Agricultural Research

IN SOUTH DAKOTA

36th Annual Report

JUNE 30, 1952

JULY 1, 1953

Agricultural Experiment Station

SOUTH DAKOTA STATE COLLEGE

BROOKINGS, SOUTH DAKOTA
Letter of Transmittal

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

Dear Dean Eberle:

The fiscal year ending June 30, 1953 was very productive of research by the Experiment Station. The problems upon which research was conducted are all reported herein. The first 102 pages of this report were included in the South Dakota Farm and Home Research quarterly, (Vol. IV, Nos. 1 to 4, inclusive). The succeeding pages present a brief statement of the research activities not included in the quarterly issues. This publication represents the sixty-sixth annual report of the South Dakota State College Agricultural Experiment Station.

A general review of agricultural research shows clearly the influence it has had on farm production in the state. If it were possible to chart the different research activities and their result on production, the importance of research to our South Dakota agriculture would be strikingly evident. Many are now asking if our present rate of progress in research is rapid enough to develop improved farm practices to meet the future demand for agricultural products. Are new findings being uncovered at a rate equal to the rate at which they are being used? Eighteen new projects have been started this year with the funds and trained personnel available.

With agricultural surpluses accumulating and the possibility of restricting certain crop acreages, more and more interest is being taken in the production of grasses and legumes in the crop program for the farm. To secure more up-to-the-minute data on effective utilization of grasses and legumes, two of the projects added by the Station deal with pasture investigations in eastern South Dakota and with the handling, storing and feeding of grass-legume silage, including comparisons of labor requirements, costs, feeding values and losses in six different methods of storage. The pasturing of legumes brings to the fore the problem of bloat in cattle and sheep. With present funds and personnel only a limited amount of research can be conducted on the causes of bloat.

On behalf of the Station staff may we express our appreciation for the support accorded the work of the Experiment Station throughout the state.

Respectfully submitted,

[Signature]

Director, Experiment Station
Agricultural Research
in South Dakota

Sixty-sixth Annual Report
July 1, 1952 to June 30, 1953

South Dakota Agricultural Experiment Station
I. B. Johnson, Director

SOUTH DAKOTA STATE COLLEGE
of Agriculture and Mechanic Arts
Brookings, South Dakota
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Farmers were left with a quantity of low grade feed as a result of the 1951 weather conditions. Early season rains caused much of the alfalfa hay to be of poor quality. Frosts on a late maturing corn crop caught many fields of corn in an early stage which produced a crop that was too high in moisture for safe storage. The question is: Can this poor quality feed be put to good use?

Looking ahead to future years when weather conditions may be similar to 1951, the South Dakota Agricultural Experiment Station made a study of the value of these feeds when put up in the form of silage. As a result of this year's trial, it was found that it was possible to produce as high quality beef on ear corn silage as on ground ear corn, and at the same time make good use of a corn crop which might have been a partial or total loss to the farmer.

How Silage Was Put Up

Ear corn silage was made from corn which was picked in October then put through an ensilage cutter and blown into a temporary silo. This silo was made of corn cribbing and lined with sisal craft paper. A stack 16 feet in diameter and about 10 feet high was ensiled. No water was added as the corn had 58 percent moisture at the time of ensiling. The corn was cut relatively fine in order that it would pack well and

W. C. McConne and I. B. Johnson discussing the ear corn silage feeding trials at the feedlot.
the cobs would not be sorted out in feeding.

Second cutting alfalfa was left in a windrow and allowed to wilt until it was cut by a field chopper and put in a cement block silo. No preservative was added at the time the alfalfa was ensiled.

Plan of Feeding Outlined

Thirty long-yearling Hereford steers were fed in three different lots of 10 steers each. These steers were started on the feeding trial in late January at which time the average weight per steer was 815 pounds.

Rations fed in the three lots were as follows:

Lot I Ground ear corn (mature) Alfalfa hay Linseed meal
Lot II Ear corn silage (immature) Alfalfa hay Linseed meal
Lot III Ground ear corn (mature) Alfalfa silage Linseed meal

All cattle were offered salt, bone-meal, and limestone, free choice.

Lots I and II received equal

Continued on page 20
Those weak and wobbly turkey poults on the left lived only 10 days after hatching. They had no phosphorus in their diets. A minimum of 0.8 percent phosphorus is required for normal growth according to trials conducted at the Station. These are Beltsville white poults, 7 days old.

By Robert Wilcox

The growing poult needs phosphorus to build a rugged frame on which to hang that delicious turkey meat. Seventy to eighty percent of the phosphorus that it takes in will go to this purpose, and the remaining phosphorus is directly involved with the production of that meat. In the work now underway at the Poultry department, we are trying to find out what amounts of phosphorus these ambitious little birds need to accomplish their task in the most successful way.

Feeding Plan Outlined

We fed them a purified diet so that we could control the amounts of calcium and phosphorus in it. The diet contained dried beef blood fibrin and gelatin to give 30 percent protein, corn starch and corn sugar as a source of carbohydrate, finely ground cellulose to give 5 percent fiber for roughage, soybean oil for 5 percent fat, and synthetic vitamins and pure forms of minerals to supply all the known needs of the poults.

Weights Improved with Added Phosphorus

Table 1 lists the average weight in grams (454 grams are equal to 1 pound) of the poults when they were four weeks old. Note that the weights improve as the amount of phosphorus is increased until the levels of 0.8 and 1.0 are reached. Increasing phosphorus above 1.0 percent was of no benefit.

The poults grew better when dried buttermilk and forage juice (juice obtained by putting green grass in a press similar to a lard press) were added to this purified diet. This means that there are some unidentified factors in these two products that give better growth. Note, too, that levels of 0.8 and 1.0 phosphorus gave the best growth when these materials were fed.

Stronger Bones with Phosphorus at One Percent Level

In order to study the effect of the phosphorus on the bones themselves, the poults were sacrificed when they were four weeks old and
These poults died three days after the picture was taken at three weeks of age. They are the two surviving poults out of 18 which were started on a 0.4 percent phosphorus trial diet. The left tibia (the drumstick bone) removed from each. These were chemically treated to remove the water and the fat and were then burned to an ash. The amount of ash remaining from each bone is an indication of how rugged and strong the bone was, with the higher percentages of bone ash meaning stronger skeletons.

Table 1. Average Four Week Weights of Poults Fed Various Levels of Phosphorus

<table>
<thead>
<tr>
<th>Phosphorus Levels Percent</th>
<th>Purified Diet Grams</th>
<th>Purified Diet Plus Dried Buttermilk Grams</th>
<th>Purified Diet Plus Dried Buttermilk and Forage Juice Grams</th>
<th>Vegetable Protein Diet Grams</th>
<th>Animal Protein Diet Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>238</td>
<td>331</td>
<td>392</td>
<td>298</td>
<td>410</td>
</tr>
<tr>
<td>0.6</td>
<td>284</td>
<td>399</td>
<td>409</td>
<td>374</td>
<td>403</td>
</tr>
<tr>
<td>0.8</td>
<td>338</td>
<td>373</td>
<td>419</td>
<td>375</td>
<td>403</td>
</tr>
<tr>
<td>1.0</td>
<td>335</td>
<td>356</td>
<td>404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>334</td>
<td>351</td>
<td>388</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>336</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Average Percentage of Bone Ash of Tibias from the Poults Fed the Various Levels of Phosphorus

<table>
<thead>
<tr>
<th>Phosphorus Levels Percent</th>
<th>Purified Diet</th>
<th>Purified Diet Plus Dried Buttermilk</th>
<th>Purified Diet Plus Dried Buttermilk and Forage Juice</th>
<th>Vegetable Protein Diet</th>
<th>Animal Protein Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>24.95</td>
<td>36.50</td>
<td>40.45</td>
<td>37.73</td>
<td>43.41</td>
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<td>0.6</td>
<td>34.52</td>
<td>40.61</td>
<td>46.50</td>
<td>43.29</td>
<td>43.37</td>
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<tr>
<td>0.8</td>
<td>40.08</td>
<td>42.47</td>
<td>45.71</td>
<td>43.48</td>
<td>43.71</td>
</tr>
<tr>
<td>1.0</td>
<td>42.36</td>
<td>44.10</td>
<td>46.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>43.83</td>
<td>43.61</td>
<td>46.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>43.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 3. Feed Efficiencies*

<table>
<thead>
<tr>
<th>Phosphorus Levels Percent</th>
<th>Purified Diet</th>
<th>Purified Diet Plus Dried Buttermilk</th>
<th>Purified Diet Plus Dried Buttermilk and Forage Juice</th>
<th>Vegetable Protein Diet</th>
<th>Animal Protein Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>2.85</td>
<td>1.95</td>
<td>1.58</td>
<td>2.43</td>
<td>2.07</td>
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<tr>
<td>0.6</td>
<td>2.02</td>
<td>1.78</td>
<td>1.66</td>
<td>2.05</td>
<td>2.27</td>
</tr>
<tr>
<td>0.8</td>
<td>1.89</td>
<td>1.83</td>
<td>1.66</td>
<td>2.27</td>
<td>2.25</td>
</tr>
<tr>
<td>1.0</td>
<td>1.83</td>
<td>1.70</td>
<td>1.75</td>
<td>2.29</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>1.83</td>
<td>2.05</td>
<td>1.74</td>
<td>2.32</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>1.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ratio of pounds of feed eaten for each pound of weight at four weeks of age
The bone ash percentages (average for each diet) increased as the amount of phosphorus in the diets was increased. From this it would seem that the more phosphorus was supplied the stronger the bones would be. However, the increases were small, from 0.8 and 1.0 percent phosphorus on up, so this may not be important (Table 2).

**Work to Continue Using Ordinary Feeds**

The feed efficiency figures (which are the number of pounds of feed that the birds ate to produce a pound of body weight) show that the pouls eating the purified diets have better (lower) figures than pouls fed the ordinary type of feed. The pouls on the purified diets then had to get more nutrients out of each pound of feed than did the ones on the ordinary feed. This means that research will have to be continued using ordinary feeds as well as the purified diets so that we can evaluate our findings (Table 3).

In another trial still in progress, there seems to be some difference in response of Broad Breasted Bronze pouls to phosphorus levels as described in the preceding paragraphs, so we expect to use more of them after the pilot studies with the Beltsville White pouls are completed. (Project 221. Leaders: R. Wilcox, C. W. Carlson and Wm. Kohlmeyer, Poultry Dept.; O. Olson, Station Chemistry.)

*Left tibias (drumstick bones) of pouls on various diets, as indicated. Note twisting and small shank of the 0.6 percent phosphorus bones and even for the 0.8 percent phosphorus diet which was non-supplemented, showing that other factors enter the diet picture. The other bones are normal.*

2% Calcium — Purified Diet — No Supplements

2% Calcium—Supplemented with Dried Buttermilk and Forage Juice
ALL BACON ends in the skillet. How it performs in that skillet and on the breakfast table is what concerns both the consumer and the research man, who is, of course, ultimately a consumer also. It is well known that great differences exist between lots of bacon which were very similar when graded as fresh sides and were subjected to similar curing and smoking procedures. Many factors may cause these differences. Two of these undergoing research by the Animal Husbandry department are: (1) whether there is a relationship between chemical composition and bacon quality, and (2) whether the type of hog is related to bacon quality.

**Objective Methods of Determining Quality Needed**

Quality has become such an important factor in the evaluation of present-day meats and meat products that more objective methods of its determination are necessary.

Four different groups of swine were tested at the South Dakota Experiment Station to determine the chemical composition of fresh and cured pork sides, and whether the chemical properties of the fats (iodine number and refractive index) are a means of judging the quality and desirability of cooked bacon. As a secondary objective, the differences and variations between breeds, inbred lines, and line crosses...
The cured side, showing location of the 16 sample slices removed for analysis and cooking.

**ANIMAL Husbandry Department**

were also determined, using the above criteria.

**What Other Stations Report**

In studying the effects of live-weight differences on the chemical composition of bacon, U. S. Department of Agriculture personnel have found that the fat (ether extract) increased in almost direct proportion to the liveweight; whereas the protein, moisture, and ash decreased by similar proportions.

A comparison of lard and bacon type hogs in which Yorkshire, Poland China, and Durocs were used was made by Ferrin and McCarty of Minnesota. In this study, the uncooked Yorkshire bacon was graded slightly higher by the judges.

In cooking the bacon, the fat loss was least from the Yorkshire bacons and greatest from the Duroc bacons. The shrinkage through evaporation was in the reverse order, but total shrinkage was least in the Yorkshire bacon and greatest in the Duroc.

**South Dakota Station Tests Quality From Pig to Pan**

The hogs used in this research were bred and raised at the South Dakota Experiment Station. Ten barrows from each of three different breeds of hogs were used, as well as one group of 10 crossbred barrows. The breeds used were the Poland China, Spotted Poland China, and Durocs; and the crossbred barrows
were a Poland China x Landrace x Duroc x Hampshire cross having a predominance of Poland China breeding. All barrows were fed the same ration and had similar management.

The barrows were weighed out of the feeding lots as nearly as possible at 225 pounds in weight and were slaughtered after a 24-hour shrink. The carcasses were chilled for 48 hours at a temperature of 34 to 36 degrees Fahrenheit and were then cut according to the standard method employed by the USDA. As soon as possible after cutting, one side from each carcass was put into dry salt cure for a period of two weeks. After curing, the side was prepared for smoking and smoked for 20 hours at a constant temperature of 125 degrees Fahrenheit and then removed from the smoker and chilled for 48 hours.

A sample section of sixteen slices was taken from the center of each cured bacon, and alternate slices were used for chemical analysis and cooking. Each slice was approximately one-sixteenth of an inch in thickness. A sample of the opposite fresh side was removed at the time of cutting and used for an analysis of the chemical properties of the fats. This sample was obtained in similar manner as described above with the exception that it was not sliced.

Differences Show Up in Cold Carcass Weights

Many factors were considered as possible causes of variation in the quality and desirability of the cooked bacon, and each was analyzed separately to determine its significance. All slaughter data, such as the age in days of the individual barrows, weight at the time of slaughter, weight of cold carcass, and dressing percent, were analyzed. Significant differences existed between the number of days required for the various groups to reach 225 pounds in weight. This fact was the direct result of the more rapid growth of the crossbred barrows.

As expected, there were no differences between groups in their weight at time of slaughter, but highly significant differences were present in the cold carcass weights between groups. This fact was confirmed by similar differences in dressing percentages. However, only minor importance can be given to this finding since the barrows tested represented only the closed population of the Experiment Station swine herd.

No Significant Difference in Weights of Fresh Sides

The more pertinent data relating directly to the fresh sides were obtained by measuring their weight, length, width, and thickness. The
thickness measurements were made at both the blade and flank end. Since there were significant differences in the carcass weights to begin with, one would expect that the weight of the cuts would also differ. Such was not the case, because the weights of the fresh sides were not significantly different. As far as thickness was concerned, the greatest variation occurred at the flank end of the side. An interesting discovery in this respect is the fact that the group having the greatest thickness of backfat did not have the thickest sides.

**Chemical Tests Did Not Reveal Large Differences**

A statistical analysis of the chemical composition data did not reveal any large differences in moisture, protein, fat, or ash content. Although small differences existed in protein content between groups, their significance was not sufficient to indicate a trend. The chemical composition data of the cured sides did not show any large variation existing between groups. An unexplainable difference in iodine number of the cured bacon was found between groups and appeared to be the result of the low iodine number of the Duroc group. Again, however, only minor importance can be given to this finding, due to the restricted population from which the barrows were obtained.

**Samples Cooked as Final Test**

The most enlightening phase of the research was brought about by the cooking of sample slices of bacon from each cured side. This was the final test for determining the quality and desirability of the bacon. All eight slices were cooked by the broiling method for a period of 4½ minutes.

After broiling, the bacon was sampled by an impartial committee and rated numerically according to desirability and quality. No sample was rated lower than satisfactory, and those receiving that rating did so because of being off flavor and the need of more cooking. The numerical ratings which were assigned the cooked bacon were treated statistically and did not reveal any significant differences between groups.

Considerable shrinkage occurred in all samples cooked, but the groups were not significantly different. An interesting discovery in this respect, however, is the fact that the average shrinkage for all samples during the broiling process was 60.2 percent. Practical application of this finding means that for every pound of uncooked bacon, you could expect no more than four-tenths of a pound of cooked product.

**Chemical Composition Cannot Be Used as Criteria**

Conclusions reached as a result of this study are negative in nature, and indicate that the chemical composition of the fresh and cured pork sides cannot be used as criteria for determining the quality and desirability of cooked bacon. Only a very minor importance can be given to those few factors in which statistically significant differences were found, because the barrows slaughtered were a sample of only a very small and relatively limited group.

(Project 208. Leader: Ellis A. Pierce, Animal Husbandry Dept.)
HAVING A WINDBREAK means being able to feed livestock without loss of feed, energy, or hat, to be able to go outside without too many wraps or having the door slam open; to be able to have and enjoy outside dining—everything that makes for more comfort and enjoyment in work and in leisure. More comfort in farm living can and has done much to achieve a progressive and permanent agriculture on the Plains. This value of windbreaks can scarcely be overestimated.

Although the terms "windbreak" and "shelterbelt" are used interchangeably, there are sufficient basic differences to justify separate and distinct definitions. A windbreak is any kind of a wind barrier that in some measure protects the farmstead unit such as the buildings, service area, garden or feed lot. The most common and perhaps the most efficient type of barrier is a tree windbreak. Shelterbelts, on the other hand, are tree plantings made primarily for field protection.

It is not for mere convenience sake that the two kinds of tree barriers are separated; rather it is that their basic functions require different designs and engineering. For instance, a windbreak must stop drifting snow from entering the farmstead service area if it is to be considered worth while, yet it cannot be planted too far away from the buildings or much of the effect of wind reduction will be lost. This means that the main windbreaks need to be at least 100 feet in width and have a dense mass of branches and foliage from the ground level to the tops of the tallest trees.

The wind blowing over the tops of these trees is also getting

What a Windbreak Does for Farm Living

Few studies have been made at experiment stations to measure the value of benefits which can be attributed to windbreaks. The lack of basic research has led to sampling farmer opinions as one method of determining the benefits. Briefly, some of these may be listed as follows:

1. A reduction of winter fuel consumption that may be as high as 35 to 40 percent.
2. A reduction of over-winter livestock feed consumption and a better weight gain, a value of tremendous importance to farming enterprises based on livestock feeding.
The order in which these many benefits are presented does not necessarily reflect their relative importance. Each farm is an individual situation, and the relative value of the benefits varies accordingly. Perhaps liveability is the most universal, and certainly it ranks as one of the most important and most appreciated.

Survey Made in Seven Counties
As a part of the economic and social evaluation of the benefits to be derived from irrigation in the Oahe unit, a survey was made in the fall of 1951 to determine the value of windbreaks. The survey area included portions of Edmunds, Faulk, Spink, Hand, Beadle, Jerauld, and Brown counties. The sample covered about 8 percent of the area and about the same percent of the farmsteads. A total of 159 farmsteads were visited. Of that total 152 were occupied, 70 percent by owners and 30 percent by tenants (Table 1).

Each farmer was interviewed, and any tree plantings in the survey area were measured by area and effective heights as well as by date of planting; each windbreak and shelterbelt was rated according to its present effectiveness (Table 2).

Only 19 Percent of Windbreaks Well Designed
Although 64 percent of the occupied farmsteads had windbreaks, only 19 percent could be rated good or better. For all practical purposes, 46 percent (fair or less) of the windbreaks required considerable renovation and additions if they were to serve effectively. Most of the non-rated windbreaks will rate higher
Table 1. Number of Windbreaks Present in the Survey Area of the Oahe Unit (December, 1951)

<table>
<thead>
<tr>
<th></th>
<th>Total Number of Farmsteads</th>
<th>Total Number Having Windbreaks</th>
<th>Total Windbreaks Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farmsteads</td>
<td>159</td>
<td>99</td>
<td>62</td>
</tr>
<tr>
<td>Occupied</td>
<td>152</td>
<td>98</td>
<td>64</td>
</tr>
<tr>
<td>Vacant</td>
<td>7</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Owner operated</td>
<td>106</td>
<td>75</td>
<td>71</td>
</tr>
<tr>
<td>Tenant operated</td>
<td>46</td>
<td>23</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 2. Rating of Windbreaks by Effectiveness and Class of Ownership, Oahe Unit (December, 1951)

<table>
<thead>
<tr>
<th>Class</th>
<th>Excellent %</th>
<th>Good %</th>
<th>Fair %</th>
<th>Poor %</th>
<th>Non-rated %</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farmsteads</td>
<td>4</td>
<td>15</td>
<td>29</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Occupied</td>
<td>4</td>
<td>15</td>
<td>29</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Vacant</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Owner</td>
<td>6</td>
<td>16</td>
<td>28</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Tenant</td>
<td>0</td>
<td>13</td>
<td>31</td>
<td>17</td>
<td>39</td>
</tr>
</tbody>
</table>

*Non-rated—young windbreaks of insufficient height

than fair, provided their present survival rate is maintained. As could be expected, tenant-operated farms had a lower percentage of windbreaks (50 percent) than owner-operated farms (71 percent).

The total acreage occupied by trees and the average acreage in trees per farm are shown in Table 3. Windbreaks are further broken down into year-of-planting classes.

