth rate is higher now than the rural, the former being 28.4 and the latter 23.7 per 1,000 population according to estimates for 1948. The marked differences in rural and urban increases in preschool children also corroborate the conclusion that the rural-farm population is not reproducing itself as extensively as it did (Table 3).

These changes in the age structure of the population are of great significance for the social institutions of the state. A few of them may be pointed out. Cities have experienced a drastic housing problem. Elementary school buildings are crowded and new buildings are being planned in many urban districts. Homes for the aged are also...
sorely needed. As has been brought out, both pre-school children and elderly people are increasing in numbers while young and mature adults are decreasing. In other words, in South Dakota we have now, and can expect during the next two decades, a larger proportion of dependents in relation to supporters. Furthermore, these population trends are the result of long-operating forces which are regional and national in the scope of their influence. It is not reasonable to expect that they can be materially counteracted unless an extensive and effective program of resource development, such as that of the Missouri basin projects, can be brought about.

Migrants From State Mostly Youths and Young Married Adults

What evidence is there that it is youths and young adults who are leaving the state? Very detailed data for the 1950 census are not yet available. Nevertheless, it is possible to obtain an answer on the basis of the data in Table 2.

Instead of the comparison of age-groups which has just been made, a different method may be suggested. It involves, for example, comparing the group 5 to 14 years of age in 1940 with the ten-year-older group (15 to 24 years) in 1950. In this important instance there was a decrease of 19,364 persons. Taking the next older group, those who were 15 to 24 in 1940 and who would be 25 to 34 in 1950, there was a decrease of 25,573 persons. These decreases are to be attributed either to deaths or to migration out of the state. Since the death rate in these age groups is relatively small, it follows that the main cause is found in the greater migration from the state than into it.

Extensive Urban-Rural Shift of Population

The second main trend is the shift of population from rural areas to urban centers. The increase of urban population (all incorporated places having 2,500 inhabitants or more) from 1940 to 1950 was greater than that of any earlier decade in the history of the state. The urban population now accounts for 31.1

Table 4. Rural and Urban Residence of the Population of South Dakota from 1920 to 1950

<table>
<thead>
<tr>
<th>Class</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>636,547</td>
<td>692,849</td>
<td>642,941</td>
<td>652,740</td>
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<tr>
<td>Urban*</td>
<td>101,872</td>
<td>130,907</td>
<td>158,087</td>
<td>216,157</td>
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<td>Rural</td>
<td>534,675</td>
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<td>484,874</td>
<td>436,583</td>
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<td>Rural-Nonfarm</td>
<td>172,789</td>
<td>172,511</td>
<td>178,204</td>
<td>183,088</td>
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<td>Rural-Farm</td>
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<td>389,431</td>
<td>306,670</td>
<td>253,495</td>
</tr>
<tr>
<td>Percent (Total)</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Urban</td>
<td>16.0</td>
<td>18.9</td>
<td>24.6</td>
<td>31.1</td>
</tr>
<tr>
<td>Rural</td>
<td>84.0</td>
<td>81.1</td>
<td>75.4</td>
<td>66.9</td>
</tr>
<tr>
<td>Rural-Nonfarm</td>
<td>27.1</td>
<td>24.9</td>
<td>27.7</td>
<td>28.1</td>
</tr>
<tr>
<td>Rural-Farm</td>
<td>56.9</td>
<td>56.2</td>
<td>47.7</td>
<td>38.8</td>
</tr>
</tbody>
</table>

*Using here the old urban definition. Data from United States Census of Population: 1950, South Dakota—Number of Inhabitants, p. 41-8, and Release, July 8, 1951, Series PC-12, No. 31, Table 2. One urbanized area with 553 inhabitants was included in the rural-nonfarm classification for 1950.
Fig. 2. Increase of urban population was greater (1940-50) than that of any earlier decade.

A chart showing the population of South Dakota urban and rural, 1920-1950.

percent of the state's total. In 1930, when the state reached its largest census total (692,849 inhabitants), the urban population was only 18.9 percent of the total (Table 4).

On the other hand, the rural-farm population has fallen off sharply from 389,431 in 1930 to 253,495 in 1950, or from 56.2 to 38.8 percent of the total population. The rural-non-farm population (which is approximately the same as the population of incorporated and unincorporated places of less than 2,500 inhabitants) has remained fairly constant.

There are now 25 places in the urban classification with a total population of 216,157. Two cities experienced a very rapid growth. Rapid City grew by adding 11,466 to its total, or 82.8 percent. Sioux Falls added 11,864 to its total, or 29.1 percent. The main cities of the James River Valley—Aberdeen, Huron, and Mitchell—grew by more modest increases. Six places—Belle Fourche, Lemmon, Redfield, Spearfish, Webster, and Winner—had increases in population above the 2,500 mark which gave them rank as urban centers.

The rapid growth of cities, not only in the state, but in the nation and the world over, has many implications. At present, the world's population is growing faster than its food supply. Cities are great consumers of food, water, milk, fuel, light, sanitation, transportation, and many other basic necessities. Food and water are indispensable. Cities are possible because agriculture is capable of feeding them. But if agricultural production is unstable or precarious, the situation of the cities is vulnerable indeed. This is one aspect of the justification for a program designed to increase and stabilize South Dakota's agricultural production.

**Farm Population Declines**

The farm population has been declining over the last 25 years, but the decrease was especially pronounced.

Continued on page 76
By Richard F. Wilson

Benefits from feeding antibiotics and vitamin B₁₂ to pigs during the suckling period and the growing-fattening period have been reported by many experiment stations. Such benefits include greater daily gain, less time from farrowing to market, greater appetites, less feed to produce a hundred pounds of gain, smoother hair coats, and reduced occurrences of scouring and similar intestinal disorders.

Because of the cost of these supplements, it seemed worth while to learn what would be the effects if feeding the supplements were to be discontinued after the pigs reached 125 pounds in weight.

An experiment was conducted at the Experiment Station at Brookings where vitamin B₁₂ plus aureomycin, as well as terramycin were fed to pigs in the summer of 1951. This experiment brought out the above-mentioned favorable results when the feeding of antibiotics and

These pigs were fed vitamin B₁₂ and antibiotics, in an experiment to find out what the effects would be if the supplements were discontinued after the pigs reached 125 pounds in weight.
vitamin B₁₂ was continued until the pigs reached a desirable market weight (225 pounds). These pigs reached market more uniformly than those not receiving the supplement.

The pigs fed these supplements to 125 pounds only, did better than those pigs which did not receive the supplements at all during the trial, but not as well as those that received them through the entire feeding period. The feed cost per 100 pounds of gain was approximately the same for all lots fed the supplements, except for the lot that was fed terramycin all through the trial. For this lot, the cost was 10 cents less.

How the Experiment Was Set Up

Seventy-five pigs averaging about 50 pounds in weight were allotted into five comparable lots according to litter, sex, weight and breed. The four breeds represented were: Hampshire, Spotted Poland China, Duroc, and Poland China. They were fed and housed on concrete and had access to self-waterers. The pigs in Lot I (control lot) received the following basal feeds:

Shelled No. 2 yellow corn, self-fed
Protein supplemental mixture, self-fed, consisting of:
- 42 parts of soybean meal
- 30 parts of tankage (60 percent crude protein)
- 28 parts of ground, sun-cured alfalfa hay

Simple mineral mixture, self-fed, consisting of:
- 40 parts of ground feeding limestone
- 40 parts of steamed bonemeal
- 20 parts of common salt

For Lots II and III, three pounds of alfalfa hay in the protein supplement were replaced by three pounds of vitamin B₁₂-aureomycin supplement (Aurofac³). Lot II received this protein supplement until the pigs reached market weight, and Lot III, until the pigs reached about 125 pounds, after which they received the same feed as Lot I.

For Lots IV and V, one pound of

³Supplied by Lederle Laboratories, Pearl River, N. Y.

Table 1. Results From Beginning of Trial Until Pigs Reached Approximately 125 Pounds

<table>
<thead>
<tr>
<th>Items Compared</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
<th>Lot V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pigs</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Average number days on feed per pig</td>
<td>49.7</td>
<td>49.5</td>
<td>50.5</td>
<td>50.1</td>
<td>50.5</td>
</tr>
<tr>
<td>Average initial weight per pig, lbs.</td>
<td>116.1</td>
<td>136.7</td>
<td>134.5</td>
<td>136.9</td>
<td>132.7</td>
</tr>
<tr>
<td>Average final weight per pig, lbs.</td>
<td>66.4</td>
<td>87.2</td>
<td>84.0</td>
<td>86.8</td>
<td>82.2</td>
</tr>
<tr>
<td>Average total gain per pig, lbs.</td>
<td>1.36</td>
<td>1.78</td>
<td>1.71</td>
<td>1.77</td>
<td>1.68</td>
</tr>
<tr>
<td>Feed Consumed Per Pig</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily grain, lbs.</td>
<td>3.43</td>
<td>4.54</td>
<td>4.44</td>
<td>4.26</td>
<td>4.04</td>
</tr>
<tr>
<td>Average daily protein supplement, lbs.</td>
<td>.96</td>
<td>.92</td>
<td>.84</td>
<td>.92</td>
<td>.84</td>
</tr>
<tr>
<td>Feed Consumed Per 100 Lbs. of Gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelled Corn, lbs.</td>
<td>252.9</td>
<td>250.3</td>
<td>258.8</td>
<td>240.5</td>
<td>241.3</td>
</tr>
<tr>
<td>Protein supplement, lbs.</td>
<td>71.0</td>
<td>51.9</td>
<td>50.4</td>
<td>52.2</td>
<td>50.2</td>
</tr>
<tr>
<td>Vitamin B₁₂ and Antibiotics Consumed Per Lb. of Total Feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B₁₂, micrograms</td>
<td>9.2</td>
<td>8.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aureomycin, milligrams</td>
<td>9.2</td>
<td>8.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terramycin, milligrams</td>
<td></td>
<td></td>
<td></td>
<td>8.9</td>
<td>8.6</td>
</tr>
</tbody>
</table>
### Table 2. Results From Time Pigs Weighed Approximately 125 Pounds Until Market Weight

<table>
<thead>
<tr>
<th>Items Compared</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
<th>Lot V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pigs</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Average number days on feed per pig</td>
<td>61.9</td>
<td>45.0</td>
<td>48.1</td>
<td>45.0</td>
<td>53.0</td>
</tr>
<tr>
<td>Average initial weight per pig, lbs.</td>
<td>116.1</td>
<td>136.7</td>
<td>134.5</td>
<td>139.2</td>
<td>132.7</td>
</tr>
<tr>
<td>Average final weight per pig, lbs.</td>
<td>228.3</td>
<td>227.5</td>
<td>225.2</td>
<td>225.2</td>
<td>225.9</td>
</tr>
<tr>
<td>Average total gain per pig, lbs.</td>
<td>112.2</td>
<td>90.8</td>
<td>90.7</td>
<td>86.0</td>
<td>93.2</td>
</tr>
<tr>
<td>Average daily gain per pig, lbs.</td>
<td>1.81</td>
<td>2.02</td>
<td>1.89</td>
<td>1.89</td>
<td>1.76</td>
</tr>
</tbody>
</table>

### Feed Consumed Per Pig

- Average daily grain, lbs.: 6.35
- Average daily protein supplement, lbs.: .78

### Feed Consumed Per 100 lbs. of Gain

- Shelled Corn, lbs.: 350.5
- Protein supplement, lbs.: 43.0

### Vitamin B₁₂ and Antibiotics Consumed Per Lb. of Total Feed

- Vitamin B₁₂, micrograms: 5.6
- Aureomycin, milligrams: 5.6
- Terramycin, milligrams: 6.3

### Table 3. Results of Feeding Antibiotics and Vitamin B₁₂ to Pigs (All Feeding Periods)

<table>
<thead>
<tr>
<th>Items Compared</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
<th>Lot V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pigs</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Average number days on feed per pig</td>
<td>110.9</td>
<td>94.0</td>
<td>97.1</td>
<td>94.0</td>
<td>102.0</td>
</tr>
<tr>
<td>Average initial weight per pig, lbs.</td>
<td>49.7</td>
<td>49.5</td>
<td>50.5</td>
<td>51.7</td>
<td>50.5</td>
</tr>
<tr>
<td>Average final weight per pig, lbs.</td>
<td>228.3</td>
<td>227.5</td>
<td>225.2</td>
<td>225.2</td>
<td>225.9</td>
</tr>
<tr>
<td>Average total gain per pig, lbs.</td>
<td>178.7</td>
<td>178.0</td>
<td>174.7</td>
<td>173.5</td>
<td>175.4</td>
</tr>
<tr>
<td>Average daily gain per pig, lbs.</td>
<td>1.61</td>
<td>1.89</td>
<td>1.80</td>
<td>1.84</td>
<td>1.72</td>
</tr>
</tbody>
</table>

### Feed Consumed Per Pig

- Average daily grain, lbs.: 5.06
- Average daily protein supplement, lbs.: .86
- Average daily mineral, lbs.: .03
- Average daily feed, lbs.: 5.95

### Feed Consumed Per 100 lbs. of Gain

- Shelled corn, lbs.: 314.2
- Protein supplement, lbs.: 53.4
- Mineral mixture, lbs.: 2.1

- Total, lbs.: 369.7

- Feed Cost Per 100 lbs. of Gain: $11.12

### Vitamin B₁₂ and Antibiotics Consumed Per Lb. of Total Feed

- Vitamin B₁₂, micrograms: 7.2
- Aureomycin, milligrams: 7.2
- Terramycin, milligrams: 7.4

Alfalfa hay in the protein supplement was replaced with one pound of a terramycin supplement (TM-5). Lot IV received this protein supplement until the pigs reached market weight, and Lot V, until the pigs reached about 125 pounds, at which time these pigs were put on the same feeds as Lot I. The amounts of vitamin B₁₂ and antibiotics actually consumed per pound of total feed during the two periods are shown in Tables 1, 2 and 3.

*Supplied by Chas. Pfizer and Co., Chicago, Illinois.*
Definite Advantages Result
Until the pigs reached about 125 pounds in weight (Table 1) those fed the terramycin and those fed the aureomycin plus vitamin B₁₂ made much faster gains, ate more, and required less feed to make their gains than did the control pigs (Lot I), although the control pigs made good daily gains (1.36 pounds per head per day).

During the growing-fattening period, from 125 pounds to market weight (Table 2), the pigs in the control lot made faster daily gains than did the pigs which had received terramycin up to 125 pounds (Lot V), but less than those which had received the aureomycin and vitamin B₁₂ to the same weight (Lot III). Appetites were somewhat greater in the lots which received the antibiotics during this period. Feed efficiency in the control lot tended to be comparable with the feed efficiency in the other lots, except for the lot which received the vitamin B₁₂ and aureomycin to 225 pounds (Lot II). During this period one pig died in Lot IV of causes not due to the treatment in this trial.

The results for the entire feeding period are given in Table 3. Daily gains, feed eaten per pig per day, and feed required per 100 pounds of gain were all advantageous for those lots which received an antibiotic plus vitamin B₁₂ or an antibiotic only, especially in those lots receiving these supplements during the entire feeding period.

From these results, it is obvious that the feeding of aureomycin and vitamin B₁₂, or of terramycin, produced very definite advantages as to feed efficiency and rate of gain. Although the differences in feed cost per 100 pounds of gain were not large, the feed cost was highest in the control lot and lowest in the lot which received terramycin throughout the test. Also, the pigs fed the antibiotics were more uniform than the controls. This was reflected in the number of days from the time the first pig in a lot reached 225 pounds until the last pig in the lot reached this weight. This period of time was less in the lots which received the antibiotics than in the control lot.

The control pigs were marketed during the first week in October (average marketing date, October 4). The average marketing date for Lot II was September 17, for Lot III, September 20, for Lot IV, September 17 and for Lot V, September 25. Though the control pigs were the last lot to reach market, they brought more per hundred weight on the Sioux Falls central market due to the rather unusual hog market price trend in the fall of 1951. However, when determining the value of feeding these supplements, certain other items of cost should be considered. These include the cost of the extra labor required by the control pigs to reach market weight, interest on investment, and risk.

In order to determine the effect of vitamin B₁₂, aureomycin and terramycin upon the carcass of swine, eight barrows from each lot were slaughtered at the conclusion of the test. These data are not summarized to date but will be reported later. (Project 213. Leader: R. F. Wilson, Animal Husbandry Dept.)
Farm-grown feeds may be deficient in some of the needed minerals.

**MINERALS IN SOUTH DAKOTA FEEDS**

By George Gastler and O. E. Olson

The animal body requires at least fourteen mineral elements for normal growth or function. Some are required in comparatively large amounts and may be referred to as the principal minerals. Others need to be present in such small amounts that they are called trace minerals. All fourteen minerals, listed below, are found in farm-grown feeds, but in some cases they are present in insufficient amounts to supply the needs of animals. When this is the case, the deficient mineral must be fed as a supplement to the normal ration.

<table>
<thead>
<tr>
<th>Principal Minerals</th>
<th>Trace Minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Iodine</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Manganese</td>
</tr>
<tr>
<td>Calcium</td>
<td>Copper</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Iron</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Zinc</td>
</tr>
<tr>
<td>Potassium</td>
<td>Cobalt</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Fluorine</td>
</tr>
</tbody>
</table>

Not all of these minerals are reported on here because some of them (sulfur, potassium, magnesium, zinc and fluorine) are present in farm feeds at a level high enough so that deficiencies are not likely to occur in animals getting these feeds. On the other hand, sodium and chlorine are usually deficient, and allowing animals free access to salt, which contains these minerals, is a common and necessary practice.

Studies on South Dakota feeds must be made concerning the remaining two principal and five trace minerals to determine whether what is grown here can be expected to contain normal quantities of these minerals and what parts of the state are deficient in any of them. These studies have been under way for about three years now, and some of the results are reported here.
Analyses Made of Principal Minerals in Farm Needs

Calcium is generally in good supply in South Dakota soils. This does not mean, of course, that all of the South Dakota feeds are good sources of this mineral. It does mean, though, that it can be fairly certain that the feeds grown in the state contain normal amounts of this nutrient. If the soils were deficient, then some feeds listed as good sources of calcium might fall into a “fair” or “poor” class. A number of calcium analyses have been made on feeds grown in this state and no cases of unusually low values have been found. The work will be continued, however, to insure that the more humid areas within the borders of the state are free from calcium deficiency. It should be remembered in connection with calcium that water, especially hard water, may contribute appreciable amounts of this element to the nutrition of animals.

Phosphorus presents quite a different picture. Of the essential minerals likely to be in short supply in farm-grown feeds, it appears to be the first to need study. It is well known that many South Dakota soils are deficient in phosphorus, and some of the neighboring states have reported soils deficient in this nutrient near the South Dakota borders. This, in addition to the excellent response of crops to phosphorus fertilization, points toward a rather serious deficiency.

Several factors act in determining the phosphorus content of feeds.
Fig. 1 illustrates how two of these, type of crop and maturity when harvested, are concerned. The values indicated are averages of several values obtained on feeds from various parts of the state. Cereal grains are normally fair to good sources of phosphorus. Hays, too, are fair sources of this nutrient when they are cut at the proper stage and handled properly, but the three values for western wheatgrass show that the phosphorus content falls to a low level when the wheatgrass is allowed to mature to the seedripe stage before harvesting. All hays follow this same general pattern, and those that are fairly good sources of this mineral when cut early are poor sources when cut late.

Rainfall, climate and variety of the crop will also cause variations from the average values for phosphorus content for a feed crop. However, soils low in available phosphorus may produce phosphorus deficient feed, even if all other factors influencing phosphorus content, such as rainfall, climate, and variety of crop, are at their best. In one area of the state where studies have been carried on for four years, it has been found that the average phosphorus content of bluegrass at eighteen different sites varied from 0.085 percent to 0.204 percent. The cause for this variation is due to differences in available phosphorus in the soils. Although this study was not the detailed type that would allow for accurate mapping of low-phosphorus areas, it has established a base for further work and demonstrates the need for continued study.

Trace Minerals Also Analyzed

Manganese determinations have been made on several feed samples from various locations in the state. In general, the values obtained were considerably lower than those published for grasses and grains from other states. There was considerable variation between samples from the various locations, indicating large differences in manganese availability in different soils. To date, however, no areas within the state are known where the manganese content of the feeds is so low as to cause deficiency symptoms in the animals.

Copper is considered deficient in the ration at a level of about 4 parts per million (ppm). Sixteen samples of hay from four different areas in the state believed possibly deficient in copper were examined for their content of this mineral. Eight of the samples contained 4 ppm or less of copper, but none were lower than 3.3 ppm. However, the generally low content of this nutrient makes a deficiency appear highly probable. Further studies on this element are planned for the coming growing season.

Cobalt was determined on the same samples used in the study on copper. This mineral appears to become limiting at levels of 0.04 to 0.07 ppm in the ration. None of the hays fell below 0.04 ppm, but eight of them fell within the range indicated as limiting. As in the case of copper, deficiencies appear probable and the work must be extended.

Iron analyses have been made on a large number of samples from var-
YOU CAN GROW MATURE CORN!

EASTERN PART OF THE STATE

For the eastern part of this state, mature corn can be grown most years by:

1. Using earlier hybrids
2. Planting earlier hybrids thicker, about 4 plants per hill
3. Planting only when the ground is warm, or about May 10 to May 20

CENTRAL PART OF THE STATE

In the central part of this state, more mature corn was produced by using earlier hybrids and planting them during the first three weeks in May at the rate of two or three plants per hill. The use of late hybrids often results in great losses in production and income, causes storage, feeding and spoilage problems and delays corn picking until cold and snowy weather.
A. N. Hume

In five of the past ten years considerable soft and immature corn has been produced in South Dakota. This not only has caused many problems, such as late harvesting, storage, drying, feeding, and spoilage, but has also greatly reduced the wealth and income from some 4,000,000 acres of our most productive land. This great loss is especially significant since it happened in years favorable for crop production.

In order to determine some of the factors that affect yield and maturity of corn, experiments were started in 1945 at Brookings and at Highmore. For these experiments three kinds of corn were used: An early corn, a corn with a medium growth period, and a full-season (not a late corn). With each hybrid the corn was planted thick and thinned as nearly as possible to two, three and four plants per hill. Hills were 42 inches apart in each direction. Also, each set (three hybrids, each at two, three, and four plants

Most farmers would prefer to harvest their corn early like the farmer is doing below. Planting late hybrids often delays the corn picking until the weather is cold and snowy.
Corn Yields Are Affected by:

<table>
<thead>
<tr>
<th>DATE OF PLANTING</th>
<th>PLANTS PER HILL</th>
<th>MATURITY OF HYBRID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAY 1</td>
<td>51.0</td>
<td>51.0</td>
</tr>
<tr>
<td>MAY 20</td>
<td>54.8</td>
<td>46.9</td>
</tr>
<tr>
<td>2 PER HILL</td>
<td>53.9</td>
<td>49.4</td>
</tr>
<tr>
<td>3 PER HILL</td>
<td>57.8</td>
<td>52.5</td>
</tr>
<tr>
<td>4 PER HILL</td>
<td>57.8</td>
<td></td>
</tr>
<tr>
<td>EARLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEDIUM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FULL SEASON</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

per hill) was planted on about May 1, and again on about May 20, at Brookings and at Highmore.

Each year, then, corn was grown in 18 different ways or combinations in the eastern as well as in the central section of this state. Except for the 1951 cool season, the growing conditions at these locations were quite favorable during the seven years of this study. A satisfactory stand and a crop worth harvesting was produced each year. The corn was harvested soon after a freezing frost (September 16 to October 19), and before it had a chance to lose much moisture, because other experiments also had to be harvested during the fall period. However, moisture samples were taken on each plot harvested and all yields corrected and adjusted to a uniform moisture basis. Yields are reported in bushels per acre with 15 percent moisture.

The corn in these experiments was grown on good soil that was fertilized and manured. Fertility, therefore, was not a limiting factor as the soil contained more plant food than was used by the various treatments. The average yields of corn (15 percent moisture) at the Station at Brookings are shown graphically under the heading "Corn yields are affected by:"

Plant May 10 to May 20 in Eastern Part of State

Note that in the eastern part of this state, corn planted about May 20, yielded more than that planted May 1. This is true not only as an average but also for each of the
seven years under test. The higher yields obtained on May 20 were due to the early- and medium-season hybrids, since the full-season hybrid produced about one bushel more per acre when planted on May 1. The results indicate, therefore, that in the eastern part of this state the ground should be warm before planting corn, so that the seedlings can continue to grow and their vigor not be delayed by colder weather. With early- or medium-season hybrids, lower yields can be expected if corn is planted too early. With full-season hybrids, early planting increased the yield by about one bushel over the later planting.

At Highmore, or in the central part of this state, the date of planting had little effect on the yield of corn. Results from seven years' trials show an average yield of 22.9 bushels when planted on May 1 and 23.4 bushels for the May 20 planting.

Greater Yields From 4 Plants Per Hill

The number of plants per hill greatly affected the yield of the early-, medium-, or full-season hybrids in the eastern part of the state. The average yields for all hybrids planted at the two dates were 46.9 bushels for two plants, 53.9 bushels for three plants and 57.8 bushels for four plants per hill. In the central part of the state, the number of plants per hill had little influence on corn yields. The yields were 22.9, 23.9 and 22.7 bushels per acre for two, three and four plants per hill, respectively, at Highmore.

At the main station at Brookings, when all treatments are averaged, the early hybrids did not produce as much corn as the medium- or full-season hybrids. It must be remembered, however, that this experiment was conducted on good fertile soil and fertility was not a limiting factor as it often is on many farms. Soils low in fertility delay maturity, reduce yield and increase the moisture content of the corn.

At Highmore, during this 7-year period, yield of corn was not affected by maturity of the hybrids used. The early hybrid produced 23.5 bushels, medium 23.0 bushels and full-season hybrid 23.0 bushels per acre.

Highest yielding hybrids are desirable, but moisture content or maturity is also very important and must be considered in choosing the proper corn. Soft and immature corn results in additional bulk, spoilage, storage, drying and feeding problems, as well as harvesting during cold and snowy weather. The moisture content of corn trials obtained at Brookings are shown in the graph. As mentioned earlier, the moisture percentages reported are higher, since this test had to be harvested soon after frost and before it had a chance to lose the normal moisture content.

Moisture Content Affected by Planting Date, Rate, and Maturity

It will be noted that the corn planted May 1 possessed less moisture than that planted May 20. The same was true at Highmore, since the average moisture content of corn planted on May 1 was 28.0 percent and on May 20, 31.5 percent. The number of plants per hill also
Moisture of Corn is Affected by:

<table>
<thead>
<tr>
<th>Date of Planting</th>
<th>Plants Per Hill</th>
<th>Maturity of Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAY 1</td>
<td>2  PER HILL</td>
<td>28.0</td>
</tr>
<tr>
<td>MAY 20</td>
<td>3  PER HILL</td>
<td>32.3</td>
</tr>
<tr>
<td>MAY 20</td>
<td>4  PER HILL</td>
<td>36.4</td>
</tr>
</tbody>
</table>

had some effect on the moisture content. For eastern South Dakota, corn with two plants per hill possessed about 2 percent less moisture than that having three and four plants per hill. At Highmore, corn with four plants per hill contained about 3 percent more moisture than that planted thinner.

As would be expected, the earlier hybrids contained less moisture than the later hybrids. At Brookings, the early-, medium- and full-season hybrids contained an average of 28.0, 32.3 and 36.4 percent moisture, respectively. At the Highmore sub-station, the average moisture percentages were 25.9 for early, 27.9 for medium and 30.9 for full-season hybrids.

Averages as reported above, and which include different maturity hybrids grown under varied conditions, show only general trends and reflect the kind of corn crops produced in this area during the past seven years. To improve on our methods and grow mature corn most years, rather than only 50 percent of the time, it is necessary to examine more closely each of the 18 different combinations in this experiment. A study of three of the various combinations of growing corn (Table 1) shows the following:

**Grow Mature Corn**

These three ways of growing corn illustrate that either mature corn was grown in eastern South Dakota every year (Method No. 3), or soft

<table>
<thead>
<tr>
<th>Method Used</th>
<th>Yield (Bu.)</th>
<th>Moisture (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 3. Early hybrid, 4 plants/hill, May 1</td>
<td>52</td>
<td>26</td>
<td>Fair yield, mature corn every year.</td>
</tr>
<tr>
<td>No. 17. Full season, 3 plants/hill, May 20</td>
<td>58</td>
<td>40</td>
<td>High yield, soft corn 4 years in 7.</td>
</tr>
</tbody>
</table>
corn was produced four years out of the past seven (Method No. 17). The average yields obtained, however, were lower when sound mature corn was produced every year than when other methods were used. For eastern South Dakota the results indicate that more mature corn and high yield can be obtained in most years by adopting the practices used in Method No. 6. For the eastern part of this state that would mean:

1. Growing earlier hybrids
2. Planting thicker, or about 4 plants per hill
3. Planting after the ground is warm, or about May 10 to 20.

Under conditions of less rainfall, such as exist in the central part of this state, corn yields are limited more by rainfall than by such factors as plants per hill or maturity of hybrids. The results from the study at Highmore indicate that more mature corn can be obtained by using earlier hybrids and planting them during the first three weeks in May at a rate of two or three plants per hill.

The use of full-season or late corn hybrids can result in great losses in production and income. This was especially true in 1951 and is illustrated in Table 2.

Table 2 indicates that in 1951 the early hybrid not only produced 10 bushels more of corn, but also the corn was of higher quality and contained 10 percent less moisture. The plots at Brookings were harvested on October 19, 1951. (Project 4. Leader: A. N. Hume, Agronomy Dept.)

Table 2. Unadapted Hybrids Reduce Wealth and Income, Brookings, S. D., 1951

<table>
<thead>
<tr>
<th>Method Used</th>
<th>Yield (Bu.)</th>
<th>Moisture (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 6. Early hybrid, 4 plants/hill, May 20</td>
<td>46</td>
<td>36</td>
<td>Fair yield of soft corn</td>
</tr>
<tr>
<td>No. 18. Full season, 4 plants/hill, May 20</td>
<td>36</td>
<td>46</td>
<td>Poor yield of immature corn</td>
</tr>
</tbody>
</table>

Minerals in South Dakota Feeds

Continued from page 61

Iodine deficiencies have been reported in the state, but, to date, no chemical determinations on feeds have been made. The failure of present analytical methods to prove trustworthy is a problem in the study of this element. Studies on methods must be completed before the work on iodine can be extended to the field. (Project 180. Leaders: George Gastler and O. E. Olson, Station Chemistry Dept.)
Can Chemicals Weed Your Garden?