Tree Planting on the Increase

Although the percentage of farm land in trees is less than one-half per cent, the trend of tree planting has increased from approximately 7 acres prior to 1919 to over 47 acres in the last 8 years (Table 3). The impetus given to tree planting by the Prairie States Forestry Project, and, after 1942, by other state and federal agencies, is well illustrated. At the time of the survey (1951), there was about one acre of windbreaks to every 1050 acres of farm land, and about one acre of all kinds of tree plantings to 240 acres of farm land.

All farmers interviewed in the survey were asked about individual

Table 3. Total Area Occupied by Trees in the Oahe Unit (December, 1951)

<table>
<thead>
<tr>
<th>Type of Tree</th>
<th>Total Acres of Trees</th>
<th>Average Acres on Farms Having Trees</th>
<th>Percent of Area in Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windbreaks</td>
<td>94.66</td>
<td>1.00</td>
<td>.09</td>
</tr>
<tr>
<td>Year Planted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—1919</td>
<td>6.93</td>
<td>.43</td>
<td>.09</td>
</tr>
<tr>
<td>1920–1934</td>
<td>4.00</td>
<td>.57</td>
<td>—</td>
</tr>
<tr>
<td>1935–1942</td>
<td>36.17</td>
<td>1.25</td>
<td>—</td>
</tr>
<tr>
<td>1943–1951</td>
<td>47.56</td>
<td>1.11</td>
<td>—</td>
</tr>
<tr>
<td>Shelterbelts</td>
<td>228.75</td>
<td>7.15</td>
<td>.23</td>
</tr>
<tr>
<td>Timber claims</td>
<td>81.85</td>
<td>5.12</td>
<td>.08</td>
</tr>
<tr>
<td>Other</td>
<td>8.40</td>
<td>1.40</td>
<td>.008</td>
</tr>
<tr>
<td>Total</td>
<td>413.66</td>
<td></td>
<td>.41</td>
</tr>
</tbody>
</table>
benefits that they had received from windbreaks. Too few farmers had sufficiently accurate records to improve upon earlier surveys, but all of the benefits listed previously were mentioned. Among those most frequently mentioned were livestock protection, snow protection, liveability, and appearance.

Typical of their comments was that of a farmer who had good north and west protection but none to the south. He stated that when the winter wind was in the north his cattle ranged the feed lot freely, but on days of south winds they remained in the barn. Also, he noticed a higher fuel consumption in the house when cold south winds prevailed.

Windbreak Raises Selling Value of Farm

If windbreaks are of value in Plains agriculture, that value should be recognized in land transactions. Those real estate and appraisal services that were contacted readily assented to this opinion. All of the farmers interviewed except one stated that they would pay more for a farm if it had good windbreak protection.

To arrive at some monetary value, a hypothetical situation was set up: Each farmer was asked, "How much more would you pay for a farm (160 acres) having a good north and west windbreak as compared to one not having a windbreak, everything else (buildings, land, appearance, etc.) being equal?"

One hundred and thirteen farmers gave an answer in terms of dollars. The answers ranged from a low of $160 ($1 per acre) to a high of $5,000, but most of the answers fell in the range from $500 to $2000.

Continued on page 21
LONG- OR SHORT-TERM Leases?

BY RUSSELL L. BERRY

Under a Long-Term Lease
Will a Tenant Take owner's advice?

One-Year Leases are preferred by many South Dakota farm landlords. Despite efforts to encourage longer term leases, little or no progress has been made. It has been pointed out that tenants with one-year leases cannot afford to farm like farmers who own their land. Such tenants have insecure possession of the farm and tend to stress cash crops, hogs and poultry, rather than grasses, legumes, beef cattle and sheep.

Failure to increase the number of long-term leases suggests that there must be valid reasons why landlords or tenants, or both, prefer short-term leases. To determine what these reasons were, a questionnaire 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 those who replied gave answers which are representative of those who did not, has not yet been tested. Therefore, this report applies only to those who answered the questionnaire.

63 Percent of Landlords Prefer One-Year Lease

Over 63 percent of the landlords replying to the questionnaire said that they preferred the short-term lease of one year. (This number is higher if we leave out the 54 landlords who did not reply to this question.) About 60 percent of the landlords thought that their tenants preferred the short-term lease, but results from another survey show that over two-thirds of the tenants prefer a long-term lease of three years or more.

Share leases are really partner-
He is talking over the new flexible cash lease with Winston Ullman, farmer and agricultural economist.

Divide crops fairly? Work hard? Take more care?

ships, in fact, if not in law. The landlord partner furnishes the land, and buildings at the beginning of the year and the tenant partner usually furnishes the labor, machinery and operating capital at various times during the year. The landlord puts his entire investment in the land and buildings to the use of a partnership. There is no way that the landlord can hold back on his contribution under the usual crop-share lease.

Use Short-Term Lease to Bargain With Tenant-Partner

The tenant, on the other hand may not be inclined to do as much work or use as much care as the landlord thinks he should, in looking after the partnership business. He may not prepare the seedbed for highest yields; he may not cultivate the crop at harvest time. This suggests that the chief way the landlord can protect himself or encourage the tenant to consider his partner's interest is to give him only a one-year lease.

To test this idea the following question was asked: We have been given the following reasons why one-year leases are customarily used in South Dakota. Which do you think is the most important reason? (See Box.)

Nearly half (45 percent) of the landlords replying to this question say that the chief reason for the short-term lease was to "keep the tenant on his toes." If those who gave no reply (26 percent) are eliminated, then over 61 percent of those replying held this view.

Many hold the view of one landlord who wrote: "With my 3-year lease, each succeeding year my ten-
WHY LANDLORDS PREFER SHORT-TERM LEASES

<table>
<thead>
<tr>
<th>REASON</th>
<th>No. Thinking Reason</th>
<th>Most Important Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Because long-term leases are not as binding on tenants as they are on landlords</td>
<td>49</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>B. Because the one-year lease gives the landlord a chance to increase the rent as his expenses rise</td>
<td>21</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>C. Because the short-term lease keeps the tenant on his toes since he knows that you can get another tenant if he does a poor job</td>
<td>142</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>D. Other</td>
<td>22</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>E. No reply</td>
<td>83</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>317</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The tenant became more independent and less cooperative. By the third year he acted as though he now owned the farm and could do as much or as little as he liked, and you had to accept it and like it. That was my experience—no more 3-year leases.” Or, as another put it: “Long-term leases aren’t the whole answer to tenant-landlord relations!”

Advantages of Long-Term Leases Not Recognized

Another reason why the short-term lease may be preferred is that the advantages usually claimed for long-term leases of three years or more were not generally recognized by these landlords. (See Table 1.) These answers suggest that only 20 landlords out of every hundred who replied recognized some of the chief advantages claimed for the long-term lease. (The advantages claimed are that longer term leases encourage tenants to grow more grasses and legumes and keep more livestock. See questions A and B.)

Only 32 farmers out of a hundred landlords think that longer term leases would cause tenants to be more willing to repair buildings and fences while 68 thought otherwise (see question C). Landlords thought that a longer term lease

Table 1. Are Longer Term Leases Desirable? Replies of 317 S. D. Landlords, 1952

<table>
<thead>
<tr>
<th>I. How would a lease for 3 years or longer:</th>
<th>Replies per 100 Landlords</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Affect the amount of legumes and grasses seeded by your tenants?</td>
<td>20 28 3 39 10 100</td>
</tr>
<tr>
<td>B. Affect the amount of livestock kept by your tenants</td>
<td>20 30 1 34 15 100</td>
</tr>
<tr>
<td>C. Affect the willingness of your tenants to repair buildings and fences?</td>
<td>32 29 6 22 11 100</td>
</tr>
<tr>
<td>D. Affect your tenants’ willingness to follow your advice concerning farm operations?</td>
<td>23 29 11 29 8 100</td>
</tr>
<tr>
<td>E. Affect the care with which your tenant divides the crops?</td>
<td>15 40 12 24 9 100</td>
</tr>
<tr>
<td>II. How would more grasses, legumes and livestock on your leased farm affect the amount of your net income over many years?</td>
<td>38 15 13 25 9 100</td>
</tr>
</tbody>
</table>
IN STORED POULTRY FEEDS

A. W. Halverson and L. D. Kamstra

Poultry feeds when exposed to the air lose valuable vitamin A. This presents a problem in poultry and livestock production. The degree of loss varies widely under similar storage conditions, and these variations are no doubt related to the composition of the diet. The importance of the relation of minerals and other feed ingredients to the stability of vitamin A is not completely understood and needs investigation.

Changes in Poultry Nutrition Make Further Research Necessary

Study of poultry diet composition and its relation to unstable ingredients such as carotene (plant form of vitamin A) and vitamin A is particularly important at present, since rapid changes in poultry nutrition concepts make former data and standards of limited value. For instance, the introduction of high energy feeds, together with vitamin B₁₂ and the antibiotics, has increased egg and meat production to the extent that the use of these feeds has become widespread.

In the past decade, the high fiber cereal by-products which formerly served as vitamin and mineral sources have been rapidly replaced by industrial preparations. Ingredients which must now be added to replace cereal by-products include many of the essential minerals and vitamins in the pure form. The problem now, with the new type of diet, is to discover what effect these minerals have upon vitamin A and carotene losses.

Are they getting the needed vitamins? Storing poultry feeds may cause losses of vitamin A.
Current feeding practice includes the addition of free trace mineral salts of manganese, iron, copper, and cobalt to all types of animal feeds. Many nutritionists agree that adding these essential trace elements to diets is a practical means for preventing costly mineral deficiencies of the minor elements. While trace minerals are known to cause rancidity in feeds, little information is available concerning the relation of trace minerals to the rate of loss of nutrients such as carotene and vitamin A. Thus, determination of the best mineral level as well as the type of mineral compounds most suitable for vitamin A stability will serve a definite role in the further improvement of poultry and livestock diets.

Other work done along this line has neglected the practical aspect as to which ingredients, if any, are involved in these carotene losses when combined in mixed feeds.

Test Stability of Carotene in Alfalfa Meal

Work at the South Dakota Experiment Station has included study of carotene storage losses from alfalfa meal and carrot oil when added to mixed poultry diets. Carrot oil was used in this trial because it is a cheap and readily available source of carotene and would provide a good comparison with alfalfa meal.

One of the diets was composed of a corn-soybean oil meal base (a high energy diet), while another contained oats, sorghum grain, wheat bran and middlings in addition to the corn and soybean oil meal ingredients (the old type poultry diet). The third diet preparation was a mash concentrate which contained high protein, mineral, and vitamin levels, and was included to determine if such high levels of minerals would have an effect on carotene losses. Vitamin and antibiotic supplements were also added to all diets at levels recommended by the Committee on Animal Nutrition of the National Research Council.

The mineral supplements employed ranged from calcium carbonate and calcium phosphate to more complex ingredients such as meat scraps, limestone, and four trace mineral salts. They were added at levels commonly employed in mixed feeds. The two carotene supplements which were used with each diet were alfalfa meal, which was added at the 5 percent level, and carrot oil, which was added at the 0.5 percent level. The carotene supplement levels were increased four-fold in the feed concentrate.

Warm Temperatures Increase Losses

Carotene losses were determined at several different storage temperatures and periods. The losses shown in Table 1 are with diets stored at room temperatures for about five months time, since those conditions are most representative of normal summer storage. At higher temperatures, losses were greater and at lower temperatures they were less than those shown in the table. The stability of alfalfa meal carotene was similar in the different diets at a given storage temperature and showed no notable change in the presence of added meat scraps, limestone, and trace mineral ingredients.
Table 1. Carotene Storage Losses in Poultry Diets (Storage at Room Temperature for 5 Months)

<table>
<thead>
<tr>
<th>Diet Description*</th>
<th>Carotene Losses in Storage</th>
<th>Carotene Losses in Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When Carrot Oil Was the Carotene Source %</td>
<td>When Alfalfa Meal Was the Carotene Source %</td>
</tr>
<tr>
<td>I. A high energy corn-soybean oil meal diet supplemented with carrot oil or alfalfa meal and one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I a—Pure calcium and phosphorus salts</td>
<td>39</td>
<td>53</td>
</tr>
<tr>
<td>I b—Meat scraps and limestone</td>
<td>47</td>
<td>52</td>
</tr>
<tr>
<td>I c—Meat scraps and limestone plus manganese salt</td>
<td>44</td>
<td>57</td>
</tr>
<tr>
<td>I d—Meat scraps and limestone plus manganese, iron, copper, and cobalt salts</td>
<td>57</td>
<td>50</td>
</tr>
<tr>
<td>II. A lower energy mixed cereal-soybean oil meal diet supplemented with carrot oil or alfalfa meal and one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II a—Pure calcium and phosphorus salts</td>
<td>59</td>
<td>53</td>
</tr>
<tr>
<td>II b—Meat scraps and limestone</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>II c—Meat scraps and limestone plus manganese salt</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>II d—Meat scraps and limestone plus manganese, iron, copper, and cobalt salts</td>
<td>69</td>
<td>60</td>
</tr>
<tr>
<td>III. A mash concentrate supplemented with carrot oil or alfalfa meal and one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III a—Pure calcium and phosphorus salts</td>
<td>31</td>
<td>43</td>
</tr>
<tr>
<td>III b—Meat scraps, fish meal, limestone, and steamed bone meal</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>III c—Meat scraps, fish meal, limestone, and steamed bone meal plus manganese salt</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>III d—Meat scraps, fish meal, limestone, and steamed bone meal plus manganese, iron, copper, and cobalt salts</td>
<td>61</td>
<td>42</td>
</tr>
</tbody>
</table>

*Iodized salt was included in all diets.

Carotene Losses Affected by Composition of Diet

In contrast, the carrot oil supplement showed a carotene loss picture which was noticeably affected by diet composition. For instance, the addition of meat scraps and limestone ingredients resulted in large increases in the rate of carotene loss. The further addition of the trace minerals increased the losses of the carrot oil diets, and thus made the carotene stability picture shift in favor of alfalfa meal with such diets.

The general observation with the carrot oil supplemented diets was that the addition of meat scraps and limestone increased carotene losses much more than did the further addition of the trace minerals. In addition, when no meat scraps and limestone were present, there were greater carotene losses in the mixed cereal-soybean diet than in the corn-soybean diet (see table). This indicated that certain cereal ingredients are inferior to corn in carotene stabilizing properties.

Alfalfa Superior to Carrot Oil as Carotene Source

Alfalfa meal was somewhat superior to carrot oil as a carotene source when diets contained common mineral ingredients such as meat scraps, limestone, and trace mineral salts. These minerals are usually added to livestock and poultry feeds, so carotene supplements such as carrot oil which show greater stability only in the absence of such minerals probably have no preference over alfalfa as a carotene source for mixed feeds. (Project 180. Leaders: A. W. Halverson, O. E. Olson, and G. F. Gastler, Station Biochemistry Dept.)
amounts of alfalfa hay and linseed meal but differed in that Lot I was on full feed of matured ground ear corn and Lot II was full-fed ear corn silage. Alfalfa silage fed in Lot III was checked with alfalfa hay fed in Lot I, as these two lots were fed equal amounts of mature ground ear corn and linseed meal.

The feeding of silage to 10 steers presented a problem in that the rate of feeding was not considered sufficient in relation to the top surface of the silo. The ear corn silage in the temporary silo was fed from the side rather than from the top in order to expose as little surface as possible. This method was successful, as relatively little spoilage resulted throughout the feeding period.

Both Ear Corn and Alfalfa Silage Gave Good Results

The results of the feeding trial, which ran from January 31 to May 29 of 1952, are given in the table. Daily gains per head were: 2.40 pounds for Lot I (ground ear corn), 2.21 for Lot II (ear corn silage), and 2.23 pounds for Lot III (alfalfa silage). The highest daily gain of 2.40 pounds in Lot I, which received mature ground ear corn, alfalfa hay and linseed meal, was a result of rapid gains during the latter part of the feeding trial. The ear corn silage, Lot II, and the alfalfa silage, Lot III, made greater daily gains during the first eight weeks of the trial.

The steers in Lot II ate about 30 pounds per head daily of ear corn silage, whereas the steers in Lot I were on a full feed with 18 pounds of ground ear corn. The Lot II steers required 1,358 pounds of ear corn silage to produce 100 pounds of gain, while 748 pounds of ground ear corn produced an equal gain in Lot I. Considering that the ear corn silage had 57 percent moisture at the time of feeding and the ground ear corn had 15 percent moisture, the steers on ear corn silage gained on slightly less dry matter in their feed than did the steers on ground ear corn. About 8 pounds of 17 percent moisture alfalfa hay produced gains similar to those produced by 13 pounds of 59 percent moisture alfalfa silage.

Under feed prices which prevailed, it was possible to produce beef most economically on the ear corn silage. Very little difference was noted in the selling price, shrinkage, or dressing percentage of the three different lots. (Project 143, Leader: W. C. McCone, Animal Husbandry Dept.)
Long- or Short-Term Leases

would have a detrimental effect upon the tenant's willingness to take advice and the care with which he divided the crops (see questions D and E in Table 1).

Replies to questions D and E support the idea that the most important reason why landlords prefer short-term leases is that it keeps the tenants on their toes.

But why are landlords concerned about this? The answer lies in the fact that the landlord's rent depends to a considerable degree upon how the tenant farms the land which he leased. Short-term leases are associated with the partnership aspects of the share leases. Most landlords and tenants apparently favor crop-share leases, but as long as they continue to use the crop-share lease they will continue to lose the advantages of longer-term leases.

Flexible Cash Lease a Compromise

A possible compromise is the use of a flexible cash lease which has the chief advantages of both the crop-share lease and the cash lease. This flexible cash lease automatically adjusts the cash rent to changing price and to crop yields. For example, suppose the landlord and the tenant agreed the normal cash rent for a farm was $1,000. Suppose that the normal yield of wheat for the entire county was agreed to be 10 bushels per acre and it is further agreed that the average or “normal” price is $2.00 per bushel for August at a market agreeable to both.

Now if the county average was 15 bushels, or one-third over the normal, the rent would be increased to $1,500 for the year, if the average price during August was $2.00 per bushel. But suppose the price dropped to $1.00 per bushel? Then only one-half of the $1,500, or $750, would have to be paid as rent for that year. In this manner the rent can be calculated for each year no matter how the crop yields and prices vary from the normal.

A special advantage of this lease is that the landlord is not affected by the tenant's management. This makes it possible for the landlord to make a long-term lease. Such a lease should include a limit on the acres of the various crops to be grown. With such provisions the short-term lease should not be necessary to protect the landlord against the undesirable tenant.

Copies of this flexible-cash lease may be obtained by writing to the Agricultural Economics Department, South Dakota State College, State College Station. (Project 147. Leader: Russell L. Berry, Agricultural Economics Dept.)

Break That South Dakota Wind

Continued from page 16

Those farmers having older windbreaks gave an average value of better than $2,150; those having young ineffective windbreaks, or none, gave an average value of $1,000. Taking an average of all answers, the increased price that the above described windbreak would add to the sale value of a farm was $1,125. (Project 142. Leader: Paul Collins, Horticulture Dept.)
New Technique Cuts Years Off Time Needed to Develop New Varieties

A new technique worked out by C. J. Franzke and Dr. J. G. Ross on sorghums, makes it possible to establish a purebred in a single year and cut 5 years from the 15 or 18 years that are required to develop a new variety. Treatment of the sorghum seed with colchicine, an ancient drug, results in the first generation of the new strain transmitting its characteristics to succeeding generations. By this method, Ross pointed out, it is possible to get a great many more pure lines and is also possible to uncover desirable characteristics, such as size of seed, and standability, which are not normally immediately evident.

Sweet Clover Weevil Found Over Most of State

The sweet clover weevil is a comparatively recent arrival in the state, having come in from Canada in 1941. Its principal damage is with young plants—it likes to nibble leaves. It is particularly flourishing in wet weather. Control can be obtained by spraying or dusting with DDT, toxaphene and chlordane, according to H. C. Severin, entomologist.

Hybrid Corn Developed That Doesn't Need Detasseling

Those interested in hybrid seed corn production will welcome the new development in corn breeding that eliminates the necessity for detasseling. The tassel, or male portion of the plant sheds no pollen. The ear, or female portion of the plant, is fertile and is cross-pollinated with selected strains in the usual manner. Dr. D. B. Shank, agronomist in charge of the corn breeding, estimates that about 125,000 persons each year are employed in detasseling corn and that it costs upwards of $10 to $20 an acre.

Although this will make little difference in seed cost to the farmer, because of increased cost to produce this seed, it will result in a better quality corn, since the seed should be pure.

New Alfalfa Strain for Range and Pasture Lands

News for cattlemen at Agronomy Field Day was the creeping strains of alfalfa, displayed by Dr. M. W. Adams. The plant has a laterally spreading root system and it buds from tubers on the roots. The alfalfa is expected to be valuable on range and pasture lands where it should stand up well under continued grazing. From 28 to 30 million acres of land in South Dakota should benefit from having a legume and grass, Dr. Adams said.

The new alfalfa will be tested under actual grazing conditions for at least two years before it may be released. Recommended alfalfa varieties for South Dakota are still Ladak, Cossack and Ranger.
By M. W. Adams

If we were able to see our native ranges as they were 100 years ago, before the white man and the white-face cattle settled on them, we would marvel at the sight—wild grasses “belly deep” and a colorful profusion of non-grass plants, or forbs, intermingling with the grasses. A part of this rich panorama of color and a part of the lush vegetative growth would be due to the native legumes on the South Dakota prairies and ranges.

We still may find remnants of these legumes, but their contribution to the total productivity of the range grass is but a fraction of what it once was. The problem of restoring the productivity of the range by putting back into the rangeland a hardy, persistent legume is a most challenging one. As a small part of the broader approach to the problem, an experiment on establishing plants of alfalfa in the range sod without totally destroying the grass itself was undertaken in 1951.

Trial Sites Selected

Two sites for the trial were selected: The first was at the Range Field Station near Cottonwood
where the sod of the experimental area was quite variable, consisting of patches of Crested wheatgrass and annual bromegrass interspersed in native grasses, of which the predominant was Western wheatgrass, although remnant specimens of sideoats grama and Western needlegrass were also present. The second site was on the substation grounds at Eureka where the area was more typical of the undisturbed upland prairie. Here the sod was uniformly composed of Needle and Thread and Western wheatgrass with small amounts of Blue grama and Threadleaf sedge. Carl Larson and Albert Dittman, superintendents at the Range Field Station and Eureka substation, respectively, took an active interest in this part of the project and aided in its establishment.

Years ago, in the late teens and early twenties, Mr. Samuel Carver, working at the Department of Agriculture Field Station at Redfield, had scattered seeds of common alfalfa and yellow-flowered Siberian alfalfa on the undisturbed prairie sod. Only a few weak plants could be found the next year. In succeeding years these plants never realized a full measure of vigor, and ultimately they disappeared completely.

Dr. N. E. Hansen, the famed horticulturist and plant explorer of South Dakota State College, favored transplanting healthy well-rooted plantlets of alfalfa into the sod. His early experiments were not successful, but when the land was plowed before transplanting, the plants became established readily and persisted.

Four Methods Tried to Establish Alfalfa

Thus it seemed that in our experiments measures should be taken to reduce the competitive action of the sod grasses. Accordingly, four treatments were tried: (1) no previous treatment except grazing to reduce top growth, (2) moderate disking with a tandem offset disk, (3) burning off the accumulated trash and litter early in the year before growth started, and (4) shallow plowing with a moldboard plow, followed by dragging in the usual manner.

Three varieties of alfalfa were seeded on large plots treated as described. Nomad was selected as one strain because it had been found adapted to the dry rangelands of eastern Oregon. In addition, it is somewhat less vigorous than hay types and might be more affected by competition than the standard forms. Sevelra had been used in range seedings on the semi-arid foothills of western Idaho. It descended from predominantly yellow-flowered stocks and might be expected to be more resistant to grass competition. Ladak, a standard hay type adapted to the area, was used as the third variety.

Seedings were made at the rate of 2 to 3 pounds per acre, using a grain drill with alternate runs plugged, and with disk tension adjusted to seed approximately three-fourths of an inch deep.

The season of 1951 was generally favorable in the Cottonwood and Eureka areas for the establishment of alfalfa seedings. The plots were not grazed or cut during the first season of growth.
Observations the First Year

Except for minor differences the results were similar at both locations; hence the treatment effects will be discussed usually without reference to the particular station involved.

Two criteria were used to estimate the success of each treatment or variety: (1) the relative number of plants per plot (100 or over being considered an adequate stand on a 10 by 40 foot plot), and (2) the vigor of those plants.

Treatment I (untreated): germination poor, seedling mortality high, usually at about the first or second true leaf stage. Very few plants survived till October of the first year; these were dwarfed, of unhealthy color, and unable to form crown buds. It appeared that these few plants (less than 10 plants per plot) would not survive the winter.

Treatment II (disking): germination good, seedling mortality considerably reduced in comparison with Treatment I. Well over 100 plants per plot were observed. Individual plant vigor was noticeably restricted however, and in October of 1951 many plants had formed no crown buds. It appeared doubtful that these plants would live through the winter.

Treatment III (burning): germination was good and many plants seemed to have made an initial establishment. In early summer however, coincident with development of the sod grasses, the seedlings began to fail. In October less than 50 plants per plot were counted. These had not made enough growth to form crown buds in many cases.

Treatment IV (plowing): germination good and seedling mortality at a minimum for the experiment. Well over 100 plants could be counted per plot. In the fall these plants were prepared for winter.

Factors Which May Have Had Some Influence

Initial soil moisture was better at Eureka than at the Range Station and stands generally got off to a better start.

Where the sod had been undisturbed or burned over, however, the aggressive native grass, already well established as it commenced its late spring growth, soon utilized the available moisture, and growth of the alfalfa seedlings was arrested. Short periods of drought in midsummer thereupon caused the failure of these plants. Shading is not believed to have been a factor in their loss.

Where double disk ing had set back the grasses temporarily, a somewhat greater number of plants were able to live through till October, and where the sod was turned under excellent stands were secured. In the latter case the grass

Alfalfa stand on the right was seeded on plowed ground, that on the left received no treatment
had not yet come back, the stand being composed of alfalfa and weeds.

Variety Reaction Not Significant
The kind of alfalfa was not a significant factor under plowing or no-treatment, since in these plots it was an "all or none" proposition. Nothing definite could be shown for plots burned over. Where the land had been disked, however, and grass competition reduced but not eliminated, Ladak with its superior seedling vigor, was more readily established than the others. Sevelra came through on these plots in somewhat better condition than Nomad.

In the second year most of the observations of 1951 were confirmed. The plots where the sod was left undisturbed were barren of alfalfa plants, none having become well enough established to live out the winter. Only sparse, non-vigorous plants could be found on the burned-over plots and these were making no contribution to the productivity of the grass.

On plowed plots, full stands of alfalfa suitable for hay were obtained, no grass having come into the plots as yet. Where heavy diskimg was practiced, a satisfactory mixture of grass and legume resulted, particularly when Ladak alfalfa was used.

Competition of Grasses Important

Consideration
It is perhaps inadvisable to make broad recommendations on the basis of results from this short-term and limited experiment. Certain observations do stand out, however:

1. Moisture reserves must be adequate and seasonal rainfall sufficiently frequent to get new seedings started and to carry them through the first summer.

2. The desirable perennial grasses must be set back by severe diskimg or cultivating so as to limit their ability to compete against new seedings, but they must not be eliminated, as by plowing, else the proper mixture most suitable for grazing will not be achieved.

3. The variety of legume chosen must possess enough seedling vigor to enable the new plants to become quickly established, aggressive root and crown growth being particularly desirable.

Management Also Important

In addition to the above principles, certain features of management may become important. In general, grazing should not be permitted during the first season. Phosphate fertilizer may be used advantageously, but under no consideration should nitrogen fertilizer be applied, since the grass would be stimulated so greatly that the new legume seedlings would be lost.

Where heavy grazing over the years has resulted in a pure short-grass range, it might be expected that legumes could be established more readily. The short grasses are summer-growing; they exert no competition during the spring at which time alfalfa seedlings are getting started.

Shallow moldboard or wheatland plowing would be suitable where it was desired to utilize the new stand for hay for a few years. Natural re-vegetation with grass would eventually occur and a mixed sward for grazing be established. (Project 74. Leader: M. W. Adams. Agronomy.)
Urea

A SATISFACTORY PROTEIN SUBSTITUTE IN RATIONS FOR WINTERING RANGE CALVES

By L. B. Embry and G. T. King

When there is a short supply of protein-rich feeds and the prices of these feeds are high, non-protein nitrogenous compounds, such as urea, can be used as a partial replacement for protein in rations for ruminants. Under such conditions, feeders are able to obtain a cheaper protein supplement for cattle and sheep and can extend their supply of protein-rich feeds.

Urea Has Limitations

There are a number of important facts to consider when using feeds containing urea. Urea is a highly concentrated source of nitrogen and it is toxic when fed in large amounts. Therefore, it should be mixed thoroughly at low levels with other feeds. Commonly recommended levels of urea are 1 percent by weight of the total ration, or one-third of the total protein in the ration. The level used in a mixed feed should depend upon the amount of protein to be fed and whether it is to be mixed with other feeds not containing urea.

It is generally recommended that the optimum level of urea in a protein supplement for direct feeding is approximately 3 percent, and that no mixture should contain more than 5 percent. Much higher levels have been fed without any harmful effects when the supplement was properly diluted with other feeds. The Association of American Feed Control Officials has recommended that supplements with more than 3 percent urea be labeled with appropriate feeding instructions. Urea should not be added to rations already adequate in protein. It does not furnish energy, and the excess nitrogen supplied by addition of urea is of no value to the animal.

How efficiently the urea is utilized by the animal depends upon the activity of the bacteria in the ru-
men. This bacterial action is affected by the supply of readily fermentable carbohydrates, the protein level of the ration, and probably other factors.

Urea is broken down rapidly in the rumen and readily available sources of carbohydrates are needed for the efficient conversion of the urea to protein. Heavy grain rations contain a good supply of these carbohydrates, but coarse roughages may be too low in carbohydrate content for efficient utilization of urea. Including sugars and starches with high fiber rations increases the efficiency of conversion of urea nitrogen into protein. A mixture of common protein supplements and grain with urea appears to be one of the better feed combinations for the best utilization of the urea.

Feeding Trials Test Value of Supplement

Winter feeding trials have been conducted at the Cottonwood, Eureka, and Highmore substations to determine the value of prairie hay cut at different stages of maturity and of hay stored for a number of years. Purebred and grade Hereford calves have been wintered on a full feed of hay and a small amount of protein supplement so as to gain about 0.75 to 1.0 pound daily. This gain is considered adequate for wintering calves that are to be grazed the following summer.

In two trials, 1950-51 and 1951-52, a pellet containing 4 percent urea was compared with soybean meal as a supplement to the hay. The pellets were mixed to contain about the same amount of protein (41 percent) as in the soybean meal. Approximately 1 pound of the pellets was fed per animal daily. Thus the percent of urea in the total ration and the daily consumption was low.

In the first trial, the percent of the various ingredients in the urea pellet was: soybean meal, 65; ground oats, 26; molasses, 5; and urea, 4. A pellet more similar to soybean meal in total digestible nutrients and phosphorus was mixed for the sec-

| Table 1. Protein Supplement Containing 4 Percent Urea Compared with Soybean Meal in Wintering Calves for Gains of About 0.75 to 1.0 Pound Daily |
|---|---|---|---|---|---|---|---|
| | Soybean Pellet | 4% Urea Pellet* | | | | |
| | 1950-51 | 1951-52 | Av. 2 Yrs. (Weighted) | 1950-51 | 1951-52 | Av. 2 Yrs. (Weighted) |
| Number of calves per lot | 8 | 8 | 16 | 8 | 8 | 16 |
| Number of days fed | 113 | 168 | 140.5 | 113 | 168 | 140.5 |
| Av. initial weight (lbs.) | 359 | 348 | 354 | 359 | 348 | 354 |
| Av. final weight (lbs.) | 434 | 501 | 468 | 442 | 496 | 469 |
| Av. daily gain (lbs.) | 0.66 | 0.91 | 0.81 | 0.77 | 0.88 | 0.83 |
| Av. daily rations (lbs.) | | | | | | |
| Hay | 11.5 | 11.6 | 11.6 | 11.5 | 11.5 | 11.5 |
| Protein supplement | 1.01 | 0.90 | 0.94 | 1.01 | 0.90 | 0.94 |
| Feed per 100 lbs. gain (lbs.) | | | | | | |
| Hay | 1735 | 1280 | 1430 | 1495 | 1314 | 1381 |
| Protein supplement | 151.8 | 99.5 | 116.7 | 130.9 | 102.2 | 112.8 |

*Urea used was DuPont “Two-Sixty-Two” and was supplied by I. E. Du Pont De Nemours and Company, Inc., Wilmington, Delaware.
ond trial as follows (percent): soybean meal, 66.0; ground shelled corn, 29.5; dicalcium phosphate, 0.5; and urea 4.0.

The hay used in the 1950-51 trial was cut in early July 1948, and stacked. Sufficient hay for the experiment was baled shortly before the feeding period began. Hay for the 1951-52 trial was cut in an early stage in 1951.

Salt and bone meal were offered free choice in separate containers in 1950-51, but in 1951-52, salt and a mixture of 1 part salt to 2 parts bone meal were fed free choice.

Results of the Feeding Trials

The results of the two feeding trials are summarized in Table 1. Greater gains were obtained in the lot fed the supplement with urea in the 1950-51 trial. The next year the average daily gain was slightly more for the calves fed soybean meal pellets, but the difference was less than in the previous year. The weighted average over the two years was essentially the same for the rate of gain and feed per 100 pounds of gain for the two pellets. There was no noticeable difference in appetite or condition of the calves when fed either soybean meal or the supplement with 4 percent urea.

Two factors that probably account for the better performance in the 1951-52 experiment are the higher protein content of the hay and the time the experiment was ended. The hay fed in this trial contained 8.06 percent protein, while the hay fed in 1950-51 contained 6.50 percent. It was intended to feed enough supplement to give about 10 percent total protein, or slightly more, in the total ration. The total protein content of the 1951-52 rations was 10.4 percent, while the rations fed in 1950-51 contained only 9.3 percent. A greater amount of supplement would have undoubtedly improved the performance of the calves fed in the first trial.

The feeding periods were started each year in late November. The first trial had to be closed on March 22, 1951 because of a shortage of hay. This date followed a blizzard and gains between individual calves were quite variable. This fact may be responsible for the difference between the two lots in the first trial rather than nutritive value of the pellets. Variations in gains between calves following severe weather probably can be accounted for largely by differences in fill. The 1951-52 trial was not terminated until May 3, 1952, when the weather was more favorable.

Urea a Satisfactory Protein Substitute

The results of these two trials indicate that a protein supplement containing 4 percent urea is a satisfactory supplement with prairie hay for wintering calves. The urea pellet was equal to soybean meal when used at these low levels to produce gains of about 0.75 to 1.0 pound daily. Both supplements were about equal in total digestible nutrients and protein. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry Dept.; O. E. Olson, Station Biochemistry; and J. G. Ross Agronomy. Project partially supported by a grant from Swift and Company.)
Under microscope—common twisted stomach worm, *Haemonchus contortus* (normal size)

**By G. S. Harshfield**

Extensive losses of lambs in range and semi-range flocks occurred in several western counties of South Dakota from 1940 to 1944. The deaths occurred while the flocks were on grass during July, August and September and were preceded by dysentery and loss of weight. Ewes were not affected.

Because of the nature of the losses, the cause was generally attributed to worm infestations. Investigations conducted in the area in 1944 proved the presence of parasites in sufficient number to cause trouble in some flocks, while in others there was doubt that worms were responsible.

There was a peak in sheep population in the state at the time of the greatest lamb loss. Overstocking of sheep ranges was common. This type of management favors heavy worm infestations as well as limits the nutrition of the flock. With the decline in sheep population since 1944, there has been very little lamb loss on range from dysentery.

In continuation of this research, the establishment of a flock of sheep at the Antelope Range Field Station in Harding County has provided an opportunity to study the relation of different levels of grazing to the parasite load acquired by sheep during the grazing seasons.

Four pastures have been fenced on the range to provide light grazing (Lot 1, 550 acres), moderate grazing (Lot 2, 410 acres), heavy grazing (Lot 3, 254 acres) and rotate

Intestinal round worms called strongyles, or *Trichostrongylus colubriformis* (normal size)
tion grazing (Lot 4, 408 acres). Lot 4 was cross-fenced to provide four pastures of 102 acres each for rotation, the total area corresponding to that of Lot 2 for moderate grazing. Each of the four lots was stocked with 100 ewes and their lambs about May 1 in 1950 and 1952. In 1951 only 65 ewes with their lambs were available for each lot. The Lot 4 animals were rotated at weekly intervals in their pasture. The other groups had free use of their respective pastures.
The levels of round worm infestations in the four lots of sheep were determined at intervals during the grazing season by counts of the worm eggs in fecal samples. In 1950 and 1951 composite fecal samples from the ewes and the lambs collected separately were examined. Each composite sample contained feces from at least 10 individual animals. It was not possible to make collections from the same individuals each time.

During 1952, fecal samples for the worm egg counts were collected from the same individual ewes and lambs every four weeks at the time of weighing. Ten ewes and their lambs of each lot were selected for sampling and the egg counts were made of each sample. Tape-worm eggs were not included in the counts since the number present is not indicative of the degree or seriousness of the infestation.

Egg Count Reaches Peak by July 1 in Ewes

In the examinations made over the 3-year period, eggs of the common twisted stomach worms (*Haeomonchus contortus*), medium stomach worms (*Ostertagia circumcincta*), thread-necked strongyles (*Nematodirus species*), small intestinal strongyles (*Trichostrongylus species*), large mouth bowel worms (*Chabertia ovina*) and broad tape-worms (*Moniezia expansa*) were identified. Eggs of the common twisted stomach worm were the most prevalent of the several species of round worms.

The over-all picture of the round worm infestation for the ewes and lambs sampled in 1952 is illustrated in the graph. It can be noted that egg counts in the ewes had reached a peak by July 1 in all four lots, with a marked decline through the remainder of the season. This lowering of the parasite level is attributed to development of resistance on the part of the ewes with a resulting "self-cure" and elimination of large numbers of the worms.

Light Infestation Found in Lambs

In the lambs, few eggs were found before July 1, with an increase following that date. In none of the lots, however, did the parasite load reach a level which could be considered more than a light infestation. The lambs of Lot 3 (heavy grazing) reached the highest level of 448 eggs per gram. The trends in 1950 and 1951 were similar to 1952.

Although the ewes were eliminating worm eggs to contaminate the pastures at the early part of the season, the lambs failed to build up any significant infestation. Judging from observations in other flocks, egg counts of 2000 eggs per gram or above are indicative of a dangerous level. Dysentery has not been observed in any of the lambs in the experiment and any differences in weights between lots cannot be attributed to parasites.

The level of grazing is only one of several factors which can influence the development of parasite infestations in sheep. Moisture conditions, temperature, nutrition and age of the animals may also play a part. Additional observations will be necessary along similar lines so that some of the seasonal variations may be included. (Proj. 193. Leader: G. S. Harshfield, Veterinary.)
Proper disposal of sewage from the farm home requires some type of septic tank. At present the monolithic (or poured) concrete type is the most popular. However, in some areas construction of a monolithic tank may be inconvenient or expensive. The cost of sand and gravel may be high, or good gravel may be unobtainable. A concrete mixer may not be available, or perhaps the cost of materials and labor for forms may be too great if they are to be used only once.

Various other types of tanks have drawbacks of one kind or another. Steel tanks have been used, but they are likely to rust through in a relatively short time. Pre-cast concrete tanks which are now being manufactured in South Dakota, are quite satisfactory, but may not be available in remote areas, or the cost of hauling may be prohibitive.

In an attempt to overcome some of these objections, two new methods of constructing septic tanks have been developed by the South Dakota State College Experiment Station. One type is built of concrete silo staves, which are available from manufacturers in South Dakota, and the other of standard concrete blocks, which are manufactured extensively in the state.

Both types of tanks have been in operation in South Dakota for four years or more, and have proved satisfactory. Both cost somewhat more (exclusive of labor) than did a similar size of monolithic tank, if forms for the monolithic tank could be borrowed or rented. However, they could be expected to show a small saving in cost if the forms for the monolithic tank were to be bought and used only once.

Tanks Built of Concrete Silo Staves

This tank was in the form of a vertical cylinder, 6 feet in inside diameter and 5 feet in depth. The capacity below the outlet was 850 gallons (suitable for a family of eight).

The floor of the tank was poured concrete, 4 inches thick. The walls were built of 2½ by 10-inch concrete silo staves of three different lengths, held together by three bands of one-half-inch steel rod which were tightened by nuts and steel silo lugs. The inside surfaces of the floor and...
This cistern, built from concrete silo staves has been in satisfactory use for five years.

walls were plastered and waterproofed to prevent leakage.

The top was made of 4½ by 8-inch reinforced concrete slabs of varying lengths, which are easily removed for cleaning or inspecting the tank.

The Concrete Block Tank

The concrete block tank was rectangular in shape, 7 feet 4 inches long, 2 feet 8 inches wide, and 4 feet 8 inches deep with a usable capacity of 550 gallons (suitable for a family of five).

The floor was of poured concrete. On it, walls of standard 8 by 8 by 16-inch concrete blocks were erected. The cores of the blocks were filled with concrete after placing, in order to increase the strength of the walls.

The inside surfaces were plastered and treated with a waterproofing material. The top was formed of 4½-inch by 12-inch by 4-foot reinforced concrete slabs.

In both types, the inlet and outlet were sewer tile tees mortared in place in openings left when the walls were built.

Both tanks may be made larger by the use of more staves in the concrete stave tank, and by lengthening or widening with more blocks in the concrete block tank. The method of construction would be the same, regardless of the size.

Tanks should not be made smaller than described. In the case of the silo stave tank, there is little or no saving in cost by reducing the size, whereas the concrete block tank described is close to the minimum recommended size. Tanks smaller than 500 gallons are not recommended.

Waterproofing must not be neglected; both silo staves and concrete block are of rather porous concrete which allows the passage of liquids and contaminating material. Proper waterproofing is essential to eliminate the danger of ground water pollution. Waterproofing materials such as Aquella, Akona, etc., may be used when applied in accordance with the manufacturer’s instructions.