By Solomon Cook

Yes, if you’re careful!

Garden yields will be increased by efficient weed control, and the use of chemicals, a fairly new development, has proved satisfactory for a number of crops. The main advantage of this method of weed control is its labor-saving feature. Nevertheless, it is not a substitute, but a supplement to standard weeding practices which will reduce hand-weeding and cultivation.

Points To Be Kept in Mind

1. Herbicides (weed killers), when not applied with great care can kill the crop as well as the weeds. Therefore, the following precautions should be observed:

(a) Only the amount recommended on the container or given in this article should be used. Amounts recommended here may vary from those given on the container, since they are worked out for the specific conditions in the state and are, therefore, more effective for South Dakota gardens.

(b) Vapors from standard ester formulations of 2,4-D may be carried a considerable distance by air movements. Wind direction and velocity have to be watched to avoid damage to sensitive trees, flowers, hedges, or crops.

(c) When a chemical in form of a dust is used, measuring the powder and filling the sprayer should be done away from the vegetable garden. Wind may carry the dust and injure other crops.

(d) A sprayer that has been used for herbicides should not be used for insecticides or fungicides until it has been cleaned thoroughly. (Household ammonia is a good cleaning agent.) If 2,4-D is used, a special sprayer reserved for only this chemical is recommended. Residues left, even after thorough washing, might cause great harm to sensitive crops such as tomatoes and grapes.

Weeding gardens can be backbreaking work.
Leaves of potato plants treated with 2,4-D, showing response at different stages of application. Cultural control is preferred, but spraying with chemicals may be desirable in wet weather.

2. Only one spraying is needed with chemicals.

3. It should be kept in mind that spraying is only successful when the weeds are small, that is, not taller than one to two inches. Also, under dry conditions, weeds are tougher and harder to kill.

4. Some chemicals when sprayed retain their ability to destroy plants for a very long time. In that case they might harm the crop, even if used in a pre-emergence treatment (before the crop has come up), because they would still be active by the time the crop came up. Therefore, it is of the greatest importance that only the chemical recommended for a given crop is used.

Experiments with chemicals, such as 2,4-D, TCA, Dinitro and Standard Solvent, were made on a number of crops at the Experiment Station at Brookings during the last year.

Spraying With 2,4-D

Since pure 2,4-D is not soluble in water, many formulations have been manufactured by different companies. Most of these formulations can be classified as amines, esters and sodium salts. The sodium salt of 2,4-D, a powder form, is convenient to handle and is easy to measure accurately by weight. Low-volume sprays of less than 20 gallons per acre have not been generally successful with this powder because it clogs the small nozzles. This salt is not appreciably volatile (does not evaporate easily) and thus causes injury only when brought into direct contact with the plant.

Several amine salts of 2,4-D are available on the market. If a low-volume sprayer is used, this is the type of 2,4-D to use.

The ester forms of 2,4-D are more effective than either the amine or sodium salts. They will cause more
<table>
<thead>
<tr>
<th>Crop</th>
<th>What to Use</th>
<th>When to Use</th>
<th>How Much</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASPARAGUS</td>
<td>2,4-D</td>
<td>On established beds before cutting season in spring, following discing; or immediately following last cutting.</td>
<td>1 to 2 lbs. per acre or 1 to 72 tsp. per qt. of water for 100 sq. ft.</td>
<td>Where broadleaved weeds are more troublesome than grasses. Curling may result when applied directly on spears. When “leafed out,” apply directly at base of stalks.</td>
</tr>
<tr>
<td>BEANS</td>
<td>Dinitro</td>
<td>Pre-emergence: within 2 days after planting snap beans; within 5 days after planting lima beans.</td>
<td>6 to 8 lbs. per acre or 3 to 1/2 oz. per qt. of water per 100 sq. ft.</td>
<td>Will control most annual weeds.* Will not kill perennial weeds.</td>
</tr>
<tr>
<td>BEETS</td>
<td>TCA</td>
<td>At least 2 days before beets emerge.</td>
<td>8-10 lbs. per acre or 9 to 12 tsp. per qt. of water per 100 sq. ft.</td>
<td>Where annual grasses are a problem.</td>
</tr>
<tr>
<td>CARROTS</td>
<td>Stoddard Solvent (undiluted) on crop in field.</td>
<td>Before weeds are over 2 inches high.</td>
<td>80-100 gals. per acre or 1 to 3/4 pts. per 100 sq. ft.</td>
<td>Good control of annual weeds. Carrots should not be sprayed after tap root is more than 1/4 in. in diameter. Celery should be sprayed only in seed bed.</td>
</tr>
<tr>
<td>CELERY</td>
<td>Dinitro</td>
<td>Peas should be 4-8 in. tall. Must not be wet with dew or rain.</td>
<td>40-80 gals. per acre or 1/4 to 1 1/2 pts. per 100 sq. ft.</td>
<td>For weeds that emerge before onions, pre-emergence spray gives good results.</td>
</tr>
<tr>
<td>DILL</td>
<td>Stoddard Solvent (undiluted)</td>
<td></td>
<td>40-80 gals. per acre or 1/4 to 1 1/2 pts. per 100 sq. ft.</td>
<td>Excellent control of wild mustard and broad-leaved weeds. Will not kill most perennial weeds and grasses.</td>
</tr>
<tr>
<td>PARSNIPS</td>
<td>Stoddard Solvent (undiluted)</td>
<td></td>
<td>40-80 gals. per acre or 1/4 to 1 1/2 pts. per 100 sq. ft.</td>
<td>Excellent control of wild mustard and broad-leaved weeds. Will not kill most perennial weeds and grasses.</td>
</tr>
<tr>
<td>PARSLEY</td>
<td>Dinitro</td>
<td>Peas should be 4-8 in. tall. Must not be wet with dew or rain.</td>
<td>40-80 gals. per acre or 1/4 to 1 1/2 pts. per 100 sq. ft.</td>
<td>Excellent control of wild mustard and broad-leaved weeds. Will not kill most perennial weeds and grasses.</td>
</tr>
<tr>
<td>POTATOES</td>
<td>Dinitro</td>
<td>Pre-emergence</td>
<td>6-8 lbs. per acre or 1/2 to 1 oz./qt. of water per 100 sq. ft.</td>
<td>Cultural weed control preferred. Chemical sprays during wet weather may be desirable. Post emergence sprays with 2,4-D not recommended. Alters growth of tops and tubers.</td>
</tr>
<tr>
<td></td>
<td>2,4-D</td>
<td>Pre-emergence</td>
<td>1 to 2 lbs. per acre or 3/4 to 3 tsp./qt. of water/100 sq. ft.</td>
<td>Cultural weed control preferred. Chemical sprays during wet weather may be desirable. Post emergence sprays with 2,4-D not recommended. Alters growth of tops and tubers.</td>
</tr>
<tr>
<td>RASPBERRIES</td>
<td>2,4-D</td>
<td>Early in spring, when weeds are not over 1 in. tall.</td>
<td>1/2 to 1 lb. per acre or 1/2 to 3/4 tsp./qt. of water/100 sq. ft.</td>
<td>Where broadleaved weeds are a problem.</td>
</tr>
<tr>
<td>STRAWBERRIES</td>
<td>2,4-D</td>
<td>On first-year berry beds and in non-fruiting older plantings.</td>
<td>1 lb. per acre or 1/2 tsp./qt. of water/100 sq. ft.</td>
<td>Newly set plants should not be sprayed until well established. Should not be used on flowering or fruiting strawberries.</td>
</tr>
<tr>
<td>SWEET CORN+</td>
<td>2,4-D</td>
<td>Pre-emergence: 5 to 7 days after planting</td>
<td>1 to 2 lbs. per acre</td>
<td>Controls annual grasses and some broad-leaved weeds. Pre-emergence spraying not recommended on sandy soils. May be superior to pre-emergence spraying.</td>
</tr>
</tbody>
</table>

*Common annual weeds are: Frenchweed, mustard, ragweed, pigweed, purslane, lamb’s quarters, pigeon grass (foxtail), barnyard grass, etc. Some perennial weeds are: dandelion, field bindweed, milkweed, Canada thistle and quackgrass.

†See section on sweet corn in this article for more detailed information.
injury to more species of plants and therefore they are more hazardous to use. Great care should be exercised when applying this form of 2,4-D.

2,4-D, in all its forms, is toxic to most annual broadleaved plants and retains its toxic activity in the soil for 3 to 6 weeks. Even if it is used in a pre-emergence treatment, some injury to the crop can be expected. Where a range in the rate of application of 2,4-D is given in the table, the lower rate applies to the esters and the higher rate to the amine or sodium salt formulations. Since water is used only as a carrier, any amount from a quart to a gallon may be used—according to how much water is needed to cover the crop. However, the 2,4-D used must be accurately measured in the amount stated.

When to spray 2,4-D. Best results are obtained when 2,4-D is sprayed during warm and sunny days in the forenoon. During this time and under those conditions, more of the chemical is absorbed.

Spraying With TCA
TCA is an effective herbicide for grasses, particularly perennial weed grasses, quackgrass and Kentucky bluegrass. Areas under irrigation, where the main weeds are annual grasses, will profit greatly by this weed killer. TCA like 2,4-D stays toxic in the soil for some time, though not as long as 2,4-D.

Spraying With Dinitro
Dinitro is effective in the control of most annual weeds. It stains protein materials, hair, silk, wool and leather and the stains are difficult to remove. Dinitro is soluble in oil and only after an emulsifying agent has been added, can the oil be mixed with water.

Spraying With Stoddard Solvent
Stoddard Solvent will, in most cases, kill all weeds except perennials, ragweed, and related plants. It should be applied as soon as most weeds have emerged, but before any are over two inches high.

Stoddard Solvent, which is a dry cleaning fluid, should be used undiluted. The time of spraying is very important, because it can impart an oily flavor to the vegetable if sprayed at too late a date. Also, it should not be sprayed during very hot, dry and windy weather.

When Spraying Sweet Corn
Spraying sweet corn should be done as early as possible to control weeds. Spraying with 2,4-D can be used to reduce the number of cultivations needed by controlling some weeds. It should not be expected to replace cultivation.

Isopropyl and butyl ester formulations are less hazardous to corn than amine or sodium salt formulations. Dry weather after pre-emergence treatments may make them ineffective, and excessive rain may create a hazard to corn.

If the corn is higher than the weeds, a rate of 1/4 to 1/2 pound per acre is satisfactory. The spray must reach the top of the weeds to be effective. Some injury is to be expected at any time, and high temperature at time of treatment increases corn injury. (Project 118. Leader: Solomon Cook, Horticulture Dept.)
The creation of a large reservoir has serious and definite impacts on any community where it is established. Any development that takes thousands of acres of good land permanently out of production, that removes property from the tax roll and makes it necessary for families to move and establish new homes elsewhere will have such impacts.

An estimated 467,000 acres of land are earmarked for reservoir use in South Dakota. Of this total 98,000 acres are cropland, 66,000 dry hayland, 180,000 pasture and 124,000 timber and rough grazing. Since landowners were dissatisfied with the methods used in acquiring land for the reservoirs, a committee was set up to study the problem and to help work out better techniques.

The two federal agencies involved in building dams in the Missouri Basin Development are the Corps of Engineers and the Bureau of Reclamation. At the present time, the Corps of Engineers has three dams under construction—Fort Randall, Oahe and Cold Brook; the Bureau of Reclamation has completed the problems found in the Fort Randall Area were the following.

What Farmers At Fort Randall Thought

The right of the government to take land for a public purpose was not clearly understood by the people of the area. Problems have arisen in the Fort Randall Reservoir as a result of the use of this right by the
Corps of Engineers. The complaints centered around appraisal procedure, land values, cost of moving, severance damages and flowage easements. The present policy of the Corps of Engineers does not permit the negotiators to show the appraisal breakdown which was used to determine the final figure. Farmers and ranchers state that they are not accustomed to secretive dealings.

They wished to know how the appraisal figure was arrived at, showing what amounts were allowed for improvements, wells, cropland, severance damages and other values. In arriving at a fair value for land, the Corps of Engineers has placed considerable emphasis on prices paid for land in recent sales in the same area. Landowners believed that recent land sales included the less productive land in the area. Also some sales may have been made because of peculiar circumstances. The owner might have been forced to sell because of poor health, the need to settle an estate or other reasons. Though the Corps of Engineers states that they try to segregate the circumstances under which sales are made, only two of the 46 farmers interviewed said that they would be able to buy comparable property with the money offered by the government. The rise in land values from the time of the

Some Local Reactions

Fig. 1. Location of some of the reservoir areas in South Dakota. The Corps of Engineers has three dams under construction—Fort Randall, Oahe and Cold Brook (not shown); the Bureau of Reclamation has completed Deerfield, Angostura and Shadehill under the Missouri Basin program.
appraisal makes this still more difficult.

A time lag of 6 months to a year between appraisal and the time an owner finds a farm could be important. The prices of farm real estate in South Dakota increased approximately 17 percent from July 1950 to July 1951. During the same period, average land prices in the United States increased about 17 percent.

It appears desirable to find some method by which a price could be determined that would be considered fair, and thus avoid court cases.

Many of the landowners interviewed suggested that an appraisal board would be better able to arrive at a fair market value. This board could consist of a representative of the Corps of Engineers, a man selected by the landowners and a third man, familiar with land values but not directly representing either the Corps of Engineers or the landowners. It was suggested that the third man could be appointed by county commissioners from the counties involved, or perhaps be appointed by the Governor of the State. The representative of the Corps of Engineers could be paid by them, the representative of the landowners could be paid by the landowners on the basis of the amount of land to be taken, and the third man could be paid by the state or counties involved.

Another alternative would be to have the board appointed by the Federal courts.

In several cases the farmers said they would rather grant flowage easements for land which would not be permanently inundated, than sell their farm. At the present time there appears to be no policy for establishing values for flowage easements.

What Shadehill Landowners Thought

The strongest point of discontent among displaced landowners in the Shadehill area was a feeling that the dam was not needed. This seemed to result from the fact that there was no provision for participation by local people in the planning of the project. Also, appraisal procedures were criticized, not because of the price offered, as prices were generally satisfactory, but because the breakdown of the appraisal was not shown. Payment seems to have been slow. The period from the time of agreement of sale until payment was made, ranged from nine months to well over a year. As a result, some people had to borrow money to buy another place and to cover expenses such as moving costs. Complaints about moving costs and decreased value of the remainder of the unit, after a part of it had been bought by the agency were also encountered. According to law, the government cannot now pay moving costs.

This Is What They Suggested

The people interviewed in the two areas studied had the following suggestions for possible improvement in the land purchase procedures:

(1) All information in the appraisal report should be made known to the landowner upon request. The landowners want to know how much is allowed for buildings, cropland, pasture, sever-
ance damages etc. Inspection of the appraisal reports indicated that they contained such information, but it was not made available to the farmers. (Experience in Nebraska indicates that land acquisition can be improved by making appraisal information available to the landowners.)

(2) Land appraisals should be made by a three-man board representing the agency acquiring the land, the landowners and the general public.

(3) The cost of comparable property should be used as the guiding principle in determining fair land value. Emphasis should be placed on determining whether the price offered the landowners allows them to buy other property having the same earning power as the land taken.

(4) When bottomland which provides winter feed, water, and shelter for cattle is required for the reservoir, leaving only hill pasture which cannot be operated as an economic unit, the purchase of the entire farm should be considered.

(5) Consideration should be given to paying moving costs and loss of income as a result of disrupting the farm as a going concern.

(6) Flowage easements should be considered when the land is not expected to be flooded very often.

(7) Payments should be made as soon as possible after the land is sold to the government. (At the present stage of land purchase in the Fort Randall area, indications are there is no dissatisfaction in this respect. In the Shadehill area under the Bureau of Reclamation considerable dissatisfaction in this respect still exists.)

(8) When the reservoir separates two parcels of land which were formerly operated as one unit, the government should offer to buy the isolated tracts.

Other Questions Need Clarification

People in the reservoir areas are also concerned with other questions such as income tax rules when land is sold under threat of condemnation. There is a need for clarification and discussion of these rules when the land acquisition begins.

There is also a need to give further consideration to the responsibility of the federal government to local units of government where large areas of land are taken off the tax roll. At present, there is no uniform procedure followed by federal agencies in making payments in lieu of taxes. The Corps of Engineers pays 75 percent of its rental returns to the counties for school and road purposes. The Bureau of Reclamation pays no rental money to the counties. The Bureau can make payments to schools to help provide educational facilities for children of construction workers. The U. S. Commissioner of Education is also authorized to make some adjustments for loss of revenue to school districts. There is need for further study of the responsibility of the federal government to local units of government when the right of eminent domain is exercised on a large scale. (Project 198. Leaders: Russell Berry, Agricultural Economics Dept.; Kris Kristjanson, Agricultural Economics Dept.; Experiment Station and B.A.E.)
between 1935 and 1945. The population was reduced by 104,305 persons or 29.1 percent of the count in 1935. This is certainly a pronounced reduction, a severe thinning out of farm settlement.

Because of the return of veterans to farm homes since 1945, it might be expected that the farm population would show some recovery of its numbers. This has not occurred, however. The rural-farm population in 1950 was reported as 253,495—which is nearly the same as in 1945 (253,899 persons).

Many reasons may be cited to account for the decrease in farm population. Briefly they are: (1) The reduced number of farms: 72,454 in 1940 compared with 66,452 in 1950; (2) larger and more mechanized farms; (3) older and smaller farm families; (4) increased financial requirements necessary for young people to get started in farming; (5) better opportunities in cities; (6) the dominance of urban conditions and standards of life.

In view of these trends and conditions, it is apparently going to be difficult to establish more farm families on the land in South Dakota. Nevertheless, it has been proved feasible in irrigation areas.

To Sum It Up

During the past decade, South Dakota did not gain population to the extent that would be expected as a result of the large annual excess of births over deaths. The reason is that it sustained a large net out-migration. Those who leave the state are preponderantly single youths, and young married adults and their children. For this reason (and several others), the population of the state is aging more rapidly than the nation as a whole. Both the state and the nation have had a large increase of the elderly and the aged. But South Dakota had both increases of children under 5 and of those above 55 and decreases of young and mature adults; which means a growing proportion of dependents in relation to supporters. The two other main trends are the pronounced shift of population to urban centers and the large decrease in the farm population.

An extensive program of resources development is needed to provide opportunities for the youths of the state, to increase and stabilize agricultural production, and to make a more satisfying way of life possible. The future of South Dakota—the future of its agriculture, industries, population and culture—is to a large extent going to be influenced by the projects of the Missouri basin. These are now being planned and constructed by the U. S. Corps of Engineers, the Bureau of Reclamation, the United States Department of Agriculture, and other federal and state agencies. Their significance may be envisioned under four main heads—irrigation, electrification, conservation and recreation. As these projects advance from blueprint to reality, they hold promises of opportunity for the youth of the state. (Project 222. Research conducted by the South Dakota Experiment Station in cooperation with Bureau of Reclamation.)
The situation can change with the weather. Map prepared by U. S. Bureau of Entomology and Plant Quarantine, Div. of Grasshopper Control, in cooperation with the State College Extension Service.

By H. C. Severin

Only two small areas were found in South Dakota in which the grasshopper situation is threatening. The light areas of the map total more than 80 percent of the state and in these areas the grasshopper situation in 1952 should be primarily negligible. However there may occur local areas where grasshoppers will probably become a problem, such as in alfalfa fields.

The forecast is made with the supposition that South Dakota will experience average weather conditions during the spring and early summer. If, however, the spring and early summer should be unusually hot and dry, the situation may become changed.

Unshaded areas on the map are expected, under average weather conditions, to develop 0 to 3 grasshoppers per square yard throughout cultivated fields. No general damage is expected.

Areas on the map that are crosshatched and labeled "light" are expected to develop 3 to 7 grasshoppers per square yard in the fields. Some damage may result to crops under these conditions, but the damage is not expected to be serious unless the weather turns hot and dry.

Sections that are crosshatched and are labeled "threatening" are expected to develop 7 to 14 grasshoppers per square yard throughout grain fields. Early spring damage may be expected in these areas and the damage may become more severe as the growing season advances unless control practices are used. If the weather becomes hot and dry the damage will increase.
C89 Fungicides for Potato Blight Control, by C. M. Nagel and L. T. Richardson.
Sixteen fungicides were tested over a period of years from 1945 to 1950, with the object of developing a potato spray program adapted to South Dakota conditions. Results and yields are discussed in the circular.

C91 Tomato Leaf Spot Control, by C. M. Nagel and L. T. Richardson.
Results from a 6-year experiment from 1944 to 1950 with 16 fungicides are given in this circular, as well as practical information on control measures.

Suggested rotations for South Dakota, as well as recommended fertilizer applications for different crops in the various regions of the state.

C93 South Dakota Corn Performance Tests, 1951, by G. E. Nachtigal and D. B. Shank.
Corn yield trials in eight agricultural areas, with entries selected from the most widely used varieties. Tables include date of planting and harvesting, performance score, yield per acre and moisture content. Averages for two, three, four and five years are included whenever information was available.

C94 Chemical Control of Weeds in South Dakota, by Lyle Derscheid and L. M. Stahler.
Recommended chemicals and their effect on the important crops. Control measures, with special attention to noxious weeds, are given, with instructions as to amount of spray to use and the method of application.

Information on quality of eggs, deterioration at egg buying stations, egg handling methods and their effect on quality is given in this bulletin. A discussion of the economic aspects of quality is included.

A technical discussion of the influence of dyeing, dry cleaning, wear, and exposure to light on the wearing quality of reused wool.

B416 Marketing Lambs, A Comparison of Liveweight Method and Carcass Weight and Grade Method, by Ottar Nervik and David G. Paterson.
This is a preliminary study of marketing lambs by carcass weight and grade instead of by live weight. The main emphasis is on how adequately sale by live weight reflects to producers the value of the lambs.

Results of five years of feeding sorghum to lambs as compared to feeding corn, both in the dry lot and by lambing-off sorghum of various varieties.
The block held up to show its lightness is a new block developed by the Agricultural Engineering department and weighs about 25 pounds. The standard building block held in his right hand weighs about 45 pounds. In addition to its light weight, the new block has better thermal and acoustical qualities than the standard block. It was made from an aggregate processed from South Dakota shales.

Lightweight CONCRETE AGGREGATE from SOUTH DAKOTA SHALES

By Dennis L. Moe

A concrete block which is approximately half the weight of a standard block and which has better thermal and acoustical properties has been made from a new aggregate. This new aggregate was developed from South Dakota shales by the Agricultural Engineering department to fill a pressing need in farm building construction.

Shortage of concrete building blocks is nationwide, and plants in production are so scattered that transportation charges increase the cost to the South Dakota consumer.

An abundant supply of various shales exists in the state, and it was thought that a use could be found for this natural resource. However, the wide range of geological formations over the state makes it impossible to give reliable recommendations as to the possibilities of the raw shale without a careful and de-
Shale was sampled at these locations in the state

tailed laboratory study of the specific shale in question.
Research was undertaken to determine the feasibility of obtaining a finished product from raw shales suitable for concrete and concrete block construction which would have as many desirable characteristics as possible.

Qualities to Look for in a Good Aggregate

The following qualities should be sought in a good aggregate:

Light weight in aggregates is desirable so that a worthwhile saving in weight can be made. It should not be more than one-half the weight of the standard sand and gravel aggregate it replaces. Since the bulk density of gravel aggregate is approximately 100 pounds per cubic foot, lightweight aggregate should weigh 50 pounds per cubic foot, or less.

Strength is necessary, with the individual particles of the aggregate being as strong as possible. For a concrete of a given strength, less cement is usually needed for a stronger aggregate than for a weaker one. This results in a cost saving plus a lighter weight concrete. At times in certain specific applications, however, a weak aggregate product could never be brought up to strength regardless of the amount of cement used.

Absence of sharp edges and a spherical surface are necessary. If sharp corners are present on the particles, the concrete is usually hard to work into the forms, tends to honeycomb, and makes a harsh concrete.

A low water absorption is a definite advantage in concrete aggregates, as absorbed moisture has a tendency to dehydrate the cement in the mixture.

A good gradation of size in the aggregate is a very important factor for workability of the concrete and for the appearance of concrete blocks.

Chemical inertness of an aggre-
gate is also important, as certain compounds have a tendency to react with the cement thereby affecting its setting.

Probably the most important factor in determining the acceptability of a good lightweight aggregate is the initial cost per cubic yard. The extra cost over heavier aggregates must be offset by one of three things, or a combination of them: (1) less weight to permit elimination of reinforcing steel and lighter form construction, (2) better thermal and acoustical qualities, and (3) ease in handling in construction.

At the present time there is no high quality lightweight aggregate produced in South Dakota. There are a few plants in operation in the state producing a small amount of Perlite, froth-like particles of acidic volcanic glass, and a considerable volume of cinders from power plants and furnaces is being used.

**Abundant Supply of Raw Material Located**

A survey of possible raw materials suitable for lightweight aggregate production was made west of the Missouri River during the summer of 1950. Nineteen different geological strata were sampled the first year, and these samples were tested for expanding characteristics. In 1951, 14 additional samples were collected and tested from various locations throughout the western portion of the state. From this total of 33 samples, two seemed to have good possibilities and one looked particularly good. The locations of the samplings are shown in the accompanying map.

The shale from the Virgin Creek member of the Pierre formation offered the best possibilities, and it has been with this member that most of the research deals. One excellent outcrop of the Virgin Creek shale is located near Creston, South Dakota, and several other equally good formations are located near Promise.

In many locations of the Virgin Creek member in South Dakota, the shale can be scooped up from the surface of the outcrops without blasting. Mechanical handling breaks the shale into particles of about the size suitable for heating.

**How Shale Is Expanded**

All of the raw shale samples were tested for expansion in crucibles in an electric furnace at the Station Chemistry laboratory. The process prior to heating involved the sizing of the aggregate by screening. After considerable testing, most of the work involved four sizes:

![Image](image_url)

When the shale is expanded it is lighter than water and does not absorb more water than 3 percent by weight, which is a real advantage.
The pan on the left contains the original shale which is a light gray in color. On the right is the shale after it is expanded. The outer shell is light brown and the surface is sealed.

<table>
<thead>
<tr>
<th>Size of Screen</th>
<th>Weight per Cubic Foot After Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>.371 inch mesh</td>
<td>39.1 pounds</td>
</tr>
<tr>
<td>.187 inch mesh</td>
<td>43.8 pounds</td>
</tr>
<tr>
<td>.093 inch mesh</td>
<td>52.0 pounds</td>
</tr>
<tr>
<td>.0394 inch mesh</td>
<td>57.9 pounds</td>
</tr>
</tbody>
</table>

**Does Not Require Excessive Temperature for Expansion**

Considerable testing was required for each shale to obtain an expansion or a bloating of the material. In the original work, difficulties were encountered as to the proper temperatures to use and the time element involved at each temperature range. The best heating process found for the Virgin Creek shale was to introduce the material at a temperature not exceeding 400° C. After a preheating period of 20 minutes at 400° C., the temperature can rise fairly rapidly up to 1050° to 1070° C.

In the batch process used in the laboratory, the material reached this temperature range in approximately 40 minutes. The Virgin Creek shale expands in a unique manner. As the temperature approaches 1050° C, the surface becomes pyroplastic (molded by heat) and after a few minutes the shale particles begin to bloat, with the interior of the particle becoming cellular or honeycombed. Upon cooling, the surface becomes hard and more or less glazed. The resulting particles are very strong and the surface is about as hard as glass.

This particular shale expanded well without excessive heat requirements which is a determining factor in commercial production. If the temperature is too high at the beginning, or if heating is too rapid, considerable shattering of the particles occurs before the surface is sufficiently plastic to hold the particles in single pieces as they bloat.

Some bloating was obtained at 1020° C., but it was not consistently satisfactory below 1050° C. Bringing the heat up rapidly without a preheating period resulted in about 40 percent of the material expanding to a degree where it was lighter.
than water, which gave a bulk density of approximately 50 pounds per cubic foot. A stronger product was obtained by preheating; however, expansion was slower and required a slightly higher temperature.

Too rapid a heating caused an explosive shattering of the particles. Extremely slow heating was also found to be undesirable. When the heating period was well over an hour, the temperature necessary for bloating was over 1100° C., and the bloated material was glossy and fused into hard clusters.

Slight sticking tendencies were noticed, but in a rotary kiln in large production this would be minimized. However, slow heating in a rotary kiln might cause some sticking, especially if the material were held above 1000° C. for more than 15 minutes. Further experimental work in a rotary kiln is necessary to show the proper cycle to produce a strong product with a minimum of sticking between the particles.

At temperatures used in the laboratory, the interior of each piece was the original light gray color, and the outer shell was light brown with the surface completely sealed. The majority of the unbroken particles float on water and do not absorb more than 3 percent (by weight) of water.

Physical Tests Made in Laboratory

A large number of test cylinders have been made from expanded Virgin Creek shale. Physical tests on processed aggregate, weighing less than 50 pounds per cubic foot, indicate that the aggregates are as good or better than the best lightweight aggregates which have been made from other shales and other expanding materials.

A number of concrete blocks of the 8" x 8" x 16" standard size have been made. Compressive strength tests on these blocks were performed in the laboratory. Various volume proportionings of cement

Test cubes made from the expanded Virgin Creek shale. Physical tests indicate that these aggregates are as good or better than the best lightweight aggregates from other shales.
(such as a 1:2:4 mix) to given parts of dry aggregate, including fine and coarse material, were used in the tests.

In general, lightweight aggregate mixtures require a higher percentage of fines to coarse aggregate than do sand-gravel aggregates to produce a reasonably workable concrete. There is a limit, however, to the proportioning of fines to coarse for any given cement content without adversely affecting the strength of the concrete. Aggregates which are lighter in weight usually require more cement to develop strengths comparable to heavier aggregates.

**Adequate Structural Strength Shown in Tests**

Seven-day compressive strength tests on concrete blocks weighing from 22 pounds to 26 pounds tested 1265 pounds to 1805 pounds per square inch, when mixed with a proportion of one part cement to six parts aggregate, including both fine and coarse.