Cisterns Built of Concrete

Silo Staves

A cistern has been built, following the same method of construc-
Diagram for a concrete silo stave tank of 850 gallons capacity, suitable for a family of eight members. The tank has been in use for over five years. When first filled, some leaks developed due to insufficient tightening of the bands. These were repaired with an asphalt compound, and no subsequent leakage has occurred. Experience with this cistern indicates a need for thorough tightening of the bands, and careful application of the plaster and waterproofing coats.

Four Years of Operation

Four years of operation have shown that satisfactory septic tanks can be built of concrete silo staves or concrete block. They may be expected to cost somewhat less than monolithic concrete tanks of similar size, if the cost of forms for the monolithic tank is included. Careful plastering and waterproofing are essential to make such septic tanks watertight. (Project 165. Leaders: T. R. C. Rokeby, Agricultural Engineering Dept., and Niels Anderson, formerly of the Agricultural Engineering Dept.)
by B. L. Brace

"The grass is greener on the other side of the fence" is an old saying that may apply to crops west of the Missouri River. It is a common belief in this area that these soils will always produce abundant lush green crops if the moisture supply is right. This reasoning is far from correct. Even with abundant rainfall some supposedly fertile fields do not produce the way they should. The crops are pale, stunted, and do not have any pep! On the other hand, even in seasons of limited rainfall, yields on well managed fields are higher than on poorly managed land. The crops in the former case have made more efficient use of the same amount of moisture because they have been well fed.

Crops require three major plant foods. They are nitrogen, phosphorus, and potassium. There is no lack of potash in western South Dakota; phosphorus is needed to some extent; nitrogen, however, is the limiting plant food in most cases. It is what makes the grass and other crops grow green. Now that it is realized that nitrogen is needed on most of our western South Dakota soils, the problem is to determine how the crops are going to get a plentiful supply of this element.

Does Commercial Nitrogen Have a Place in Western Agriculture?

The use of commercial fertilizer is slowly finding a place in the west river area. Fertilizer has been tried experimentally on individual farms in scattered locations for the past two years. The crops fertilized have been winter wheat, spring wheat, crested wheat, native grass, and al-
falfa. Of the three main fertilizing elements, nitrogen, phosphorus and potassium, nitrogen has been found to be the most limiting for all crops other than alfalfa.

Winter Wheat Showed Marked Response

The use of fertilizer on winter wheat has been tried on a number of farms. It has been found that wheat following clean fallow will not respond to any extent, but yields of wheat following well managed stubble land have been increased by applications of nitrogen fertilizer. This fact is shown by the yields from the average of three winter wheat plot setups located in Lyman County (Table 1). The treatments in each plot setup were repeated four times. These experiments were conducted in 1952.

The yields show a marked re-

Winter wheat in the sheaf to the right shows the increase in yield obtained from a field fertilized with both nitrogen and phosphorus. Below: Plowing under sweet clover is a good way to add nitrogen and organic matter to the soil. Sweet clover fallow, instead of the usual plain fallow, is a better soil practice.
Table 1. Response of Winter Wheat to Fertilizer

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Yield in Bu./A. When Fertilizer Was Applied in Fall</th>
<th>Yield in Bu./A. When Fertilizer Was Applied in Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (check plot)</td>
<td>12.8</td>
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<tr>
<td>0-40-0</td>
<td>15.2</td>
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</tr>
<tr>
<td>20-0-0</td>
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<td>20-40-0</td>
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<td>40-40-0</td>
<td>28.3</td>
<td>23.1</td>
</tr>
<tr>
<td>60-40-0</td>
<td>31.7</td>
<td>24.0</td>
</tr>
</tbody>
</table>

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide and the third to pounds potassium oxide applied per acre.

Response of Winter Wheat to Fertilizer

The better treatments gave increases in yield of more than twice the check plots, which shows that nitrogen is a definite limiting element. Phosphorus is somewhat limiting but not as marked. Twenty pounds of nitrogen applied in the fall gave a 7.2 bushel increase in yield while 20 pounds of nitrogen plus 40 pounds of phosphorus gave an 8.7 bushel increase. The bushel and a half extra wheat would not pay for the 40 pounds of phosphorus.

The plots which had all the fertilizer put on in the fall, especially at the higher rates, yielded better than those where it was put on in the spring. Also, the fall fertilized plots matured nearly a week earlier than the others.

In reviewing these data and the data from the year before, it seems logical to state that 40 pounds of nitrogen with possibly about 20 pounds of phosphorus, both applied in the fall, would be the best rates to use. It will be found that the wheat will usually respond better to fertilizer on the well-managed fields than on the more poorly managed ones. Remember that weeds respond to fertilizer too. It seems very likely that fertilized stubble ground will compete with fallowed ground in giving good yields of winter wheat.

Response of Spring Wheat Varied According to Moisture

Fertilizer on spring wheat has also been tried. In Lyman County in 1951, the spring wheat responded fairly well. In 1952, fertilizer was used on spring wheat in Perkins County. There was no effect from the use of fertilizer because the season was too dry. Whether the wheat was on stubble or fallowed land made no difference. However, there was no burning of the crop where the fertilizer was applied. The yields of the check plots were about the same as the fertilized plots. There might even be some carry over of this fertilizer for the next year’s crop. This will be checked.

Hay Yields Doubled

In time, a tame grass field becomes starved for nitrogen and does not make the best growth. Normally this field should then be broken up and cropped for a few years, thus making it a part of a rotation. However, if the piece of land is unsuitable for cultivation, the producing ability of the soil may be maintained or increased by the means of nitrogenous fertilizer. A field trial of fertilizer on crested wheat in Lyman County was carried out in 1951. The results are shown in Table 2.

Nitrogen fertilizer was especially effective in increasing the yield of hay. The yields were actually doubled by the highest application. It did not appear to make much difference on the yield whether the ferti-
Irrigating alfalfa to get around the effects of dry weather in western South Dakota. Alfalfa is a good crop to grow for hay or seed production. Rotations should be on a long-term basis and somewhat flexible. Stands are usually maintained for three or more years. Because of available subsoil moisture, river bottom land often makes good alfalfa ground. Scientists find that for seed it is also profitable to space alfalfa plants by planting them in rows.

The yield of seed was greatly increased by the use of fertilizer; in fact, an increase of 20 times was realized for the heavy treatments. On the average, where the nitrogen was put on in the fall, 50 to 100 percent increases in seed yield were received over those plots where the fertilizer was put on in the spring.

Practically two-thirds of the state of South Dakota is in permanent range. This is a sizeable acreage and should remain as it is. Some of this range is very unproductive, and something must be done to improve its producing power. Over-grazing is probably one of the main reasons why some ranges do not produce. Since the grass food manufacturing system is in its top growth, the plant does not have a chance to make any more grass if this growth is kept down to the ground all the time. One of the best answers is to graze less heavily.

### Table 2. Effect of Fertilizer on the Yields of Crested Wheat Forage and Seed

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Fall Forage</th>
<th>Fall Seed</th>
<th>Spring Forage</th>
<th>Spring Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (check plot)</td>
<td>1480</td>
<td>24.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-0-0</td>
<td>1940</td>
<td>143.0</td>
<td>2100</td>
<td>53.3</td>
</tr>
<tr>
<td>40-0-0</td>
<td>2440</td>
<td>187.5</td>
<td>2560</td>
<td>132.4</td>
</tr>
<tr>
<td>60-0-0</td>
<td>2760</td>
<td>285.2</td>
<td>2760</td>
<td>146.6</td>
</tr>
<tr>
<td>120-0-0</td>
<td>3420</td>
<td>574.8</td>
<td>3320</td>
<td>235.4</td>
</tr>
<tr>
<td>40-40-0</td>
<td>2480</td>
<td>252.3</td>
<td>2880</td>
<td>131.5</td>
</tr>
</tbody>
</table>

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide and the third to pounds potassium oxide applied per acre.
Nitrogen Increased Yield of Grass in Heavily Grazed Pastures

Another possible way to increase the production of this grass is to fertilize. This was tried at the Cottonwood Range Field Station in 1952.

A plot setup of four replications was placed on three different pastures which had been heavily, moderately and lightly grazed for the last 10 years. The grazing experiment has been conducted by the Animal Husbandry Department in cooperation with the Soil Conservation Service. The information given in Table 3 shows that nitrogen increased the yield of grass on the heavily grazed pasture to quite an extent, less on the moderately grazed, and none at all on the lightly grazed pasture. Phosphorus also increased the yield but not so much as the nitrogen. The fertilizer was all applied as a top dressing the spring of 1952 and not worked in.

Table 3. The Effect of Fertilizer on Native Grass

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Heavy Forage Yield Lbs./A.</th>
<th>Moderate Forage Yield Lbs./A.</th>
<th>Light Forage Yield Lbs./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (check plot)</td>
<td>172</td>
<td>515</td>
<td>1200</td>
</tr>
<tr>
<td>20-0-0</td>
<td>392</td>
<td>743</td>
<td>1301</td>
</tr>
<tr>
<td>40-0-0</td>
<td>724</td>
<td>981</td>
<td>1220</td>
</tr>
<tr>
<td>80-0-0</td>
<td>1351</td>
<td>1143</td>
<td>1292</td>
</tr>
<tr>
<td>40-40-0</td>
<td>936</td>
<td>1122</td>
<td>1292</td>
</tr>
</tbody>
</table>

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide, and the third to pounds potassium oxide applied per acre.

A few analyses of the forage for protein content have been made, and there was a trend in favor of fertilizer. The experiment will be carried on for a number of years to find, first, if there is any lasting effect of the fertilizer, and secondly, if the species of grass will change with further application of fertilizer.

May Have Residual Effect

The residual or lasting effect of fertilizer is an important problem in western South Dakota. In some years the weather is too dry for fertilizer to do any good. If, however, some of that fertilizer remains in an available form for succeeding crops, the effect is not lost but postponed. An experiment at Cottonwood has demonstrated this residual effect very well. A particular piece of land was cropped by winter wheat, barley, and spring wheat in that order from 1950 to 1952. Various rates of nitrogen were applied to this acreage the fall of 1949 (Table 4).

Table 4. The Residual Effect of Fertilizer at Cottonwood

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Winter Wheat (1950) Yield in Bu./A.</th>
<th>Barley (1951) Yield in Bu./A.</th>
<th>Spring Wheat (1952) Yield in Bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (check plot)</td>
<td>10.8</td>
<td>28.7</td>
<td>13.2</td>
</tr>
<tr>
<td>20-0-0</td>
<td>11.6</td>
<td>31.2</td>
<td>11.3</td>
</tr>
<tr>
<td>60-0-0</td>
<td>13.4</td>
<td>37.0</td>
<td>11.5</td>
</tr>
<tr>
<td>100-0-0</td>
<td>14.0</td>
<td>40.7</td>
<td>13.1</td>
</tr>
<tr>
<td>140-0-0</td>
<td>14.1</td>
<td>47.6</td>
<td>12.9</td>
</tr>
</tbody>
</table>

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide, and the third to pounds potassium oxide applied per acre.

The year 1950 was an unfavorable crop year at Cottonwood, 1951 was above average, and 1952 was average. The fertilizer brought about little effect on the winter wheat. There was a little boost however—about three bushels for the better rates. On the other hand, there was a very definite effect from the fertilizer on the barley crop, the year following the winter wheat crop year. Nearly
20 bushels of barley were obtained for the 140 pounds of nitrogen that was applied for the winter wheat crop. There were no noticeable effects in appearance of crop or on yield for the 1952 crop of spring wheat.

No Boost of Alfalfa Yields from Nitrogen

The use of commercial fertilizer to increase the yield of alfalfa has been tried in a number of places in the west river area. In general, added fertilizer has not increased alfalfa yields. However, in some areas, phosphorus was found to have some effect. Soils which have been irrigated and heavily cropped for many years have been found to benefit from the use of phosphorus.

Table 5. The Effect of Phosphorus on the Yield of Alfalfa

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Fall Yield (lbs./A.)</th>
<th>Spring Yield (lbs./A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (check plot)</td>
<td>2810</td>
<td>3422</td>
</tr>
<tr>
<td>0-20-0</td>
<td>3577</td>
<td>4233</td>
</tr>
<tr>
<td>0-40-0</td>
<td>4295</td>
<td>4061</td>
</tr>
<tr>
<td>0-60-0</td>
<td>3175</td>
<td>4255</td>
</tr>
<tr>
<td>0-40-40</td>
<td>3413</td>
<td>4466</td>
</tr>
<tr>
<td>Minor elements†</td>
<td>3413</td>
<td>4466</td>
</tr>
<tr>
<td>0-40-0 + minor elements†</td>
<td>3413</td>
<td>4466</td>
</tr>
</tbody>
</table>

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide, and the last to pounds potassium oxide applied per acre.
†Minor elements included borax, manganese sulphate, zinc sulphate, and copper sulphate, at 20, 25, 10 and 20 pounds per acre, respectively.

Some of the lighter soils under fair to good moisture relations have also been found to respond to phosphate fertilizer. Table 5 shows the effect of

Continued on page 50

**THESE SOIL PRACTICES ARE IMPORTANT TOO!**

Commercial fertilizer has its place, but good soil management practices should not be neglected. These practices will conserve the nitrogen in the soil and save in the use of expensive fertilizers.

1. Nearly all of the nitrogen in soils is contained in the organic matter. If the straw is burned, all of the nitrogen in that straw goes up in smoke. All residues such as corn stover and straw should be returned to the soil.

2. Tillage not only improves the tilth of the soil, but it also stimulates the breakdown of organic matter and releases more nitrogen. It should be carried out in such a way that most of the residues remain on the surface to aid in the prevention of wind and water erosion.

3. Summer fallow increases the nitrogen supply by releasing available nitrogen from crop residues and organic matter. If fallow is practiced, the ground should be worked just enough to keep the weeds down which rob both the moisture and available nitrogen supply. Sweet clover summer fallow is even better.

4. The use of intertilled crops in place of fallow has been practiced by many farmers with good results. Soil following cleanly cultivated corn or sorghum will contain more moisture and available nitrogen than soils following small grain.

5. All manure on the ranch or farm should be returned to the soil, as it is a valuable source of nitrogen and organic matter. On intertilled crops, such as corn or sorghum, a low rate over a large acreage will give greater returns than a high rate over a small acreage.
The striking improvement in the farm home shown below resulted from the help of a farm-ownership loan. Photo courtesy FHA.
TO FARM OWNERSHIP
A Study of FHA Farm-Ownership Loans

By C. M. Johnson

That the farmer should own the land he tills is an ideal developed in this country since early colonial times. Nearly all federal land use legislation has been designed to promote this ideal of family farm ownership. In the past, the Homestead Acts, with this objective in view, were distinctly successful in getting land into the hands of owner-operators.

At the present time, the Farmers Home Administration represents a direct governmental effort toward assisting farmers to achieve farm ownership. This federal credit institution makes loans (mortgage, production, farm enlargement, development and housing, water facilities, and disaster loans) to farm people who are unable to obtain credit with favorable rates and terms from other credit institutions.

There naturally is a great deal of interest on the part of farm people and others as to just how well the farm-ownership program has operated in South Dakota. This interest prompted a survey to find answers to the questions: (1) What effect has the program had toward increasing farm ownership in South Dakota? (2) How effective has the program been in establishing tenants as farm owners? and (3) How effective was the supervision of farm-ownership clients?

The farm-ownership loan program came into existence through the Bankhead-Jones Farm Tenant Act of 1937. This program makes both insured and direct supervised mortgage loans to eligible tenants, farm laborers, and sharecroppers for the purpose of acquiring ownership of family-sized farm units. Its related objective is to reduce farm tenancy in areas of the United States where there is a large proportion of farm tenants.

Program Increases Farm Ownership

Farms operated by tenants in South Dakota in 1950 amounted to only 30 percent of the total number of farms; this proportion is the smallest since 1910. The trend toward fewer farms operated by tenants is especially significant when consideration is given the fact that in 1940 South Dakota had 58 percent of its farms operated by tenants.

Few farm-ownership loans were made in South Dakota prior to 1940. Therefore, in determining the effect which this program has had toward increasing ownership, it was considered best to use the period between 1940 and 1950. Moreover, because many farm-ownership clients have repaid their loans and have shifted into the part-owner classification, the two tenure classes of owner and part owner were combined for making this computation.

Of the total farm ownerships achieved during the decade, the farm-ownership program accounted for 554 of the 12,228 or 4.53 percent (Table 1). While this figure is...
Table 1. Farm Ownership Achievement in South Dakota, 1940—1950

<table>
<thead>
<tr>
<th>Year</th>
<th>Numerical Increase in F-O Program Ownership</th>
<th>Number of Ownership Ownerships</th>
<th>Percent of F-O Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940-45</td>
<td>8,424</td>
<td>334</td>
<td>3.96</td>
</tr>
<tr>
<td>1945-50</td>
<td>3,804</td>
<td>220</td>
<td>5.78</td>
</tr>
<tr>
<td>Total</td>
<td>12,228</td>
<td>554</td>
<td>4.53</td>
</tr>
</tbody>
</table>

small, it should be considered in relation to the limited amount of loanable funds with which the program in this and other states has operated. At least, this figure is indicative of the part which the farm-ownership program might have played in reducing tenancy or increasing farm-ownership had increased funds been made available to meet the demand.

Repaid Loans One Measure of Success

How effective has the farm-ownership program been in establishing tenants as farm owners? One indication of effectiveness in this respect is to be found in the repayment record of farm-ownership clients (Table 2).

Table 2. Farm-Ownership Loan Repayment Record

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Loans, 1938-51</td>
<td>728</td>
<td>100.0</td>
</tr>
<tr>
<td>No. Active</td>
<td>342</td>
<td>47.0</td>
</tr>
<tr>
<td>No. Inactive (Paid up)</td>
<td>386</td>
<td>53.0</td>
</tr>
<tr>
<td>Repaid from:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm Income</td>
<td>248</td>
<td>64.2</td>
</tr>
<tr>
<td>Refinancing</td>
<td>66</td>
<td>17.1</td>
</tr>
<tr>
<td>Sale of Farm</td>
<td>45</td>
<td>11.7</td>
</tr>
<tr>
<td>Transfer Agreement</td>
<td>18</td>
<td>4.7</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Fifty-three percent of all loans made under the program have been repaid. Sixty-four percent were repaid from farm income and 4.7 percent were repaid by means of a transfer - assumption agreement, which is a method used for transferring an F-O farm from one person to another. Transfer - assumption agreements are used when the borrower is not successful in the operation of his farm, or when personal circumstances force him to release his farm in this manner. Therefore, technically, a part of this group of transferors could be considered failures. The program appears to have been successful as indicated by the low proportion (far less than five percent) of failures.

If economic and weather conditions during the 1940's had not been so favorable, the farm-ownership clients might not have been so willing to make payments according to farm income. In this event, a greater amount of careful supervision might be necessary to obtain the proper payments. The compulsion to make payments under a variable payment plan is not nearly so strong as it is under a fixed repayment schedule. It should also be noted that the proportion of failures might have been somewhat different under different economic and weather conditions. The 1940's were prosperous times during which most farmers succeeded.

A further indication of the program's success is to be found in the length of the repayment period.

This farm family remodeled their barn with the money obtained from a farm-ownership loan.
More than 70 percent of the total loans repaid and also those repaid from farm income were paid up in six years or less. All repaid loans were paid up in 12 years or less regardless of which method of repayment was used. This repayment record speaks well for the farm-ownership program.

Even though the ability to repay loans as rapidly as this had come about largely because of favorable weather conditions and prices, two other factors are at least partially responsible. These are the regulation to the effect that repayments are to be made according to the farm income received (variable payment plan) even though the payment might be a great deal more than the regularly scheduled payment, and the willingness and desire of the borrowers to clear their mortgage indebtedness as soon as possible. This latter fact can be taken as a positive indication that, in general, the borrowers did not abuse, but rather used, the favorable terms afforded them by this program.

**Individual Farmers Are Contacted**

Thus far, this report on the farm-ownership program has dealt only with mass data. It is often desirable to seek out the individual and to discover how such a program has affected him. This was done by contacting 45 of the 1940 borrowers residing in the eastern half of South Dakota. Thirty of these 45 borrowers cooperated in giving detailed information concerning themselves and their farming operations.

In addition, it was considered essential that the same type of information be obtained from a group of farm people who might have been eligible for farm-ownership loans, but who followed some alternative method for financing their farm purchase, or who continued farming as tenants. The objective in obtaining information from a non-client group was to make progress comparisons between the two groups.

The procedure used for locating individuals for this non-client group was to contact the farmer living nearest to the corresponding farm-ownership client, who had a 1940 tax evaluation most nearly equal to that of the farm-ownership client, and who did not own his farm prior to 1940. The assumption underlying this method of selection was that individuals having approximately the same tax evaluation in 1940 would also have similar assets, liabilities, and net worth.

The two groups, each containing 30 cases, are compared as to 1940 and 1951 net worth, income, level of living and number of farm management practices employed. This comparison is made by tenure classes, because such a comparison seems to be the most equitable to make. The individuals were grouped into tenure classes according to their 1951 tenure status as follows: 18 owners, 12 part-owners, and no tenants in the farm-ownership client group; and 10 owners, 15 part-owners, and 5 tenants in the non-client group. Individuals in the non-client group who are classed as tenants in 1951
Table 3. Average Net Worth in 1940 and 1951 by Tenure Classes

<table>
<thead>
<tr>
<th>Tenure Class</th>
<th>1940 Av. Net Worth</th>
<th>1951 Av. Net Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-O Client Group</td>
<td>Non-client Group</td>
</tr>
<tr>
<td>Tenants</td>
<td>$3010</td>
<td>$16,936</td>
</tr>
<tr>
<td>Part Owners</td>
<td>2841</td>
<td>3839</td>
</tr>
<tr>
<td>Owners</td>
<td>3316</td>
<td>3518</td>
</tr>
<tr>
<td>All Classes</td>
<td>3129</td>
<td>3606</td>
</tr>
</tbody>
</table>

*There are no tenants in the farm-ownership group because they achieved ownership in 1940 through the program.

were also tenants in 1940. There are no tenants in the farm-ownership client group because all these individuals achieved farm ownership through the program in 1940.

Net Worth of the Two Groups Compared

Valuations for determining net worth of the two groups were deliberately made conservative (Table 3). Land values, in particular, were conservatively made by taking the appraised value or the purchase price and adding the cost of major improvements which had been added by the owner since he had acquired the farm. This procedure had the effect of keeping the farm value in line with its long-term productive capacity.

The non-client group had a net worth advantage in 1940 but the farm-ownership group had attained this advantage by 1951. Part-owners in both groups, except the F-O client part-owners in 1940, have a net worth advantage over both tenants and owners. Conclusions based upon these facts are: (1) The net worth advantage of part-owners over tenants and owners is the result of a larger scale of farming operations.

Some objections to the farm-ownership loan program center around what are considered its "limiting features." These are the limitations placed upon the size of farm which the borrower may operate, and the requirement that farm operations should be diversified. It is believed by those voicing objections that these "limiting features" hinder the financial progress of the borrowers. The data contained in this study do not appear to support these contentions. Moreover, in some of the cases contained in this study, the individuals got around these "limiting features" in one way or another. First, the borrower paid off his loan as rapidly as possible, and thereafter he expanded or specialized to suit his personal inclinations. Second, the borrower rented or purchased additional land regardless of regulations to the contrary. Third, the borrower obtained a supplemental or farm enlargement loan from the Farmers Home Administration, and thereby he expanded his scale of operations.

Three shack-like buildings and a loan from the FHA resulted in modern farm shed shown at right:
Income Comparisons for 1940 and 1951

Conclusions similar to those arrived at with regard to the net worth of the two groups apply equally as well to income pattern (Table 4).

Level of Living Compared

A list of convenience items which included the use of electricity, electrical appliances, and other items of home or farm convenience was constructed for measuring the level of living. These “convenience” or “consumer’s luxury” goods were employed as indicators of the level of living because their use varies greatly with changes in income, whereas the consumption of goods classed as basic necessities do not vary a great deal with income changes. It is interesting to note the contrast between 1940 and 1951 in the use of these goods on the farm (Table 5). The index number expresses the average number of convenience items used by the members of a particular tenure class. Farm living conditions have improved greatly in the past decade. Much of this improvement has been possible because of the Rural Electrification program, and, of course, the economic prosperity of the past decade.

The farm-ownership group started in 1940 with an inferior average level of living index and by 1951 had attained an average index superior to that of the non-client group. The level of living index by tenure classes indicates that the part-owners had a superior level of living in both groups for both points in time. This phenomenon is probably the result of a larger net worth and income due to a larger scale of farm operation.

The evidence—a low proportion of failures, a short average repayment period, and the relatively

Table 5. Average Level of Living Index For 1940 and 1951 by Tenure Classes

<table>
<thead>
<tr>
<th>Tenure Class</th>
<th>1940 Average Index</th>
<th>1951 Average Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-O Client Group</td>
<td>Non-Client Group</td>
</tr>
<tr>
<td>Tenants</td>
<td>5.4</td>
<td>10.1</td>
</tr>
<tr>
<td>Part-Owners</td>
<td>7.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Owners</td>
<td>5.6</td>
<td>16.2</td>
</tr>
<tr>
<td>All Classes</td>
<td>6.1</td>
<td>16.9</td>
</tr>
</tbody>
</table>

*There are no tenants in the farm-ownership group because they achieved ownership in 1940 through the program.

Sturdy, well-built sheds add to a farmer’s pride in ownership. Photos courtesy of FHA
greater progress which the F-O client group has made as indicated by their net worth, income, and level of living in comparison with the non-client group—points to the fact that the farm-ownership loan program has been effective in establishing tenants as farm owners.

However, farm-ownership program clients achieved ownership earlier than non-clients, and this might very well be the reason for their relatively greater progress. Granted that this may be true, the advantages—a low rate of interest, variable repayments, and a purchase price gauged by appraisal to the long-term productive capacity of the farm—which the F-O client group obtained under the program cannot be entirely discounted. In fact, the effect of earlier ownership is, in part, a result of the program.

**Is Supervision Necessary?**

The final question which must be considered in evaluating the farm-ownership program concerns the effectiveness of the supervision of its clients. Although supervision of the borrowers touched upon nearly all aspects of farm life, its effectiveness might be partially determined by making a comparison of the number of widely accepted farm management practices employed by the members of both groups. Farm management practices used for this purpose are those which are commonly recommended by the farm-ownership supervisory program, the Soil Conservation Service, and the Extension Service. Typical practices included in the list were use of adapted seed varieties and seed preparation, soil conservation practices, and improved livestock feeding, breeding, and disease protection practices (Table 6).

The facts are somewhat reversed from those obtained previously with regard to net worth, income, and level of living. These facts are: (1) Owners in both groups employed more of these management practices than did tenants and part-owners, (2) part-owners, in general, in both groups employed fewer management practices than tenants, and (3) there is no great or unusual difference between the two groups in the number of practices employed.

This does not mean that supervision of borrowers is not necessary, especially in an expanded farm-ownership program, or that it is not necessary with other types of loans, such as production loans. It does mean that it appears that no particular amount of supervision would have been necessary with the group surveyed. (Project 166. Leader: Max Myers, Ag. Economics Dept.)
A new hybrid tomato, No. 65, was still firm, ripe, edible fruit on the first of December after being harvested and stored green in the fall. For the last three years this new hybrid developed by the Horticulture department has created much interest among those who have grown it. Its good points are that it has a smooth, attractive fruit of good quality and is a vigorous plant with little damage from foliage diseases. It is not early in maturing and has not always given a good yield.

Perhaps You Grew This Tomato Last Year

In the spring of 1952, 400 packages of seeds of this hybrid were distributed to every county in the state. Growers were requested to report their observations and make any comments they cared to about it. To date, approximately 10 percent have reported.

These reports were classified into three groups: (1) those most favorable who would probably plant this hybrid if seed were available; (2) those moderately favorable, but who did not consider it outstanding; (3) those who observed some weakness that would limit planting of the hybrid. Eighty-five percent of those reporting were classed in Group 1.

Excels in Good Keeping Qualities

The characteristic most frequently mentioned by those reporting on the tomato, was its freedom from cracking. Quality, high yield, earliness, freedom from disease, and plant vigor were other characteristics reported almost as frequently. Two reported that this hybrid was good for storage as a fall supply. (Not all tomatoes keep well when harvested as green fruit just before frost.)

You can pick them in the fall and eat them in December! These tomatoes were stored green in an ordinary basement at temperatures of 50 to 60 degrees. They were individually wrapped in waxed paper such as citrus fruit comes in.
Tests Verify Reports

Observations at the Experiment Station agree with these reports except for earliness. Those who consider it as an early variety were no doubt comparing it with some late maturing varieties. From three replications in the 1952 season, it produced eight tons per acre in the test plots at Brookings. This is approximately half the yield produced from the better yielding varieties included in the test plots. While yields have not been as large for this hybrid as for many others, one grower reported seven bushels from eight plants.

Of the two reporting objectionable features, one indicated the variety as being too late. This is a valid criticism unless some early variety, such as Sioux or Siouxann is also used. Those who rate this hybrid as early were evidently comparing it with late maturing varieties. The use of late maturing varieties is a common practice.

Longer Harvest Period

South Dakota No. 65 was developed with the thought that it would combine well with Siouxann and give a longer harvest period. By harvesting the late maturing fruit of No. 65 and holding it in storage, a supply of tomatoes can be kept until well into the fall season. From these two varieties a supply of tomatoes was available from August 1 to December 1 in 1952.

From these reports, it is believed that South Dakota hybrid No. 65 may be worth further testing. It will not be offered for sale in the spring of 1953, but will again be tested extensively. It is suggested that an early variety be planted also. (Project 49. Horticulture Dept.)

Is Nitrogen Needed

fertilizer on alfalfa in Tripp County in 1952. The soil was a sandy loam. The fertilizer was broadcast on the surface and not worked in.

All of the treated plots yielded more than the check, but in reviewing the data, and observing the plots in the field, it can be said that the 0-40-0 was the better all around treatment. The 0-60-0 and the 0-40-0 plus minor elements plots yielded more, but the increase in yield would not be enough to offset the cost of the extra fertilizer. Fall applications are just as good or better than spring applications.

If the use of fertilizer is to be attempted on alfalfa, it is suggested that the fertilizer be tried on a small area of the field before it is put on the entire field. The fertilizer to use is one of the superphosphates. Forty pounds of phosphorus pentoxide (P₂O₅), equivalent to 90 pounds of treble superphosphate or 200 pounds of ordinary superphosphate per acre, would be a recommended amount to try. It can be applied with a fertilizer attachment when the alfalfa is planted; otherwise it can be broadcast before it is seeded, or after a stand is obtained. Advice on fertilizer use can be obtained from the Soil Testing Laboratory at South Dakota State College. (Project 4. Leader: B. L. Brage, Agronomy Dept.)

Continued from page 41
THE EUROPEAN CORN BORER IS a self-appointed 'tax collector' who visits every corn-producing farmer in South Dakota. This pest 'puts the bite' on the pocketbook (in a roundabout way, of course) of every farmer who depends to any appreciable extent upon growing corn for part of his income.

The corn borer makes out no "tax reports." In fact, the farmer often does not realize the amount of damage being done to his fields until it is too late to do anything about it.

Every farmer, especially in eastern South Dakota, should be greatly concerned about his losses due to corn borer damage. The accompanying map (Fig. 1) shows the corn borer distribution for South Dakota at the end of the 1952 growing season, as indicated by fall abundance studies.

Losses During Last Five Years

The following loss figures apply to corn grown for grain in South Dakota. They are based on studies of the fall abundance of corn borers, made by the State College Experiment Station Entomology Department, and corn production figures by the South Dakota Crop Reporting Service. Here are the figures:
I Ab Sfiec/men Records io Raie /d'O -/9 9

I Rrrers PrysfinA AAofoH Suryey ZOO or More

Fig. 1. Distribution of the European corn borer in South Dakota, Fall 1952

Growing Season | Loss Due To Corn Borers |
-----------------|-------------------------|
1948            | $2,442,000              |
1949            | 7,545,000               |
1950            | 5,415,000               |
1951            | 5,847,000               |
1952            | 8,090,000               |
Total           | $29,339,000             |

In a year such as 1952, in which there was a much better than average corn crop in the more favorable corn producing area of South Dakota, the loss due to borers is difficult to see, because it is removed before the crop is harvested. In fact, a major part of the loss (due to broken stalks, etc.) is caused before the crop has an opportunity to be made. Other loss results from the production of nubbins instead of good ears, chaffy kernels instead of full kernels, and from ears dropped to the ground. If the crop is much better than usual these percentage reductions in yield are largely obscured, and we fail to realize that the excellent crop could have been better.

Corn Borer Population Trends
The chart (Fig. 2) shows the corn borer population figures for southeastern, central eastern and northeastern areas of South Dakota as indicated by fall abundance studies conducted by the Station during the last five years. The list of counties shows the average number of European corn borers per 100 stalks of corn for each county surveyed in the fall of 1952.

How Much Was Your Corn Borer “Tax”?
The farmer can figure his own “corn borer bill” in the following manner. He should:
Determine the average number of borers per 100 stalks for the county in which he lives, from the county list (page 54).
Locate this figure, or its approximate place, on the left side of the graph, Fig. 2. Follow straight across
HOW TO USE THE CHART

Suppose that a Minnehaha County farmer has 160 acres of corn on his farm with an average yield of 60 bushels per acre. Then, 160 x 60 equals the total yield received, or 9,600 bushels. By referring to the county list, we find that Minnehaha County averaged 584 borers per 100 stalks. This figure, on the graph, comes close to the top of the chart on the left side, or, reading straight across the graph, indicates about 17.5 percent reduction in yield due to borers. Now, 17.5 percent of 9,600 bushels equals 1,680 bushels of corn. Figuring the price of corn at $1.37 per bushel, the December 15 price farmers received for corn, the loss figure (or so-called corn borer “tax”) becomes $2,301.60. This is what the borer cost this particular farmer.

Fig. 2. European corn borer population trends in eastern South Dakota during the last five years.
# CORN BORER COUNT BY COUNTIES

<table>
<thead>
<tr>
<th>County</th>
<th>Average Number of Corn Borers Per 100 Stalks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurora</td>
<td>186</td>
</tr>
<tr>
<td>Beadle</td>
<td>64</td>
</tr>
<tr>
<td>Bon Homme</td>
<td>700</td>
</tr>
<tr>
<td>Brookings</td>
<td>585</td>
</tr>
<tr>
<td>Brown</td>
<td>174</td>
</tr>
<tr>
<td>Brule</td>
<td>55</td>
</tr>
<tr>
<td>Buffalo</td>
<td>65</td>
</tr>
<tr>
<td>Charles Mix</td>
<td>305</td>
</tr>
<tr>
<td>Clark</td>
<td>31</td>
</tr>
<tr>
<td>Clay</td>
<td>284</td>
</tr>
<tr>
<td>Codington</td>
<td>63</td>
</tr>
<tr>
<td>Davison</td>
<td>350</td>
</tr>
<tr>
<td>Day</td>
<td>89</td>
</tr>
<tr>
<td>Deuel</td>
<td>161</td>
</tr>
<tr>
<td>Douglas</td>
<td>166</td>
</tr>
<tr>
<td>Edmunds</td>
<td>73</td>
</tr>
<tr>
<td>Faulk</td>
<td>72</td>
</tr>
<tr>
<td>Grant</td>
<td>235</td>
</tr>
<tr>
<td>Gregory</td>
<td>81</td>
</tr>
<tr>
<td>Hamlin</td>
<td>53</td>
</tr>
<tr>
<td>Hand</td>
<td>71</td>
</tr>
<tr>
<td>Hanson</td>
<td>349</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>County</th>
<th>Average Number of Corn Borers Per 100 Stalks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hughes</td>
<td>102</td>
</tr>
<tr>
<td>Hutchinson</td>
<td>461</td>
</tr>
<tr>
<td>Hyde</td>
<td>75</td>
</tr>
<tr>
<td>Jerauld</td>
<td>253</td>
</tr>
<tr>
<td>Kingsbury</td>
<td>141</td>
</tr>
<tr>
<td>Lake</td>
<td>216</td>
</tr>
<tr>
<td>Lincoln</td>
<td>327</td>
</tr>
<tr>
<td>Lyman</td>
<td>28</td>
</tr>
<tr>
<td>Marshall</td>
<td>99</td>
</tr>
<tr>
<td>McCook</td>
<td>186</td>
</tr>
<tr>
<td>Miner</td>
<td>143</td>
</tr>
<tr>
<td>Minnehaha</td>
<td>584</td>
</tr>
<tr>
<td>Moody</td>
<td>136</td>
</tr>
<tr>
<td>Potter</td>
<td>70</td>
</tr>
<tr>
<td>Roberts</td>
<td>118</td>
</tr>
<tr>
<td>Sanborn</td>
<td>124</td>
</tr>
<tr>
<td>Spink</td>
<td>172</td>
</tr>
<tr>
<td>Sully</td>
<td>74</td>
</tr>
<tr>
<td>Tripp</td>
<td>53</td>
</tr>
<tr>
<td>Turner</td>
<td>420</td>
</tr>
<tr>
<td>Union</td>
<td>356</td>
</tr>
<tr>
<td>Yankton</td>
<td>197</td>
</tr>
</tbody>
</table>

To the right side of the graph where the figure for percent reduction in yield is shown. This tells him what percent of the average corn yield in his county was lost due to the borer. Next, he should multiply the number of acres he had planted to corn, times the number of bushels per acre his field yielded, to get the total yield that he received. This total yield figure times the percent of loss due to the borer will give him a figure that will be approximately what the borer cost him.

Actually, this loss figure will be a little too low, since the percent damage should be figured on the normal yield (without borers present), when in reality he is taking the percent of the yield obtained after the borers have deducted their percentage. It will, however, give the farmer an actual dollars and cents estimate of the amount corn borers are costing him.

It is to be remembered that the above figures are worked out on the basis of an average infestation for 1952. One field on a farm may not be so heavily infested; another might be more heavily infested. Date of planting, fertility of soil as it affects rate of growth, or variety of corn planted may cause variations in the severity of the infestation.

**How Can the Corn Borer “Tax” Be Reduced?**

Both the South Dakota State College Experiment Station and the Extension Service have issued several publications that list suggestions for farm practices which, if followed, will reduce corn borer numbers. These publications are available... Continued on page 57
By J. E. Grafitus and Dan Chisholm

Barley growers know that varieties differ in their ability to resist drought. In making a selection for drought resistance, the plant breeder chooses those lines in his breeding nursery which show evidence of being outstanding in the characteristic he is looking for. If, however, the breeder could determine what particular characteristic in the plant gave him the desired drought resistance, his problem of selection would be simplified.

Darker Green Leaves Appear More Tolerant to Drought

In developing drought-resistant barleys, it has been noted that some of the darker green barley varieties appear to have greater tolerance to drought. This dark green is due to chlorophyll—used by plants in the production of food long before its discovery by the dentifrice manufacturers. In the search for the reason why one variety was more drought resistant than the other, the amount of chlorophyll in the leaves seemed to be an important starting point. It was reasoned that the darker green plants might hold on to
water more tightly and thus resist drying out by the hot winds.

**Loss of Moisture Necessary to Growth of Plant**

Plants lose water through transpiration from the pores, or stomata, in the leaves. This water loss, while undesirable in one sense, is necessary in the growth of the plant. The moist surface of the cell walls lining the stomata absorbs carbon dioxide from the air. Carbon is a very necessary element in the growth of the plant, and since only 0.03 percent of the atmosphere is carbon dioxide, the plant must be very efficient in collecting this gas. Air movement causes the absorption of carbon dioxide, but it also causes the evaporation of water from the surface of these cells. Under extreme conditions of hot drying winds, the moisture in the cells is exhausted and the leaf wilts.

Obviously the ideal would be to obtain a variety which can absorb the greatest amount of carbon dioxide with the least loss of moisture through transpiration.

**Chlorophyll Content High in Darker Leaved Varieties**

Through chemical analyses, it was found that the darker green plants had more chlorophyll. Next it was found that when the plants were subjected to hot, dry conditions, 115° F., with a relative humidity of 18 percent, that the darker green varieties did resist wilting better.

In order to be able to produce drought conditions at will, in which to appraise different varieties, it was necessary to design and build a drought machine. This was planned to control both humidity and temperature in such a way as to duplicate the hot, dry winds accompanying severe drought on the Great Plains.

With the facts obtained from the chemical analyses and the drought machine, a relationship was established between the chlorophyll content of the plant and its drought resistance, as is shown in Table 1.

**Drought Resistance Related to Chlorophyll Content**

It is not possible at this time to say that drought resistance in barley is due directly or indirectly to the amount of chlorophyll in the leaves.

---

The authors wish to thank Professor S. A. McCrory for suggestions in connection with the design of the drought machine.
Table 1. A Variety Comparison Between the Amount of Chlorophyll in the Leaf of the Plant and Its Ability to Resist Drought

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Average Chlorophyll Content Mg./Gm.</th>
<th>Drought Resistance Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plains</td>
<td>2.08</td>
<td>1</td>
</tr>
<tr>
<td>Feebar</td>
<td>2.26</td>
<td>2</td>
</tr>
<tr>
<td>Trebi</td>
<td>2.21</td>
<td>3</td>
</tr>
<tr>
<td>Velvon 11</td>
<td>2.17</td>
<td>4</td>
</tr>
<tr>
<td>Tregal</td>
<td>2.01</td>
<td>5</td>
</tr>
<tr>
<td>Peatland</td>
<td>1.97</td>
<td>6</td>
</tr>
<tr>
<td>Pedigree 38</td>
<td>1.64</td>
<td>7</td>
</tr>
<tr>
<td>Montcalm</td>
<td>1.70</td>
<td>8</td>
</tr>
<tr>
<td>Moore</td>
<td>1.75</td>
<td>9</td>
</tr>
</tbody>
</table>

More research would be needed to establish this, but two rather interesting facts did emerge. For the sample of varieties used, drought resistance and chlorophyll content were related, and there was a definite difference in drought reaction between varieties (See Illustration). The drought resistance ranking shown in Table 1 is remarkably similar to what has been observed in the field.

Drought resistance studies are being continued, and early generation progenies of new crosses are being tested as a standard part of the program to produce new and better varieties of barley for South Dakota. (Project 25. Leaders: J. E. Grafius and D. Chisholm, Agronomy Dept. Part of the work was financed under the auspices of a fellowship supplied by the Mid-west Barley Improvement Association.)

The Corn Borer "Tax" Continued from page 54

from State College, Brookings, or from County Extension Agents.