Figures on shrinkage tests of specimens at the end of 100 days were considerably larger than figures for sand and gravel aggregates but were less than published figures for the majority of lightweight aggregates.

Indications are that thermal conductivity values, which represent heat loss in British Thermal Units per hour per square foot of area per degree Fahrenheit temperature difference per inch of thickness, will be comparable to other expanded aggregates made from shales.

Up to the present time no tests have been made on resistance to freezing and thawing. (Project 203. Leader: Dennis L. Moe, Agricultural Engineering Dept.)
Chemical Control of Grasshoppers

By H. C. Severin

Chlordane, toxaphene and aldrin have been used extensively and successfully in South Dakota for destroying grasshoppers and greatly reducing outbreaks of these insect pests. These insecticides have been employed in the state chiefly as sprays and occasionally as dusts for grasshopper destruction, but they may also be used advantageously at times in baits for this purpose. Baits are most effective in dry vegetation and in fall-seeded grain that is only a few inches tall.

How Much Spray or Dust to Apply

Aldrin, chlordane or toxaphene, when applied as sprays or dusts for grasshopper control, should be used according to the following recommendations:

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Sprays</th>
<th>Dusts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>½—2 oz</td>
<td>3 oz.</td>
</tr>
<tr>
<td>Chlordane</td>
<td>½—1 lb</td>
<td>¾—1½ lbs</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>1—1½ lbs</td>
<td>1½—2½ lbs</td>
</tr>
</tbody>
</table>

The lower dosages recommended in the table may be used when the grasshoppers are small, when the vegetation is short, dense and succulent, and in tall, open vegetation when long residual action is not desired. The higher dosages are recommended when the grasshoppers are more mature, when the vegetation is tall and dense, and when a longer residual action is desired.
Whenever a grasshopper hatch extends over a period of two weeks or more, the heavier dosage should be used in order to kill the hoppers that hatch later. If the heavier dosage is not employed, a second treatment may become necessary. Whenever grasshoppers develop in a field of small grain located next to a field of corn, the corn should be protected by spraying or dusting the adjoining strips with a heavy dosage of one of the insecticides listed. This should be done when the small grain is ripening and when the grasshoppers are about to leave the small grain and invade the corn.

Aldrin, chlordane and toxaphene may be purchased as ready-mixed dusts, as solutions, as emulsifiable concentrates and as wettable powders. The emulsifiable concentrates and wettable powders are to be diluted with water before they are applied as sprays, while the solutions are to be diluted with a solvent such as kerosene or diesel oil before being used.

There is danger of burning foliage with solutions, and consequently they should be applied to crops only by an experienced operator or under his supervision. Regardless of the type or formulation of aldrin, chlordane or toxaphene that is used in the control operation, the quantity of actual poison that is to be applied per acre of cropland should conform to the recommendation as listed in the foregoing table.

Methods of Application

The insecticides may be applied by ground sprayers, ground dusters or by airplanes. All three methods have been used successfully in South Dakota, and each has its advantages and disadvantages. Dusting has been found to be the most wasteful method of applying the insecticide because of the tendency for the dust to drift, and it requires the most favorable type of weather for successful operation.

An airplane can treat a field in a relatively short space of time, but spraying or dusting by airplane is more dependent upon favorable weather than is spraying or dusting by ground equipment. If airplane spraying is used, care should be exercised to treat the entire infested areas thoroughly, including fence rows and roadsides. Either the solution or emulsifiable type of insecticide may be sprayed from a plane. The operator of the plane should be certain that he applies the recommended amount of the insecticide per acre.

If ground sprayers are employed, the emulsion concentrate should be used, preferably, or the wettable powder formulation. The amount of water applied in the spray does not matter, just so the proper quantity of insecticide is applied per acre.

Time of Application

Spraying for grasshopper control should, if possible, take place as soon as the main hatch of the grasshopper eggs has been completed. At times, however, damage to crops may begin before this can be done. This may necessitate an early treatment before the bulk of the eggs have hatched and a later one to destroy the later hatch. If grasshopper eggs were deposited throughout a field of small grain and in sod around the edges of the field, and
nothing was done to control the grasshoppers through tillage, then the hatch will occur throughout the field and in the borders. Under these circumstances, spraying or dusting must cover the entire field and the borders as well. The heavier dosage of insecticide recommended in the table should then be used.

If the eggs are found only in sodland bordering a field of small grain, the egg beds should be sprayed or dusted shortly after the eggs hatch and before the young hoppers have moved into the small grain. If some of the young hoppers have already moved into the small grain, the egg beds should be treated and, in addition, the strip of infested grain and a narrow adjacent strip of uninfested grain must be treated.

If an alfalfa field is infested with damaging numbers of grasshoppers, it may be economically wise to cut the first crop of hay early and then spray or dust to protect the next cutting. Strips of alfalfa may be left uncut and when the grasshoppers concentrate in these strips, the hoppers may be destroyed by spraying or dusting. Or a block of alfalfa may be left uncut near the center of the field and when the grasshoppers concentrate here, they may be destroyed by spraying or dusting. If the grasshopper eggs have not hatched until after the first hay crop has been removed, then it is advisable to wait until the new growth is about 6 inches high before spraying or dusting is done. Whenever alfalfa fields are sprayed or dusted for grasshopper control, the margins of such fields and any nearby weed patches should also be treated.

In the case of a row crop such as corn, the egg masses are usually found in grass or sodland bordering such a field. Such borders should be watched carefully, and whenever the eggs hatch the sodland should be sprayed or dusted. If necessary, the treatment should be repeated two weeks later.

Precautions Should Be Taken

Aldrin, chlordane and toxaphene are poisonous to man and domestic animals. However, these poisons can be used for grasshopper control if care and good judgment are exercised by the operator. Care should be employed not to permit the insecticides to come in contact with the skin, not to inhale the dust fumes or mist when breathing, and not to swallow any of the poisons accidentally. If the skin or clothing become contaminated with the insecticide, a thorough soapy bath should be taken and a change to clean clothing should be made.

Feed contaminated with any of the insecticides should not be fed to dairy animals nor to animals that are being finished for slaughter. In fact, animals being finished for slaughter should not be fed sprayed hay during the last two months. Hay sprayed or dusted with aldrin, chlordane or toxaphene will gradually lose more and more of the poisonous insecticide as time goes on, but this proceeds faster in uncut hay than in hay cut and stacked, or cut and baled.

For directions on the preparation and use of poison baits in grasshopper control, write to the Experiment Station. (Project 18. Leader: H. C. Severin, Entomology Department.)
Comparing an artificially sired daughter on the left with her mother on the right, the daughter shows an improvement in straightness of topline, depth of body and strongly attached udder. When the daughters' scores were compared with those of their dams, the scores showed an increase due to influence of the sires. On the right, are high quality, artificially sired Brown Swiss cows on pasture.

ARTIFICIAL INSEMINATION

KENNETH GROSS and CHASE WILSON

ARTIFICIAL INSEMINATION is the fastest growing development ever to be introduced to dairy cattle management. From a meager beginning of only 1,000 or so cows bred artificially in the United States in 1938, there are now approximately 4,000,000 cows bred annually by this method. This is being done by 1200 associations scattered throughout the country. Servicing as many as 10,000 cows a year with one bull is a long way removed from the days when each farmer kept a bull for as few as six or seven cows.

South Dakota farmers first tried this method of breeding cattle in 1946 when the South Dakota Cooperative Breeders’ Association was formed. This organization is a farmer-owned cooperative, operating in the eastern section of the state, with offices and bull stud located at Brookings.

Since the Cooperative Breeders’ Association was formed, many dairymen have questioned the use of artificial insemination and the value of the offspring from the sires used in the bull stud. The true value of “test-tube” progeny has been difficult to measure because of inadequate facilities, few DHIA testers, and because of manpower shortages. Since only a few artificially produced progeny have been tested for production, adequate production indexes have not been obtained on many of the bulls used artificially in South Dakota.

A large percentage of dairy cattle sold in South Dakota, whether for breeding purposes or for commercial production, are evaluated primarily on the basis of their type or appearance instead of production. Since there is considerable evidence which shows that type is correlated with production, the South Dakota Agricultural Experiment Station designed an experiment to study the type of the daughters of the sires used by the South Dakota Cooperative Breeders’ Association.
Heifers Classified as to Type

Daughters of the sires of Holstein, Brown Swiss and Guernsey breeds were used in making the study. Classification data were obtained from 277 daughters and 159 of their dams. The daughters were by seven Holstein, five Brown Swiss, and three Guernsey sires. The animals classified were on 72 different farms, located in 12 eastern South Dakota counties. Each farm was visited and all animals were classified, as nearly as possible, according to the standards of the breed association concerned.

The breed associations require that all animals must be registered and must have freshened. The Guernsey Breeders’ Association also requires that each animal presented for classification must have completed at least one official production test. In this study these rules were not followed. All heifers of the Holstein, Brown Swiss and Guernsey breeds, provided they could be identified as to parentage and were at least six months of age, were classified. Nearly all of the animals classified were over one year of age, with the exception of a few as young as six months. In order to obtain daughter-dam comparisons, dams of daughters, when available, were classified in the same manner.

Type classification means the comparison of the individual animal with the true type or ideal of the breed. It is an unbiased appraisal of the type or conformation of each animal. The animal is given an over-all rating based on general appearance, dairy character, body capacity, and mammary system. General appearance and mammary system count 30 points each, with dairy character and body capacity 20 points each, making a total of 100 points.

Adjustment of Age Differences Made for Type Comparison

The various breed associations have correction factors for the ages
Table 1. Production Records and Classification Scores of Daughters

<table>
<thead>
<tr>
<th>Name and Registration—Number of Sire</th>
<th>Barn No.</th>
<th>Average Production of Daughters</th>
<th>Average Classification of Daughters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Milk No.</td>
<td>Test</td>
</tr>
<tr>
<td>Holstein</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redfield Gypsie Bettina Belle 769336</td>
<td>H-1</td>
<td>40</td>
<td>13,313</td>
</tr>
<tr>
<td>7X Triple Klaver Pride 777842</td>
<td>H-2</td>
<td>33</td>
<td>14,337</td>
</tr>
<tr>
<td>Redfield King Gypsie Julia 811304</td>
<td>H-3</td>
<td>9</td>
<td>12,900</td>
</tr>
<tr>
<td>Ludwig Fobes Sir Echo 895361</td>
<td>H-7</td>
<td>12</td>
<td>14,186</td>
</tr>
<tr>
<td>Redfield Fobes Emma Segis 900841</td>
<td>H-8</td>
<td>1</td>
<td>12,250</td>
</tr>
<tr>
<td>Femco Korndyke Royal Inka 796016</td>
<td>H-9</td>
<td>53</td>
<td>11,396</td>
</tr>
<tr>
<td>Campanile Heilo Segis Super 1043828</td>
<td>R-11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown Swiss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maiden’s Betty Boy J. B. 42937</td>
<td>BS-1</td>
<td>33</td>
<td>11,328</td>
</tr>
<tr>
<td>Maiden Jane King 53915</td>
<td>BS-4</td>
<td>7</td>
<td>8,973</td>
</tr>
<tr>
<td>Tarter Fenlea Ora 67182</td>
<td>BS-5</td>
<td>6</td>
<td>13,470</td>
</tr>
<tr>
<td>Judd’s Bridge Harmony 61565</td>
<td>BS-7</td>
<td>18</td>
<td>13,758</td>
</tr>
<tr>
<td>Lorena’s Sammie Design 73013</td>
<td>BS-8</td>
<td>5</td>
<td>10,229</td>
</tr>
<tr>
<td>Guernsey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McDonald Farms Informer 354143</td>
<td>G-1</td>
<td>5</td>
<td>8,443</td>
</tr>
<tr>
<td>Foremost Royal Valor 377129</td>
<td>G-2</td>
<td>3</td>
<td>10,156</td>
</tr>
<tr>
<td>Graceland Forward 310763</td>
<td>G-5</td>
<td>8</td>
<td>6,589</td>
</tr>
</tbody>
</table>

of animals in making production comparisons; however, there have been no age-correction factors for type. Since it would be unfair to compare daughter and dam, or any two animals without allowing for age differences, mature equivalent factors were prepared for the purpose of adjusting for age differences in this study.

The mature equivalent ratings herein reported may be somewhat higher than many of the animals will actually score as mature animals, as these factors were computed from the official breed publication in which there has undoubtedly been some selection of those animals classified. This culling would be especially true of the older animals approaching maturity. Nevertheless, it provided a more nearly equal method of comparing the daughters and dams in this study, as well as comparing the sire effect within each breed, since the age of every animal was adjusted to an equal age. The average mature equivalent classification scores of the daughters of each sire studied are in Table 1.

Sires Show Increase in Type of Daughters Over Dams

The average type scores of the daughters of the different sires ranged from a low of 83.56 to a high of 87.82, with an average of 85.25. When the daughters’ scores were compared with those of their dams, the scores showed an increase due to the influence of the sires. These increases ranged from 1.18 to 4.73, with an average of 2.92. Five sires, H-1, H-2, H-7, H-8, and H-11...
showed a statistically highly significant increase in the type of daughters over their dams (highly significant means that there is less than 1 chance in 100 that this difference occurred by chance in sampling, and therefore the odds are high that this difference between daughters and dams actually exists).

Four sires showed a significant increase in type of daughters over their dams; these were G-1, G-2, BS-7, and H-9 (significant means that there is less than 1 chance in 20 that this difference occurred by chance in sampling, and therefore the odds are that 19 times out of 20 this difference between daughters and dams actually exists.) Six sires showed increases which were not statistically significant; these were G-5, BS-1, BS-4, BS-5, BS-8, and H-3. It should be kept in mind that the number of daughter and dam comparisons will affect, to some extent, the importance of the increase.

Production records have been completed on a few daughters. Many of these records were made before the sire was brought into the stud at Brookings. Some were made in other states and some were produced under conditions which are a great deal different than average South Dakota conditions. Some may have been made on one or two farms under excellent feeding and management practices. The average mature equivalent 305 day, 2x records of daughters are shown in Table 1. These averages are made up of official records and DHIA records.

Artificial insemination has encountered many problems in South Dakota which cannot be accurately appraised in a study of this nature. On the basis of the cattle that have been sired artificially, the present data indicate that an improvement is being made. However, more information and time will be required to fully determine the extent of this improvement. (Project 184. Leaders: Emery Bartle, Chase Wilson and Kenneth Gross, Dairy Husbandry Dept.)

Big, strong, deep, hard working Guernsey cows that were artificially sired
One of the Home Economics research staff is shown taking a cobbler out of the oven which has just been tested successfully.

With the approach of summer and hot weather, fruits have a strong appeal to flagging appetites, partly for their color and partly for their refreshing juiciness and tartness. In areas such as South Dakota, where much of the fruit has to be shipped in, there is an additional zest for fruits that can be grown at home. One such fruit is the native sandcherry of South Dakota which has been developed through plant breeding into a fruit of a size and quality for sauce. Some select varieties which are budded on native plums are even good to eat fresh.

In recent years the relatively hardy, drouth-resistant bushes which produce these cherries have established their value in shelterbelt plantings and as an aid in the prevention of soil erosion. As a result, this fruit has become available to an increasing number of South Dakota families; and quite naturally, home-makers have shown an interest in knowing more about this fruit, its nutritional value, and different ways of preparing it for the table. To meet these requests for information, the foods and nutrition laboratory of the South Dakota Experiment Station has carried on some tests for both nutritive value and use of sandcherries in recipes for the home.
Dark Purple Varieties Used
Sandcherries vary in color from yellow to a very dark purple, but the ones used in this study were all of the purple varieties. They compare in size to most sour cherries and have a relatively large pit. As with any other cherries, pitting is a problem that has to be considered. They can be pitted by hand which produces a superior product. When large quantities are to be handled, a mechanical pitter, of which there are a number on the market, might be used. However, this laboratory has as yet made no evaluation of such devices. Limited experience would indicate that more crushing of the fruit takes place with the use of the mechanical pitter than with hand pitting. Another method of getting rid of the pits is to run the cherries through a food mill with the spring loosened on the underside. This produces a smooth puree which is satisfactory for many purposes.

Vitamin C Content Good
Vitamin C is the vitamin which is probably the most important in considering the nutritive value of a fruit. Chemical analyses of six different varieties of sandcherries have shown that they average about 19 milligrams of vitamin C per cup of fruit. This figure compares favorably with accepted values of vitamin C in other types of cherries, either sweet or sour.

A Number of Recipes Developed
The development and testing of recipes using sandcherries has resulted in a variety of good-tasting products. In all recipes both the hand-pitted cherries and the cherry puree were tried with success, but generally the whole cherries were preferred.

Two Cobbler Recipes
To introduce some variety in dinner desserts which might be made from sandcherries, recipes for two different types of cobblers proved especially successful—one, the conventional type and the other one made by placing the fruit on top of the batter and pouring a mixture of boiling juice and water over both.

Sandcherry Cobbler No. 1
2 cups flour 2 tsp. sugar
½ tsp. salt ½ cup shortening
4 tsp. baking powder 1 egg, well beaten
¾ cup milk

Filling
3 cups cherries
2 tbsp. quick cooking tapioca
1 tbsp. lemon juice
½ tsp. cinnamon
1 cup sugar

Place cherries (whole or puree) in greased 8” square pan. Sprinkle with mixture of sugar, tapioca, cinnamon and lemon juice. Prepare dough by sifting dry ingredients together. Then cut in the shortening until mixture resembles coarse meal. Add well beaten egg and milk. Stir only until ingredients are dampened. Drop dough in mounds over cherries. Bake at 400°F for 30—35 min.

Pie made from sandcherries and rhubarb
Sandcherry Cobbler No. 2

1 cup flour
1 1/2 tsp. baking powder
1/2 cup plus 1 cup sugar
1/4 cup butter or margarine
2 tsp. lemon juice
1/2 tsp. cinnamon
1 1/2 cups boiling water and juice
2 cups cherries
1/2 tsp. salt
1/2 cup milk

Cream shortening and 1/2 cup sugar. Sift together flour, salt and baking powder. Add milk and dry ingredients alternately to creamed mixture. Spread batter in greased 8"x8"x2" pan. Cover with cherries (whole or puree). Sprinkle 1 cup sugar plus 1/2 tsp. cinnamon and lemon juice over cherries and pour on 1/4 cups boiling water and juice. Bake at 350° F. for 1 hour.

Sandcherry Cobbler

The word "cherry" usually brings forth a mind's-eye picture of a luscious pie just coming out of the oven. Although quite different from one made from ordinary sour cherries, a pie made from sandcherries can be a real delight on the dinner table. To some people, these cherries have quite a strong flavor, to others they are bland or lacking in flavor. Depending on one's taste, sandcherries when used in a pie may be mixed with other fruit such as apples or rhubarb, or lemon juice may be added to "pep up" the flavor.

The recipes which follow represent two ways of using sandcherries in pie. If apples are preferred to rhubarb, they may be substituted, measure for measure, in that recipe.

Sandcherry Pie

3 1/2 cups sandcherries, pitted
5 tbsp. cornstarch 1/2 tsp. cinnamon
1 1/2 cups sugar 1 tbsp. butter
1 tbsp. lemon juice

Line 9" pie pan with pastry. Combine sugar, cornstarch and cinnamon in saucepan. Add cherries (whole or puree) and cook until mixture comes to a boil and thickens. Add lemon juice. Pour into pastry lined pan; dot with butter. Adjust top crust; seal and flute. Bake in hot oven (450° F.) for 10 min.; then reduce heat to moderate (350° F.) and bake for 30—40 min.

Sandcherry and Rhubarb Pie

1 1/2 cups sandcherries, pitted
2 cups rhubarb, 1/2 inch pieces
1 egg 2 tsp. lemon juice
3/4 cup flour 1/2 tsp. cinnamon
1 1/4 cup sugar 1 tbsp. butter

Line 9" pie pan with pastry. Combine cherries (whole or puree), rhubarb, sugar, flour, egg, lemon juice, and cinnamon. Turn into pastry lined pan. Dot with butter. Adjust top crust; seal and flute. Bake in a hot oven (450° F.) for 10 min.; then reduce heat to moderate (350° F.) and bake for 30—40 min.

Muffins and Coffee Cake

Sandcherries can also be used in breakfast or luncheon menus. For instance, hot sandcherry muffins are a tempting addition to either of these meals. The cherries add just the right zip to the rich muffins to make them extra good. Another possibility is delicious sandcherry coffee cake. These two recipes are as follows:

Sandcherry Muffins

2 cups flour
3/4 cup sugar
3 tsp. baking powder
1/2 tsp. salt
1/4 cup shortening, melted
1 egg, beaten
3/4 cup milk
3/4 cup cherries, pitted
1/2 tsp. cinnamon

Sift together flour, sugar, baking powder, salt and cinnamon. Combine beaten egg, milk, and melted shortening. Place whole cherries in dry ingredients and mix until they are all covered with flour. Add liquid ingredients to the dry ingredients and cherries and stir only enough to blend. Bake in moderately hot
Young bushes loaded with sandcherries

oven (400° F.) for 20 to 25 minutes.

If cherry puree is used in place of whole cherries, combine as above except that the cherry puree will be carefully folded in just before placing in the muffin pans.

**Sandcherry Coffee Cake**

2 cups flour
2 tsp. baking powder
1/2 tsp. salt
1/4 cup sugar
1/4 cup shortening, soft
1 egg
1/2 cup milk
1 cup cherries

**Crumb Topping**

1/2 cup flour
1/2 tsp. cinnamon
1/2 cup sugar
1/4 cup butter, soft


To go with breakfast muffins or as a tart garnish for meats, sandcherry jelly is hard to beat. Since the cherries themselves are quite low in pectin content, additional pectin in powder or liquid form should be added to the cherry juice to make it jell. When concentrated apple juice is combined with the cherry juice, it not only adds a little different flavor, but also makes the jelly somewhat lighter in color and furnishes enough pectin so that it is not necessary to use a commercial pectin. This concentrated apple juice must, of course, be extracted from good "jelly" apples for this purpose.

The sandcherry juice can be extracted by the double extraction method. This method consists of adding one pint boiling water to 11/2 pounds unpitted cherries and boiling for 7 minutes before straining. For the second extraction, the above process is simply repeated. Then the two extractions are combined.

**Jelly Recipes**

**Sandcherry Jelly**

3 1/2 cups sandcherry juice
3 1/2 cups sugar
1 pkg. powdered pectin

Follow the directions on your commercial pectin package.

**Sandcherry-Apple Jelly**

1 cup cherry juice
1 cup concentrated apple juice
1 1/2 cups sugar

Combine juice and sugar and cook over high heat until it sheets when poured from spoon. If using a thermometer, boil until juice reaches 218° F.

**Sandcherry-Lemon Jelly**

3 cups sandcherry juice
1/2 cup lemon juice
3 1/2 cups sugar
1 pkg. powdered pectin

Follow directions on your commercial pectin package.

(Project 210. Leaders: Lida Burrill and Beth Alsup, Home Ec.)
SOIL Survey
IN SOUTH DAKOTA

By George Buntley

Soil surveys are now being conducted in six counties in South Dakota, and in due course of time, a soil survey will be made and published of every county in the state. These surveys vary in the degree of mapping detail according to the intensity of the agriculture in the area to be surveyed. For instance, a soils map of rangeland areas does not require the detail that is necessary for maps of intensive farming or irrigation areas. The order of priority in which new survey areas are selected depends on the popular demand and the scientific need for information in any certain area.

Survey Basis for Recommendations

The primary objective of the soil survey program is to make an inventory of South Dakota soil resources, and to put this information on maps where it may be used as a basis for making soil management recommendations.

Many hundreds of different kinds of soil exist in South Dakota. Crops are sensitive to these soil differences. Therefore, it is necessary to define these soils and to separate them on maps, in order that consistent predictions and applicable recommendations, in respect to fertility, productivity, and soil management practices, may be made. In areas where irrigation is a possibility, additional information on soil permeability, salt pattern, and harmful alkali content is necessary to assess the adaptability of the soils for irrigation.

The soil survey program may be divided into several phases: (1) soil mapping, (2) field observations and investigations in soil fertility, productivity, and management, (3) laboratory analysis of field samples, (4) soil genesis (soil formation) studies, and (5) cartographic and publication processes.
Mapping Is First and Most Important Job

The most important job of the soil surveyor is mapping soils as they occur naturally in the field. This consists of separating the soils on the basis of their profile characteristics and putting these separations on maps. By a soil “profile” is meant a vertical cross-section of soil consisting of several layers. This profile has many characteristics which are visible, such as the number and thickness of the layers, the texture (loam, silt loam, etc.), and the structure (granular, prismatic, etc.).

The surveyor's completed map shows the occurrence of the different types of soil, the percent slope of the land upon which these soil types occur, the degree of erosion, plus a number of secondary features, such as fences, roads, rivers, streams, and general land use.

Complete soil profile samples are taken regularly in the field. These samples are analyzed in the laboratory during the winter months as a means of checking the uniformity of the field mapping units.

Productivity of Soils Tested in Field and Greenhouse

To help interpret the information obtained by mapping, fertility, productivity, and management investigations are carried on in the survey area. Fertility plots are laid out on a number of identified types of soil. Many fertilizers, of varied composition, are applied at different rates on plots, and during the winter months the fertility studies are carried on in the greenhouse.

Investigations as to the possibility of improving the internal drainage in soils which have a hard, compact layer are also carried on. Various rates of gypsum, an agent which promotes aggregation, are applied to soils that allow only a slow passage of water through them. This work is undertaken in areas where it appears that irrigation is not feasible unless improved profile drainage can be obtained.

Results Verified Further by Laboratory Analysis

Laboratory analysis is made of all samples taken in the course of field mapping, fertility investigations and irrigation studies. This varies with the area in which the sample is taken and the purpose for which the analysis is to be used. The analysis may include: Mechanical analysis to determine soil texture; pH (acidic or basic) and salt determinations for potential irrigation areas; soil mineralogical analysis for soil genesis studies; permeability studies for assessing internal drainage for irrigation, and the testing of known soil types for fertilizer needs.

Completed field sheet of surveyor, showing differences in soil, slope and soil erosion.
Plots are laid out on identified types of soil to test the fertility

In order that all the different phases of the soil survey program may be carried on systematically, definite survey areas, usually county units, are set up. At the present time, detailed basic soil surveys are underway in Spink, Hand, and Brookings counties. Less detailed surveys, known as reconnaissance surveys, are also being carried on in Potter, Sully and Hughes counties.

Irrigation Areas Receive Major Emphasis

The major emphasis of the survey program now is on the areas being considered for irrigation. Up to the 1952 field season, approximately 650,000 acres, or about two-thirds of the county, have been mapped in Spink County, and about 110,000 acres have been mapped in Hand County. Mapping in Brookings County has been limited, because of the summer activities in Spink and Hand counties, to a spring and fall program, with about 45,000 acres completed now. Reconnaissance surveys of Potter and Sully counties have been completed, and about 253,000 acres in Hughes County have been mapped.

Well over 500 samples have been analyzed for pH and salt content in Spink and Hand counties and the data plotted on charts and maps. Permanent files are kept of all sample data obtained. (Project 183. Leaders: F. C. Westin, A. J. Klingelhoetz, W. C. Moldenhauer, G. J. Buntley, J. M. Beardsley, and F. E. Shubeck, Agronomy Dept., in cooperation with the USDA.)

SOILS REPORTS COMPLETED

The most recent soils reports are B 411, Soils of Jerauld County, 1951, and B 421, Soils of Day County, 1952.

Older soil reports are available on Beadle, Brown, Douglas, Grant, Hyde, McCook, Moody, Union and Walworth counties. These can be obtained from your county agent or by writing to the Agricultural Experiment Station, Bulletin Room, Brookings, South Dakota.
The 1951 corn crop had not only a far greater moisture content than had been previously experienced, but it was also immature. Much of this corn tested 40 percent moisture, or more. Because of its exceptionally high moisture content, a trial was conducted to determine the feeding value of this immature corn as compared to hard corn, and also to determine satisfactory methods of feeding immature corn. In previously conducted trials, soft corn of 24 to 34 percent moisture was shown to be approximately equal to hard corn when compared on a dry matter basis.

Immature Corn Compared With Hard Shelled Corn

In this experiment, hard shelled corn, fed as a check in Lot I, was of No. 1 grade and came from the 1951 crop.

The immature corn was fed in three ways: (1) dried and shelled, (2) wet and shelled, and (3) wet on the ear. This corn, fed in Lots II, III, and IV, was picked with a mechanical picker early in January 1952, from one field. At the time it was
picked, it contained about 50 percent moisture (kernels) and had a test weight of 33 pounds. Approximately one-third of this corn was stored in an open crib and the remaining two-thirds was shelled while frozen.

About half the shelled corn was dried to 17 percent moisture in a local commercial drier and the other half was stored about 2 feet deep in steel bins. At the end of the trial, the stored shelled corn analyzed 43.6 percent moisture, indicating that some loss of moisture had occurred during storage. The dried corn was also stored in a steel bin, and at the end of the trial it analyzed 13.7 percent moisture, which indicated that further drying had occurred during storage. A chemical analysis of this corn is presented in Table 1.

The corn was self-fed in a conventional grain self-feeder, except for the ear corn (Lot IV), which was hand-fed twice daily on a concrete feeding floor. By the end of the first week it was apparent that the pigs in this lot were not able to get enough corn by this method of feeding due to the accumulation of cobs, snow and ice on the feeding floor. A small hay self-feeder was then put on the feeding floor and used as an ear corn self-feeder. Another one was added about three weeks later. The pigs in this lot had a tendency to overeat on protein supplement during the first week of the trial, but use of the ear corn self-feeders remedied this.

No difficulty was encountered in self-feeding the wet shelled corn because of freezing. During periods of freezing and thawing weather, a little difficulty was encountered from the wet shelled corn freezing into a mass in the bin of the self-feeder.

All lots were self-fed a protein supplement to which an antibiotic and vitamin B12 had been added. A mineral mixture was self-fed to all lots.

Most Rapid Gains Made on Hard Corn

The results of this trial, which was conducted during the period January 30 to April 9, 1952, are summarized.