Studies of recommended chemical controls have been conducted by the Experiment Station Entomology Department for the past three years. The combined results of these experiments indicate that if a field needs chemical treatment, an average saving of from 7 to 10 bushels per acre may be obtained from one properly timed and properly applied spray treatment.

The Experiment Station and Extension Service, in cooperation with the U. S. Bureau of Entomology and Plant Quarantine, provide press and radio information on the progress in development of the borer each spring and summer. These news releases are designed to aid the farmer in deciding for himself whether or not it will pay him to spray his fields for corn borer control. The news releases will also aid the farmer in determining the proper time to spray, a factor of extreme importance in a corn borer control program.

We cannot expect to prevent the entire amount of damage done by corn borers each year. To do that the corn borer would have to be eradicated, where as right now it appears that the borer is here to stay. However, if all fields needing spraying were to receive the proper treatment at the proper time the annual loss figure could be reduced by an estimated 60 percent or possibly more. In the last five years this would have meant a reduction in the corn borer "tax" on South Dakota farm incomes of $17,603,400. (Project 187. Leader: Gerald B. Spawn, Entomology-Zoology Department.)
By M. A. Maxon

The Hopa crab apple, which Professor N. E. Hansen of the State College Agricultural Experiment Station introduced in 1920, has become our most popular ornamental flowering tree. Hardy and drought resistant, flowering well throughout the north where the more tender Asiatic crab apples cannot be grown, it is the best known of the crabs in the "Rosy-bloom" group.

The Hansen varieties, Hopa, Red Flesh, and Red Tip were introduced in the twenties. Many seedlings of similar type were planted in the test orchards at Brookings and Watertown in 1941. These have been observed for a number of years and selections made.

A great improvement in color and size of flower, and a considerable variation in type of tree and fruit were found. The older variety, Hopa, had great quantities of small flowers of a rather poor rosy-purple color which faded to a slight bluish tinge. These newer seedlings have very large flowers with clearer colors. The fruit varies greatly in size and color, though only a few of these selections give a display of bright fall color similar to Hopa.

Several of these seedlings have been propagated and sent for testing to arborets and nurseries. Because of the great number of crab apples in this group already named and introduced, it is desirable to have them thoroughly tested before introducing them. Therefore, these seedlings are not yet available.

It is difficult to forecast which of these might merit introduction until further observations have been made. They should be compared with Canadian varieties of the "Rosy-bloom" group, of which "Almey" is the best known. The following are considered the most worthy: D-2, D-4, E-41, E-46. Project 1. Leader: Marcus A. Maxon, Horticulture Dept.)

(Top) The Hopa crab tree, which Dr. N. E. Hansen introduced, is one of the most widely planted of our ornamental flowering trees in the north. Many of our recent varieties are of the same parent strain. (Bottom) E-42. A round-headed tree with masses of flowers of moderate size clothing the slender branches. Flowers open a lavender pink, quickly fade to white. The fruits are a dull purple hue.
D-1 (not shown). A large, rose-red flower with no blue tinge and a prominent bunch of yellow stamens in the center. It fades only a little. The tree is strong growing and round headed. The fruit is dull red, and three-fourths inch in diameter, of no great beauty in the fall. It flowered well in 1949 and only lightly in 1950, '51 and '52.

D-2 (above). A large, light pink, extremely floriferous tree with spreading pole-like branches covered with great masses of bloom. The fruit is the largest of these crabs, about 1½ inches across, green-striped red, to all red in color. It has been observed for a number of years and flowered even as a young tree in the orchard. The soft pink color is entirely different from any other of these Rosy-bloom crabs. It flowered heavily in 1949 and '51 with no bloom in '50 and '52.

D-4 (not shown). This has the best color of all the crabs. A clear, warm rose with no trace of blue. The flower is large with somewhat wavy-edged petals. It flowered heavily in 1949 and lightly in 1950 and '51, with no bloom in 1952. The fruit is not outstanding—a dull red, about one-half inch in diameter. The tree is slightly irregular and of moderate height.

E-43 (below). A large, rose-red flower, rather late in flowering. The tree is irregular and vigorous with fruit rather like Red Flesh, though smaller. It flowered well in 1950.
Ears of S.D. 220, though small, are very uniform, which contributes to its high yielding ability.

By D. B. SHANK

SOUTH DAKOTA 220, a new, early, high yielding corn hybrid has been developed and released by the State College Agricultural Experiment Station.

The single crosses which make up this hybrid have been increased by the College Foundation Seed Stocks Division and are available. The South Dakota Experiment Station does not distribute the hybrids it develops, but commercial growers can get the single crosses that make up the hybrids, once they are released, put them together to make the various hybrids, and sell them to the farmer.

What Goes Into South Dakota 220

The pedigree of South Dakota 220 is (SD26 x B8) (SD5 x SD48). Three of the inbred lines are of South Dakota origin and the fourth, B8, is an Iowa line.

In making the hybrid, (SD26 x B8) should be used as the female parent because it produces a high percentage of medium flat seed, whereas (SD5 x SD48) forms kernels which are not as well shaped. In addition, each single cross should be made in the way indicated. In the case of the first cross, SD26 is a good seed producer while B8 has a high percentage of dead kernels on each ear and, therefore, makes a poor ear parent. For the other single cross, SD5 has fairly good kernels while SD48 is too small and too low yielding to be a good seed parent. In producing the double cross, both single cross parents can be planted at the same time with good pollination and fertilization results.

How SD220 Compares with Other Early Hybrids Developed by the Station

South Dakota 220 is much earlier than any previous South Dakota number, with a relative maturity rating of 83 days when grown at Brookings. In the Brookings and...
McPherson County tests it was much earlier than South Dakota 204. At the time of harvest, 220 ranged from 4.3 to 12.5 percent drier than 204 in six tests, with an average of 7.5 percent less moisture. Essentially the same maturity differences existed between South Dakota 220 and South Dakota 212, while even greater spreads were observed between the new hybrid and South Dakota 224.

Yield Potential Is 100 Bushels
South Dakota 220 is not only earlier than other South Dakota hybrids, but it also outyielded, oftentimes by a significant amount, South Dakota 204 in every test in which they were both planted (Table 1). In only one case, in the McPherson County test in 1951, did it fail to outyield South Dakota 212, and in only one test, the 1952 Brookings County test, did South Dakota 224 manage to outyield South Dakota 220.

South Dakota 220 has a yield potential of approximately 100 bushels per acre when grown under good conditions. It produced 99.6 bushels of 15.5 percent moisture corn under irrigation at Redfield in 1952. In Lawrence County, also in 1952, it yielded 113 bushels under irrigation. SD220 also does very well under dry and hot conditions as is evidenced by its performance in the Hyde County tests.

Corn Field Has Pleasing Appearance
A field of this corn has a very pleasing appearance because the stalks are generally quite uniform in size. They are slender and reach a height of 6 to 7 feet. The stiffness of the stalks, combined with a good root system, gives this hybrid excellent lodging resistance. This was evidenced in the 1952 Brookings County test where 220 was compared with other South Dakota hybrids that are commercially avail-
Table 1. Performance Record of South Dakota 220 in Comparison with South Dakota Hybrids 204, 212 and 224 for Four Years at Four Locations

<table>
<thead>
<tr>
<th></th>
<th>1952</th>
<th>1951</th>
<th>1950</th>
<th>1949</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield</td>
<td>Moisture</td>
<td>Yield</td>
<td>Moisture</td>
</tr>
<tr>
<td></td>
<td>Bu./A.</td>
<td>Percent</td>
<td>Bu./A.</td>
<td>Percent</td>
</tr>
<tr>
<td>S. Dak. 220 (Exptl. 10)</td>
<td>61.7</td>
<td>20.1</td>
<td>39.3</td>
<td>37.6</td>
</tr>
<tr>
<td>S. Dak. 204</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Dak. 212</td>
<td>59.9</td>
<td>23.8</td>
<td>35.1</td>
<td>40.9</td>
</tr>
<tr>
<td>S. Dak. 224</td>
<td>62.6</td>
<td>22.2</td>
<td>36.0</td>
<td>45.0</td>
</tr>
<tr>
<td>L. S. D.*</td>
<td>10.7</td>
<td>4.4</td>
<td>5.8</td>
<td>5.3</td>
</tr>
</tbody>
</table>

**Brookings County**

| S. Dak. 220 (Exptl. 20) | 28.4 | 10.3 | 38.3 | 27.5 | 30.8 | 17.9 |      |      |
| S. Dak. 212 | 18.4 | 13.7 | 33.4 | 33.2 | 23.8 | 23.2 |      |      |
| S. Dak. 224 | 23.8 | 11.0 | 35.9 | 38.5 | 24.8 | 25.2 |      |      |
| L. S. D.* | 7.8 | 5.4 | 2.1 |      |      |      |      |      |

**Hyde County**

| S. Dak. 220 (Exptl. 10) | 29.1 | 15.6 | 28.9 | 63.6 | 34.0 | 40.4 | 37.6 | 25.6 |
| S. Dak. 204 | 24.1 | 19.9 | 23.1 | 69.4 | 28.0 | 52.9 | 34.3 | 34.9 |
| S. Dak. 212 | 24.9 | 19.0 | 29.5 | 66.3 | 32.5 | 52.1 |      |      |
| L. S. D.* | 5.7 | 3.8 | 5.0 | 4.3 |      |      |      |      |

**McPherson County**

| S. Dak. 220 (Exptl. 10) | 99.6 | 12.2 | 81.5 | 27.6 |      |      |      |      |
| S. Dak. 224 | 98.1 | 17.7 | 74.9 | 34.4 |      |      |      |      |
| L. S. D.* | 21.2 | 14.9 |      |      |      |      |      |      |

**Spink County (irrigated plots)**

| S. Dak. 220 (Exptl. 10) | 99.6 | 12.2 | 81.5 | 27.6 |      |      |      |      |
| S. Dak. 224 | 98.1 | 17.7 | 74.9 | 34.4 |      |      |      |      |
| L. S. D.* | 21.2 | 14.9 |      |      |      |      |      |      |

*Least significant difference in bushels. In other words, the least amount by which two varieties must differ in yield before that difference is considered statistically significant.

able; South Dakota 220 had 7.1 percent lodging, South Dakota 212 had 40 percent, and South Dakota 224 had 22.1 percent lodging.

The plants have good tassels which shed ample pollen. They are medium green, being neither particularly dark nor light.

**Ears Are Uniform**
The ears have 12 to 14 rows of kernels, are medium in size and are very uniform. The uniformity, and the fact that the ears have very few small nubbins, is a factor in 220's yielding ability. South Dakota 220 also harvests quite free of the husk, giving the picked product a clean, uniform look. (Project 66. Leader: D. B. Shank, Agronomy Dept.)

**SOUTH DAKOTA CORN HYBRIDS TOPS**

Corn hybrids developed in South Dakota gave top performance in eight out of twelve test locations in the state this year. This was in competition with the most popular hybrids grown in the areas where the tests were conducted.

South Dakota hybrids were in the lead in the county tests of Butte, Lawrence, McPherson, Hyde, Spink, Brookings, Brule and Minnehaha. They ran second in the Hanson and Brown county tests.
Grassland farming has become a popular subject during recent years. Farmers are being urged to grow more legumes and grasses to maintain or improve soil fertility, to prevent erosion, to avoid surplus production of grains, and to improve and stabilize farm income. These are splendid objectives and most farmers are for them. But how many acres out of each 100 acres of cropland can a farmer afford to put in legumes and grasses?

To answer this question we need to know the effects of 10, 20, 30 percent, or more, of forage (legumes and grasses) on crop yields. Unfortunately, our experimental rotations do not show the effects of so many varying amounts of forage on crop yields. Therefore, we will have to estimate some of them. This is a hard thing to do, but it can be done if we simplify the problem. To do this let us assume:

1. That serious erosion is not a problem (on most farms wind or water erosion will be a problem but we will deal with that later).

2. That the crop weather will be like that we have had from 1943-50.

3. That the crops will receive excellent care and management.

4. That the sweet clover and the last crop of alfalfa-brome will be plowed under (yields would be considerably lower if they were not).

5. That the alfalfa-brome will stand at least three years in all rotations.

6. That these rotations have been in use long enough to show major effects.

By making these assumptions we have conditions quite similar to those under which the crop rotation experiment on the highly fertile Barnes loam at the State College Experimental Farm has operated for the eight years, 1943-50. After things are set up for these favorable conditions, we can change them one at a time and estimate the costs and benefits we may get.

Now let's look at the yields first. Figure 1 will give you an idea as to how we believe corn and oats yields will increase. They increase rapidly.

How much forage should you have in your rotation? There's no rule of thumb to fit every farm, but some close figuring will guide you in selecting the most profitable crop rotation for your farm.
ESTIMATED EFFECT OF FORAGE ON CORN AND OATS

Fig. 1. As more and more legumes are added, the increase in yields of corn and oats slacks off. Yields are estimated from the 1943-50 crops grown on Barnes loam in eastern South Dakota.

at first and then more slowly as more and more legumes are added. The yield figures in the graph are taken from Table 1. How did we get these yield figures?

In Rotation 1 the corn yield of 31 bushels per acre and the oats yield of 37 bushels are the Brookings County average for the eight crop years, 1943-50. Corn and oats are the principal crops in Brookings County and they are grown in about equal amounts.

In Rotation 5 the corn yields of 53 bushels per acre are taken from the experimental yields on highly fertile Barnes loam at the State College Experimental Farm for the eight years, 1943-50. This yield of 53 bushels was obtained by a rotation (not included in the table) of corn-wheat-sweet clover in which the sweet clover was plowed under in late summer.

The other corn, oat, and hay yields were estimated with the help of several members of the Agronomy Department at State College.

Returning to Figure 1, note that the yields climb quite rapidly at first but slow down as more and more legumes are added. This is a
well-known principle of diminishing returns. A wit once said that if this were not true then we could raise all our food in a flower pot by merely adding more and more fertilizers! Speaking of fertilizers, some phosphate is assumed to be used but no nitrogen. It would probably pay, but at the moment we are considering legumes. Estimates of the effects of nitrogen fertilizer on these crop rotations will be prepared at a later date.

How Much Pays Under Good Conditions?

Now let us look at the production per 100 acres of cropland in Table 1. We use 100 acres as a convenient measure, but what we are interested in is the total production per farm. If you have 300 acres of cropland, multiply the results by three. For Rotation 1 we used the average yields per planted acre for Brookings for the years 1943-50. Only 73

Continued on page 80

<table>
<thead>
<tr>
<th>Rotation†</th>
<th>Acres of Land Out of 100 Acres in</th>
<th>Per Acre Yield of</th>
<th>Total Annual Hay Gained per 100 Acres of Grain</th>
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<tbody>
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<td></td>
<td>Forage Corn Oats</td>
<td>Corn Bu. Oats Bu. Hay Tons</td>
<td>Grain Tons Hay Tons Sacrificed Tons</td>
</tr>
<tr>
<td>1. CO (Brookings County)</td>
<td>0 50 50</td>
<td>31† 87†</td>
<td>73</td>
</tr>
<tr>
<td>2. COCOCO COS</td>
<td>11 44 44</td>
<td>45 51</td>
<td>92 $ Comp. $</td>
</tr>
<tr>
<td>3. COCO COS</td>
<td>14 43 43</td>
<td>47 53</td>
<td>93 $ Comp. $</td>
</tr>
<tr>
<td>4. COCOA</td>
<td>20 40 40</td>
<td>50 56 2.0</td>
<td>92 33</td>
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<tr>
<td>5. COCOAA</td>
<td>33 33 33</td>
<td>53 59 2.0</td>
<td>80 55</td>
</tr>
<tr>
<td>6. COCOAAA</td>
<td>43 28 28</td>
<td>53 59 2.0</td>
<td>69 72</td>
</tr>
<tr>
<td>7. COCOAAAA</td>
<td>50 25 25</td>
<td>52 59 2.0</td>
<td>60 88</td>
</tr>
</tbody>
</table>

*Estimated effects of legumes on crop production per 100 acres on Barnes loam in eastern South Dakota under excellent management and with weather similar to that of 1943-50. These estimates were prepared in cooperation with several members of the Agronomy Department. It was assumed: (1) that the rotations have been established long enough to show the major effects of the legumes in the rotation, except in rotation 1 where the yields are expected to decrease in the future; (2) that the alfalfa-brome would stand three years in rotations 4 and 5 before being moved to another field; (3) that enough phosphate is applied to the rotations to avoid limiting effects on crop yields; and (4) that the sweet clover crop and the second crop of the last year of alfalfa is plowed under in late summer; (5) that 2.5 bushels of sweet clover seed and 1 ton of alfalfa hay is harvested before the last crop is plowed under.

†C=corn; O=oats; S=sweet clover; A=alfalfa-brome.
‡For comparison purposes, and as a starting point, the average corn and oats yield per planted acre for 1943-50 was used in rotation 1. It is not assumed that these yields will remain at this level in the future.
§No hay is harvested, but 2.5 bushels of sweet clover seed per acre can be expected.
‖These figures do not agree with acreage and yield columns because the last crop of alfalfa-brome in the final year is not harvested but plowed under. One ton of hay is harvested as a first crop in the last year.
¶Complementary. No grain was sacrificed even though the acres of forage increased. The legumes stimulated or “complemented” the grain production per 100 acres.
Self-Feeding GRASS

By Chase Wilson and Oscar Olson

Good grass silage has many of the features of fresh grass; it is cheaper to feed than hay and it retains more of the original protein. Put up in the silo or stacked in the field, it can be fed to dairy cows all through the winter. Though no production cost figures have been kept in connection with the open stack experiment discussed here, experiments in progress at this station and results at the Vermont Station indicate that the cost of feeding silage is only about half that of feeding hay. This is true even though the cows eat twice as much silage as hay. By next summer the South Dakota Station will be ready to publish cost figures on feeding silage to growing heifers and on milk production.

What is a good way of making open stack grass silage? And what is the nutritive value of this silage compared to fresh grass? To find answers to these questions, a stack of 120 tons of bromegrass and alfalfa silage was made at the Dairy farm of the State College Agricultural Experiment Station in the middle of June 1952. The mixture was mostly brome, as it contained only about 10 to 20 percent alfalfa. The stack was rectangular, approximately 60 feet long and 24 feet wide at the base. After it had finished settling, it was 10 feet high at the top of the crown.

This silage was self-fed during the late summer and early fall months to 50 milking cows. When the stack was about half fed, samples for chemical analysis were taken to evaluate the feeding value of the silage.

How the Silage Was Stacked

A windrower was used to cut and windrow the grass. Very shortly after, it was picked up by a field cuto
Silage from the Stack

The grass was cut shortly after the heads were formed and had emerged from the boots. Its moisture content as it went into the stack averaged 58 percent; this is considered low, as 60 to 70 percent moisture is thought to be necessary for making top quality silage. Nevertheless, the silage was very palatable and the cows ate it readily. Proper fermentation took place (Fig. 1) without the addition of a preservative. It has been shown in previous work that the addition of dry matter is necessary only if the moisture content of the grass exceeds 70 percent; then it is advisable to add dry matter to take up excess moisture.

Stack Located in Well-Drained Area

As it was planned to let the cows self-feed from the stack, it was imperative that the stack be placed
where they would have reasonably dry footing. Therefore, a well-drained spot was chosen to avoid having a mudhole.

**Portable Panels Constructed for Self-feeding**

The ensiling process lasted three months. When in early September the dairy cow pasture ran out because of dry weather, the cows were started on the silage.

Two portable panels were constructed so that the cows could reach through. Each panel was 12 feet long, built on heavy sled-type runners so that it could be pushed forward as the cows ate into the stack. On the average, the cows ate 60 pounds per head per day. They were also fed a limited amount of alfalfa hay during this period.

**Cows Ate Mold on Surface Readily**

A layer of mold formed over the entire surface area of the stack, which ranged in thickness from 6 inches on the top where the silage was reasonably well packed, to 12 to 18 inches on the sides where it was loose and not well packed. One end of the stack was opened for the cows by using the manure fork on the front of the tractor. After the panels were placed in position for the cows to eat, there was no more dry mold hauled from the stack. The cows ate it readily right along with the rest of the silage.

No scouring or digestive disturbance in any of the cows was observed.

**Self-Feeding Saved Labor**

A large amount of labor was saved by the self-feeding of the cows. The only labor involved in feeding was the moving of the panels every second day, after the cows had eaten as far as they could reach. The scoop on the front of the tractor was used to push the panels forward.

**Chemical Composition of the Silage**

When the stack of silage was about half fed, samples for analysis were taken at various points through the center of the stack, as illustrated in Fig. 1. Since analyses had also been made at the time the stack was put up, a comparison of the chemical composition of the freshly cut grass and the silage can be made. This comparison is also illustrated in Fig. 1. The dotted line across the chart represents the average analysis of the freshly cut grass. The bars represent the analyses of the silage samples, and it should be noticed that in going from left to right on the graphs the samples progress from those taken near the outside of the stack to those taken at the center and bottom.

Since the graphs represent only a comparison between the freshly cut material and the silage, they do not accurately show how much of the various constituents was lost from the stack. Actually, large amounts of all constituents might be lost during silage formation without appreciably changing the chemical composition of the silage, provided the rates of loss were similar.