Table I. Chemical Analysis of Immature Corn and Hard Corn Fed to Growing-Fattening Pigs, 1952*

<table>
<thead>
<tr>
<th></th>
<th>Hard Corn (Shelled)</th>
<th>Immature Corn (Dried, Shelled)</th>
<th>Immature Corn (Wet, Shelled)</th>
<th>Immature Corn (Wet, Ear)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>10.0</td>
<td>17.1</td>
<td>49.8</td>
<td>49.6</td>
</tr>
<tr>
<td>Crude protein</td>
<td>9.1</td>
<td>10.1</td>
<td>10.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>73.3</td>
<td>81.4</td>
<td>65.2</td>
<td>78.6</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>1.7</td>
<td>1.9</td>
<td>3.0</td>
<td>3.6</td>
</tr>
<tr>
<td>Crude fat</td>
<td>4.4</td>
<td>4.9</td>
<td>2.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Ash</td>
<td>1.5</td>
<td>1.7</td>
<td>1.8</td>
<td>2.2</td>
</tr>
</tbody>
</table>

*Samples for these analyses were taken January 21, 1952.

′Calculated to a moisture-free basis.

1Protein supplement consisted of 42 parts tankage, 28 parts soybean meal, 29 parts ground alfalfa hay and 1 part Bi Con 3 + 3 (3 grams of terramycin and 3 milligrams of vitamin B12 per pound).

2Mineral mixture consisted of 40 parts ground limestone, 40 parts steamed bone meal and 20 parts iodized salt.
Table 2. Immature Corn Compared With Hard Corn for Growing-Fattening Pigs, 1952

<table>
<thead>
<tr>
<th>Items Compared</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pigs</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Av. number days on feed per pig</td>
<td>63.5</td>
<td>66.3</td>
<td>68.1</td>
<td>68.5</td>
</tr>
<tr>
<td>Av. initial weight per pig, lbs.</td>
<td>95.6</td>
<td>96.3</td>
<td>96.5</td>
<td>96.6</td>
</tr>
<tr>
<td>Av. final weight per pig, lbs.</td>
<td>213.5</td>
<td>210.6</td>
<td>210.4</td>
<td>200.5</td>
</tr>
<tr>
<td>Av. total gain per pig, lbs.</td>
<td>117.9</td>
<td>114.3</td>
<td>113.9</td>
<td>103.9</td>
</tr>
<tr>
<td>Av. daily gain per pig, lbs.</td>
<td>1.86</td>
<td>1.73</td>
<td>1.67</td>
<td>1.52†</td>
</tr>
</tbody>
</table>

**Feed consumed per pig**

| Av. daily corn, lbs. | 6.36  | 7.85   | 10.02   | 18.35  |
| Av. daily protein supplement, lbs. | .76   | .51    | .60     | .64    |
| Av. daily mineral, lbs. | .05   | .04    | .06     | .05    |
| Av. daily total feed, lbs. | 7.18  | 8.41   | 10.68   | 19.05  |

**Feed consumed per cwt. of gain**

| Corn, lbs. | 342.7 | 455.1  | 599.0   | 1209.6 |
| Protein supplement, lbs. | 41.2  | 29.8   | 36.1    | 42.3   |
| Mineral, lbs. | 2.6   | 2.4    | 3.4     | 3.6    |
| Total feed, lbs. | 386.5 | 487.3  | 638.5   | 1255.5 |
| Total dry matter per cwt. gain | 348.8 | 407.0  | 337.1   | 426.4  |
| Feed cost per cwt. gain‡ | $12.39| $10.96 | $6.67   | $7.88  |

*Test weight, 2/1/52: hard corn, 55 pounds; dried corn, 29 pounds; soft shelled corn, 33 pounds; on 2/29/52: hard corn, 55 pounds; dried corn, 30 pounds; and soft shelled corn, 30 pounds.

†Significant over Lot III. Highly significant over Lots I and II.

‡Feed prices used: hard corn, $1.68 per bu. ($3.00 per cwt); dried corn, $1.16 per bu. ($2.07 per cwt); wet shelled corn, $.45 per bu. ($.80 per cwt); wet ear corn, $.33 per bu. of 70 pounds ($.47 per cwt); protein supplement, $4.91 per cwt; and mineral mixture, $3.32 per cwt.

ized in Table 2. The most rapid gains were made on the hard corn and the slowest on the immature ear corn. Also, in the amount of corn required to produce a hundredweight of gain, the hard corn lot excelled all other lots.

By comparing Lots III and IV, shelling the wet corn before feeding it was justifiable, not only on the basis of an increased rate of gain but also on the basis of a noticeable increase in efficiency of gain, as indicated by the feed requirement for each hundredweight of gain.

The gains produced on the dried shelled corn were made at a higher cost than those on the wet corn, due to the cost of drying (24 cents for 56 pounds of wet shelled corn). Drying the corn, however, eliminated inevitable spoilage which takes place during warm months and increased the rate of gain (1.73 pounds gain daily for the dried shelled corn as compared to 1.67 pounds for the wet shelled corn).

The difference in average daily gain made by the pigs in Lot I and Lot IV was highly significant, and the same was true of the gain in Lot II as compared to Lot IV.

**Less Protein Supplement Consumed in Soft Corn Lots**

It will be noted that the consumption of protein supplement was lower in the lots which received the
dried corn and the wet shelled corn than that in the lot which received the hard corn. This may have been due to the fact that the crude protein content of the immature corn was somewhat greater than that of the hard corn when compared on a dry matter basis. A slightly greater intake of protein supplement will be noted in the lot which received the wet ear corn. This may be attributed to a somewhat limited intake of corn the first week of the trial, due to the method by which the corn was fed.

Immature Corn Produces Cheaper Gains

Based on the feed cost to produce a hundred pounds of gain, the immature corn definitely produced cheaper gains than did the hard corn. This, of course, is dependent upon the prices paid for the immature corn and for the hard corn. Shelling of the wet corn in order that it could be fed more conveniently than the ear corn, resulted in less feed cost per hundredweight of gain, because the rate of gain was increased and less feed was required to produce this gain. The ear corn required to produce a hundredweight of gain in Lot IV (1209 pounds) was equivalent to 762 pounds of wet shelled corn (based on a shelling percentage of 63 percent).

Can Be Fed Profitably

According to the results of this feeding trial, it is apparent that immature corn can be most profitably fed to growing-fattening pigs in the wet form during the winter months. In order to realize maximum gains, it must be fed in large enough quantities to compensate for its high moisture content. Artificial drying of immature corn may be profitable, depending upon price relationships, when greater amounts of wet immature corn are available than can be fed before spoilage occurs in the spring, or where storage for summer feeding is desired.

Based on the results of this trial, immature shelled corn (50 percent moisture) is approximately equal to hard corn when compared on a dry matter basis as a feed for growing-fattening pigs. A comparison of the corn in Table 1 also indicates this. However, more dry matter was required where dried corn was fed. There was a noticeable waste in the lot fed the dried corn, but none in the lot fed hard corn and none in the lot fed wet shelled corn, even though the same type of grain self-feeders was used in each lot. This waste may, in part, account for the additional dried corn required as compared to hard corn. (Project 131. Leaders: C. J. Heidenreich and R. F. Wilson, Animal Husbandry.)

**POINTS ON FEEDING IMMATURE CORN**

1. A profitable way of using soft, immature corn is to feed it to growing-fattening pigs during winter months.
2. When compared on a dry matter basis, soft immature corn is about equal to hard corn as a feed.
3. Immature corn produced cheaper gains. Feed costs per hundredweight gain were $12.39 for the hard corn lot as compared to $6.67 for the lot getting wet immature shelled corn.
4. To self-feed protein supplement with soft corn, the corn must be fed liberally.
Many changes in physical and social environment have taken place in Belle Fourche's 50-year history.

Some of the changes are due to factors pertaining directly to the project, such as methods of water supply or introduction of new crops or livestock. Others are due to trends affecting the country as a whole, such as the depression in the "thirties," prosperity during and after World War II, rural electrification and the use of power machinery.

To evaluate the changes and improvements that have been achieved on the project, it is necessary to consider that the Belle Fourche project was one of the very first to be undertaken by the Bureau of Reclamation. It was natural, therefore, that many mistakes would be made in that early stage of Reclamation development, as engineers had little or no experience in irrigation. Also, during the first 10 years, the main emphasis was placed on the engineering features and not on agricultural development.

Another point to be remembered, is that the project is located in the northwest part of South Dakota and was started in an area in which agriculture was not strongly developed. It was thus naturally slow in getting underway and in overcoming the customs and habits of the western ranching region.
At the present time, the average size dry-land farm in Butte County has between 1800 and 1900 acres, according to the 1950 census, whereas the average size irrigated farm unit is about 331 acres.

The adjustments that have taken place are closely related to the changes in irrigation and farming techniques, such as: (1) Obtaining a dependable water supply, (2) shift in the types of livestock used, (3) adaptation of crop varieties, and (4) changes in marketing demands.

**Obtaining a Dependable Water Supply**

The original irrigation plan diverted water from the Belle Fourche river through a diversion dam. This inlet canal is located about 6½ miles from the Belle Fourche reservoir. It was not long before the engineers discovered that the “intake” to the Belle Fourche reservoir was not big enough and considerable run-off was wasted each year. An additional reservoir was planned and this “off-stream” storage on Owl creek assured a considerable added water supply as a safety device.

Also, the Reclamation Bureau, recognizing the deficiencies in early planning, cooperated with the Geological Survey Service in establishing a system of stream gauging stations, so that water supply data, covering long cycles, would be available to project engineers. This made it possible, to some degree, to store water in the reservoir and to offset losses through evaporation and leakages. In the early stages of determining the water requirements for the project, water gauges had not been perfected.
Another serious drawback was the lack of proper drainage provisions. This was later corrected and the distribution and drainage system now includes 410 miles of lateral and approximately 200 miles of project drains.

**Introducing a Livestock Economy**

Livestock has always been the primary source of income for Belle Fourche water-users. Even before the irrigation project was developed, this area was well suited for livestock grazing with its abundant native grass pasture and its relatively mild climate for that far north.

After the close of the Civil War, the cattle drives were started northward from the open range of western Texas to eastern and western livestock markets. Cattle trails running from north to south, intersecting transcontinental railroad lines, were used. Some of the cattle not marketed worked up into the northern Great Plains region.

Under irrigation, hogs and sheep, which proved to be especially profitable, were added to the livestock industry. Dairy cattle were also introduced and dairy products are now in strong demand in the local Black Hills area.

**Adapting Crop Varieties**

In adapting crops for the Belle Fourche area, the need of feed for livestock was taken into foremost consideration. Such crops as alfalfa, sweet clover and tame bromegrass mixtures provide good pasture, especially on clay soils. Some suggestions for irrigated crop rotations on clay soils were published in Circular 83, by the South Dakota Station.

Another fairly recent development is the extended use of vegetable gardens. With the increase of food prices, much saving can be effected by the greater use of homegrown vegetables and fruit. Project families estimated that the typical irrigation farm unit could easily produce enough to reduce the food costs to half, even at present prices. During the pre-irrigation period, under semi-arid conditions, many ranchers felt that it would not pay to attempt to raise their own gardens.

Weed control has been always a problem under irrigation. New research data, especially on chemical weed control are now available and various efficient chemical weed killers are on the market.

Another problem of importance under irrigation conditions is the prevention of plant diseases and insect damage. This also has been given serious attention by plant breeders.

**Developing Markets and Industries**

During the period from 1908 to 1920, the principal market outlets for livestock and cash crops were the large central markets. Since World War II, however, emphasis has shifted from selling in central markets to meeting nearby local demands in the Black Hills and on the project itself. The main reason for this change is the population growth throughout the Black Hills.

There also has been a distinct shift from rural farm and rural nonfarm to city. Since the 1950 census, Rapid City has become the second largest city in the state and lays claim to being the fastest growing city in the state, as well.
On the project itself, the decline in population in the rural-farm and non-farm families has been slightly more than compensated for by the growth of Belle Fourche and Newell in the same 10-year period.

Industries have been introduced in the last 10 to 15 years. Among these are the developments of bentonite and the manufacture of brick and tile. Other industries are a creamery, two grain elevators, two wool warehouses, active livestock exchange, a sugar beet factory, a large lumber yard and planing mill, and tourist camps and motels. Many other industries are in the process of development.

**Improving Education and Farm-Home Management**

Each new generation on the Belle Fourche project finds it easier to learn the art and practices of irrigation. Better tools and more information is available to the families, and school programs adapted to the needs of farm communities are increasing. Of the farm families interviewed in this study, the average farmer had only completed a partial grade school education. The average wife had completed all the grades and had one year of high school. In contrast, the average child of 18 years has completed at least high school and in addition has had some training in business and management.

The four towns in Butte County, Belle Fourche, Newell, Nisland and Vale have a combined high school attendance of 462 pupils. Courses in home economics or vocational agriculture and bookkeeping are offered; 4-H clubs and womens' home extension clubs also have played their part in education.

Families have gained considerable experience in the purchase and maintenance of efficient farm and household equipment. Usually the mechanization of the farm with new types of power machinery takes place a few years before equipment for the household is purchased. However, during the past 10 or 12 years, REA has revolutionized household equipment as well as that of the farm.

The use of power machinery has required considerable extra capital and special financing. While this has had a tendency, to some extent, to slow up the adoption of mechanization, on the other hand, it has had many compensating factors. Less full-time hired help is now being used on farms, but the amount of custom work for doing specialized jobs has increased.

Interesting developments have taken place in the way increased financing costs of farm equipment are handled. A number of families with several sons and daughters who are planning on farming, have formed family cooperatives for the ownership and use of the more expensive machines. A similar exchange among relatives and nearby neighbors has resulted in a considerable savings.

As a result of improved equipment, more education, and a somewhat higher average net income in the last few years, there has been a general rise in the standard and levels of living for the irrigation farmer on the Belle Fourche project. (Project 64. Leader: W. F. Kumlien, Rural Sociology Dept.)
Major projects in research for many of the departments have been reported on in the forepart of this Annual Report. They will be listed here under the proper subject and a page reference given so the entire accomplishments of the Station in any one field will be apparent under a single heading.

Crops and Soils

Tillage and Nitrogen Affect Yields

Greatest productivity of the soil is secured only when certain basic soil management practices are used. These include crop rotations, maintenance of soil organic matter, use of manure and crop residues, tillage and moisture conservation and the application of fertilizer.

Soil organic matter is essential for high productivity. Materials like straw which have been considered to have little value for soil improvement have a very beneficial effect on the yields of crops. For example, in 1951 the wheat plots which have had all straw returned yielded 3½ bushels more wheat per acre than the plots which have had the straw removed. Chemical analysis of these plots reveals that the loss of soil nitrogen for the rotation which included corn, oats and wheat for a period of eight years was only 202 pounds per acre in the surface soil as compared to a loss of 540 pounds of soil nitrogen in those plots which had the straw removed.

The methods of tillage also influence crop yields. Wheat yielded 12.7 bushels to the acre when the seed bed was prepared by subsurface tillage and 17.5 bushels per acre when the seed bed was plowed. No fertilizer or manure was added to these plots. When fertilizer and manure were added to the subsurface tilled plots the yields of wheat and oats were greatly influenced as indicated in the table.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Yield in Bushels per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface tillage</td>
<td>49.4 11.8</td>
</tr>
<tr>
<td>Subsurface with residue</td>
<td>44.7 12.7</td>
</tr>
<tr>
<td>Subsurface with residue &amp; manure</td>
<td>64.3 18.6</td>
</tr>
<tr>
<td>Subsurface with residue &amp; nitrogen</td>
<td>68.6 20.4</td>
</tr>
<tr>
<td>Subsurface with residue &amp; phosphorus</td>
<td>50.2 13.3</td>
</tr>
<tr>
<td>Subsurface with nitrogen and phosphorus</td>
<td>69.4 22.8</td>
</tr>
</tbody>
</table>
The results of this experiment show that crops growing in subsurface tilled soil will give substantially higher yields when the fertility of soil is improved by adding a combination of nitrogen and phosphorus fertilizer or manure. Good rotations, especially those including a legume, were very effective for increasing small grain yields in 1951. The following table shows the results of a sweet clover rotation on the yields of wheat. (Project 46. Leaders: L. F. Puhr and W. W. Worzella, Agronomy Department.)

### Effect of Sweet Clover Rotation on Wheat Yields

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield of Wheat in Bushels per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet clover plowed June 15</td>
<td>31.5</td>
</tr>
<tr>
<td>Sweet clover plowed June 15 with</td>
<td>34.2</td>
</tr>
<tr>
<td>phosphorus fertilizer</td>
<td></td>
</tr>
<tr>
<td>Sweet clover plowed August 1</td>
<td>31.9</td>
</tr>
<tr>
<td>Sweet clover plowed August 1 with</td>
<td>33.7</td>
</tr>
<tr>
<td>phosphate fertilizer</td>
<td></td>
</tr>
<tr>
<td>No legume-corn-oats-wheat rotation</td>
<td>14.0</td>
</tr>
</tbody>
</table>

Is Nitrogen Needed in Western South Dakota?

It seems very definite that nitrogen is a limiting element for western South Dakota. For instance, wheat following fallow yielded more than that following sorghum at the Cottonwood Range Field Station. Fallow not only is a moisture conserving practice, but it is a practice which stimulates the release of available nitrogen in soils. However, the use of a row crop in place of fallow is better than grain after grain, for the growing of a row crop is a semi-fallow operation. Nitrogen can also be added by the use of sweet clover. Second-year sweet clover should be turned under in June and then the land fallowed for the remainder of the summer.

The use of commercial fertilizer is beginning to have a place in western South Dakota. In Lyman County, it was found that winter wheat yielded 32 bushels per acre in 1951, where 33 pounds of nitro-
The use of nitrogen on grass also seems promising. Crested wheat in Lyman County yielded 1480 pounds of forage per acre where no nitrogen was applied and 2760 pounds where 60 pounds of nitrogen was put on. It seems very probable that winter wheat and grass at the present time can make the most economical use of commercial fertilizer in dry-land crop production in that area. (Project 4. Leader: B. L. Brage, Agronomy Department.)

Soil Problems in Relation to Irrigation Development

During the 1951 season, experiments initiated in earlier years were continued, and new experiments were begun. Major emphasis was placed on (a) studies of required amounts of supplemental irrigation water for corn and alfalfa, (b) the optimum planting rate and nitrogen fertilization rate required for corn production, (c) the management practices concerned with production of irrigated grasses and legumes for forage and seed, and (d) yields of crops in certain rotations as influenced by fertilizer application.

Among the more important findings for the season are the following: Both corn and alfalfa used “luxury” amounts of water without producing appreciable yield increases after certain minimal requirements were met. These requirements were approximately 13 inches of available water for corn and 20.5 inches for alfalfa. Corn produced optimum yields in drill planted plots with 19,360 plants per acre fertilized with 50 pounds of nitrogen per acre. Grass hay yields and seed yields for all species tested responded markedly to applications of commercial nitrogen fertilizers, the optimum application being about 80 pounds of nitrogen per acre.

Grass hay yields and seed yields for all species tested responded markedly to applications of commercial nitrogen fertilizers, the optimum application being about 80 pounds of nitrogen per acre. Wheat and corn in rotation experiments showed quite marked yield responses to management practices which increased available soil nitrogen, whether commercial fertilizer or legume rotations were used. In both dryland and irrigated non-legume rotations, the use of phosphate fertilizers with nitrogen gave yield increases with wheat, but not with corn. (Project 173. Leader: L. O. Fine, Agronomy Department, USDA cooperating.)

Soil Testing

The laboratory tested approximately 3000 soil samples during the year; 58 percent of these were submitted by individual farmers. Recommendations for soil fertility maintenance and management were made for the samples sent in by farmers, including the use of commercial fertilizers where needed.

Soil samples from fertilizer demonstration plots located on farms in 38 counties were tested. Soils of specific profiles from both Jerauld and Day counties were also analyzed. This was done to help evaluate the fertility status of these soils prior to the publication of the soil survey bulletins for these counties.

Soil samples from the Regional Radio-active phosphorus fertilizer experiments conducted on oats throughout the United States were tested for available phosphorus and available potassium. These tests were made in cooperation with the National Soil Test Work Group in an attempt to standardize methods and procedures of soil testing and to better calibrate the tests used here. (Project 172. Leader: P. Carson, Agronomy Department.)

New Small Grain Varieties Reduce Hazards

In 1952, Marine flax and Nugget durum wheat (described in S. D. Ext. Bul. 474) were released to farmers in cooperation with the USDA and the North Dakota Agricultural Experiment Station. Both varieties will contribute to
crop stability in the hazard areas of flax and durum production respectively.

Resistance to leaf rust and race 15B of stem rust has been emphasized in spring wheat breeding. Forty selections that appeared promising in 1950 were increased in California in the winter of 1950-51. Four of the most promising of these were increased further this past winter. These lines combine high yield capacity, resistance to leaf rust, and apparent tolerance to race 15B of stem rust. Quality determinations on them will be made this year.

Thirty crosses in flax are now being tested in bulk. Selections of disease resistant progenies will be made. The objective is an early, disease resistant flax, combining yield capacity with heat resistance.

An oat variety resistant to race 45 of crown rust is now under cooperative increase. Breeding for early, heat and disease resistant, stiff-strawed oats for central and western South Dakota is being continued, with Brunker, Osage and Mindo used as parents. (Project 181. Leader: V. A. Dirks, Agronomy Department.)

Malting Barleys and Hardy Wheat Sought

Some progress can be reported in improvement of winterhardiness in wheat, although this research is still in an exploratory stage. During the fall and winter of 1951-52, artificial freezing tests were conducted with good survival obtained in some lines. In addition some of the *Agropyron trichophorum* x *Triticum vulgare* backcrosses exhibited good winterhardiness. Field tests are necessary before more definite statements can be made.

A determined effort is being made to get an improved malting barley. Two approaches are being used. One is to improve Odessa Cl 182, our standard malting variety, through backcrossing. The other method being used is through standard crossing techniques. Thirty of the better agronomic types were tested for malting quality in small sample lots and several appear to be satisfactory. Efforts will be made to increase the better lines for further testing with a view to possible release. (Project 25. Leader: J. E. Grafius, Agronomy Department.)

Sorghum Variety Testing and Breeding

Sorghum yield tests are conducted on new promising sorghum strains and standard varieties to determine which ones are able to perform the best when all are grown on the same soil, and under similar environmental conditions. In 1951, eight trials were planted at seven locations in the state. A Uniform Regional Sorghum Nursery of 35 strains from five states was conducted at Brookings, Highmore and Newell.

Information from these trials was obtained on adaptability, height, standability, maturity and yield. The 1951 average yield from all tests of Norghum was 22 bushels, Sooner Milo 3.6 bushels, Martin 4.2 bushels, and Midland 5.0 bushels. In general, yields were not too high, due to a very cool growing season in part of the state and low rainfall in other locations.

Over 1600 strains and segregating populations of grain, forage and sudan grass were grown in the breeding nursery. Many of these combination crosses and strains were treated with Colchicine. Many new types of sorghum are produced with Colchicine treated strains and the treating of F1 progeny crosses. (Project 61. Leader: C. J. Franzke, Agronomy Department.)

Planting Sorghum Early Results in Sound Grain in Cool Seasons

Nine strains were selected and planted in a date of planting test. Plantings were made at weekly intervals; the first planting was in early May and the last
Effect of Date of Planting on Sorghum Yield at Brookings. 1950 and 1951

<table>
<thead>
<tr>
<th>Variety</th>
<th>May 10</th>
<th>May 17</th>
<th>May 24</th>
<th>May 31</th>
<th>June 7</th>
<th>June 14</th>
<th>June 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norghum</td>
<td>45.5</td>
<td>45.6</td>
<td>31.6</td>
<td>31.8</td>
<td>20.5</td>
<td>14.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Sooner Milo</td>
<td>22.4</td>
<td>19.6</td>
<td>10.6</td>
<td>12.1</td>
<td>1.6</td>
<td>1.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

planted in the third week of June. The results are shown in the above table.

It will be noted that early planting of grain sorghum produced the higher yields and well matured grain in a cool season. Also early planted grain sorghums can be harvested earlier in the fall before the plants break down from hard killing frost, and late fall rains and snow. Also, in cold seasons early planted sorghum produces sound grain with low moisture content that will store safely.

(Project 112. Leader: C. J. Franzke, Agronomy Department.)

Development of New Corn Hybrids Progressing

Special emphasis is being placed on the development of early hybrids for northeastern South Dakota and on later hybrids for the southeastern part of the state. One promising early combination, temporarily designated Experimental 10, has been found. It has been tested for three years in yield trials of experimental hybrids and from one to two years in a limited number of trials on commercial hybrids. If it continues to perform satisfactorily, its release is anticipated. It is five to seven days earlier than any hybrid released to date by the South Dakota Experiment Station.

Hand pollination work in the nursery at Brookings was directed toward the development of both new inbreds and new experimental hybrids. Several recovered inbreds are approaching homozygosity and will soon be uniform enough to use. New inbreds were started from several different parental sources.

Yield testing consisted of several trials on experimental double crosses and on single crosses. Results from the latter are used for prediction of double crosses. The season was so poor in 1951 that the results obtained from the yield trials were of little value. Moistures at harvest in some tests ran from 40 to 60 percent.

During the winter of 1951-52 all material used for developing new inbreds was subjected to a cold germination test. Also, pollinations were made on greenhouse grown material in which the first steps were completed toward the introduction of cytoplasmic male sterile into South Dakota inbred lines. (Project 66. Leader: D. B. Shank, Agronomy Department.)

Corn Adaptability Trials Continued

Corn yield performance tests are conducted each year on popular commercial hybrids to determine their yielding ability when all are grown on the same soil, and under similar environmental conditions. The results obtained were published in South Dakota Experiment Station Circular 93, and are available to anyone interested.

In 1951, 11 plots were planted with at least one being located in each of the eight agricultural areas of the state. The locations were near Spearfish, Cottonwood, Eureka, Claremont, Chamberlain, Highmore, Mitchell, Brookings, Sioux Falls, Redfield. From 16 to 33 entries were included in the various tests. These consisted of the corn hybrids purchased most frequently by farmers in the agricultural area represented by each test. A survey was conducted in which county agent and corn company recommendations were obtained.

Yield and percent moisture in the grain were calculated at the time of har-
vest. Two-, three-, four-, and five-year averages for both yield and moisture were included when the same hybrids had been grown in a test plot for a period of years.

In general, conditions were unfavorable for corn production. Yields were not too large and moisture percentages were unusually high. A very cool growing season coupled with above normal precipitation and early frosts reduced the yield severely. (Project 151. Leader: G. Nachtigal and D. B. Shank, Agronomy Department.)

Seed Production of Grasses Increased Through Breeding

Breeding of bromegrass, intermediate wheatgrass and crested wheatgrass is carried out by maintaining a degree of inbreeding coupled with selection pressure for yield of forage and seed and for disease resistance.

Special attention is being given to increasing seed production of the cultivated grasses, since the extent of their use is dependent upon the availability and cheapness of seed. Through selection and crossing, increase in the percentage seed set is being achieved in certain strains of Ree wheatgrass, crested wheatgrass and bromegrass.

A reserve of germ plasma for introduction into the breeding programs is maintained for each species by phenotypic and genotypic selection of native and introduced collections, as well as material treated with mutagenic agents. Introductions of new species and strains are grown for evaluation of agronomic and adaptive characteristics. A total of approximately 9,000 transplants of the above groups have been set out in the spring of 1952 at Brookings and Cottonwood.

Forage yield data collected at Brookings, Eureka, Highmore and Cottonwood continue to demonstrate the value of alfalfa in a grass-legume mixture for maintenance of the yield of the grass. Bromegrass and Rees wheatgrass are outstanding in yield in the eastern and central areas of South Dakota. (Project 182. Leaders: J. Ross and W. W. Worzella, Agronomy Department.)

New Research Pastures Established

Three types of pastures were established in the spring of 1952 as follows: alfalfa-brome; bromegrass; and sweet clover-rye. Each type of pasture was planted on 8-acre plots in duplicate. Grazing studies with beef cattle will be started in 1953 to determine the returns per acre and carrying capacity in comparison to returns obtained from several crop rotations. (Project 225. Leaders: W. W. Worzella, Agronomy Department and R. F. Wilson, Animal Husbandry Department.)

Pasture-Type Legumes Being Developed

Emphasis in breeding has been placed upon developing alfalfa strains specially adapted to withstand grazing and competition from aggressive grasses, and which are intended for use on dryland pastures and ranges. Selection nurseries are maintained at Brookings and at the Range Field Station near Cottonwood. A few parental plants have proved to be superior in general combining ability for the desired characteristics. Four of these, being particularly good for pasture type and quality, have now been vegetatively increased and transplanted to isolated crossing blocks so that three of the possible two-line synthetics can be formed for more adequate testing in pasture and range plots.

Small plot grazing tests of several alfalfa strains have been established at Brookings, Eureka, and Cottonwood. Grazing has commenced on the latter two, and will start at Brookings in 1953. Replicated experiments on technic of establishing stands of alfalfa successfully on range and pasture land were started in 1951. It has been concluded that estab-
lishment can only succeed where the sod forming grasses have been plowed down or thoroughly broken up by heavy disking with an offset, cut-away-type disk.

Strain trials with alfalfa, sweet clover, red clover and birdsfoot trefoil have been continued. A-46, a low-coumarin strain of sweet clover from Wisconsin, looks very promising. (Project 74. Leaders: M. W. Adams and W. W. Worzella, Agronomy Department.)

**Soybean Improvement**

Adaptation trials have been conducted on promising new selections at three maturity zones in the state. This is carried out in cooperation with the Regional Soybean Laboratory of the USDA and with farmer-cooperators in Roberts and Clay counties. In 1952, some 40 entries are being studied for yield, maturity, lodging, height, seed quality, seed size, and shattering. Chemical determinations for percent oil and protein will be made.

Through the activity of this project the Experiment Station has participated in the foundation increase and cooperative release of three improved soybean varieties: Hawkeye, Capital, and Blackhawk. The present high acreage of soybeans grown in South Dakota stems in part from the generally wide adaptability and superiority of these new releases. (Project 148. Leader: M. W. Adams, Agronomy Department, USDA cooperating.)

**Selenium Poisoning**

Studies on selenium poisoning during the year have dealt largely with the investigation of substances which counteract it, the manner in which selenium poisons animals, and the chemical form of selenium in plants.

The experimental work with cattle at the Reed Ranch has continued. Arsenic at a level of 37½ parts per million in the salt has been somewhat effective against selenium poisoning and has had no deleterious effects on reproduction or other physiological processes.

In the laboratory, fractionation of linseed oil meal is under way. The work to date gives promise for possible concentration and perhaps identification of the substance in linseed oil meal which prevents liver damage in rats. This substance may prove of value in counteracting selenium poisoning in farm animals.

Two substances which are being used in feeds as growth stimulants, much like antibiotics are used, have also been investigated for their effects on selenium poisoning in rats. The reason for investigating them is that they both contain arsenic, but they are much less toxic than is sodium arsenite (the form of arsenic now being used). Both compounds, phenylarsonic acid and arsanilic acid, appear effective in preventing symptoms of selenium poisoning in rats. These compounds are also being used in studies with poultry, and they will be used in experimental work with hogs.

Animals that eat seleniferous feeds exhale a considerable quantity of selenium in the breath. Under some conditions, arsenic has been found to prevent the selenium from being exhaled. Since it also prevents poisoning by selenium, there may be a relationship between selenium exhalation and the toxic effect of this element. It is hoped that further studies will yield an answer to what selenium does in the animal body to
produce the symptoms it does, which will make it easier to find effective control measures.

Wheat kernels containing radioactive selenium have been used to study possible selenium loss from the stored grain via volatile compounds arising during respiration. After 60 days no activity due to radioeselenium was detected in any of the six absorbing solutions used. This investigation will be repeated with selenium preparations of higher activity.

Water extracts and acid hydrolysates of field grown wheat plants and kernels have been examined by means of starch column chromatography for amino acid content and areas of radioeselenium activity. With respect to radioisotope measurements, the study has been largely unsuccessful, except to show that activity due to radioeselenium compounds can be found in several discrete areas of the chromatograms. This suggests that selenium is metabolized via several intermediate compounds. Similar studies with *Actragalus bisulcatus* plants show the activity to be localized in seven or more compounds. The identity of these compounds is being sought and the quantitative aspects of the study will be furthered by selenate preparation of higher activity. (Project 19. Leaders: O. E. Olson, A. W. Halverson, E. I. Whitehead, L. D. Kamstra, C. M. Hendrick and R. M. Pengra, Station Biochemistry; C. A. Dinkel, Animal Husbandry Department, cooperating in Reed Ranch studies.)

**Nitrate Poisoning**

Investigations of the past year have been devoted almost exclusively to studying the effects of herbicide treatments on nitrate accumulation in various plant species.

Plantings of millet, foxtail, mustard, small ragweed, Kochia, Russian thistle, and pigweed were sampled at 3, 8, 14 and 19 days after spraying with 2,4-D at 1/8, 1/4, and 1/2 pounds per acre levels. Only a slight and perhaps non-significant nitrate accumulation was noted in the treated plants.

In another study TCA, CMU, EC-3890, Niagarathal, and Dow pre-emergence sprays were applied to cowpeas, oats, beets and foxtail plants. Stem, leaf, and occasionally root or seed fractions of these plants were analyzed for nitrate content after pre-emergence and post-emergence sprayings (treatments applied to separate plots). Treatment with any of these herbicides resulted in generally consistent increases in the nitrate content of the stems, but not the leaves, of these plants with either the pre- or post-emergence treatment.

While the results of this 2,4-D experiment were not in agreement with those of the preceding experiment, it was noted that the untreated control plants of the 2,4-D series contained much less nitrate than the untreated control plants of the latter study. The possibility that low nitrate levels in the soil may considerably diminish the effect of herbicide treatment on the nitrate content of plant tissue is being investigated and in addition applications of herbicide sprays at lower, or more nearly hormonal, levels are being made. (Project 87. Leaders: E. I. Whitehead, F. L. Moyer and O. E. Olson, Station Biochemistry; L. Derscheid, Agronomy Department.)

**Cornstalk Poisoning**

No evidence of cornstalk poisoning was observed in cattle placed in a field of flint corn at the Central substation at Highmore. There have been no reports during 1951 of losses due to cornstalk poisoning, nor have there been any such outbreaks for several years.

Lack of plant material capable of causing cornstalk poisoning limits the scope of research on this problem to fundamental studies. Thus far, the investigations have centered around nitrogen metabolism, involving both nitrate and ammonium forms of nitrogen. The re-
sponse of various nitrogen containing fractions to fertilization with either form of nitrogen is being determined. With this plan of work nearly completed, the carbohydrate and organic acid fractions of the corn plants will be investigated.

The major purpose of this fundamental approach to the problem is to obtain basic information about the corn plant which will enable one to ascertain possible differences in the constitution of normal and poisonous corn plants, when the latter become available for study. (Project 130. Leaders: E. I. Whitehead, F. L. Moyer, and O. E. Olson, Station Biochemistry; G. L. Harshfield, Veterinary Department; C. M. Nagel, Plant Pathology Department.)

Treatment of Hard Waters for Household, Farm and Dairy Use

Farm water supplies in South Dakota are in many cases excessively hard. This creates problems in laundering and cleaning.

Several chemical softening agents and detergents are sold commercially. They vary in composition and effectiveness, and it is difficult for the farm housewives to know which and how much of the various substances to use. Controlled studies have been carried out on several softening agents and detergents in an effort to evaluate their efficiency.

Great differences in softening agents have been found. Some are very effective in increasing dirt removal from soiled fabric while others are not. Certain of the softening agents appear to work well when used in the proper amount, but the use of too little or too much greatly reduces effectiveness.

Further studies are planned, using large-scale washing, to obtain information which will be of assistance in guiding the farm homemakers in the use of chemical softeners and detergents for laundry purposes. The work will also be extended to include household and dairy equipment cleansing. (Project 193. Leaders: O. E. Olson and G. F. Gastler, Station Biochemistry; D. F. Breazeale, Dairy Department; Lillian Lund, Home Economics Department.)

South Dakota Barley—High in Protein, see page 34

Minerals in South Dakota Feeds, see page 59.

Crop Insects

European Corn Borer

The loss in dollars that the European corn borer caused to South Dakota farmers during the past four growing seasons has been estimated as follows:

- 1948 $2,442,000
- 1949 $7,545,000
- 1950 $5,415,000
- 1951 $5,847,000

The 1951 loss amounted to 7.4 percent of the total corn production in the state.

Experiments have indicated that savings of from 5 to 11 bushels of corn per acre were obtained from single applications of DDT spray by aircraft in Minnehaha County in 1950.

Ground sprayer experiments in Clay and Yankton counties during the past two years have shown savings of from 8.9 to 10.7 bushels per acre from one-treatment, and 14.5 bushels per acre from two-treatment spray applications.

In Moody County, the one-spray treatments indicated savings of from 7.8 to 9.7 bushels of corn per acre. Single application of 5 percent and 10 percent DDT dusts gave savings of 6.9 and 4.8 bushels per acre, respectively. One treatment with Ryania dust gave 3.9 bushels more per acre than did untreated corn, but Ryania was found difficult to apply.

In the field of biological control, four species of insects which are parasitic on corn borers have been introduced. One of these is a fly, Lydella stabulans grise-
The other three are wasp-like insects, *Chelonus annulipes*, *Horogenes punctarius*, and *Macrocentrus gifuensis*. The latter two have been recovered from corn borer larvae as much as a year after introduction, but there is not yet conclusive evidence that any of these species have become permanently established.

Another species of wasp-like parasite, *Symopsis viridulus*, which was released in Minnesota and Iowa, has been recovered from eastern counties of South Dakota. Other forms of biological aid in reducing corn borers are being studied and a report will be issued when more information has been obtained. (Project 187. Leader: Gerald B. Spawn, Entomology Department.)

**Cottonwood Leaf Beetles**

The cottonwood leaf beetle is one of the most important insect pests of cottonwoods in South Dakota. The insect is harmful in both the adult and larval stages. Control of the pest was readily obtained by spraying infested trees with the following insecticides:

- **Lead arsenate (commercial)**
  - 4 lbs. water 100 gallons
- **DDT (50% wettability powder)**
  - 4 lbs. water 100 gallons
- **Aldrin (emulsion, 2 oz. actual)**
  - water 100 gallons

It is usually necessary to spray more than once to control cottonwood leaf beetles during the growing season.

**Cottony Maple Scale**

The cottony maple scale increased during the past two years and has become a serious pest of many shade and fruit trees and vines. Elm, boxelders, maple, linden, hackberry, apple, plum, Virginia creeper and grape suffered the greatest amount of damage.

Spraying with reliable miscible oils diluted to give 2 percent of actual oil and applied early in the spring before the leaves appear gave excellent control.

Spraying with DDT, 3 pounds of 50 percent wettability powder per 100 gallons of water and applied thoroughly shortly after the eggs hatched in mid-July gave about 50 percent control of the scale insects. (Project 220. Leader: H. C. Severin, Entomology Department.)

**Buffalo Tree-hopper**

The buffalo tree-hopper, *Stictocephala bubalis* Fabr., has developed into a serious insect pest in South Dakota. Damage is caused by the egg-laying activities of the female insects and little or no damage is done by the feeding habits of the insects, either nymphs or adults. Fruit and shade trees are affected, apples, pears, plums, elms, chinese elms, poplars, willows and boxelders being most commonly damaged.

The female buffalo tree-hoppers have a saw-like instrument at the back of their body and with this they cut slits through the bark and into the sapwood of two- or three-year-old twigs. Into these slits they insert their eggs. As many as four or five pairs of slits may be made and filled by one female in a day.

The plant tissue between each pair of slits dies, leaving an oval or circular scar. This scar increases in size with each season's growth and as a result the injured twig becomes gnarly and rough. If the twig has received many egg-slits, it remains dwarfed and becomes deformed and weak. Such twigs are readily broken off by wind and they may become attacked by fungus diseases and other insects.

In the later part of May of the following year, nymphs begin to emerge from the eggs. The nymphs must make their way to other host plants to feed, usually weeds and grasses, but alfalfa and sweet clover also serve as food plants.

**Control.** The buffalo tree-hopper is dependent upon weeds, grasses, alfalfa and sweet clover from which the
nymphs may obtain their food. If such food is not available, the nymphs die. If, then, the orchard or windbreak is kept well cultivated during June and July and if, in addition, the borders of the orchard and windbreak are also cultivated, little, if any damage need be experienced from the buffalo tree-hopper.

If the twigs of fruit or shade trees contain many egg slits of the buffalo tree-hopper, then these trees may be severely pruned before the eggs hatch in the spring (before May 1). Such prunings should be gathered up and destroyed by burning. A dormant spray of 4 to 6 percent of oil applied to the trees late in the fall or early in the spring or on a warm day in winter may kill the majority of the eggs, but such spraying is not always successful.

If it is the practice to grow a cover crop in the orchard and buffalo tree-hoppers have become a problem, then it would be advisable to discontinue growing such a cover crop for a year or two and, in addition, to keep down all weeds and grasses during this time in order to starve out the nymphs. (Project 142. Leader: H. C. Severin, Entomology Department.)

Chemical Control of Grasshoppers, see page 83.

Fruits, Vegetables and Shelterbelts

Runner Formation in Strawberries Discouraged by Hill Planting

In 1950 several varieties of strawberry plants were grown in greenhouse pots for laboratory study. These were later planted outside to be grown in a "matted-row." By the end of the growing season few runners had formed and the original plant had grown to a large vigorous size.

In April of 1951, 200 plants of the Red Rich variety were divided into two lots with one lot being held in storage and the other lot grown in the greenhouse in flower pots for 30 days. Both lots were then transplanted outside for observation.

The potted plants produced runners on only two plants. Those planted directly outside produced runners and set plants normally. The yield was greater from those set in the field without potting.

This suggests a means of growing plants by the hill system where runner formation is not wanted. (Project 145. Leader: S. A. McCrory, Horticulture Department.)

Sandcherry Useful for Fruit and Shelterbelt

For 20 generations the native sandcherry has been grown and selections made. All seedlings now grown from seeds of these selections produce fruit with sufficient quality to serve as edible fruit. It is doubtful if further improvement will come from more selection.
Since the seedlings can be depended upon to produce fruit of edible quality, the need for vegetative propagation by budding is not required.

The sandcherry is frequently used in shelterbelts. A budded plant is considered too expensive for this purpose. With the improved seedlings the sandcherry may serve a dual purpose as a home fruit supply and as a shrub in the shelterbelt. (Project 1. Leader: S. A. McCrory, Horticulture.)

**Good Root Stocks Are Essential to Good Trees**

In order to use root stocks that are winter hardy, nurseries are forced to use material about which little is known as to the kind of tree it will produce. Some hardy stocks are being studied to determine their value as root stocks. Two have been observed long enough to draw some conclusions.

A selection of *M. baccata* called Yellow Siberian crab has produced a large vigorous growing tree. It has been compatible with all varieties grafted upon it to date. However, with many varieties the branches assume an upright habit of growth and form acute angles which break easily. Another selection named Manchurian crab has produced a semi-dwarf tree. Varieties have, in most cases, grown from the trunk at a very wide angle and have given strong scaffold branches when grafted onto it. It is a promising root stock. (Project 174. Leader: S. A. McCrory, Horticulture Department.)

**Breeding Triploid Apples**

Breeding stock for Triploid apples has been maintained but no further work was done this year. More active research is anticipated for the future. (Project 59. Leader: S. A. McCrory, Horticulture Department.)

**Tomatoes for Home Use**

Crossing of the early, drought resistant small fruited varieties of the Plains with the early high quality tomato varieties of other regions was continued. These crosses are made in the greenhouse during the winter and then planted in the field for observation as to yield, type and size of fruits and plants.

Another hybrid, S. D. No. 65, is on trial for the first time this year. It ma-
tures later than Sioux or Siouxann but has a firmer, larger and more attractive fruit (weighing 5 to 6 ounces) than either.

An experiment is under way on the effect of different planting and transplanting dates on earliness and yield of ripe fruit of the Sioux variety. (Project 49. Leader: S. Cook, Horticulture Department.)

**Best Sweetcorn Hybrids Increased for Distribution**

The best hybrids (early, midseason and late) developed at this station were again observed and compared with other commercial hybrids. Those hybrids that had shown favorably in yield and quality last year are being increased for further trial. The selected inbred lines are being increased for storage and for distribution to other experiment stations. (Project 68. Leader: S. Cook, Horticulture Department.)

**A Winter-hardy Strain of Siberian Elm**

The importance of the seed source of trees and shrubs used in windbreak and shelterbelt plantings cannot be overemphasized. Siberian elm (erroneously called Chinese elm) well illustrates this fact. The natural range of this tree covers a wide area including China, Turkestan, Siberia, and Manchuria. Much seed from southerly and central portions of its range were imported into this country years ago, and the resulting trees have occasionally suffered winter-killing or dieback during unfavorable years.

On the other hand, some lots of Siberian elm have never been affected by our winters. Testing of various sources of seed at this Station has shown that northern strains are better adapted to our climate. One particular strain from seed collected in the vicinity of Harbin, Manchuria, exhibited outstanding characteristics of adaptability. A seed-tree block with sufficient isolation from all other elms has been established, and certified planting stock will be available for general planting in the near future.

**Hybridization of Elms**

Natural crosses between slippery elm and Siberian elm have been investigated during the last two years. Seed collected from both the elms growing in close proximity has produced variable percentages of hybrid elms in addition to seedlings that resemble the parent. Climatic conditions at the time of natural pollination as well as the position of the crown from whence the seed was picked influenced the degree of crossing. The hybrids have shown a more vigorous growth rate than either parent. Further testing is needed to evaluate other qualities. (Project 142. Leader: Paul E. Collins, Horticulture Department.)

Can Chemicals Weed Your Garden? see page 68
Plant Diseases

Yellow Streak Mosaic of Wheat

Wheat mosaic was found on winter wheat in 14 counties nearly all of which were in the south central area of the State west of the Missouri River. In most fields the disease appeared to have very little effect on yield. In the few isolated instances where severe losses of yield occurred, the winter wheat had been sown early and near fields that had infected wheat the season before.

Experiments performed in the greenhouse have shown that if wheat becomes infected with the virus causing wheat mosaic when the plants are very young, severe losses in yield will result, but if the plants do not become infected until they are in the boot stage, yield losses will be slight.

Experiments on the host range of wheat streak mosaic have shown that a number of annual grass weeds that commonly grow in grain fields are highly susceptible. All of the weeds listed in the following table are susceptible.

Some of these weeds which grow in wheat fields help to perpetuate mosaic after harvest until the weeds are killed by frost. Winter wheat if sown early, in late August and early September, may be exposed to heavy infection because of the presence of mosaic-infected weeds. To reduce the chance of serious mosaic infection of winter wheat farmers are advised to combat these weeds and to avoid sowing winter wheat too early.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese chess</td>
<td>Bromus japonicus Thunb.</td>
</tr>
<tr>
<td>Cheat</td>
<td>Bromus secalinus L.</td>
</tr>
<tr>
<td>Downy brome grass</td>
<td>Bromus tectorum L.</td>
</tr>
<tr>
<td>Crabgrass</td>
<td>Digitaria sanguinalis (L.) Scop.</td>
</tr>
<tr>
<td>Barnyard grass</td>
<td>Echinocloa crusgalli (L.) Beauv.</td>
</tr>
<tr>
<td>Stink grass</td>
<td>Eragrostis cilianensis (All.) Lutati</td>
</tr>
<tr>
<td>Witchgrass</td>
<td>Panicum capillare L.</td>
</tr>
<tr>
<td>Bristly foxtail</td>
<td>Setaria verticillata (L.) Beauv.</td>
</tr>
<tr>
<td>Green foxtail</td>
<td>Setaria viridis (L.) Beauv.</td>
</tr>
</tbody>
</table>

Striate Mosaic of Wheat

Striate mosaic, which was discovered in South Dakota in 1950, is very similar to streak mosaic. Like streak mosaic it causes yellow streaks in the leaves as well as severe stunting of the wheat plants and may cause losses in grain yield and grade. This disease often occurs in the same fields as streak mosaic, and usually the two diseases cannot be distinguished except by infecting plants in the greenhouse. Unlike streak mosaic, striate mosaic cannot be transmitted to new plants by hand. In the field it is spread by a common, grass-feeding leafhopper Endria inimica (Say), commonly called the hurtful leafhopper.

Like streak mosaic, striate mosaic can infect certain of the annual grass weeds that often grow in grain fields.

The control measures recommended for this disease are the same as those recommended for streak mosaic, namely, avoid early seeding of winter wheat and destroy the susceptible weeds before the new crop of wheat is planted in the fall.

False Stripe, A Virus Disease of Barley

A virus disease known as false stripe has occasionally been found on barley. It causes yellow to whitish stripes on barley leaves, and may cause severe stunting of infected plants. However, infections that have been found to date have been light and no important yield losses have been noted.

Common Annual Grass Weeds Susceptible to Streak Mosaic

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese chess</td>
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<td>Cheat</td>
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<td>Downy brome grass</td>
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</tr>
<tr>
<td>Green foxtail</td>
<td>Setaria viridis (L.) Beauv.</td>
</tr>
</tbody>
</table>
The false-stripe virus can be carried in the seed from infected plants. In addition to barley, certain varieties of wheat, rye, corn and millet have been infected in the greenhouse with false stripe. A number of annual grass weeds are also highly susceptible.

**Agropyron Streak Mosaic**

A fourth virus disease has been found on quack grass (*Agropyron repens*) in South Dakota. This disease which is usually very mild on quack grass can be severe on tall wheat grass (*A. elongatum*). It can also infect and cause mild symptoms on certain other grasses and on wheat and rye.

**Fungicidal Sprays for Leaf Diseases of Small Grain**

During 1950 and 1951 a number of spray chemicals were tested for the control of rust and other leaf diseases of wheat, oats and barley. The varieties of grain being tested were sprayed three times during the shoot and early boot stages.

Considerable leaf rust occurred on wheat and oats, and net blotch was abundant on certain varieties of barley grown in the experiment. Several of the sprays used caused marked reductions in the severity of rust and net blotch, and in addition some sprays increased the grain yield of the more susceptible varieties in the experiment. The best spray used was Parzate. Manzate, Zerlate, Fermate and Sulforan also increased yields in certain instances. (Project 204. Leader: John T. Slykhuis, Plant Pathology Department.)

**Reaction of Barley Varieties to Pythium Root Rot**

Barley varieties grown in experimental plots in south-central South Dakota showed small differences in their ability to yield under rather severe Pythium root rot attack (*Pythium arrhenomanes* Drechsler). In general, early varieties had short straw, were unable to extend the heads beyond the boot, and yielded poorly. Spartan produced fair yields and straw but matured later than normally when diseased. Yield data are presented in the table for 1950-51.

Pythium root rot was severe in 1950 and mild in 1951. Some of the late varieties which did well in these tests are not usually recommended for the area. If a farmer finds that early varieties fail to perform satisfactorily on his farm, it might be advisable to try a medium-late variety on a small acreage for comparison.

Many barleys from all over the world are being grown by the Plant Pathology

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity Class</th>
<th>1950</th>
<th>1951</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olli</td>
<td>Very early</td>
<td>5.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plains</td>
<td>Early</td>
<td>4.9</td>
<td>10.3</td>
<td>7.6</td>
</tr>
<tr>
<td>Dryland</td>
<td>Early</td>
<td>5.7</td>
<td>11.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Feebar</td>
<td>Early-medium</td>
<td>7.4</td>
<td>16.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Spartan</td>
<td>Early</td>
<td>9.9</td>
<td>14.6</td>
<td>12.3</td>
</tr>
<tr>
<td>Moore†</td>
<td>Medium-late</td>
<td>9.4</td>
<td>15.8</td>
<td>12.6</td>
</tr>
<tr>
<td>Odessa</td>
<td>Medium-late</td>
<td>12.4</td>
<td>15.2</td>
<td>13.8</td>
</tr>
<tr>
<td>Wisconsin Barless</td>
<td>Medium-late</td>
<td>11.5</td>
<td>16.3</td>
<td>13.9</td>
</tr>
<tr>
<td>Trebi</td>
<td>Medium</td>
<td>11.6</td>
<td>18.6</td>
<td>15.1</td>
</tr>
<tr>
<td>Velvon</td>
<td>Early-medium</td>
<td>10.7</td>
<td>19.7</td>
<td>15.2</td>
</tr>
<tr>
<td>Manchuria</td>
<td>Medium</td>
<td>13.2</td>
<td>18.2</td>
<td>15.7</td>
</tr>
<tr>
<td>Montcalm</td>
<td>Medium-late</td>
<td>16.4</td>
<td>19.7</td>
<td>18.1</td>
</tr>
</tbody>
</table>

*Tested on the farm of John Pospisil, Colome, Tripp County, South Dakota.
†Moore barley is not recommended because of its susceptibility to net blotch (*Helminthosporium teres*).
Department in 1952 in the hope of discovering superior sources of resistance to Pythium root rot and a better understanding of the factors which determine root rot resistance. (Project 115. Leader: G. W. Bruehl, Plant Pathology Department.)

Tree Diseases
During 1951 several of the highly leaf rust resistant cottonwood strains have been designated for preliminary increase. Further increase is planned for 1952.

A heretofore unimportant fungus leaf spot disease reached epidemic proportions in the cottonwood disease nursery and defoliated approximately 50 percent of the foliage in 1951. A number of the highly resistant leaf rust strains were likewise resistant to the leaf spot attack.

Winter killing or "dieback" occurred in the cottonwood leaf rust nursery during the winter of 1951-52. There was rather close correlation between dieback and susceptibility to leaf rust. (Project 142. Leader: C. M. Nagel, Plant Pathology Department.)

Corn Root Rot
The search for root rot resistance in corn was continued in 1951. Approximately 250 strains were under field tests and several strains which indicated resistance in previous trials again appeared promising.

Records on lodging and other disease reactions were made throughout the season and all of the lines were again self-pollinated. However, because of the poor growing weather for corn in 1951, considerable frost damage occurred and in some instances viable seed was not obtained.

Four hundred and fifty lines were planted in 1952 with certain of the plots failing to produce plants because of chaffy seed which was damaged by frost. (Project 185. Leader: C. M. Nagel, Plant Pathology Department.)

Tomato Diseases and Their Control
Fungicide experiments to control foliage diseases showed Zerlate plus tribasic to be first in the production of U. S. No. 1 and 2 fruits. It also checked the diseases best. The other fungicides with high yield were Phygon 1 percent, F1003, tribasic and Zerlate. The yield differences were not significant. Due to the cool weather conditions which prevailed during the 1951 growing season, tomato fruit quality was rather low.

Forty-seven tomato lines were grown in field plots in 1951. The inclusion of a number of these lines was based on previous greenhouse inoculation tests. Detailed information as to disease reaction, foliage, and fruit characteristics was collected under field conditions. Seven of the lines referred to above appeared to be uniformly resistant; others were segregating.

During the past winter and spring, several greenhouse inoculations were made with the tomato leaf spot fungus to establish the reaction of certain hybrid selections. These inoculations were, for the most part, only moderately successful. Some 70 crosses were made in the greenhouse during late spring using plants from lines showing resistance to leaf spot and early maturing commercial varieties as parents. Two hundred and thirty-one lines and accessions are being evaluated in the field this summer for disease resistance. Also, the four fungicidal materials which have proved most adequate during recent years are being used in a tomato spraying and yield experiment. (Project 146. Leaders: L. T. Richardson and Allyn Cook, Plant Pathology Department.)

Potato Fungicide Trials
Early blight infection appeared in the plots at the beginning of August and developed rapidly. The percentage defoliation due to this disease was determined on August 8 and again on August 14. A week later the entire field was completely defoliated. Dithane, Zerlate plus tri-
basic, and Crag 658 were the most effective in holding back the disease but no treatment prevented ultimate complete defoliation.

Although weather conditions were favorable for the development of late blight, no infection appeared, even on inoculated plants before the plants were killed by early blight. Late blight was found later on other potato plantings in the same field.

No chemical injury resulting from the use of Bordeaux mixture was observed. The high lime mixture (8-8-100) appeared to be less deleterious to the foliage than the low lime mixture (8-4-100) used in the two previous seasons.

The differences between treatments in mean yield were not statistically significant. As in the four preceding seasons, the highest yield was obtained where Zerlate was used. Since this material was not as effective as some of the others in checking defoliation by early blight, this appears to be further evidence of stimulation of the plants by zinc. (Project 107. Leaders: L. T. Richardson and Allyn Cook, Plant Path.)

**Potato Scab Resistance**

Yield trials were conducted at Brookings and at Garden City with several lines of potatoes that showed resistance to scab in previous seasons. Sequoia was included in the plot at Brookings although it is not resistant to scab. It produced a very heavy yield with many oversize tubers. Cherokee (B61-3) gave the best all-round performance at both locations, with heavy yield of tubers of good type and quality, and only traces of surface scab (no pitted or raised lesions). CS6316 produced good type tubers free from serious scab but was low in yield. B28-153 yielded well, produced good type tubers and appeared quite resistant to scab. A serious drawback of this selection is the rolling of the leaves which is very difficult to distinguish from leafroll.

Canus is not resistant to scab but yields well with good quality tubers. B515.2 has a heavily russetted skin but shows no sign of scab. The yield was poor however and growth cracks were abundant. These potatoes are low in starch and cook poorly. Yampa is somewhat resistant to scab but a few lesions do occur. Tubers are medium to large, rather irregular in shape, and slightly russetted. Columbia Russet appeared free from scab at Garden City. The tubers are long and the skin is netted. Yield was good. Kennebec did not yield too well and does not have sufficient scab resistance. The tubers are of good type.

Over 100 new selections were introduced from Louisiana, Tennessee, Nebraska, North Dakota and Maine. All new material was indexed in the greenhouse to eliminate virus diseases before they were planted in the field.

A number of selections are being grown in 1952 for further observation. (Project 107. Leaders: L. T. Richardson and Allyn Cook, Plant Pathology Department.)

**Bacterial Ring Rot**

Experiments with disinfectants on knives used to cut seed potatoes in 1950 showed that the materials used were not 100 percent effective in preventing the spread of ring rot at the concentrations and treatment used. The experiment was repeated in 1951, varying the concentrations and exposures.

The crop was harvested by hand and the tubers from each hill were cut and examined for visible symptoms of ring rot. The average infection in the check plots was 57.3 percent. This was lower than in 1950 when the checks showed 92.0 percent, possibly because the plants were less mature when harvested.

Following treatment of the knife with 5 percent Lysol for 10 seconds, 2.7 percent infection was found; after 2 percent acid mercury was used for 10 seconds, the infection was 2.7 percent; fol-
lowing the treatment with Puren for 10 seconds, 1.3 percent infection was observed.

These results confirm those of the previous year, that the treatments commonly recommended are not completely effective in preventing spread of ring rot by means of the cutting knife. By doubling the treatment time for Lysol, acid mercury, and Puren, and by doubling the concentration of Lysol to 10 percent, complete control was apparently obtained. There is the possibility that trace infections were present but not detected; and these might show up in the following season’s crop.

Seed Treatments

Various seed treatments were again tested in 1951 to determine their effect on stand and disease incidence. Each treatment was applied the day before planting to both whole and cut seed, and was replicated three times, 50 seed pieces being planted in each row. Emergence counts were made 22 and 30 days after planting. The earlier count showed that emergence was retarded markedly by treatment of cut seed with acid mercury, and to a less extent by treating whole tubers with acid mercury, cut tubers with Dithane, and whole tubers with formaldehyde (treated the day before planting). The final count showed little difference between treatments with the exception of acid mercury used on cut seed.

No symptoms of blackleg or rhizoctonia appeared on any of the plants in this plot, therefore no observations could be made of the effect of the treatments in controlling these diseases. The amount of scab found on the tubers when they were harvested was uniform in the check and for all treatments with the exception of the mercury treatments. Both acid mercury and Semesan Bel increased the severity of scab infection by at least 100 percent. These materials apparently inhibit organisms which are normally antagonistic to scab organisms.

One thousand tubers were indexed in the greenhouse during the winter and spring of 1952. Some 30 lines are being evaluated in the field this summer for resistance to common scab, and another 30 varieties and lines are included in a replicated yield test plot. Also, at Brookings, the four best fungicidal materials, based on data from previous years, are being used in a spraying and yield experiment. Eighteen lines from Louisiana were added in the yield test plot at Garden City. (Project 107. Leaders: L. T. Richardson and Allyn Cook, Plant Pathology Dept.)