**Moisture Content Inside Stack Satisfactory**

Considerable evaporation might be expected from an open stack
such as was used in this study. A dry, moldy layer about 12 to 18 inches thick at the outer edge of the stack was found to be low in moisture. However, just inside this layer the moisture content increased to almost that of the freshly cut grass. At the bottom of the stack, the moisture content was higher than that of the freshly cut grass, so that the average moisture content of all the material inside of the moldy layer was not much changed from the day of ensiling.

**Crude Protein Equals That of Fresh Grass**

The moldy layer of silage was about equal to the freshly cut grass in its protein content. All other samples were slightly higher. The explanation for the increase may be that during the silage forming processes some non-protein substances (nitrogen-free extract and ether extract) may be partially used by the bacteria, resulting in an increased proportion of other constituents. Future studies should give a more definite explanation for these results.

**Exposure to Air Reduces Ether Extract**

This portion of the silage (sometimes referred to as “fat”) was lower in all samples than in the freshly cut grass. The results suggest that the greater the exposure to air, the greater is the destruction of ether extract. This fraction of the silage is relatively unimportant as far as feeding value is concerned, except that it includes carotene.
Disregarding the carotene, the difference between the ether extract content of the silage and the freshly cut hay is probably of little consequence from a nutritive standpoint.

**Mineral Losses Through Leaching**

The ash (minerals) in plant material is stable material, although losses through leaching may occur during silage formation. Because of the relative stability of ash, as other components of the silage are lost, the remaining material will have a higher ash content. In this study the silage compares well with the original grass as far as this constituent is concerned, but in the samples near the outer part of the stack the ash is somewhat increased. Losses in other constituents may be the cause for this. Leaching may also contribute, since the sample at the bottom of the stack (Sample 1), being low in ash as compared to the original material, probably contains non-mineral constituents leached from above at a faster rate than is the ash.

**Crude Fiber and Nitrogen-Free Extract**

Crude fiber is resistant to chemical and bacteriological change, and is of little value from a nutritive standpoint. The results obtained in the study of crude fiber are quite
variable, but they indicate that the silage is very similar to the original hay in its content of this fraction.

Nitrogen-free extract is that part of a feed (soluble carbohydrates) that yields energy and forms fat. It is quite susceptible to bacteriological decomposition and some of it will disappear as carbon dioxide during silage formation. The results shown in Fig. 1 indicate that the average nitrogen-free extract content of the silage is a little lower than that of the freshly cut grass, but the difference is so small that little significance can be attached to it.

**Carotene Losses in Open Stack Are High**

Because animals can use carotene as vitamin A, it is a very important constituent of silage. Unfortunately, carotene is not very stable, and in the presence of air it is destroyed. In the stack of silage used in this study, the carotene was almost completely destroyed except in the center of the stack and near the bottom, where exposure to air was at a minimum. Samples A through F are so low in their carotene content that they could not under any feeding program be expected to supply the carotene requirements of cattle. Sample G would supply sufficient carotene if fed at a high level, and samples H and I have fairly good carotene levels. Silage stored in closed types of silos (upright, trench, pit, etc.) retains much more of its carotene than did this stacked silage. Where good quality hays are fed along with silage the rather serious losses in carotene in silage stacked like that used in this study, would not be important, since the hay would supply this provitamin.

**Acidity Increases Palatability**

Air encourages acid production in silage, as the results obtained in this study show. Of course in the dry layer where the molds grew, the acids formed were destroyed by the molds and an alkaline condition resulted. However, just inside the moldy layer the acidity was high and it decreased toward the center and bottom of the stack. Acidity increases the palatability of the silage and aids in its preservation. Excessive acid production can, it is true, result in “sour” silage, but none of the samples analyzed here were that acid. Samples at the center and bottom of the stack (G, H and I) were probably a little low in acidity to be considered top quality.

**Further Work Is Planned**

The results of the chemical analyses indicated that the composition of the silage was quite similar to that of the original grass. However, large losses in carotene were found, especially toward the edge of the stack, and it appears that stacked silage should not be relied upon to furnish the carotene requirements of cattle and sheep. Further work will be carried out to establish what factors may be most important in preventing the large loss of carotene. Feeding and digestion trials will also be necessary to determine the efficiency of use of the various chemical fractions by cattle and sheep. (Project 227. Leaders: Chase Wilson, Dairy Dept.; Oscar Olson, Biochemistry Dept.)
Cottage cheese is becoming increasingly popular, since it is both nutritious and inexpensive.

... Improved Methods to Assure High Quality in this Popular Food Product...

By R. J. Baker

Sales of cottage cheese in the United States have almost doubled within the last five years, increasing from 210 million pounds in 1946 to 396 million pounds in 1951. The potential market for this nutritious and versatile dairy product looms very large for several reasons such as: more attractive packaging, better distribution, an improved product that suits most tastes, and better processing methods. Still another factor in the growth of the potential cottage cheese market is the housewife, who, in the face of increased food costs and decreased value of the dollar, is hard pressed to find the means within her budget to feed her family properly and at the same time give them menus that are both appetizing and nutritious.
Nutritional Value of Cottage Cheese

Cottage cheese, whether it be large-flaked or country style, is a wholesome food which is adaptable to a wide variety of menus and one that can adequately replace high-cost protein foods—especially meats. It will replace these high-cost protein foods on an equal basis from a nutritional standpoint, yet at a significantly lower cost.

Proteins are essential in the diet since in the process of digestion they are broken down to amino acids, the "building blocks" for body tissues. Proteins show a wide variation in composition according to the kinds and amounts of amino acids which they contain, therefore some proteins are more valuable in the diet than are others. The proteins of milk, meat and eggs rank at the top of the list of valuable proteins, because, from a nutritional standpoint, they all contain adequate amounts of the essential amino acids. The proteins of milk have the added advantage that they are obtainable at a lower price to the consumer, than are the proteins from meat and eggs. Finally, cottage cheese has another advantage that it is strikingly versatile in the manner in which it can be used—in the form of salads, hot dishes and desserts. All this, and economy too, can be found in cottage cheese. No wonder this is such a popular food!

Good Milk Is Necessary for Quality Cheese

The best quality of raw milk that can be produced is one of the primary necessities for the production of high quality cottage cheese. The milk must be fresh, wholesome, reasonably rich and free from antibiotics (penicillin, aureomycin, etc.). A fresh, wholesome product will usually be free from off-flavors and odors, which is necessary for a mild flavored product such as cottage cheese. The milk must be reasonably rich so that the skim milk will have a total solids content which is high enough to yield a satisfactory product. Lastly, the milk must be free from antibiotics so that the desirable lactic acid bacteria will grow rapidly and produce enough lactic acid to coagulate the milk.

Effect of Total Solids in the Milk

One phase in the manufacture of cottage cheese which has been studied is the effect of total solids content upon the resultant cottage cheese curd. Unsatisfactory results were obtained in the spring of 1950 with milk which had a low total solids content. Even though sufficient acid development took place, the milk did not form a firm enough curd so that it could be cut and cooked in a normal manner.

Subsequent work has shown that the problem can be largely overcome by the addition of dried milk-solids-not-fat (skim milk powder)
to the fluid skim milk. The addition of 2 percent of dried milk-solids-not-fat is usually sufficient to yield a cheese of satisfactory quality. Extra grade non-fat dry milk solids made by the low heat process is recommended. This is also known as a special dairy type of powder.

Adding Dry Milk Solids Creates Problem in Measuring Acidity

The addition of non-fat dry milk solids to the milk presents another problem in the manufacture of uniform quality cottage cheese. Titratable acidity, which has been used by cheesemakers for many years as a measurement to indicate when the curd should be cut and cooked, no longer has the same meaning after dry solids-not-fat have been added. Increasing the solids causes an increase in the acidity at which coagulation takes place. For this reason, acidity titration cannot be used when additional solids are used in the milk, unless allowance is made for the increased acidity due to the added solids. Of greater value as a means of measuring acidity is the use of electrometric pH measurements which show the true acidity.

Experimental work has shown that the proper control of pH during the cheese making process is very critical in the production of top-quality cottage cheese. The most crucial stage in the manufacturing process is during the stage of cutting and cooking the curd. The pH range of 4.75 to 4.65 for cutting and cooking the curd is the most desirable. At this stage the resultant curd will be fine textured, of uniform size and will be tender. If the curd is cut and cooked at a pH higher than 4.75 (less acidic) the resultant curd will be tough. If the pH is below 4.65 (more acidic) when the curd is cut and cooked, the curd tends to break up into fine particles and is soft and mushy. In either case, whether the curd is tough or soft and mushy, the cheese is not readily accepted by the consumer.

It is hoped that additional work on this project will give further information on the effects of solids, acidity and salt balance on the cheese manufacturing procedure. (Project 169. Leader: R. J. Baker, Dairy Dept.)

Why Avoid Antibiotics in Milk?

Antibiotics, the wonder drugs that help fight infectious diseases, present a real headache to the cheesemaker. Penicillin, aureomycin or streptomycin are commonly used to combat mastitis. Once forced into the mammary gland through the teat canal, the drug keeps working in the milk and kills the lactic acid bacteria that are essential in cheese production.

Milk from a treated cow will be unfit for cheesemaking for at least 72 hours, and as little as 1 portion of milk from a treated udder when mixed with 80 portions of normal milk will contain antibiotics at a level high enough to prevent lactic acid development.

No simple, rapid tests have been developed to date for detecting antibiotics in milk. The processor must depend upon the producer to refrain from shipping milk from a treated cow for at least 72 hours.

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Willows and Poplars

FOR YOU OR FOR THE BEETLES?

By H. C. Severin

EnEMY NUMBER ONE of South Dakota's willows and poplars is the striped cottonwood leaf beetle. With the coming of spring these beetles will leave their hibernating places and start on their destructive work by eating the young green leaves and tender shoots of the trees.

After hibernating through the winter in the soil or under fallen leaves, the beetles fly to the trees to feed as soon as the weather warms up and tree leaves unfold. Should the beetles be numerous at this time, clusters of them may be found feeding upon the tender leaves and stems of each new shoot. An efficient spray that can easily be mixed on the farm will stop this pest from defoliating the trees. Severe defoliation may result in considerable winter killing of the trees.

Beetle Easily Recognized

The striped cottonwood leaf beetle is easily recognized by the eight black stripes on its yellow wing covers. The beetle's size and markings vary; an average beetle measures about five-sixteenth of an inch (size of a corn kernel), and is oval in shape. The part of the body in front of the wing covers is yellow or reddish except for a large black central spot and a smaller black spot to the
The striped cottonwood leaf beetle (A) passes through four stages in its life cycle: the egg (B), the larva or grub (D), the pupa (E), and the adult beetle. The egg clusters (C) contain a variable number of eggs, sometimes as many as a hundred. During the process of changing from grub to pupa, the larval skin is shed, but the back end of the body remains in the cast larval skin. Since the skin is fastened to the tree, this holds the pupa to the tree. While in the pupal stage, the insects do not feed or move. In a week, or 10 days, depending on the temperature, the pupa changes to adult beetle (*Chrysomela scripta* F.)

The yellow eggs of the leaf beetle are oval and are glued by their lower ends to a leaf surface. Eggs are deposited closely together and form compact groups. If the weather is warm, the eggs hatch in about a week or less, but will require about two weeks when it is cool. The young black larvae, or grubs, which emerge from the eggs, cluster together and feed upon the lower surface of the leaves and the soft tissues between surfaces. As the grubs become older, they scatter over neighboring leaves and eat the entire leaves except the bases of the larger veins and the leaf petioles (stems). During their life as grubs, they molt several times, and as their size increases their color becomes lighter. The pupae which develop from the grubs do not feed or move about. After a week or 10 days, de-

Continued on page 79

While in the larval stages, the insects eat entire leaves of poplars and willows, except the larger veins and stems of the leaf,
IF YOUR PIGS travel more than 300 feet from feed to water, you might make better gainers out of them by putting their source of feed and water closer together.

After two summer feeding trials at the State College Agricultural Experiment Station, one in 1950 and the other in 1952, the results show that growth, feed and water consumption, and the feed required to produce 100 pounds of gain were apparently not affected when the distance between feeders and waterers was less than 300 feet. But when the distance was increased to 560 feet in a rather hot, dry summer, the rate of gain was significantly decreased. Less feed and water were consumed, but there was no apparent change in the feed required to produce the gain.

Weather May Play a Part

During the unusually cool summer of 1950, from July 20 to October 25, four lots of 10 pigs each were fed on alfalfa pastures of equal size. The distance between the self-feeders and the waterers in the four pastures varied from a minimum of 10 feet to a maximum of 300 feet. During this period, the average maximum daily temperature was 67.7° F., and at no time did the temperature exceed 93° F. This meant that the average temperatures for the months of July and August were below normal for Brookings where these trials were conducted.

No essential differences were obtained between these four lots of pigs in daily gains, daily feed and water consumed, or in feed required to produce 100 pounds of gain (Table 1). About the only difference observed was that the pigs in Lot 4 grazed their pasture more evenly and more completely than those on pastures where there was less distance between the feeders and waterers.
### SUMMARY OF RESULTS IN THE SUMMER OF 1950

**Table 1. Daily Gains and Feed Consumed per Hundredweight When Distance Between Feed and Water Was Less Than 300 Feet**

<table>
<thead>
<tr>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-Ft. Distance Between Feeder and Waterer</td>
<td>50-Ft. Distance Between Feeder and Waterer</td>
<td>150-Ft. Distance Between Feeder and Waterer</td>
<td>300-Ft. Distance Between Feeder and Waterer</td>
</tr>
<tr>
<td><strong>Number of pigs</strong></td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Average number days on pasture per pig</strong></td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td><strong>Average initial weight per pig, lbs.</strong></td>
<td>57.4</td>
<td>57.5</td>
<td>57.6</td>
</tr>
<tr>
<td><strong>Average final weight per pig, lbs.</strong></td>
<td>208.0</td>
<td>210.1</td>
<td>211.7</td>
</tr>
<tr>
<td><strong>Average total gain per pig, lbs.</strong></td>
<td>150.6</td>
<td>152.6</td>
<td>154.1</td>
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<tr>
<td><strong>Average daily gain per pig, lbs.</strong></td>
<td>1.52</td>
<td>1.54</td>
<td>1.56</td>
</tr>
<tr>
<td><strong>Feed consumed per pig</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average daily corn, lbs.</strong></td>
<td>4.75</td>
<td>4.58</td>
<td>4.67</td>
</tr>
<tr>
<td><strong>Average daily protein supplement, lbs.</strong>*</td>
<td>0.77</td>
<td>0.80</td>
<td>0.73</td>
</tr>
<tr>
<td><strong>Average daily mineral, lbs.</strong></td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Average daily feed, lbs.</strong></td>
<td>5.54</td>
<td>5.40</td>
<td>5.42</td>
</tr>
<tr>
<td><strong>Water consumed per pig per day, gal.</strong></td>
<td>1.21</td>
<td>1.22</td>
<td>1.23</td>
</tr>
<tr>
<td><strong>Feed consumed per cwt. of gain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shelled yellow corn, lbs.</strong></td>
<td>312.5</td>
<td>297.0</td>
<td>299.9</td>
</tr>
<tr>
<td><strong>Protein supplement, lbs.</strong></td>
<td>50.8</td>
<td>51.8</td>
<td>47.1</td>
</tr>
<tr>
<td><strong>Mineral mixture, lbs.</strong></td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total, lbs.</strong></td>
<td>364.7</td>
<td>350.2</td>
<td>348.4</td>
</tr>
</tbody>
</table>

*Equal parts of tankage and soybean oil meal.

### SUMMARY OF RESULTS IN THE SUMMER OF 1952

**Table 2. Daily Gains and Feed Consumed per Hundredweight When Distance Between Feed and Water Was Less Than 560 Feet**

<table>
<thead>
<tr>
<th>Lot 1</th>
<th>Lot 2</th>
<th>Lot 3</th>
<th>Lot 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-Ft. Distance Between Feeder and Waterer</td>
<td>100-Ft. Distance Between Feeder and Waterer</td>
<td>300-Ft. Distance Between Feeder and Waterer</td>
<td>560-Ft. Distance Between Feeder and Waterer</td>
</tr>
<tr>
<td><strong>Number of pigs</strong></td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Average number days on pasture per pig</strong></td>
<td>107.0</td>
<td>108.0</td>
<td>108.0</td>
</tr>
<tr>
<td><strong>Average initial weight per pig, lbs.</strong></td>
<td>50.9</td>
<td>50.8</td>
<td>50.6</td>
</tr>
<tr>
<td><strong>Average final weight per pig, lbs.</strong></td>
<td>222.0</td>
<td>221.4</td>
<td>218.2</td>
</tr>
<tr>
<td><strong>Average total gain per pig, lbs.</strong></td>
<td>171.1</td>
<td>170.6</td>
<td>167.6</td>
</tr>
<tr>
<td><strong>Average daily gain per pig, lbs.</strong></td>
<td>1.60</td>
<td>1.58</td>
<td>1.55</td>
</tr>
<tr>
<td><strong>Feed consumed per pig</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average daily corn, lbs.</strong></td>
<td>4.98</td>
<td>4.88</td>
<td>4.79</td>
</tr>
<tr>
<td><strong>Average daily protein supplement, lbs.</strong>*</td>
<td>0.71</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Average daily mineral, lbs.</strong></td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Average daily feed, lbs.</strong></td>
<td>5.71</td>
<td>5.52</td>
<td>5.42</td>
</tr>
<tr>
<td><strong>Water consumed per pig per day, gal.</strong></td>
<td>1.23</td>
<td>1.31</td>
<td>1.13</td>
</tr>
<tr>
<td><strong>Feed consumed per cwt. of gain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shelled yellow corn, lbs.</strong></td>
<td>311.4</td>
<td>308.9</td>
<td>308.6</td>
</tr>
<tr>
<td><strong>Protein supplement, lbs.</strong></td>
<td>44.6</td>
<td>39.9</td>
<td>40.4</td>
</tr>
<tr>
<td><strong>Mineral mixture, lbs.</strong></td>
<td>0.7</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total, lbs.</strong></td>
<td>356.7</td>
<td>349.4</td>
<td>349.6</td>
</tr>
</tbody>
</table>

*Equal parts of tankage and soybean oil meal plus 1 lb. of Aurefac 2A per 100 lbs. of supplement.
Trial Repeated in a Warm, Dry Summer

It seemed advisable to repeat the trial in a summer which would be more like that of a normal eastern South Dakota summer. Thus, the trial was repeated in the summer of 1952. In this trial, the four lots of pigs were on alfalfa-brome pasture from June 9 to October 9.

During this period, the average maximum daily temperatures for June, July, August, September and October were 82.6° F., 85.3° F., 81° F., 77° F., and 60° F., respectively, with the month of June being the warmest June since 1936. For this trial the distance between waterers and feeders in the first lot was increased to 20 feet, and in the fourth lot, to 560 feet.

Gains Decreased With Distance

In this trial, the average daily gain decreased as the distance between waterers and feeders was increased (Table 2). However, only the difference in gain between Lot 1 and Lot 4 could be attributed to other than chance alone. The amount of daily feed consumed decreased as the distance increased between the feeders. The amount of water consumed decreased similarly when the distance between feeders and waterers was greater than 100 feet. Again, as in the 1950 trial, the feed required per 100 pounds of gain was not much different in any of the lots.

These results indicate that average daily gains, and feed consumed per 100 pounds of gain are not materially affected if the distance between feeders and waterers is less than 300 feet. (Project 207. Leaders: R. F. Wilson and R. C. Wahlstrom, Animal Husbandry Dept.)

Willows and Poplars for You or the Beetles?

Continued from page 76

Depending on the temperature, the pupae are transformed into beetles and these, after feeding for a short time, mate and start another generation.

Sprays Can Control the Pest

For best results, both upper and lower surfaces of the leaves should be coated with the spray. The first application should be made early in the spring, as soon as the beetles make their appearance on the trees, and should be repeated whenever necessary during the growing season.

The following spray formulas are recommended:

Lead arsenate (dry, powdered, commercial)—4 pounds in 100 gallons of water, or

DDT (50 percent wettable powder) 4 pounds in 100 gallons of water, or

Aldrin (emulsion)—2 ounces, actual, in 100 gallons of water, or

Dieldron (25 percent wettable powder)—1 pound in 100 gallons of water.

If it is desired to make up less than 100 gallons of spray at a time, this may be done, but the relation of the quantity of insecticide to water should be maintained as indicated in the recommended formulas. (Project 142. Leader: H. C. Severin, Entomology Dept.)
How Much Forage Pays?

Tons of grain would be produced under these circumstances. Reading down the columns we estimate that the total annual production of grain will increase with the forage until 93 tons of grain are produced with 14 acres of legumes in Rotation 3. Remember that the sweet clover crop and the last alfalfa crop are plowed under in late summer each year. But Rotation 3 is clearly profitable even though the forage is plowed under and not used for hay or forage at all!

When an increase in the acreage of legumes also increases the total grain production, we are in what is known as the complementary range (see last column, Table 1). In other words, one crop furnishes something which the other crop needs—in this case, nitrogen. The legumes increase yields rapidly enough to more than offset the land taken out of grain. For example, increasing legumes from none to 14 acres per 100 jumped grain production by 20 tons! The yield increases more than offset the 14 acres taken out of production. Farmers with level barnes loam soil can profitably keep 14 acres out of every 100 in legumes with weather like that we had in 1943-50. This can be done when more legumes increase total production per 100 acres.