Sorghum Seed Treatment

The sorghum seed treatment experiments which have been conducted for several years were continued. Norghum seed was used in 1951. Twenty-five different fungicides were applied to an equal number of Norghum seed lots and planted on three dates at Brookings. Three plantings using 13 fungicides were made at Highmore.

The data show that several fungicides significantly increased yields as compared to no treatments. A 170 percent increase was obtained in the case of compound Number 224 and 640. The early sorghum plantings responded most favorably to seed treatments. Significant yield increases with certain fungicides occurred in the second plantings at both stations and at the third planting at Highmore.

With the exception of the last two plantings at Highmore the coefficients of correlation between stand and yield were highly significant.

Arasan added to the soil in the field at the rate of 3 pounds per acre increased first planting yields at both stations over comparable checks. The yield increases approached significance at the 5 percent level.

Fungicidal seed treatment trials for sorghum are being continued in 1952 at Brookings and Highmore. The influence of dosage and row fungicidal ap-
plications of promising fungicides will be measured. (Project 110. Leader: R. H. Converse, Plant Pathology Dept.)

Sugarbeet Diseases

The two major sugarbeet disease problems in South Dakota in 1951 were pythium-damping-off and blackroot.

The average stand determined in a number of sugarbeet fields in the Belle Fourche area in 1951 was 77 percent. The fungi most often recovered from damped off seedlings grown in the greenhouse on various Belle Fourche soils were of the Pythium species. Sugarbeet emergence tests in the greenhouse on Belle Fourche soil showed that of 10 fungicidal seed treatments, Phygon gave the best stands. This treatment is currently being used for all beet seed in the area. The fungicides tested were Arasan, Vancide 51, C & C 224, C & C 640, Panogen, Panogen S, New Improved Ceresan plus copper carbonate, Ceresan M, copper carbonate, and red copper oxide.

Black root occurred in isolated patches in beet fields throughout the Belle Fourche area. Species of Pythium, Fusarium, and Rhizoctonia solani, which were the fungi most commonly isolated from beets having blackroot, were inoculated into healthy beet roots in the greenhouse. Rhizoctonia solani isolates were the only pathogens producing symptoms which resembled those seen in the field. (Project 126. Leader: R. H. Converse, Plant Path.)

Livestock Production

Improving Beef Cattle By Breeding

Nine years of progeny testing have been completed under the beef breeding project. The over-all summary of this work was published in the 1952 Feeders’ Day Report. Results on the performance of calves from tested bulls indicate that sires selected for their rapid gains will produce calves which average high in daily gain.

Sire 101 was the high gaining bull in the 1947-48 test, and in the two years that he has had sons on test, they have been among the fastest gaining progeny groups. This bull is being used as a foundation sire for one of the nine lines being formed. These lines are being used to study the best methods of improving beef cattle by selection and the effects of inbreeding on performance characteristics.

The following table shows the results of this year’s test. All calves fed were bull calves, and three of the typiest and fastest gaining calves were saved to go back into the breeding herds. (Project 167. Leader: C. A. Dinkel, Animal Husbandry Department.)

Production Data on Bulls Tested in 1951-52 (Individually Fed 196 Days)

<table>
<thead>
<tr>
<th>Sire Number</th>
<th>Number of Calves</th>
<th>Initial Weight</th>
<th>Final Weight</th>
<th>Daily Gain</th>
<th>Feed Per Cwt. Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>4</td>
<td>380</td>
<td>878</td>
<td>2.54</td>
<td>601</td>
</tr>
<tr>
<td>101</td>
<td>6</td>
<td>456</td>
<td>1029</td>
<td>2.92</td>
<td>636</td>
</tr>
<tr>
<td>26</td>
<td>10</td>
<td>389</td>
<td>869</td>
<td>2.45</td>
<td>590</td>
</tr>
<tr>
<td>219</td>
<td>7</td>
<td>383</td>
<td>885</td>
<td>2.56</td>
<td>605</td>
</tr>
<tr>
<td>402</td>
<td>4</td>
<td>327</td>
<td>778</td>
<td>2.30</td>
<td>590</td>
</tr>
<tr>
<td>03</td>
<td>7</td>
<td>435</td>
<td>944</td>
<td>2.60</td>
<td>609</td>
</tr>
<tr>
<td>32</td>
<td>2</td>
<td>378</td>
<td>836</td>
<td>2.34</td>
<td>665</td>
</tr>
<tr>
<td>003</td>
<td>1</td>
<td>460</td>
<td>1018</td>
<td>2.85</td>
<td>615</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>380</td>
<td>858</td>
<td>2.44</td>
<td>672</td>
</tr>
<tr>
<td>401</td>
<td>1</td>
<td>476</td>
<td>1036</td>
<td>2.86</td>
<td>648</td>
</tr>
<tr>
<td>04</td>
<td>1</td>
<td>450</td>
<td>880</td>
<td>2.19</td>
<td>634</td>
</tr>
</tbody>
</table>
Soft Ear Corn Silage and Alfalfa Silage for Feeding Cattle

Weather conditions in the spring of 1951 were unfavorable for hay making. Much of eastern South Dakota's hay crop was lost or damaged because of wet weather. Many feeders are searching for the best practices of saving grass or legume hay crops. An experiment was designed to test a way of making alfalfa silage by wilting the alfalfa and then making it into silage without the use of a preservative. This alfalfa silage was fed in a fattening ration to yearling steers. A similar lot of steers was fed the same ration but alfalfa hay replaced the alfalfa silage.

A large portion of South Dakota's 1951 corn crop was frosted before maturity. This station has conducted feeding trials in which soft ear corn was fed to cattle. The extremely high moisture content of the 1951 corn presented additional problems in best ways to utilize this crop. In this silage experiment, a group of steers was fed ear corn silage which was made from ear corn testing 58 percent moisture. Steers fed corn and cob meal from a matured corn were fattened on a similar ration except that the corn and cob meal replaced the ear corn silage, in order to compare the feeding value of ear corn silage to that of mature corn and cob meal. A complete report of the results of this silage feeding work will be published this coming year. (Project No. 143. Leader: W. C. McCone, Animal Husbandry Dept.)

Summer Grazing of Beef Cows for Calf Production

The results of the summer grazing trials at the Cottonwood Range Field Station from 1942—1950 were published this year in South Dakota Agricultural Experiment Station Bulletin 412, entitled, “Cows, Calves, and Grass,” by Johnson, Albee, Smith, and Moxon.

Intensity of grazing studies are still being conducted on these same pastures with beef breeding cows. In May, 1951, the cows were weighed and allotted into six pastures which were grazed at three intensities replicated. The pastures were stocked with a variable number of animals for the purpose of achieving a utilization of less than 35 percent under light use, 35 percent to 55 percent under moderate use, and over 55 percent under heavy use during a seven-month season. Production records were based on six cows which remained on pasture during the full season, although other cows were used as harvesters of forage at different times during the season. The results of these production studies are shown in the accompanying table.

Forage production was studied by clipping three yard square plots in each of three exclosures in each pasture in June, August, and December and separately weighing each species. The average forage production as determined by this method was 1302, 1358, and 1406 pounds of air dry forage per acre respectively for heavy, moderate, and light rates of grazing. In addition, an average of 197 pounds per acre of old growth was removed from the lightly-grazed pastures. The relatively high production of the heavily-grazed pastures was probably due to the extremely dry spring which penalized the production of the cool season grasses and the very favorable summer growing season which favored the production of the short grasses.

Data presented in the accompanying table show that heavy grazing has:

1. Reduced range condition
2. Reduced the infiltration rate
3. Produced cow weight losses
4. Produced a slower gain of calves on pasture
5. Produced lighter calves at weaning
6. Produced greater cow and calf gains per acre

The advantage of greater cow and calf gains per acre under heavy grazing
Beef Production under Heavy, Moderate, and Light Rates of Grazing
(Grazing Season May 17 through November 30, 1951)

<table>
<thead>
<tr>
<th></th>
<th>Heavy</th>
<th>Moderate</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres grazed</td>
<td>160</td>
<td>266</td>
<td>376</td>
</tr>
<tr>
<td>Amount of grazing furnished, AUM</td>
<td>103</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Stocking rate, acres per AUM*</td>
<td>1.55</td>
<td>2.42</td>
<td>3.42</td>
</tr>
<tr>
<td>Utilization, visual estimate, %†</td>
<td>69</td>
<td>46</td>
<td>26</td>
</tr>
<tr>
<td>Range condition, %†</td>
<td>49</td>
<td>71</td>
<td>90</td>
</tr>
<tr>
<td>Infiltration rate, % of moderate</td>
<td>35.6</td>
<td>100.0</td>
<td>104.4</td>
</tr>
<tr>
<td>Rainfall (April 1—September 30, 1951), inches</td>
<td>14.74</td>
<td>11.77</td>
<td></td>
</tr>
<tr>
<td>Average rainfall (April—September 30), inches</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*All pastures were stocked with six cows and their calves on May 17. Two cows and their calves were added to each pasture on June 30, except that only one cow was added to pasture 4. One cow was added to each pasture on July 17. The two added cows were removed from pasture 4 on November 1.
†Relative coverage and utilization estimates were made by Leslie R. Albee, Range Conservationist, SCS.
‡Cows were allotted to the pastures so that the same number of calves were in each.

is decreasing as the experiment is continued. (Project 216. Leaders: James K. Lewis, Animal Husbandry; Oscar Olson, Station Chemistry; and Jean M. Kern, Supt., Cottonwood Range Field Station.)

Nutritive Value of Prairie Hay Cut at Different Stages of Maturity

Feeding trials at the Cottonwood, Eureka, and Highmore substations have been continued to compare the feeding value of prairie hay cut at various stages of maturity. The stages of maturity when harvested were early (heading), medium (seed ripe), and late (after frost). One lot of steer and heifer calves was wintered on each kind of hay and one other lot was fed storage hay cut at an early stage in 1950. The calves were full-fed hay and had free access to bone meal and salt. Each hay was supplemented with soybean meal pellets in amounts to give about 10 percent total protein in each ration.

At the Eureka substation, 10 calves per lot weighing approximately 460 pounds each were fed for 168 days. They consumed an average of nearly 13 pounds of hay per head daily. The average daily allowance of soybean pellets and the average daily gain were as follows (pounds): early, 1.11, 0.84; medium, 1.72, 0.94; late, 2.20, 0.90; and 1950 storage, 1.23, 0.87. These results are quite similar to those obtained last year.

At Cottonwood, 8 calves per lot weighing approximately 350 pounds each were fed for 168 days. They consumed an average of about 11.5 pounds of hay per head daily. The amount of soybean meal pellets fed per calf daily and the average daily gain were as follows (pounds): early, 0.90, 0.91; medium, 1.60, 0.73; late, 1.88, 0.68; and 1950 storage, 1.14, 0.63. These results indicate a lower value for the later stages of cutting when supplemented in this manner than the trial last year or the current trial at Eureka.

Two other lots of calves were fed early-cut hay at the Cottonwood station. One was unsupplemented and the average daily gain was 0.65 pound. The
other lot was fed a pellet (41 percent protein) composed of corn, soybean meal, dicalcium phosphate, and 4 percent urea. The average daily gain for this lot was 0.88. This pellet with 4 percent urea appeared fully as satisfactory as soybean meal for wintering calves with prairie hay.

Similar results were obtained with the medium and storage hay at Highmore as at Eureka. However, the performance with the early and late hay was unsatisfactory. The early-cut hay contained many needles, and the calves would not eat enough to maintain their weights. Several cases of severe ring worm were encountered in the lot fed the late-cut hay, and the gains were adversely affected.

Digestion trials are in progress at Brookings to compare the digestibility of different qualities of prairie hay when fed to sheep and cattle. The comparisons are made at various levels of protein and with both soybean meal and urea as protein supplements. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry Department; O. E. Olson, Station Chemistry Department; and J. G. Ross, Agronomy Dept.)

Value of Trace Mineral Supplements with Prairie Hay

An individual feeding and digestion trial was conducted with 12 yearling steers to determine the value of feeding trace minerals (cobalt, copper, and manganese) with low quality prairie hay. The initial weight of the steers was about 600 pounds and they were fed approximately 13 pounds of hay and 2.25 pounds of pellets per head daily.

Six steers were fed a 30 percent protein pellet with soybean meal as the major source of protein while the other 6 steers received a 30 percent protein pellet with urea as the major source of protein. One-half of the steers in each group was fed the pellets to which 60 mg. of manganese, 10 mg. of copper, and 2 mg. of cobalt had been added per pound of pellet. The urea pellet contained 7 percent urea and it was found to be slightly unpalatable.

Steers receiving trace minerals made slightly greater gains when fed either soybean oil meal or urea. The degree of response was about the same in each case.

Carotene as carrot oil was added to all pellets and tests made on the stability of the carotene. Carotene destruction was greater in the urea pellet than in the soybean meal pellet. The presence of trace minerals also increased carotene loss in each pellet. This work is being continued. (Project 218. Leaders: L. B. Embry, Animal Husbandry Department; A. L. Moxon, O. E. Olson, and A. W. Halverson, Station Chemistry Department.)

Nutritional Studies with Beef Cows Wintered on the Range

The effect of the addition of carotene, vitamin A, and/or trace minerals to a basal ration of range grass and 1 pound of soybean pellets containing added phosphorus is being studied in an experiment involving 48 beef cows. The range was partially or completely covered with snow for 93 days of the 127-day feeding period in 1951-52. This required rather extensive hay feeding which made the trial atypical.

The results of the blood studies and the cow weights are shown in the accompanying table. There were no differences in cow weights or in calf production attributable to treatment. The addition of trace minerals to the soybean pellet did not materially alter the blood hemoglobin. However, the addition of either carotene or vitamin A to the pellet appeared to maintain plasma vitamin A values at a higher level. It must be emphasized that this year's trial involved a longer hay feeding period than normal, and also that this is the first year of these investigations. (Proj-
Winter Nutritional Studies with Beef Cattle (December 24, 1951 to April 29, 1952—127 Days)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cows</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Average initial weight, lbs.</td>
<td>1009</td>
<td>1058</td>
<td>1039</td>
<td>1058</td>
<td>1108</td>
</tr>
<tr>
<td>Average final weight, lbs.</td>
<td>986</td>
<td>1006</td>
<td>996</td>
<td>1068</td>
<td>1082</td>
</tr>
<tr>
<td>Average loss, lbs.</td>
<td>-23</td>
<td>-69</td>
<td>-33</td>
<td>-62</td>
<td>-40</td>
</tr>
<tr>
<td>Condition score‡</td>
<td>6.5</td>
<td>7.1</td>
<td>7.1</td>
<td>6.7</td>
<td>6.4</td>
</tr>
<tr>
<td>Initial hemoglobin, gms/100 ml.</td>
<td>12.50</td>
<td>13.10</td>
<td>13.10</td>
<td>13.10</td>
<td>13.00</td>
</tr>
<tr>
<td>Change hemoglobin, gms/100 ml.</td>
<td>+1.49</td>
<td>+0.58</td>
<td>+1.22</td>
<td>+1.15</td>
<td>+1.94</td>
</tr>
<tr>
<td>Initial plasma vitamin A, mcg/100 ml.</td>
<td>21.2</td>
<td>22.2</td>
<td>26.5</td>
<td>24.0</td>
<td>24.0</td>
</tr>
<tr>
<td>Final plasma vitamin A, mcg/100 ml.</td>
<td>11.9</td>
<td>15.2</td>
<td>17.0</td>
<td>19.0</td>
<td>16.4</td>
</tr>
<tr>
<td>Change plasma vitamin A, mcg/100 ml.</td>
<td>-10.7</td>
<td>-7.0</td>
<td>-9.5</td>
<td>-5.0</td>
<td>-7.6</td>
</tr>
<tr>
<td>Initial plasma carotene, mg/100 ml.</td>
<td>92.5</td>
<td>105.4</td>
<td>116.9</td>
<td>105.9</td>
<td>107.5</td>
</tr>
<tr>
<td>Final plasma carotene, mg/100 ml.</td>
<td>29.6</td>
<td>30.0</td>
<td>49.8</td>
<td>39.5</td>
<td>42.9</td>
</tr>
<tr>
<td>Change plasma carotene, mg/100 ml.</td>
<td>-62.9</td>
<td>-75.4</td>
<td>-67.1</td>
<td>-66.4</td>
<td>-64.6</td>
</tr>
</tbody>
</table>

Feed per cow per winter

| Soybean pellets, lbs. | 126 | 126 | 126 | 126 | 126 |
| Native hay, lbs.       | 750 | 750 | 750 | 750 | 750 |
| Range, acres           | 11.67 | 11.67 | 11.67 | 11.67 | 11.67 |
| Salt, lbs.             | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |

*Synthetic vitamin A acetate donated by Charles Pfizer & Co.
†Carotene supplied from carrot oil.
‡Cows were rated in condition from 0 to 14 with 14 being the fattest group. A rating of 7 indicates an average cow under average conditions.

Sheep Production Under Different Rates and Systems of Grazing

The summer grazing experiment with sheep which was begun in 1950 was continued in 1951. This experiment was designed to determine a recommended stocking rate for sheep on western South Dakota ranges and to study the effect of different systems and intensities of grazing on ewe and lamb production and on parasite infestation. The Veterinary Department is conducting the parasite studies.

The results of the ewe and lamb production in 1951 are shown in the accompanying table. Ewe gains were proportional to the stocking rate. There were no differences attributable to treatment in lamb weaning weights or in wool production. The stocking rates shown in the table are one-third lower than normal due to the extremely dry season in early 1951. Beginning in 1952, the same ewes are being retained on the same winter and summer treatments to

ect 217. Leaders: James K. Lewis, Animal Husbandry; Oscar Olson and Andrew Halverson, Station Chemistry; Jean M. Kern, Supt., Cottonwood Range Field Station.)
Sheep Production under Different Rates and Systems of Grazing in 1951
(May 3—November 2, 1951)

<table>
<thead>
<tr>
<th>Continuous Light Grazing</th>
<th>Continuous Moderate Grazing</th>
<th>Continuous Heavy Grazing</th>
<th>Rotation Moderate Grazing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ewes</td>
<td>66</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Range allowed for season, acres</td>
<td>524</td>
<td>408</td>
<td>254</td>
</tr>
<tr>
<td>Acres per ewe per month</td>
<td>1.32</td>
<td>1.03</td>
<td>.64</td>
</tr>
<tr>
<td>Estimated utilization, %</td>
<td>20</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Average initial weight of ewes, lbs</td>
<td>122.9</td>
<td>124.7</td>
<td>124.4</td>
</tr>
<tr>
<td>Average final weight of ewes, lbs</td>
<td>131.0</td>
<td>127.9</td>
<td>126.0</td>
</tr>
<tr>
<td>Average ewe gain, lbs.</td>
<td>8.1</td>
<td>3.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Number of lambs</td>
<td>53</td>
<td>70</td>
<td>57</td>
</tr>
<tr>
<td>Average initial weight of lambs, lbs</td>
<td>21.7</td>
<td>21.3</td>
<td>21.3</td>
</tr>
<tr>
<td>Average weaning weight of lambs, (Sept. 23), lbs.</td>
<td>81.2</td>
<td>78.2</td>
<td>83.5</td>
</tr>
<tr>
<td>Average lamb gain, lbs.</td>
<td>59.5</td>
<td>56.9</td>
<td>62.2</td>
</tr>
</tbody>
</table>

study the cumulative effects of different planes of nutrition on ewe and lamb production. (Project 177. Leaders: James K. Lewis and General T. King, Animal Husbandry; Arthur J. Foxley, Supt., Antelope Range.)

**Development of a High Producing Tailless Breed of Sheep**

No-tail sheep are being run under range conditions and data from the progeny of No-tail x Rambouillet are being collected. The extreme hardiness and vigor of this breed are most evident under range conditions. At present, facilities are not available to carry the crossbred No-tail sheep and, therefore, no line development is in progress. A band of 75 pure No-tails is being run at the Brookings station. (Project 9. Leaders: J. W. Wilson and R. M. Jordan, Animal Husbandry Department.)

**Value of Cobalt in Lamb Fattening Rations**

The third year of cobalt feeding using feeds grown in western South Dakota agreed with the findings previously reported. The addition of 1 ounce of cobalt chloride to 100 pounds of mineral supplement increased the daily rate of gain about .03 pound. Cobalt analysis of the feed fed (not including the mineral supplement) showed it to contain .10 parts per million. While the increase in rate of gain is small, the consistency of the results from year to year suggests that the soil around Newell, South Dakota may be border line for cobalt content.

The results of feeding cobalt to lambs at the Brookings and Newell stations will be published this year. (Project 190. Leader: R. M. Jordan, Animal Husbandry Department.)

**Effect of Stilbestrol on Rate of Gain, Feed Efficiency and Carcass Quality of Feeder Lambs**

In this year’s trial stilbestrol increased the rate of gain and feed efficiency markedly. A metabolism trial was conducted to compare the digestibility and nitrogen retention of treated lambs with that of untreated lambs. There was no difference in digestibility between the two groups. The stilbestrol treated lambs retained slightly more nitrogen. Detailed carcass, shrinkage and cooking tests were conducted. (Project 199. Leader: R. M. Jordan, Animal Husbandry Department.)

**Alfalfa Silage as a Roughage for Fattening Lambs**

Two trials were conducted to compare the efficiency and cost of using grass silage as a roughage compared to
corn silage and alfalfa hay. Alfalfa silage proved to be a palatable feed for lambs, and when supplemented with a full feed of corn, the gain in weight was equal to that obtained with a corn silage-corn ration. The feeding of 6 to 8 pounds of alfalfa silage per head per day over a 5 to 6 months period for a slow gain, increased the costs of gain materially. (Project 223. Leader: R. M. Jordan, Animal Husbandry Department.)

Urea as a Source of Protein for Pregnant Ewes
Can pregnant ewes use urea as a source of part of their protein needs, as well as straight soybean meal? The answer to this question has been sought during the last three years at this station. Results of this year’s experiment are in agreement with that of the previous study. Either 5 or 10 percent of the protein supplement can consist of urea without greatly affecting the production and performance of the ewes. Further, a protein supplement consisting of equal parts of alfalfa meal and soybean meal plus 5 or 10 percent urea produced comparable results to a protein supplement of equal parts of wheat middlings and soybean meal plus 5 or 10 percent urea. This project will be reported in bulletin form this year. (Project 200. Leader: R. M. Jordan, Animal Husbandry Department.)

Effect of Aureomycin on Rate of Gain of Feeder Lambs and Suckling Lambs
Five separate trials with feeder lambs and two trials with suckling lambs receiving 4 to 14 milligrams of aureomycin were conducted. Aureomycin did not exert any special benefit on lambs on fattening rations. Small lambs of poor quality reacted more favorably to the aureomycin than good quality, large lambs. In one of the trials, aureomycin appeared to depress death loss from overeating disease.

In the first trial when aureomycin was added to suckling lamb rations, it increased the gain .08 pound per lamb daily and increased the feed efficiency. In the second trial, the aureomycin depressed weight gains .06 pound per lamb daily. It is concluded that lamb feeders can expect no miracles from aureomycin when used as a growth stimulant and that its addition to the ration would increase costs. (Project 206. Leader: R. M. Jordan, Animal Husbandry Department.)

Effect of Thyroprotein on Milk Production of Lactating Ewes
The addition of 1 to 2 grams of iodinated casein to the grain ration of lactating ewes apparently causes no increase in milk production. The effect on the ewes was measured by body weight and rate of gain of their suckling lambs. While this is contrary to reports at other stations, it is wholly in agreement with results obtained previously at this station. (Project 205. Leader: R. M. Jordan, Animal Husbandry Department.)

Best Level of Feeding for Ewe Lambs
A limited amount of work has been done to ascertain the level of winter feeding of lambs and yearlings for ultimate body size, wool production, and lamb production.

This is a report of three years of winter feeding at the Newell Substation with three lots of ewe lambs. They were fed as ewe lambs and returned to the range each year for summer grazing. These same ewe lambs were returned to the winter feed lots at about 18 months of age and one-third of each lot remained on the previous winter treatment. The others were divided equally between two other treatments. In this manner it is possible to measure the performance of ewes maintained at the same level through two winters and at higher and lower levels than the first winter treatment. Feeding began about November 1 each year and ended April 1. The ewes were bred their second winter beginning November 1. The rations
(treatments) consisted of the following:

<table>
<thead>
<tr>
<th></th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa hay (lbs.)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Native wheatgrass hay (lbs.)</td>
<td>2.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Barley (lbs.)</td>
<td>0.33</td>
<td>.67</td>
<td></td>
</tr>
</tbody>
</table>

Fresh water, iodized salt and a mineral mixture of two parts steamed bone meal and one part of salt was fed free choice. The barley was fed once daily and one hay in the morning and the other in the evening. The ewes were weighed every 28 days during the feeding period.

Lambs receiving two-thirds pound of barley made greater average gains than lambs being fed one-third pound of barley or hay alone. Those fed one-third pound of barley made a slightly larger gain than those fed hay alone but in both cases the differences in gain were about equalized for all three lots during the summer grazing season.

The following observations have been noted concerning the ewes as 2-year-olds:

1. Good ewe gains were made in all three lots.
2. Those fed two-thirds pound of barley made considerably greater gains during the winter feeding period but the difference was made up by the ewes fed hay alone during the summer grazing season.
3. Fleece weights are essentially the same regardless of the combinations of the two winter treatments.
4. Average birth weights of lambs are essentially the same.
5. Average weaning weights of lambs are essentially the same.

The data collected on the three years feeding trials will be statistically analyzed and published at a later date. (Project 161. Leader: General T. King and Lawrence B. Embry, Animal Husbandry Department; Harry E. Weakly, Superintendent, Newell Substation.)

Comparison of Pigs Farrowed in Spring, Summer, and Fall

This experiment has as its purpose to compare the efficiency of the one-litter farrowing system with the two-litter farrowing system under eastern South Dakota conditions. It has been in progress since the fall of 1947 and will be completed with the marketing of the 1953 spring farrowed pigs. No analyses have been made since those reported in the sixty-fourth annual station report, South Dakota Experiment Station, July 1, 1950 to June 30, 1951, although data are being continually collected. (Project 168. Leaders: R. F. Wilson, T. Wright, Ward Repp, and James Murphy, Animal Husbandry Department.)

Conception Rate in Swine

This experiment has not been conducted since the spring of 1951. All data have been analyzed and reported to date in the sixty-fourth annual station report July 1, 1950 to June 30, 1951. (Project 209. Leaders: R. F. Wilson and Ward Repp, Animal Husbandry.)

Does Distance Between Feed and Water Affect Gains of Pigs on Pasture?

This experiment was first conducted during the unusually cool summer of 1950. The distances used between the self-feeders and the waterers on alfalfa pastures consisted of 10 feet in the first lot, 50 feet in the second lot, 150 feet in the third lot, and 300 feet in the fourth lot. Essentially, no differences were obtained in daily gain and in total feed required per 100 pounds of gain in any of the lots during 1950.

During the summer of 1952, the experiment is being repeated with greater distances between the self-feeders and the waterers. The distances being used this summer consist of 20 feet in the first lot, 100 feet in the second lot, 300 feet in the third lot, and 560 feet in the fourth lot. To date, no results have been obtained. (Project 207. Leader: R. F. Wilson, Animal Husbandry.)
James Hulless Oats and Aureomycin in Creep Feeds for Suckling Pigs

Four lots of sows and their pigs were self-fed on pasture in the spring and fall of 1951. The first lot contained no creep. The creep used in the second lot contained shelled corn and a protein supplement. The third lot had a creep containing hulless oats and the same protein supplement as Lot 2. The fourth lot had a creep which contained shelled corn and the same protein supplement as Lot 2 plus aureomycin.

No difference in the gain of pigs due to the creep rations was observed, probably due to the fact that they tended to eat with their dams more than from their creeps. The pigs in all creep-fed lots consumed less than half as much creep ration per pig as they could be expected to. Consequently, the pigs in Lot 4 did not consume enough protein supplement from their creep to supply the desired amount of antibiotic in their ration.

The hulless oats were apparently very palatable to these suckling pigs since the pigs in Lot 3 took more hulless oats than did the pigs in the creep-fed shelled corn lot (Lot 2). It is likely, that had the sows been hand-fed and their feed intake limited somewhat, their pigs would have taken more feed from the creeps. This experiment is being continued this spring and summer. (Project 212. Leader: R. F. Wilson, Animal Husbandry Department.)

Barley and Sorghum Compared to Shelled Corn for Growing-Fattening Pigs

Two trials have been conducted where ground Feebar barley, ground and whole Norghum were compared to shelled yellow corn as a feed for growing-fattening pigs. A comparison of ground and whole Norghum fed in the first trial was reported in the South Dakota Farm and Home Research, Fall 1950, Vol. 2, No. 1, pages 4 and 5.

In this first trial Norghum compared very favorably with corn. On the basis of total feed required per hundred pounds of gain, the ground and whole Norghum had an approximate feed value of 98 to 99 percent that of corn. The gains produced on the Norghum excelled slightly those on corn.

In the second trial conducted in the winter of 1950-51, the Norghum-fed lot did not do as well as in the previous trial, particularly the ground Norghum-fed lot. On the basis of total feed required for hundred pounds of gain, the ground Norghum had an approximate feed value of 76 percent that of corn and the whole Norghum, 91 percent. The daily gains produced on corn and those on whole Norghum in the second trial were approximately equal while those on the ground Norghum were slightly less.

In the first trial, the ground Feebar barley had an approximate feeding value of 90 percent that of corn while in the second trial it had a value of 88 percent. In both trials the daily gain produced on the Feebar barley was less than that produced on the corn and the feed required per hundred pounds of gain was greater. (Project 85. Leaders: R. F. Wilson, Turner Wright, Hugh Barnett, Animal Husbandry Department; A. L. Moxon, Chemistry Department.)

Swine Production for Irrigated Areas of Western South Dakota

Improvement of swine breeding, feeding and management practices for the irrigated areas of South Dakota is the objective of this project. For the past several years only the breeding portion has been studied. This breeding program consists of an inbred line of Hampshire swine.

The criteria for measuring performance has been sow productivity, livability and gaining ability. Complete litter records are kept to provide the information necessary for the performance mea-
These performance records are also used in the selection of breeding stock. In 1951 nine litters farrowed an average of 9.3 live pigs and weaned an average of 6.2 pigs. The pigs averaged 32 pounds at weaning (56 days) and 125 pounds at 154 days. The inbreeding of the litters is equal to that of one generation of full brother sister matings. This line has performed extremely well for an inbred line. (Project 132. Leader: C. P. Wilder, Animal Husbandry Department, Harry E. Weakly, Supt., Newell Substation.)

Systems of Breeding Swine

Research in swine breeding is being conducted at the Brookings station and the Eureka substation. The purpose of these experiments is to study methods of increasing the effectiveness of selection as well as to increase the reliability of mating systems in terms of sow productivity and pig gaining ability. In 1951 eight breeding groups were maintained at Brookings and Eureka. The accompanying table shows the performance of the 1951 groups.

The four breed-line cross again, as in previous years, proved to be the most efficient. This mating system shows much promise for the production of commercial swine.

While inbreeding is not recommended as a general mating system, the lines are maintained in an attempt to produce a strain of closely related stock which are also efficient pork producers. These inbred lines will be tested by our station and other stations in various crosses in order to find lines which combine well.

For 1952 litters the Yorkshire inbreds have been eliminated due to the poor gaining ability. The single-cross litters were also eliminated. Thus with fewer lines more litters per line can be raised which in turn increases the amount of information which can be gained.

(Project 124. Leader: C. P. Wilder, Animal Husbandry Department, Albert Dittman, Supt. Eureka Substation.)

Summary of Results of Swine Breeding Experiment for 1951

<table>
<thead>
<tr>
<th>At Brookings</th>
<th>Comparative Test Groups</th>
<th>At Eureka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inbred Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duroc</td>
<td>Poland China</td>
<td>Yorkshire</td>
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<td>1</td>
<td>10</td>
<td>10</td>
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<table>
<thead>
<tr>
<th>No. Litters</th>
<th>Av. Inbreeding (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows</td>
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</tr>
<tr>
<td>Litter</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Av. No. Pigs per litter</th>
<th>Av. Weight per pig</th>
<th>Av. Litter weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrowed, alive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaned</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Av. Weight per pig (total)</th>
<th>Av. Litter weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrowed</td>
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</tr>
<tr>
<td>Weaned</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>154 days</th>
<th>154 Days</th>
</tr>
</thead>
</table>

*Rotational cross of the Jumbo, Alliance, Blackbird, and Minncstoa “A” Lines.
Single cross Poland China boars (cross of Arkansas and Iowa lines) mated to outbred Poland China females.
Rotational cross of inbred lines from the Poland China, Hampshire, Duroc, and Landrace Breeds.

132
Effects of Aureomycin, Terramycin, and Trace Mineral Salt on Hog Carcasses

The primary purpose of this project is to determine the effects of rations containing aureomycin, terramycin, and trace mineral salt upon the chemical composition and physical characteristics of hog carcasses from 225-pound market hogs fed in dry lot.

Eight barrows from each of six lots were slaughtered during the first year of this project. The barrows were representatives of four breeds, namely Poland China, Duroc, Spotted Poland China, and Hampshire; and had been fed in dry lot from weaning to a market weight of 225 pounds. The ration, which was fed to the various lots, differed only in respect to the antibiotic or trace mineral salt, and the length of time that the pigs received the various antibiotics. The carcasses were measured for length and for thickness of backfat in order to obtain information regarding their physical characteristics.

The ham, loin, shoulder, and trimmings from the right half of each carcass were physically separated into fat, lean, and bone. Representative samples of each of these constituents from each cut are being chemically analyzed for fat, protein, and moisture content.

All data dealing with the physical characteristic of the carcasses have been compiled and partial analysis completed. A comparison of means does not indicate any difference in the six lots when using backfat thickness as a criteria of fatness. In most cases, variation within lots was greater than between lots. Chemical analyses have been completed for all of the lean samples, but data have not yet been compiled. Chemical analysis of the fat samples is now in progress. (Project 214. Leader: Ellis A. Pierce, Animal Husbandry Department.)

Bacon Quality

The two primary purposes of this study are: (1) to determine whether the chemical composition and fatty acid content of fresh and cured pork sides can be used as a measurement of the quality and desirability of cooked bacon, and (2) to determine the differences and variations within and between breeds, inbred lines, and line-crosses of swine by using the above measurement.

Forty hogs from three breeds and crossbreds were slaughtered. A highly significant difference was found in the pocket thickness of the fresh sides which resulted in a significant difference in their weights. The results do not show any differences in carcass length, but large differences exist in carcass fatness as determined by backfat thickness.

Chemical analyses of the cured and fresh sides showed a significant difference in the protein content of the fresh sides and a highly significant difference in the "iodine number" of the cured sides. There was no difference in percentages of fat rendered from the bacon during cooking, but quality and desirability of the bacon samples varied slightly due to differences in protein content. An interesting observation resulting from the tests was the fact that all samples shrunk approximately 60 percent during the cooking period. By practical application, using the method of cooking, this means approximately .4 of a pound of cooked bacon can be obtained from each pound of sliced bacon. (Project 208. Leader: Ellis A. Pierce, Animal Husbandry Department.)

Feeding Soft Corn to Livestock, see page 1
Comparing Rations for Wintering Range Ewes, see page 12
Antibiotics for Pigs over 125 Pounds, see page 55
Feeding Immature Corn to Growing-Fattening Pigs, see page 97
Dairy Production

Progesterone and Relaxin as Aids in Ova Transfer

One of the greatest obstacles confronting ova transfer has been readjusting the estrus cycle so that several cows would be in heat within a 24-hour period. Many hormones and drugs have been used in attempts to recycle cows, but none shows more promise than the subcutaneous injection of progesterone. A means of recycling the estrus period has been demonstrated by injecting 50 milligrams of progesterone subcutaneously daily after the 14th day post-estrus. This apparently maintains the cow in a state of pseudo-pregnancy so that four days after injections are stopped she comes into heat, breeds, and ovulates as determined by a follicle and a subsequent corpus luteum on the ovary.

To determine the fertility of the ova produced by recycling the estrus period, one cow was superovulated, bred, slaughtered, and the number of fertilized ova determined. Since 100 percent of the ova recovered were fertilized, probably recycling has no ill effects upon the egg. By this method, six cows have been brought into estrus on the same day over six estrus periods. In addition, by the continued injection of progesterone, the whole herd of cattle can be brought into heat on a given predicted date.

Since ova collection depends primarily upon non-surgical techniques and the cervix appears to be the greatest obstacle hindering non-surgical techniques, a mechanical dilator has been designed that will dilate the cow's cervix 1.75 inches during heat without injuring the cow. In addition to mechanically dilating, the effects of the hormone relaxin upon the cow's cervix 5 days post-estrus have been investigated and found to relax the cervix enough so that it can easily be dilated 1.81 inches as compared to no dilation for non-treated cows. In this series of experiments 250 guinea pig units of relaxin were found to be a minimal dose, 1500 guinea pig units were found to be optimum dose, while 8500 guinea pig units relaxed the cervix slightly more than the 1500 guinea pig units.

Because diethylstilbestrol has been shown to bring cows into estrus and since the cervix is slightly relaxed at estrus, experiments were conducted to determine whether or not the injections of diethylstilbestrol would relax the cervix. The results of these experiments were negative, thus suggesting that possibly relaxin liberated in minute quantities relaxes the cervix at estrus.

A technique for obtaining uterine tissue for histological studies has been devised. In addition, histological studies were completed on six experiments where the cervix was dilated with a mechanical dilator. None of these biopsies exhibited signs of trauma at 10-days post-estrus after the cervix had been dilated at estrus and 5-days post estrus.

(Projects 189. Leader: Arthur E. Dracy, Dairy Husbandry Department.)

Identical Twins Used in Dairy Cattle Research

During the period from November 1, 1951 until April 1, 1952, four pairs of identical twins were used in a controlled open housing experiment. All of the even numbered animals were maintained in a 50° F. room and the odd numbered animals were in an open shed where temperatures coincided with outside temperatures and ranged from -15° F. to 50° F. The differences as measured by gain in weight, height at withers and chest circumference showed no significant variations between the two groups. On the average, the four animals outside gained 204.5 pounds, 13½ centimeters in height and 10½ inches in
chest circumference on 1729.7 pounds of total digestive nutrient, while the inside group gained 206.5 pounds, 13\(\frac{1}{4}\) centimeters in heights and 11\(\frac{1}{4}\) inches in chest circumference on 1719.7 pounds total digestive nutrient.

Semen evaluations were conducted to determine any climatic variations on semen from a bull kept outside as compared to one housed at 50° F. The above table shows the results from eight tests over a 19-week period.

As shown by the table, the semen from T-7 who was housed outside, was usually of slightly higher quality than T-8 who was inside at 50° F. From these data low temperatures apparently do not inhibit sperm production. (Project 191. Leader: A. E. Dracy, Dairy.)

**Milking Machine Sanitation**

Work has continued on the flush method of milking machine sanitation with the combine milker at the College dairy farm. Bacterial counts of the raw milk have remained very satisfactory. The logarithmic average of all raw milk samples tested during the past year showed a count of 17,000 per milliliter. Bacterial counts have also been made on sterile water after it had been run through the sanitized machine, as a means of checking proper sanitization procedures. Laboratory work has provided information which is valuable in checking milking machine sanitization.

The flush method as used here gives better results, bacteriologically, than the older hand brush washing methods and with much less labor. More extensive use of milking parlors increases the need for more information on simple, effective methods of keeping them in a sanitary condition. (Project 155. Leader: R. J. Baker, Dairy Husbandry.)

**Growth of Calves and Growing Heifers**

Work is being continued on this project to determine the rate of growth of dairy heifers. There is a lack of sufficient data to show how rapidly dairy heifers of the different breeds grow and attain sexual maturity under the environmental conditions of the North Central States.

Starting January 1, 1952, all of the heifer calves born in the College herd have been measured for weight at birth, and for rate of growth. These include Brown Swiss, Holstein, Guernseys and Jerseys. (Project 153. Leader: Emery Bartle, Dairy Husbandry Department.)

**Manufacturing Cottage Cheese**

Work has continued towards improved manufacturing methods for cottage cheese, both on a commercial and a laboratory basis. By using miniature cheese vats it has been possible to manufacture cheese under controlled laboratory conditions. Preliminary work has been done on the effects of (a) pH, (b) setting temperature, (c) total solids of both normal and reconstituted milk and (d) various coagulating agents upon the quality of the resultant cheese. The most desirable pH level at time of cutting and cooking the curd is pH 4.75 to 4.65.
Since the titratable acidity varies with the total solids in the milk and shows seasonal variation, no definite acidity range can be given.

Little variation in quality of the cheese was noted when the milk was set at temperatures of 86° F., 88° F., or 90° F.; however, at 96° F. the curd was tough and rubbery and would not cut satisfactorily. The total solids of the milk play a very important role in the type of cheese which is obtained. At certain times of the year, particularly in the spring, it was necessary to add two to three percent additional solids in the form of dried milk-not-fat solids, in order to have a curd which was firm enough to cut well.

Cheese was made from dry milk solids not fat which was reconstituted with water at levels of 9, 12, 15 and 18 percent solids. The cheese made from the 9 percent milk was unsatisfactory and unsalable. The cheese made from milk with 15 and 18 percent was the most satisfactory. The coagulating action of rennet was compared to the action of some commercial coagulators. All coagulators were entirely satisfactory and none showed advantages over the others tested. Work will be continued on this project in a further study of these problems. (Project 169. Leader: R. J. Baker, Dairy Husbandry Department.)

Artificial Insemination Improves Dairy Herds, see page 86

Poultry Production

Mineral Requirements of Turkeys

The requirements for calcium and phosphorus are being determined for young and growing turkeys, using purified as well as practical type rations. USP grades of CaCO₃ and Ca HPO₄ are being used as well as commercially available dicalcium phosphate and other calcium and phosphorus sources. Determining the availability, and factors which affect the availability, of phosphorus in these various sources is also one of the objects of this work. (Project 221. R. A. Wilcox, C. W. Carlson, and Wm. Kohlmeyer, Poultry Department; O. E. Olson, Chemistry Department.)

Turkey Egg Hatchability

Previous work on this project has indicated that there is a carry over of some unrecognized nutritive factor through the egg from the hen to the progeny. This factor, which promoted an increased rapid growth of the progeny, was in evidence when a commercial Animal Protein Factor (APF) supplement was added (Lederle APF 2-g and APF -5) to the breeder diet lacking animal protein sources. Hatchability of fertile eggs was also improved somewhat by the APF supplementations, especially in the latter part of the hatching season.

Work is being conducted at the present time to determine whether aureomycin or vitamin B₁₂ or an unidentified factor was responsible for the improved effect. Crystalline aureomycin and vitamin B₁₂ are being used in various combinations with both the breeder and progeny diets. In these studies Broad Breasted Bronze turkey breeders of the medium-sized College strain have been used. Further work is also being conducted to determine whether or not vitamin B₁₂ is a valuable contribution to a recommended turkey breeder diet. Beltsville white breeders are being used for the latter work. (Project 96. Leaders: C. W. Carlson, Wm. Kohlmeyer, and D. G. Jones, Poultry Department; O. E. Olson, Chemistry Department.)

Forage Crops for Turkeys

A comparison of forage crops for growing and finishing Broad Breasted Bronze turkeys has been the object of work done on this project at the North Central Substation, Eureka. Turkeys on
alfalfa and rape have not differed consistently at marketing time either with respect to body size or over-all efficiency of feed utilization. A study is planned for this season, comparing Sudan grass and alfalfa as the forage crops. (Project 79. Leaders: Wm. Kohlmeyer, C. W. Carlson, Poultry Department; Albert Dittman, Supt., Eureka Substation.)

Effects of Inbreeding
Although some lines of inbreds were severely depleted by an outbreak of Newcastle disease, it has been possible to continue all inbred lines for another generation. The four lines of inbred White Plymouth Rocks have been maintained by artificial insemination because of poor fertility encountered in floor matings. Even with artificial insemination fertility remains poor in one of the inbred White Plymouth Rock lines. There has been no appreciable change in hatchability in these lines during the past season, though slight variations up or down depending upon the line have occurred.

In the Rhode Island Red and Barred Plymouth Rock inbred lines, hatchability is somewhat lower as a result of continued inbreeding. Fertility decreased slightly in the Rhode Island Reds, but was maintained at a high level in the Barred Plymouth Rock line. A rather high incidence of crossbeaks, most of which can be detected at hatching, was observed in Barred Plymouth Rocks.

Inbreeding has advanced sufficiently far in the White Plymouth Rocks and Rhode Island Reds so that they are being tested in various combinations. To obtain a greater diversity of stocks, one inbred White Leghorn line was imported from Nebraska for use in production of single-crosses. Egg production, livability, fertility, and hatchability of single crosses has been good. Experimental hybrids have been produced whose reproductive performance will be compared with topcrosses, pure breeds, crossbreds and a commercial hybrid.

Hatching eggs from topcross matings of two inbred lines of White Plymouth Rocks and one of Rhode Island Reds were shipped to the Regional Poultry Breeding Laboratory at Lafayette, Indiana. Progeny from these crosses will be compared with topcross progeny of inbred lines produced at other stations in an attempt to determine which lines are most promising for use in crosses. (Project 179. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry Department, D. C. Warren, B.A.I. cooperating.)

Reproductive Performance of Topcrosses and Pure Breeds of Poultry
Topcrossing has been used as a method for evaluating inbred lines of poultry. From a cross of an inbred line on standard breeds or varieties, the breeder hopes to obtain some indication as to whether the inbred under test has good combining ability.

The topcross progeny of inbred White Plymouth Rock males mated to New Hampshire and to White Leghorn females has been compared with control pens of New Hampshires and White Leghorns.

Although the Leghorns came into production slower than the New Hampshire topcross, their high rate of lay during the spring and early summer months has allowed them to overcome and surpass the New Hampshire topcross in total number of eggs produced. The Leghorn topcross has not produced as well as the New Hampshire topcross, but both topcrosses have exceeded the New Hampshires in egg production. Broodiness has been a very serious problem in both topcrosses. Egg size is considerably larger in the topcrosses than in the pure breeds. Egg weight of the Leghorn topcrosses exceeds that of the New Hampshire topcrosses even though egg weight of the pure Leghorns is less than that of the New Hampshires. (Project 194. Leaders: D. G. Jones, and Wm. Kohlmeyer, Poultry Department.)

Selenium Poisoning in Turkeys, see page 20
Oats for Growing Turkeys, see page 42
Livestock and Poultry Diseases and Parasites

Newcastle Disease in Poultry
It has been six years since Newcastle Disease was first diagnosed in poultry in South Dakota. With the comparatively wide distances separating farms, the disease has not presented as much of a problem in control as exists in the more congested poultry raising areas. Vaccination for prevention is not practiced in South Dakota as generally as in some other states.

The vaccination of chicks in the first week with inactivated virus or by the intranasal method, followed by wing-web vaccination of those to be kept for breeders or layers at three to four months appears to be the best procedure where there is greatest danger of infection being introduced.

The diagnosis of Newcastle Disease must be based on isolation of the virus or serological tests because several other respiratory diseases of poultry show similar clinical symptoms and lesions. The work on this project is directed towards differentiating the respiratory diseases for accurate diagnosis. (Project 170. Leader: G. S. Harshfield, Veterinary Department.)

Sporadic Bovine Encephalomyelitis
Since 1945, when it was first recognized in this area, sporadic bovine encephalomyelitis has been diagnosed in 16 herds in South Dakota and western Minnesota. In 13 of the herds which totaled 981 cattle, 14 percent showed symptoms during the course of the outbreaks with a death loss of 42 percent of the sick animals. Almost all of those which showed symptoms were young animals up to three years of age. The death loss was highest among calves less than one year old.

The agent which causes sporadic bovine encephalomyelitis has characteristics which correspond to the psittacosis-lymphogranuloma venereum group of viruses. Elementary bodies can be demonstrated in guinea pig tissues and in the yolk sac membrane of chicken embryos which have been inoculated with infective material. Heat readily destroys the virus. Aureomycin and terramycin are at least partially effective in destroying infectivity for chicken embryos.

In cattle, the virus produces an inflammation of serous surfaces of the body cavities. Fibrinous peritonitis, pleuritis, and sometimes pericarditis are lesions by which the disease can be recognized. Inflammation of the brain, spinal cord and the meninges is always present on microscopic examination of those tissues. In an outbreak in a herd, it is quite probable that the infection is not limited to those animals that show symptoms but that others may have the disease in an inapparent form.

There has been no recurrence of the disease in the same herd nor has there been any spread to neighboring farms. Further study will be necessary to determine how sporadic bovine encephalomyelitis is spread from animal to animal. (Project 171. Leader: G. S. Harshfield, Veterinary Department.)

Sheep Parasite Control
For the second year, the course of internal parasite infestations in sheep on different grazing levels at the Antelope Range Field Station has been followed during the grazing period. Five groups of ewes with their lambs were used to stock pastures to provide light, moderate and heavy grazing, rotation at a moderate rate, and moderate grazing by cattle and sheep together. The rotation group grazed four pastures with a total acreage equal to the moderately grazed pasture, being moved at weekly intervals. Under this plan any one pasture...
was grazed for a week with a three week rest period before sheep were returned to it.

The parasite levels were determined by counting the worm eggs in one gram of composite samples of feces from ewes and lambs of each group.

During the 1951 season, parasite infestations in neither the ewes nor the lambs in any group reached a level that would be considered detrimental to growth or health. The highest egg count was reached by the lambs of rotation grazing, indicating that the rest period of three weeks was not sufficient time to allow for the reduction of infective worm larvae. The cattle pastured with sheep did not harbor any more stomach and intestinal round worms than cattle pastured separately but tape-worms were more prevalent in the cattle that had sheep with them. Further observations along these lines are necessary before making any definite conclusions. (Project 139. Leaders: G. S. Harshfield, T. A. Dorsey, Veterinary Department.)

Horn Flies and House Flies

Emphasis has been placed on range horn fly control on cattle and control of insecticide-resistant house flies. A movie on cable-type backrubbers for horn fly control on cattle has been prepared and is available for use. In addition, Bulletin 418, "Cable-Type Backrubbers for Horn Fly Control on Cattle" has been published during the year. (Project 186. Leader: Wm. M. Rogoff, Entomology Department.)

Mites Affecting Domesticated Mammals

Control work on swine mange was emphasized and satisfactory progress was made on this project.

The following publication on mites affecting domesticated mammals was prepared and published: "Mites Affecting Domesticated Mammals," Tech. Bul. 10.

This bulletin contains a pictorial key by means of which it is possible to identify the common mites affecting domesticated mammals. It also contains a description of the mites, the lesions they cause on mammals and control recommendations. (Project 186. Leader: Wm. M. Rogoff, Entomology Department.)

Screw Worms

No infestations of true screw-worms occurred in South Dakota during the past year. However, many secondary maggots were sent to the Experiment Station for identification with the thought that they might be true screw-worms. They were taken from cattle, horses, hogs, dogs, and cats. (Project 220. Leader: H. C. Severin, Entomology Department.)

Vaccination and Blood Tests for Fowl Cholera, see page 23

Cattle Grub Control in South Dakota, see page 46
Farm Engineering

Drying and Feeding of Wet Corn

The project on the storage of high moisture corn, was scheduled to close during 1951 and a bulletin copy was prepared. However, the corn crop of 1951 proved to be so very different from any in recent years that it was felt wise to re-open the project and do some corn drying and also some feeding on the extremely wet corn versus the same material put through the driers. The following departments, therefore, began emergency projects and necessary allied tests, such as moisture tests and those for total digestible nutrients and proteins: Agronomy, Animal Husbandry, Agricultural Engineering, Dairy Husbandry, Plant Pathology, and Station Chemistry.

The Plant Pathology department collected 50 samples of the wet corn in localities near Brookings. These were examined for mold damage in December and in January and it was found that the molds present were not seriously destructive to the corn. This condition, combined with a cool fall and a cold winter, made it possible to keep much of this very wet corn on through the winter feeding period without serious spoilage.

The Animal Husbandry department fed both lambs and swine on (a) soft ear corn, (b) soft shelled corn, (c) dried shelled corn. The undried corn proved to be the more economical feed because commercial drying costs were high. The Dairy department fed wet ear corn to dairy cows versus dry ear corn.

The dry corn fed by the Dairy department was dried with special equipment constructed by the Agricultural Engineering department, with drier bin mounted on scales so that moisture loss of the drying corn could be read at any time. In addition three types of relative humidity recording instruments were tried out to see how they compared in accuracy. The simplest of these instruments, the sling hygrometer, when carefully used, proved to be quite accurate as compared to the more elaborate equipment. When extremely wet corn is placed in the drying bin, the relative humidity of air coming from the corn during the first 24 hours is sometimes as high as 90 percent. If this condition lasted very long it would create serious mold growth, and would do so on a large crib installation.

The chemical analyses of the soft corn and the dry corn were checked by the Experiment Station Chemistry department for moisture content, sugar content, and total digestible nutrients.

The corn samples used in the trials averaged 60 percent moisture content early in the fall, and averaged 50 percent in December and January. Such soft and immature corn can be dried, but it was not found economical to do so. (Project 152. Leader: H. H. DeLong, Agricultural Engineering Department.)

Sprinkler Irrigation Possibilities

Interest among South Dakota farmers in supplemental irrigation has increased sharply during recent years. One of the methods of water application is the use of sprinklers. A question frequently asked concerning sprinklers is: How much water is lost due to evaporation, deep percolation, and other unavoidable losses? A direct comparison of water losses between sprinklers and the border method of irrigating was made.

The alfalfa field on which these tests were made was laid out and leveled for border irrigation with the borders being 30 feet wide and 480 feet long. A portion of this field was irrigated by use of the borders and the remainder of the field was irrigated by sprinklers. In order to determine the amount of water lost, soil moisture samples were taken
before and after irrigation and the amount of water applied was measured. The difference in the amount of water applied and the amount of water stored in the plant root zone would be the total amount of water lost. Only the over-all water loss can be determined in this manner.

It was found that the water losses from the sprinklers varied with the following factors: wind velocity, relative humidity, amount of sunshine, temperature, rate of water application, and with the amount of soil moisture present when the irrigation started.

The data collected indicated that wind velocity had the greatest effect. As the wind increased, the water losses increased. Relative humidity, amount of sunshine, and temperature are factors that are hard to segregate. It appeared that the amount of sunshine has more effect on water losses than the relative humidity or the temperature. Cloudy, humid days were the best days to irrigate.

The water losses were greater when the water was applied at a slower rate than the maximum intake rate of the soil than when applied as rapidly as the soil would allow. Also, when the soil was dry at the start of an irrigation and was filled to field capacity, lower water losses resulted.

Water losses in the border irrigated portion of the field did not vary with conditions as much as the sprinklers.

The amount of soil moisture present before irrigation had the greatest effect. Lower water losses or higher irrigation efficiencies resulted when the soil moisture was low before irrigation and was filled to field capacity with irrigation water.

This one year's work indicates that under normal conditions when good irrigation practices are used, the average water losses encountered with sprinkler irrigation will not be significantly different from the water losses encountered when border irrigation is used. (Project 192. Leader: J. L. Wiersma, Agricultural Engineering Department.)

Concrete Aggregate from South Dakota Shales, see page 77

Interest among farmers in supplemental irrigation has increased during recent years. Sprinkler irrigation will fit into many farm management programs to greater advantage than surface irrigation
Do Short Term Leases Keep Tenants on Toes?

Short-term leases are preferred by many South Dakota farm landlords. More than half of the landlords who replied to a question on this point said that the most important reason why short term leases were customarily used was "to keep the tenant on his toes."

These tentative conclusions are based on the results of a questionnaire which was mailed last January to about 1200 landlords of South Dakota tenants and part-tenants. Of the questionnaires mailed, 317 or about 25 percent were returned. This is a good return from a mailed questionnaire. Whether these answers are also representative for those who did not reply has not yet been tested. Therefore this report applies only to those who answered the questionnaire.

Over 80 percent of the landlords replying to the questionnaire said that they preferred the short-term lease of one or two years—mostly one year. About 60 percent thought that their tenants preferred the short-term lease while 40 percent said that their tenants preferred leases of three years or longer.

This study suggests that short-term leases are closely connected with crop share leases in which the landlord's rent depends upon how the tenant farms. The landlord uses the short-term lease in his day-to-day bargaining with the tenant about matters which affect his rent.

Crop-share leasing is a partnership in fact, if not by law. The short-term lease is one way the landlord can get his tenant partner to consider the landlord's interest as well as his own.

The conclusion seems to be that if we want longer term leases to encourage soil conservation—more grasses, legumes, and livestock—we will have to sell the landlords on a cash lease and that will be difficult to do.

Perhaps the landlords may find the flexible-cash lease, in which the rent varies with the average county yield of a chief crop and local prices, is the answer. This lease has the chief advantages of both the crop share and cash lease. Preliminary copies of this lease may be obtained from the county agent or from this department. Another study attempts to answer questions such as these:

- Do present leasing practices interfere with efficient use of land, buildings, labor and fertilizer?
- Do landlords and tenants share equitably in the returns from the farm?

To answer these questions 7000 questionnaires were mailed to a random sample of tenants and part-owners. Over 1400 replies have been received, edited and coded and will be analyzed by IBM equipment giving totals by economic areas and the state.

Complete reports on these two studies will be made during the next year. Also a circular on leasing laws is being prepared. (Project 147. Leader: Russell L. Berry, Agricultural Economics Department.)

Farm Records Analyzed

Blizzards delayed collection and summarization of the 1951 farm records, but the work is going forward and the usual summary reports are being prepared.

Farm record data are being punched on International Business Machine cards. Use of the IBM cards will make possible more complete sorting and comparisons within and between years. In the past, each yearly report has been a separate recommendation and some farmers were allowed, even encouraged, to make major changes in their farm program on the basis of one year's information. With the new machines it will
be possible to make comparisons over several years’ time.

Of all the farm enterprises and accounts covered by the farm record book, family living from the farm is the most underrated. When each farmer was asked how much the farm contributed to the cost of family living the answer received was always a low figure. When the number of pounds of farm-raised meat, number of quarts of vegetables canned, number of quarts of vegetables used fresh from the garden, amount of fruit grown on the farm, number of dozen eggs eaten, number of pounds of poultry eaten was asked for, and then these quantities multiplied by a reasonable price, the figure was much higher. (Project 137. Leader: Allan Clark, Agricultural Economics Department.)

Marketing Lambs by Carcass Weight and Grade

The purpose of this project is to investigate whether the marketing methods for lambs can be improved by selling them on basis of carcass weights and grades instead of by live weight. Although the former method more accurately reflects actual wholesale values of lamb carcasses, several practical problems have to be investigated before a final appraisal of the two methods of marketing can be made.

One of these practical problems is whether adjustments in prices are necessary when lambs are held over in the packer’s yards for one or more days before slaughter. If there is a significant decline in weight and grade during such holdover individual farmers may suffer a loss under the carcass weight and grade system of marketing. In order to determine the effect of such holdover, a study was made of 17 lots totaling 918 lambs. In each lot of 54 lambs, 18 lambs were killed on consecutive days. The experiment was designed to obtain uniformity of sublots for each day’s kill within the individual lots of 54 lambs.

The lambs were classified in three groups (1) western lambs from the range, (2) native lambs coming from a distance of within 70 miles, and (3) lambs fed in the packer’s yards. The day of slaughter showed a highly significant difference between yields for only one of these groups, the western native lambs. The other groups had no statistically significant difference in yield between each day’s kill.

Significant declines in grade occurred in native lambs but not in the other groups. In the grading, each Federal grade was divided into three subgrades; the average grades for each lot did not vary by more than one-third of a Federal grade in any of these groups.

The tentative conclusion from this study is that holdover in the packer’s yard for a period of one or two days could possibly have some influence on the returns to the producer under the carcass weight and grade system of marketing. (Project 156. Leaders: O. Nervik, Agricultural Economics Department and Ellis A. Pierce, Animal Husbandry Department.)

Improved Market News Service for the Poultry and Egg Industry

An analysis of local price and market information available to South Dakota poultry and egg farmers through local newspapers and radio broadcast was made in the Spring of 1951. It revealed that frequently price quotations for eggs and poultry were inaccurate and did not always correspond to prices that dealers were paying. Though dealers changed their paying prices, more or less, in accordance with price changes in terminal markets, price quotations in newspapers did not always reflect these changes, but often remained unchanged for a relatively long time.

Price quotations referring to one local market were not always reported accurately in other local South Dakota markets. In addition, at the time of the survey, there was a wide diversity in the
usage of grades. This may have been partly responsible for the wide range in prices, for the various “grades,” observable in newspaper quotations.

There appeared to be a tendency for small local markets with weekly newspapers to quote somewhat higher prices than larger, nearby, markets. Due to the small circulation of these weeklies, only relatively few farmers would be aware of these price differentials.

In view of these inadequacies, it is believed that an improved market news service for local egg and poultry conditions would be of benefit to both farmers and dealers.

In order to test the feasibility of such an improved service, the South Dakota Agricultural Experiment Station (Agricultural Economics Department) in cooperation with the Extension Service issued a weekly Turkey Market Report during the Fall of 1951. These reports contained information on local turkey prices paid to farmers, supply and demand conditions in South Dakota and quantities processed by local handlers, and various data on general conditions in turkey markets elsewhere in the States. At the end of the season, a questionnaire was sent to turkey growers to find their reaction to the weekly reports.

The overwhelming majority of the turkey growers expressed satisfaction with the reports. The turkey dealers and processors who cooperated in furnishing price and quantity data also were well satisfied.

A more detailed report for publication is in preparation. (Project 175. Leaders: Ernest Feder, Agricultural Economics; William Kohlmeyer, Poultry Husbandry Department.)

**Market Potentials of Crops in Irrigation Areas**

In this study, the competitive position of various crops which can be produced in the areas proposed for irrigation in South Dakota is examined. The present marketing facilities for farm products in the Oahe area have been surveyed and estimates are being made of the extent of new facilities needed if irrigation is introduced.

Irrigation developments in the South Dakota area involve special problems which were not present in projects in other areas. The period of production is relatively short and the climate is severe in winter. In addition the areas proposed for irrigation are distant from the larger markets. These factors limit the type of crops that can be produced and marketed from these areas. In this project these problems are analyzed and the impact of such limiting factors is examined. (Project 197. Leader: O. Nervik, Agricultural Economics Dept.)

**Grain Marketing Practices and Problems**

Grain crops are responsible for a major portion of South Dakota’s agricultural income. Much of the grain is fed to livestock on the farm where it is produced; however, 33 percent of the total farm cash income during the last five years has been derived directly from sale of grains.

In view of the importance of grain crops as a source of cash farm income in South Dakota, an investigation of the existing grain marketing structure was started in 1951.

There are essentially four questions which need to be considered in an economic analysis of grain marketing problems: What problems exist and in which geographic areas? How serious are the respective problems from the standpoint of affecting farm income? What alternative courses of action might be taken to reduce or eliminate the problems? And, in view of existing conditions and limiting forces, which of the alternatives could most likely be realized?

It was planned to gather data from farms, local elevators, and terminal elevators, which will, for the most part, provide answers to the first two ques-
tions. Unfortunately, the latter two questions cannot be resolved simply through analysis of physical data, since they involve matters of social and economic policy, personal motives, expenditures of private capital, and possible governmental regulatory measures. Some of the data collected at the farms and local elevators are being analyzed and sorted with the IBM machines. (Project 224. Leader: Ralph D. Tompkin, Agricultural Economics Dept.)

The Best Time to Sell Livestock

The purpose of this project is to determine the best time for marketing livestock, taking into consideration both production and price factors. The research is built upon available experimental and statistical material from federal, state, and private agencies. Considerable research data are available on the physical factors which influence the returns to producers.

The seasonal characteristics of livestock prices have been determined by various research workers. So far, little has been done to trace the combined effect of the production and price factors on the returns to producers. The objective of this project is to analyze the available data to determine at what time farmers should market their livestock to obtain the best returns. The work this year has been confined to compilation of statistics from research studies of livestock production. (Project 226. Leader: O. Nervik, Agricultural Economics.)

Economics of Soil Conservation

Granting that some legumes are necessary to prevent erosion and maintain crop yields, how much grass and legumes can be considered profitable for the farmer? Is 100 percent grasses and legumes the answer? If not, what is the answer? Partly, it depends upon how far the farmer can profitably go in substituting grass and legumes for grain in feeding livestock.

Needed information has been gathered in cooperation with the Animal Husbandry, Dairy, and Poultry departments and published as “Estimated Feed Requirements for Livestock and Poultry,” Agricultural Economics Pamphlet 39, 1952. In this publication the effects of substituting grasses and legumes for grain can readily be seen and the most profitable way of feeding determined.

Another part of the answer depends upon the long-run complementary and competitive relations of grasses and legumes to grain production to rotations. Some estimates of crop yields have been prepared in cooperation with the Agronomy department which show these relationships for specific rotations, and this work will be continued during the next year.

Increased efficiency in handling crops and livestock also plays an important part in determining the most profitable crops. A livestock labor requirement study is being completed at this time. This work was carried out in cooperation with veteran on-the-farm training classes.

Data for power machinery, labor and fuel requirements have also been prepared and will be published this year.

Price relationships for the various crops, livestock, and production expenses have been prepared for use in this analysis.

During the next year it is hoped that this information can be combined for specific farmers to determine how far farmers can profitably go in growing grasses and legumes on their farms. (Project 211. Leader: Russell L. Berry, Agricultural Economics Dept.)

Town-Country Trade Relations

The study of town-country trade relations in South Dakota from 1932 to 1951 is prompted by the changes in agriculture, population, transportation, and habits of living the past 20 years. There is an interdependence between town and country, and a change in one
Number of Towns and Cities in South Dakota by Population Groups for 1931 and 1951 According to Dun and Bradstreet

<table>
<thead>
<tr>
<th>Population Class</th>
<th>1931</th>
<th>1951</th>
<th>Change in Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—49</td>
<td>245</td>
<td>147</td>
<td>-98</td>
</tr>
<tr>
<td>50—249</td>
<td>202</td>
<td>198</td>
<td>-4</td>
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<tr>
<td>250—499</td>
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<td>-24</td>
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<tr>
<td>500—999</td>
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<td>62</td>
<td>0</td>
</tr>
<tr>
<td>1,000—2,499</td>
<td>41</td>
<td>32</td>
<td>-9</td>
</tr>
<tr>
<td>2,500—4,999</td>
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</tr>
<tr>
<td>7,500—9,999</td>
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<td>+2</td>
</tr>
<tr>
<td>10,000 &amp; Up</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>670</td>
<td>545</td>
<td>-125</td>
</tr>
</tbody>
</table>

affects the other. What are some of these changes?

The number of people residing on farms in South Dakota decreased from 56.2 percent of the total population in 1930 to 38.8 percent in 1950, a difference of 17.4 percent while the total population in the state decreased 5.79 percent. At the same time the number of farms decreased in the state by 16,705 or 20 percent of this 20-year period. Part of the adjustment in town-country trade relations during this time was made through fewer towns and a change in the way various sized towns specialized in servicing their respective trade areas.

In order to show trends, 10 widely scattered towns were chosen for the following analysis:

1931 figures of towns in the three population groups were compared with 1951 figures. Many of the towns in the 0 to 49 population group had disappeared by 1951 and the business places consisted largely of filling stations and grocery stores, whereas in 1931 they included lumber yards, grain elevators and general stores.

Significant changes in the types of businesses were noticed in the towns in the 50 to 249 group. In 1931 these towns had banks, drug stores, and hotels. In 1951 only one town had a bank and no town had a drug store. Most of the competition was in filling stations, garages, groceries and restaurants.

The population of the towns in the 1,000 to 2,499 classification increased from 14,324 to 22,850 and the number of business units also increased 35.9 percent.

The table indicates no change in the number of cities over 10,000; however, the total population of these six places in 1950 contained almost 21 percent of the total population in the state, an increase of 48 percent during the 20-year period when the state’s population was decreasing. This accounts for the population changes in the smaller towns.

Improved transportation facilities and roads have given farmers two, three, and even four trade centers as compared to one center previously, accounting for the decrease in the number of towns and the specialization in the way these towns service their trade areas. In 1931 there were 333 miles of hard-surfaced state highways as compared with 3,563 miles in 1951. This does not include the state graveled roads nor the county and local farm to market roads. Another index is auto registrations. There were 194,823 autos and trucks registered in 1931 as compared with 293,958 in 1951.

With respect to changed habits of living, the fact that 45,898 farms in South Dakota had electricity in 1950 as compared with 19,028 farms five years earlier suggests the conveniences, time saved, and efficiency attained in rural areas recently.

There are other variables in town-country trade relations in addition to those discussed above; however, a more complete analysis of these relationships
Lessons to be Learned from the Belle Fourche Irrigation Project

The main objective of this research is to determine whether there are any significant lessons to be learned from farm operators of the Belle Fourche Irrigation Project, 1902—1952, located in Butte County, South Dakota. If so, these lessons would be helpful to prospective irrigation farm families in the central or western parts of the state.

The over-all purpose of the study has been to make a population survey of communities under irrigation with special reference to social institutions. The problems in connection with these institutions were: school district reorganization, church consolidation, modern family relationship and health facilities.

Considerable attention was given to backgrounding population growth, distribution and characteristics, as well as rural life adjustments to the local physical environment.

A 10 percent sample was obtained from between 500 and 600 families then living on the project. This yielded 53 farm schedules from three areas on the project, together with 12 additional town schedules from retired operators who had previously lived on project farms. Many of these men were now in some other business or profession, but still owned their land. This kept them in touch with changing project conditions, social and economic, especially during the past 14 years. (Project 64 Revised. Leader: W. F. Kumlien, Rural Sociology Department.)

Do Preseasonal Rain and Snow Increase Crop Yields? see page 8

Men and Land, see page 17

Marketing and Processing Methods Affecting Butter Quality, see page 25

Recent Population Changes in South Dakota, see page 49

Land for Reservoirs—Some Local Reactions, see page 72

50 Years of Irrigation on the Belle Fourche Project, see page 101

The population of this town decreased 5.3 percent in the last 20 years but the number of its economic institutions increased 44 percent from 1931 to 1951 according to Dun and Bradstreet.
Heat Transfer of Wool Materials

In order to study the amount of heat which is transferred through wool materials it has been necessary to design new equipment and to have it built. Work has also gone forward on methodology. Samples of wool flannels and serges which were used in serviceability studies are ready to use for heat measurements. (Project 196. Leaders: Lillian O. Lund, Home Economics Department, in cooperation with Ethel L. Phelps, Minnesota Agricultural Experiment Station.)

Wool Blended with Chemically Manufactured Fibers

Chemically manufactured fibers are being blended with wool in increasing numbers and in a variety of combinations. No data are available on the behavior or serviceability of these blends. Fabrics of these types are being purchased as soon as they can be procured, and physical measurements will be made on them. (Project 215. Leaders: Lillian O. Lund, Home Economics Department in cooperation with Ethel L. Phelps, Minnesota Agricultural Experiment Station.)

Freezing Fruits and Vegetables

Studies have been completed on the freezing of fruits and vegetables, in which the operation of several home freezer units and several commonly used containers were compared. Bulletin 423, "Fruits and Vegetables in the Home Freezer," reporting the results of this work, was published during the year.

It was found that although the rate of freezing may vary significantly from freezer to freezer and in the same unit at different times, depending on a number of factors, the quality of the frozen fruits and vegetables was not adversely affected by the slower rates of freezing observed. Use of a separate freezing compartment was an effective means of shortening the actual freezing time and also prevented undue rises in the temperature of the food already in storage.

There were differences in the rate of freezing foods in the four types of containers; however, it would appear that the containers used were all quite satisfactory for preserving palatability and nutritive value. In addition, these studies would indicate that some loss of ascorbic acid, flavor and sweetness can be expected in vegetables held in frozen storage longer than 10 months and after shorter periods if sufficiently low storage temperatures are not maintained.

This work has emphasized the need for considering the following points in selecting a home freezer: (1) Is the unit dependable? (2) Does the motor have enough power to maintain adequate freezing and storage temperatures? (3) Would a separate freezing compartment be desirable for your particular needs? (Project 98. Leaders: Lida Burrill and Beth Alsup, Home Economics Department.)

What South Dakota Women Eat

In an effort to find out more about the nutritional status of adult women, considerable work has been carried on in the last few years in South Dakota. This has included a state-wide survey and several studies made on Brookings women. A large amount of data has been collected, and much of it has yet to be summarized. However, data have been prepared to be included in regional publications on food habit surveys, methods of studying food intake and blood constituents.

Ascorbic acid metabolism studies have been continued with saturation tests on eight women over 40 years of age in South Dakota. These included:

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(a) the determination of urinary excretion of ascorbic acid during a 3-day period with the subject on her own self-chosen diet; (b) determination of ascorbic acid excretion while the subject was receiving a large daily supplement (10 mg./kg. body weight) of ascorbic acid to point of saturation (when 50 percent or more of the daily supplement was excreted); (c) the determination of blood ascorbic acid before giving the supplement and again following saturation; (d) the calculation of nutrient intake of the women from their records of amount (weighed) of food eaten. (Project 178. Leaders: Lida Burrill and Beth Alsup, Home Economics Department.)

Reused Wool—Will It Wear? see page 30

New Sandcherry Recipes, see page 90

Substation Report

Cottonwood
Range Field Station

Jean M. Kern, Superintendent

Establishing Alfalfa in Range Pasture

Development of alfalfa strains especially adapted to withstand grazing and competition from aggressive grasses is being continued. Selection nurseries are maintained at Brookings and at the Range Field Station near Cottonwood.

Small plot grazing tests of several alfalfa strains have also been established and grazing has already started on those plots. For a more detailed report see page 110. (Project 74. Leaders: M. W. Adams and W. W. Worzella, Agronomy Department.)

Nutritive Value of Prairie Hay Cut at Different Stages

Feeding trials have been continued to compare the feeding value of prairie hay cut at various stages.

At Cottonwood, eight calves per lot, weighing approximately 350 pounds each, were fed for 168 days. Results at this station indicated a lower value for the later stages of cutting when supplemented with soybean meal pellets than the trial last year or the current trial at Eureka. For a more detailed report see page 125. (Project 120. Leaders: F. B. Embry and G. T. King, Animal Husbandry Department; O. E. Olson, Station Chemistry Department, and J. G. Ross, Agronomy Department.)

Is Nitrogen Needed in Western South Dakota?

Experiments with fallow and sweet clover in the rotation were continued to find out whether nitrogen is needed in western South Dakota soils.

The use of commercial fertilizer is also being investigated and has given good results. For a more detailed report see page 106. (Project 4. Leader: B. L. Brage, Agronomy Department.)

Summer Grazing of Beef Cows for Calf Production

Intensities of grazing studies were continued. In May, 1951, cows were allotted into six pastures which were grazed at three intensities. The pastures were stocked with a variable number of animals for the purpose of achieving a utilization of less than 35 percent, 35 to 55 percent and over 55 percent during a 7-month season.

Forage production was studied by clipping three yard square plots in each of three exclosures in each pasture. For a detailed report see page 124. (Project 216. Leaders: James K. Lewis, Animal Husbandry; Oscar Olson, Station Chemistry.)

Nutritional Studies with Beef Cows Wintered on the Range

The effect of the addition of carotene, vitamin A, and/or trace minerals to a basal ration of range grass and 1 pound of soybean pellets containing added
phosphorus is being studied. Forty-eight beef cows were involved in the experiment and blood studies were made. This is the first year that such investigations were undertaken and the results must be considered as preliminary. For a more detailed report see page 126. (Project 217. Leaders: James K. Lewis, Animal Husbandry; Oscar Olson, Andrew Halverson, Station Chemistry.)

Central Substation, Highmore
Wade R. Pringle, Superintendent

New Crop Varieties Tested
Several hundred new strains of sorghum, corn, wheat, oats and barley were grown and appraised for their suitability and adaptability. In addition, new crops are being tested, such as sunflower, safflower and castor beans. The results indicate that the early small grain varieties produce the highest yields. Corn planted at a rate of two to three kernels per hill yielded as well as that planted at a higher rate. Corn planted May 20 produced as much as that planted earlier or May 1. Early corn hybrids not only produced more sound corn but greater yields than late hybrids. (Projects 4, 25, 61, 66, 181. Leaders: J. Graffius, V. A. Dirks, C. J. Franzke, D. B. Shank and A. N. Hume, Agronomy Department.)

Nutritive Value of Prairie Hay
Feeding trials with prairie hay cut at different stages of maturity were continued. Results at the Highmore station were similar to those obtained at Eureka. However, the performance with the early and late hay was unsatisfactory. The early-cut hay contained many needles, and the calves would not eat enough to maintain their weights. Several cases of severe ringworm infestation were encountered in the lot fed the late-cut hay, and the gains were adversely affected. For a detailed report see page 125. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry Department; O. E. Olson, Station Chemistry Department; and J. G. Ross, Agronomy Department.)

Sorghum Seed Treatment
The sorghum seed treatment experiments which have been conducted at Brookings and Highmore for several years were continued. The fungicides used included compound Number 224 and 640 as well as Arasan. For a more detailed report see page 122. (Project 110. Leader: R. H. Converse, Plant Pathology Department.)

North Central Substation
Eureka
Albert Dittman, Superintendent

Nutritive Value of Prairie Hay Cut at Different Stages
Feeding trials with prairie hay cut at different stages of maturity were continued. Ten calves per lot weighing approximately 460 pounds each were fed for 168 days. They consumed an average of nearly 13 pounds of hay per head daily.

The results were quite similar to those obtained last year. For a detailed report see page 125. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry Department; O. E. Olson, Station Chemistry; and J. G. Ross, Agronomy Department.)

Establishing Alfalfa in Range Pasture Studied
Methods of establishing alfalfa in the range sod is being studied. Three varieties of alfalfa have been drilled in on each of four land preparations: 1. burning, 2. disking, 3. plowing, 4. undisturbed sod. The 1952 results indicate excellent stands of alfalfa were obtained when the sod was plowed and fair stands on disked land. Poor stands of alfalfa were obtained on sod land which was burned or undisturbed. For more detailed report see page 110. (Project 74. Leaders: M. W. Adams and W. W. Worzella, Agronomy Department.)
Systems of Breeding Swine
Research in swine breeding was continued at Brookings and at the Eureka Substation. In 1951, eight breeding groups were maintained. The four breedline cross proved again, as in previous years, to be the most efficient. For 1952 litters, the Yorkshire inbreds have been eliminated as well as the single-cross litters. Thus, with fewer lines, more litters per line can be raised, which in turn increases the amount of information which can be gained. For a detailed report see page 132. (Project 124. Leader: C. P. Wilder, Animal Husbandry.)

Reproductive Performance of Top-crosses and Pure Breeds of Poultry
Topcrossing as a method for evaluating inbred lines has been continued. Topcross progeny of inbred White Plymouth Rock males mated to New Hampshire and to White Leghorn females have been compared with control pens of New Hampshires and White Leghorns with respect to reproductive performance. For a more detailed report see page 137. (Project 194. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry.)

Rape, Sudan Grass, and Other Forage Crops for Turkeys
A comparison of forage crops for growing and finishing Broad Breasted Bronze turkeys has been the object of work done on this project. Turkeys on alfalfa and rape have not differed consistently at marketing time either with respect to body size or over-all efficiency of feed utilization. A study is planned for this season, comparing Sudan grass and alfalfa as the forage crops. (Project 79. Leaders: Wm. Kohlmeyer, C. W. Carlson, Poultry Department.)

U. S. Newell Field Station
HARRY E. WEAKLY, Superintendent
Best Level for Feeding Ewe Lambs
Experimental winter feeding of ewes as lambs and as yearlings is being conducted to determine the effects of three levels of nutrition on their eventual mature body size and on their lamb and wool production. For a more detailed report see page 129. (Project 161. Leaders: G. T. King and L. B. Embry, Animal Husbandry Department.)

Swine Production for Irrigated Areas
Improved breeding, feeding and management practices in swine production for irrigated areas are the objectives of this project. At present only the breeding phase is being investigated. For a more detailed report see page 131. (Project 132. Leader: C. P. Wilder, Animal Husbandry Department.)

Cobalt in Lamb Fattening Rations
The third year of cobalt feeding, using feeds grown in western South Dakota, agreed with the findings previously reported. The addition of 1 ounce of cobalt chloride to 100 pounds of mineral supplement, increased the daily rate of gain about .03 pound. Cobalt analysis of the feed fed (not including the mineral supplement) showed it to contain .10 parts per million. While the increase in rate of gain is small the consistency of the results from year to year suggests that the soil around Newell may be borderline for cobalt content. The results of feeding cobalt to lambs at the Brookings and Newell station will be published this year. (Project 190. Leader: R. M. Jordan, Animal Husbandry Department.)

Antelope Range Field Station
ARTHUR J. FOXLEY, Superintendent
Rates and Systems of Grazing
The summer grazing experiment with sheep which was begun in 1950 was continued in 1952. This experiment was designed to determine a recommended stocking rate for sheep on western South Dakota ranges. For a more detailed report see page 127. (Project 177. Leaders: James K. Lewis and G. T. King, Animal Husbandry Dept.)
Sheep Parasite Control

For the second year, the course of internal parasite infestations in sheep on different grazing levels at the Antelope Range Field Station has been followed during the grazing period.

Five groups of ewes with their lambs were used to stock pastures and to provide light, moderate and heavy grazing. The parasite levels were determined by counting the worm eggs in 1 gram of composite samples of feces from ewes and lambs of each group. For a more detailed report see Page 138. (Project 139. Leaders: G. S. Harshfield, T. A. Dorsey, Veterinary Department.)

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ERNEST FEDER, PH.D._________Associate

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S. STANGELAND, M.S._________Agricultural Economist (BR, USDA)
W. D. SCHUTZ, M.S._________Agricultural Economist (BR, USDA)

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DENNIS L. MOE, M.S._________Assistant
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LEONARD J. ERIE, B.S._________Agr. Engineer (USDA)
NIEL DIMICK, B.S._________Irriga. Engineer

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D. B. Shank, Ph.D. Associate Agronomist
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C. A. Dinkel, M.S. Assistant
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G. T. King, M.S. Assistant
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Arthur Dracy, Ph.D. Associate
Roscoe J. Baker, Ph.D. Assistant
C. C. Wilson, Ph.D. Associate
Emery Bartle, M.S. Assistant

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Gerald B. Spaw, Ph.D. Associate
Wm. M. Rogoff, Ph.D. Associate
Wayne L. Berndt, B.S. Assistant
I. H. Roberts, Ph.D. Parasitologist (USDA)

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Lillian Lund, M.S. Assistant
Elsie Beth Alsup, M.S. Assistant

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Marcus Maxon, M.S. Assistant
Solomon Cook, Ph.D. Assistant
Paul F. Collins, M.S. Assistant

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Wm. Kohlmeyer, M.S. Poultry Husbandman
Dean G. Jones, Ph.D. Associate
C. W. Carlson, Ph.D. Assistant
Robert A. Wilcox, M.S. Assistant

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John P. Johansen, Ph.D. Research Associate

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Richard Converse, Ph.D. Assistant
Allan Cook, Ph.D. Assistant
Geo. Semeniuk, Ph.D. Pathologist

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J. B. Taylor, D.V.M. Assistant
T. A. Dorsey, D.V.M. Assistant
Elaine J. Kerner, B.S.Technician

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Jean M. Kern, Superintendent Range Field Station, Cottonwood
Albert Dittman, Superintendent North Central Substation, Eureka
Wade R. Pringle, Superintendent Central Substation, Highmore
Harry E. Weakly, Superintendent U. S. Newell Field Station, Newell
Arthur J. Foxley, Superintendent Antelope Range Field Station, Buffalo

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## RESIGNATIONS

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<thead>
<tr>
<th>Department</th>
<th>Name</th>
<th>Title</th>
<th>Date</th>
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<tbody>
<tr>
<td>Entomology</td>
<td>John A. Lofgren</td>
<td>Assistant Entomologist</td>
<td>July 1, 1951</td>
</tr>
<tr>
<td>Station Biochemistry</td>
<td>A. L. Moxon</td>
<td>Department Head</td>
<td>Sept. 30, 1951</td>
</tr>
<tr>
<td></td>
<td>H. L. Klug</td>
<td>Associate Chemist</td>
<td>Oct. 31, 1951</td>
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<tr>
<td></td>
<td>L. D. Kamstra</td>
<td>Assistant Chemist</td>
<td>June 30, 1952</td>
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<td></td>
<td>Ray M. Pengra</td>
<td>Research Asst. Chemist</td>
<td>June 30, 1952</td>
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<tr>
<td>Station Plant Pathology</td>
<td>L. T. Richardson</td>
<td>Associate Plant Pathologist</td>
<td>Oct. 30, 1951</td>
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<td>John T. Slykhuis</td>
<td>Assistant Plant Pathologist</td>
<td>June 30, 1952</td>
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<tr>
<td></td>
<td>R. T. Converse</td>
<td>Assistant Plant Pathologist</td>
<td>June 30, 1952</td>
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## APPOINTMENTS

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<th>Department</th>
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<tr>
<td>Agricultural Economics</td>
<td>Ralph D. Tompkin</td>
<td>Assistant Economist</td>
<td>Oct. 1, 1951</td>
</tr>
<tr>
<td>Agricultural Engineering</td>
<td>T. R. C. Rokeby</td>
<td>Assistant Agr. Engineer</td>
<td>Sept. 16, 1951</td>
</tr>
<tr>
<td>Agronomy</td>
<td>Glen E. Nachtigal</td>
<td>Assistant Agronomist</td>
<td>July 1, 1951</td>
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<td></td>
<td>Fred E. Shubeck</td>
<td>Soil Surveyor</td>
<td>August 1, 1951</td>
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<td>James E. Beardsley</td>
<td>Soil Surveyor</td>
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<td>Marvin E. Jensen</td>
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<td>Animal Husbandry</td>
<td>G. T. King</td>
<td>Assistant Animal Husbandman</td>
<td>Sept. 4, 1951</td>
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<td>J. W. Murphy</td>
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<td>January 1, 1952</td>
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<tr>
<td>Dairy</td>
<td>Chase C. Wilson</td>
<td>Assistant Dairy Husbandman</td>
<td>Sept. 18, 1951</td>
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<td>Entomology</td>
<td>Walter M. Ring</td>
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<td>Horticulture</td>
<td>Paul E. Collins</td>
<td>Assistant Forester</td>
<td>July 1, 1951</td>
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<td>Poultry</td>
<td>Robert A. Wilcox</td>
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<tr>
<td>Rural Sociology</td>
<td>Douglas Chittick</td>
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<td>John P. Johanson</td>
<td>Associate Rural Sociologist</td>
<td>Nov. 16, 1951</td>
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<tr>
<td>Station Biochemistry</td>
<td>Robert M. Pengra</td>
<td>Research Assistant Chemist</td>
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<td></td>
<td>Catherine M. Hendrick</td>
<td>Research Assistant Chemist</td>
<td>July 1, 1951</td>
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<tr>
<td></td>
<td>Leslie D. Kamstra</td>
<td>Assistant Chemist</td>
<td>July 1, 1951</td>
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<tr>
<td></td>
<td>Oscar E. Olson</td>
<td>Head of Department</td>
<td>Nov. 1, 1951</td>
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<td></td>
<td>Carl W. Bonhorst</td>
<td>Associate Biochemist</td>
<td>May 16, 1952</td>
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<tr>
<td>Station Plant Pathology</td>
<td>Allyn Cook</td>
<td>Assistant Plant Pathologist</td>
<td>Jan. 9, 1952</td>
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<td></td>
<td>Geo. Semeniuk</td>
<td>Plant Pathologist</td>
<td>Apr. 16, 1952</td>
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## FINANCIAL REPORT—AGRICULTURAL RESEARCH FUNDS—JULY 1, 1951 TO JUNE 30, 1952

### Table: Financial Report

<table>
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<tr>
<th></th>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
<th>Bankhead</th>
<th>Jones &amp; Marketing</th>
<th>Experiment Station</th>
<th>Experiment Substation</th>
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<tbody>
<tr>
<td><strong>FEDERAL RESEARCH FUNDS</strong></td>
<td>$15,000.00</td>
<td>$15,000.00</td>
<td>$60,000.00</td>
<td>$26,510.78</td>
<td>$57,950.30</td>
<td>$269,073.00</td>
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<td><strong>STATE RESEARCH FUNDS</strong></td>
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<td>Sale Proceeds</td>
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<td>$15,000.00</td>
<td>$15,000.00</td>
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<td>$26,510.78</td>
<td>$57,950.30</td>
<td>$269,073.00</td>
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### EXPENDITURES

<table>
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<tr>
<th>Description</th>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
<th>Bankhead</th>
<th>Jones &amp; Marketing</th>
<th>Experiment Station</th>
<th>Experiment Substation</th>
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<tbody>
<tr>
<td>Personal Services</td>
<td>$7,589.28</td>
<td>$12,288.84</td>
<td>$36,718.97</td>
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<td>Transportation of Things</td>
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<td>203.53</td>
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<td>Communication Service</td>
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<td>Printing and Binding</td>
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<td>Other Contractual Services</td>
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<td><strong>TOTAL</strong></td>
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<td>$15,000.00</td>
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<td>$69,961.29</td>
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<td>$148,297.67</td>
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### Unexpended Balance, 6/30/52

- **Federal Research Funds:** $10,852.03
- **State Research Funds:** $11,384.68
- **Experiment Station:** $180,608.68
- **Experiment Substation:** $38,677.30

### GRAND TOTAL

<table>
<thead>
<tr>
<th></th>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
<th>Bankhead</th>
<th>Jones &amp; Marketing</th>
<th>Experiment Station</th>
<th>Experiment Substation</th>
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<tbody>
<tr>
<td><strong>Federal Research Funds</strong></td>
<td>$15,000.00</td>
<td>$15,000.00</td>
<td>$60,000.00</td>
<td>$26,510.78</td>
<td>$57,950.30</td>
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<td><strong>State Research Funds</strong></td>
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<td><strong>Grand Total</strong></td>
<td>$15,000.00</td>
<td>$15,000.00</td>
<td>$60,000.00</td>
<td>$26,510.78</td>
<td>$57,950.30</td>
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<td>$38,677.30</td>
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Unexpended Balance, 6/30/52: $62,573.02