With Rotation 4 we enter what is known as the competitive range. Here forage competes with grain production. Yield increases of grain are not big enough to offset the reduction in production caused by putting more land in forage. That is what happens when the legumes are increased to 20 acres as in Rotation 4. The 3-bushel increase in corn and oats yields was not enough to offset the 3-acre drop in corn and oats acres caused by planting 6 acres more legumes. However, for the ton of grain lost we gain 33 tons of alfalfa-brome hay. So no matter whether it is sold or fed, Rotation 4 would pay. Furthermore, there would be less risk because seasons unsuited to grain frequently produce good hay.

Now how about Rotations 5, 6 and 7? These rotations are all in the highly competitive range. The land taken out of legumes is not offset by rapidly rising yields. Hence, the total production of grain per 100 acres falls quite rapidly to 80, 69 and 60 tons. Hay production is increasing but not fast enough to make these rotations unquestionably profitable under farm management practices usually followed.

In Rotation 5 for example, for each ton of grain sacrificed only 1.8 tons of legume hay are gained (see last column, Table 1). At the prices expected in the next few years, it will take about three tons of loose hay to equal the price of a ton of grain. Furthermore, there is evidence that hay production costs are greater per acre than grain.

However, if a farmer needs hay for his own livestock, Rotation 5 will pay. Why? About 75 percent of the grain mixture and 50 percent of the hay are total digestible nutrients (TDN). That means for 1500 pounds of grain nutrients lost the farmer would gain 1800 pounds of hay nutrients. Since the hay has considerably more protein, the trade may pay. But hay production costs

Continued from page 65
are higher than for grain and the livestock farmer may have all the hay he needs. A sharp pencil will be needed here.

If the farmer needs still more hay for livestock, he is likely to shift from Rotation 5 to 6. With Rotation 6 only 1.5 tons of hay are gained for each ton of grain lost (see last column, Table 1.) That means for 1500 pounds of grain nutrients lost the farmer would gain 1500 pounds of hay nutrients with more protein. As mentioned above, hay costs per acre are higher but a livestock farmer who needs the hay can probably afford it.

If the farmer has need of the hay for a profitable livestock enterprise, Rotation 7 may be used instead of Rotation 5. In this case, sacrifice of 20 tons of grain is offset by an increase of 33 tons of hay. Or in terms of nutrients, he loses 15 tons of grain nutrients and gains about 16 tons of hay nutrients with more protein. On the other hand, hay costs more per acre to produce than grain and will bring less than the grain if it has to be sold. The answer, then, depends upon the farmer’s circumstances. A dairy farmer with only 100 to 200 acres of cropland could probably use the hay to good advantage. Farmers with larger crop acresages probably will not need this much hay and grain will be more profitable as a cash crop.

If Erosion Is Serious

Thus far we have been talking about the effect of forage on level land not subject to serious sheet or gully erosion. How about land that is subject to serious erosion? We do not know how much forage pays on land subject to erosion, but we can be fairly certain that more forage pays than is indicated in Table 1. The ideal situation would be for farmers on cropland with serious erosion problems to have quite a bit of forage consuming livestock and use Rotations 5, 6 or 7. Just how profitable these rotations would be would depend largely upon the effect which erosion will have on production and how much drop in production can be prevented by different amounts of legumes. Terraces and contours may be needed to help do the job. It is a tough problem, but we are going to try to find the answer.

Some Obstacles to Soil Conservation

Rotation 4, with 20 acres out of 100 in forage (20 percent) looks quite profitable and one wonders why so few farmers grow this much legumes. In Brookings County over 50 percent of the land is rented by tenants. For the state it is slightly less, or 45 percent in 1950.

Practically all of that land is rented on a crop-share basis for one year, or from year-to-year. Landlords cannot be blamed for this. On the other hand, tenants cannot be blamed for being reluctant to seed forage crops which they may not be able to harvest because their lease may end. Likewise, the situation is complicated because tenants frequently lack livestock to use the forage. Landlords are often reluctant to accept a low cash rent or a share of hay instead of grain. However, these estimates indicate that he cannot afford to keep less than 14 acres in legumes even if he gets no rent for this land.
Lack of capital for fences, wells, barns, and livestock are other reasons why owners as well as tenants do not grow more legumes and grasses. The short-run drop in income which often occurs while changing over to a conservation plan also discourages many farmers.

Even though forage may increase the total production of nutrients, it has to be fed to roughage consuming livestock. Some farmers undoubtedly find that on their farm, hogs and chickens give higher returns per 100 dollars invested than do beef or dairy cows or sheep. Hence, even though the forage could be profitably produced and fed, they may believe that still greater returns can be had from their limited resources with grain consuming hogs and chickens.

A few farmers can specialize in legume seed production and make high legume rotations pay. However, this is a specialized business with a limited market. Overproduction of seed at times forces most people who try this to return to grain and forage production.

Finally, there is a serious lack of knowledge about the costs and benefits of conservation. For example, how will fertilizers, terraces, contours, fit together in the farm plan? What is the most profitable combination of these devices to increase production and prevent erosion? These estimates are a first step in assembling such information in order that costs and benefits can be analyzed.

It Depends

The answer then to the question, "How much forage pays?" depends upon whom you are talking to, and the particular conditions of his farm. In the eastern part of South Dakota, these estimates indicate that it will pay livestock farmers to keep at least 20 percent of their crop acreage in legumes under the weather and management conditions assumed. If the land is subject to erosion, of course more may be justified. How much more depends upon the seriousness of the erosion, the extent to which more legumes and grasses will keep it under control, the use that can be made of the hay, relative prices of grain and hay, and other factors.

Dairy or beef cattle or sheep producers who need the hay may be able to keep 33 acres out of 100 in legumes, but they could not afford to do this if they had to sell the hay. Only a few seed specialists dare venture beyond this point if our estimates are correct. They could profitably use Rotations 5, 6 or 7, depending upon seed prices or hay needs. Also, new methods of handling grass-legume silage may make it profitable to produce more forage on dairy farms. (Project 211. Leader: Russell L. Berry, Agricultural Economics Department.)
Turkeys grown on a range that supplies good forage require less grain and concentrated feed than those grown in confinement or in an "exercise lot." Experience has shown that from 10 to 20 percent less feed may be required for the period of 10 weeks of age to market time, if good green range is available. This can result in a sizeable cut in the feed bill.

It is a common recommendation that one acre of range be allowed for each 100 turkeys grown. If heavy breed turkeys are placed on range when they are 10 weeks old and are sold at 26 weeks of age, they may be expected to consume about 65 pounds of grain and mash per bird during the range period, or 6500 pounds per 100 birds. When good range reduces food requirements by 10 percent, feed saved per 100 birds would be 650 pounds. If the reduction reaches 20 percent, one could save 1300 pounds of feed per 100 birds. On this basis, estimating the average cost of the feed saved at only 4 cents per pound, an acre of good range could save the turkey grower feed worth from $26 to $52. This would be considered good annual cash rent for South Dakota farm land, even though allowances are made for seed costs and other minor expenses.

Succulent green pasture is recognized as an excellent source of both fat-soluble and water-soluble vitamins. It also provides appreciable amounts of protein and minerals. When turkeys are kept on land not used for poultry for the previous two years, and are moved to a new location on such land regularly, protection against soil-borne diseases
and parasites is provided. Crops which provide a dense sod reduce the opportunities for direct contact with the soil, when compared with crops that have little sod-forming ability. Cannibalism and feather-picking are far less troublesome in flocks provided with good range than in flocks grown in confinement or on poor range. Sound use of good range can reduce feed costs and disease hazards in raising turkeys.

Desirable forage crops for turkeys should provide young, new growth during the time the birds are from 10 to 26 weeks of age. Date of hatching determines the period when forage requirements will be greatest. Turkeys hatched April 15 would be ready for the range on or about the first of July. Their greatest use of forage would come during July, August, and September. These are months of high temperatures and low rainfall in South Dakota. Many of our common pasture grasses make but very little new growth during these months.

For several years, turkey feeding trials have been conducted at the North Central Substation at Eureka using a variety of crops as forage. Under each heading are given the observations made when the different crops were used for turkeys.

**Proso Millet**
This was used both for summer forage and for grain to be harvested by the turkeys. When drilled in a solid stand it was fairly good. However, as the season advanced, there was a tendency for birds to clean it up as they went rather than feed over the entire plot. When the proso was allowed to mature before the turkeys were moved in, the birds did a good job of stripping out the seed, but there was considerable loss due to lodging and shattering. Proso does not stand and hold its seed long enough after it ripens to be most useful from this standpoint.

**Sorghum and Milo**
Several varieties have been tried. They made good growth in spite of low moisture supplies and hot weather. They would seem to be most useful when permitted to mature seed which turkeys can harvest. Some years early frosts stopped growth before the seed had matured. Even with short-stemmed varieties, it was usually necessary to break over some of the stalks in order to get the turkeys to start eating the seed. With taller growing types, it may be necessary to break down practically all of the sorghum as additional supplies are needed. This can be done by driving down the rows with a truck or tractor.

**Rape**
This has been one of the most useful forage crops tried so far. The seed is not expensive and it is not hard to get a stand in the more humid areas. Rape may be seeded alone, or combined with a light seeding of oats. It starts quickly and has ability to come back after being heavily pastured. Turkeys like rape and will eat it down to stumps if the supply is not plentiful. Rape does not form a sod. It is an annual crop that can be seeded and pastured the same year. Some turkey growers include a light seeding of rape in their small grain. After the grain has been harvested, the
rape will make sufficient growth to provide good fall pasture. Rape will continue to grow in the fall of the year until hard freezes occur.

**Sudan Grass**

This grass has made a lot of forage during hot weather. Since it is usually seeded late in the growing season, and since it requires high temperatures, it cannot be depended upon to furnish much pasturage until after mid-July. Like some other crops that grow rather tall, it may require some clipping to keep the new growth at a height that can be reached by the turkeys. When Sudan grass was allowed to grow tall, the turkeys did not range over more than a small area close to the shelters and feeders.

**Sunflowers**

Small, experimental plantings have been tried of a short-stemmed, combine-type of sunflowers. They were planted in rows and were cultivated like corn. Under these conditions sunflowers did not produce much usable forage. A good seed crop was produced and it might have been a feed saver if the turkeys had actually consumed the seed. When the sunflower seed approached maturity, multitudes of wild blackbirds descended upon the plantings and succeeded in harvesting the seed before the turkeys were able to use much of it. Various methods were used to try to discourage the blackbirds. None were successful.

**Alfalfa**

This perennial crop must be seeded at least a year before it is ready for use. It has furnished an excellent quality of forage and it stands clipping very well. In dry, hot seasons it failed to make a great amount of new, fresh growth during August and September. The cost of seed may be high at times, and it is not always easy to get a good stand. Unless one uses very early hatched turkeys, it should be possible to get a crop of hay from alfalfa before the turkeys will be ready for the range.

**Other Crops Offer Possibilities**

Crops which have not yet been tested at the North Central Substation, but which may offer possibilities for some sections of South Dakota, would include Birdsfoot trefoil and Ladino clover. These are perennial legumes that would seem to hold promise where moisture supplies are adequate and where severe winter-killing is not an excessive hazard. Reports thus far would indicate that Ladino may not be successful except in the southeastern part of the state. Birdsfoot trefoil has been grown on such a limited scale thus far that its potential territory is not yet established. Creeping alfalfa offers interesting possibilities, but a shortage of seed supplies will probably limit trials of it for some time.

The search continues for a forage crop or crops that will most effectively meet the need of turkey growers. Such experience should aid the grower to reduce the costs of producing turkeys and thus improve his position in our agricultural economy. (Project 79. Leaders: Wm. Kohlmeyer, C. W. Carlson, Poultry Dept.)
DRYING THE Corn Crop

By H. H. DeLong

Drying corn, either on the ear or shelled right from the field picker sheller, is a practice which is becoming more common in South Dakota. The fact that seasonal changes vary greatly and are unpredictable, makes the need for drying equipment urgent in some years and quite unnecessary in others. To furnish reliable information to farmers interested in grain drying, the Agricultural Engineering department undertook investigations on types of drying equipment, and on three methods of drying: (1) open crib drying, (2) forced cold air drying, and (3) forced heated air drying.

Since the moisture content of corn affects its market grade and selling price, the farmer may realize a greater return by drying his high moisture corn. The proper moisture content for shelled corn in storage has long been recognized: 13 percent moisture content is considered a safe figure, but for long-time storage and assurance against both mold and insect damage, 12 percent is sometimes desirable. Ear corn of 18 percent moisture is safe for storage in slatted cribs.

Drying corn below 14 percent moisture for marketing may penalize the producer by reducing the marketed weight without increasing the grade or price. U. S. grain grades for corn, with respect to moisture content, are as follows:
No. 1—14 percent; No. 2—15.5; No. 3—17.5; No. 4—20 percent. There are, of course, other requirements for the U. S. grades of corn in addition to given moisture content.

**Determining Moisture Content**

Moisture content is commonly defined in terms of the original sample weight or "wet weight." After drying, a sample is then defined in terms of a new "wet weight." An illustration of this is given in Fig. 1 which shows the percentage of moisture in the original sample, the moisture removed, and the moisture remaining to give 14 percent of the new sample.

There are some basic principles in drying grain that will help make the process clearer to the farmer who is interested in drying his corn. For instance, all grain may release moisture to the air or absorb it from the air. At a given temperature the aid and grain will reach a hygroscopic (moisture) balance. Knowing this, the farmer will not let his drier run on a wet day or he will have wetter corn than he had to begin with, particularly if he is using cold air drying. (See Table 1.)

**Fig. 1. Moisture relation to dry matter in corn**

Using the graph above, you can find the weight of corn you will have left after drying the corn down to 14 percent moisture. If you had a 100-pound sample of corn with 20 percent moisture, you would need to remove about 6.6 pounds of water to have a new sample of 14 percent moisture weighing 93.4 pounds, with a dry matter weight of 80 pounds. (For 10,000 pounds of corn, multiply the results by 100.) *Editor's note:* Don't let those figures on top of the columns confuse you. Our agricultural engineers explained them this way: In the same column, (20 percent moisture) it says at the top of the column that if 6.6 pounds of water are removed, 13.3 pounds of the original moisture is left to equal 14 percent of the new sample.

**Table 1.**

<table>
<thead>
<tr>
<th>Weight to be removed in pounds of water</th>
<th>24.5</th>
<th>18.5</th>
<th>12.7</th>
<th>6.6</th>
<th>1.1</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of original remaining to give 14% moisture corn</td>
<td>10.5</td>
<td>11.5</td>
<td>12.3</td>
<td>13.3</td>
<td>14.4</td>
<td>14.0</td>
</tr>
</tbody>
</table>

**Hours of Operation**

```plaintext
<table>
<thead>
<tr>
<th>Percent moisture in original sample - wet basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
</tr>
</tbody>
</table>
```

Edited by: Don't let those figures on top of the columns confuse you. Our agricultural engineers explained them this way: In the same column, (20 percent moisture) it says at the top of the column that if 6.6 pounds of water are removed, 13.3 pounds of the original moisture is left to equal 14 percent of the new sample.
Table 1. Adsorbed Moisture Equilibrium for Shelled Yellow Dent Corn with Air at Various Humidities (77° F.)

<table>
<thead>
<tr>
<th>Relative humidity</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content, %</td>
<td>6.43</td>
<td>8.39</td>
<td>10.47</td>
<td>12.93</td>
<td>14.78</td>
<td>19.06</td>
<td>23.78</td>
</tr>
</tbody>
</table>

*From Coleman and fellows, USDA.

Note that air at 77 degrees and 75 percent relative humidity will not dry corn below the 15 percent moisture content. In fact, corn that is drier than 15 percent will again take on moisture from the air. This situation is further complicated by the fact that molds grow on grains when the surrounding air is at 75 percent relative humidity, or above.

Cold air will hold, or carry very little moisture, but warm air will carry relatively large amounts. To take the guesswork out of drying corn, the farmer may be interested in consulting a psychrometric chart, or in looking up the equivalent information in tables.

Crib Drying

Ear corn that contains only a little more than the 18 percent moisture for safe storage will dry down in open cribs in many seasons. Narrow cribs, or those with adequate ventilators or breezeways are best. During the 1945 season, the South Dakota Station found that the cribs giving the best results were those in which no part of the cribbed corn was more than two feet from a side wall or a ventilator. These tests were run with corn of 30 percent moisture, and some damage from mold occurred; in fact, mold was present on the corn before it was placed in the cribs.

Drying with Forced Cold Air

Drying corn by forced cold air is satisfactory in weather that is reasonably warm and dry. Early corn harvest may allow favorable drying time in late October and in part of November. Blowing cold air through the corn will do little if any drying. However, to check heating and molding of grain, it may be expedient to force cold air through it to cool it down, even below the freezing point. The fan should not be operated in rainy weather.

The process of drying with cold air is a slow one, and the installation of fan and electric motor should be such that it can be left to operate with a minimum of the operator's time. The cold air fan and motor are less expensive than the heater dryer.

Any dryer arrangement requires a good air distribution system. Ducts should not restrict the air passage from the fan, should give an even air supply to all parts of the crib, and the air path should be about the same distance through all parts.

Drying with Forced Heated Air

Rapid drying of corn requires heated air and a factory-built combination of fan and burner with the proper controls. Such a dryer (see illustration) was operated in the fall of 1952 on a 1700-bushel upright cylindrical crib of corn. A vertical flue running up three-fourths the height of the crib was used for air distribution.

Most of the corn in the 1952 season was mature and dry. However,
one field in this experiment produced corn which averaged 23.7 percent moisture. It also contained some very soft ears. Individual ear tests ran from 15 percent to 55 percent, with some ears of 30 percent moisture content in every load.

The crop dryer used was of the direct fired type, 7½ HP motor, rated 16,500 cubic feet per minute at 1/2-inch static pressure, with dual burners that consumed 10 gallons of fuel oil per hour when set to run continuously. This dryer was operated a total of 15 hours (burner ran 13½ hours) on the following dates: Nov. 21, 24, 25, and Dec. 4 and 5. On these days the outdoor temperatures were uniform, varying from 25 to 42 degrees F. The burner raised temperatures in the crib inlet to above 150 degrees F.

For the 15 hours operation, 120 gallons of fuel were consumed at a cost of $16.80. Power cost for the 7½ HP motor, operating on 230V, was estimated at $2.10, figured at 2 cents per kwh. (A smaller motor is recommended for farm lines.)

At the close of the test, samples were obtained from the outside layers of corn and these tests averaged

Continued on page 101
Considerable interest has been expressed in the feeding qualities of Feebar barley which was released by the South Dakota Station in 1947. This barley is grown widely in the state and is noted for its high yield, resistance to stem rust and high protein content.

Feeding trials conducted at several experiment stations where barley of various weights, grades and types was fed, have shown that ground barley of good quality, either feeding or malting type, has approximately 90 percent the feeding value of corn. To determine the relative feeding value of Feebar barley, it was compared to No. 2 yellow shelled corn in two feeding trials conducted during the winters of 1949-50 and 1950-51.

How the Feeding Trials Were Conducted

Ten pigs were fed in each of two lots from weaning to a final weight of approximately 225 pounds. These pigs were of the Duroc, Poland China, Spotted Poland China and Hampshire breeds. They were allotted on the basis of breed, sex, age and litter to give lots which were as nearly alike as possible. They were housed and fed on concrete during the feeding period. Each lot of pigs received either No. 2 yellow shelled corn or medium ground Feebar barley, a protein supplement and a mineral mixture.

In the first trial, the protein supplement consisted of:

2 parts tankage
1 part soybean meal
1 part dehydrated alfalfa
1 pound of vitamin A and D oil for each 400 pounds of protein supplement

The mineral mixture was as follows:

2 parts steamed bone meal
2 parts ground limestone
1 part iodized salt

In the second trial, the protein supplement consisted of:

42 parts tankage
27 parts soybean meal
26 parts ground, sun-cured alfalfa hay
5 parts of a complex mineral mixture

Barley for years has been one of South Dakota's most dependable feed crops for pigs.
Table 1. Ground Feebar Barley Compared to Shelled Yellow Corn
Summary of Results 1949-50

<table>
<thead>
<tr>
<th>10 Pigs in Each Lot</th>
<th>Lot I</th>
<th>Lot II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shelled</td>
<td>Ground</td>
</tr>
<tr>
<td></td>
<td>Yellow Corn</td>
<td>Feebar Barley</td>
</tr>
<tr>
<td>Average number days on test</td>
<td>103.0</td>
<td>113.0</td>
</tr>
<tr>
<td>Average initial weight, lbs.</td>
<td>55.2</td>
<td>53.4</td>
</tr>
<tr>
<td>Average final weight, lbs.</td>
<td>224.4</td>
<td>224.0</td>
</tr>
<tr>
<td>Average total gain, lbs.</td>
<td>169.2</td>
<td>170.6</td>
</tr>
<tr>
<td>Average daily gain, lbs.</td>
<td>1.64</td>
<td>1.51</td>
</tr>
<tr>
<td>Average daily feed consumed per pig, lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>5.81</td>
<td>6.10</td>
</tr>
<tr>
<td>Protein supplement</td>
<td>0.70</td>
<td>0.57</td>
</tr>
<tr>
<td>Mineral</td>
<td>0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>Total feed</td>
<td>6.57</td>
<td>6.71</td>
</tr>
<tr>
<td>Feed consumed per 100 lbs. of gain, lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>354.3</td>
<td>403.9</td>
</tr>
<tr>
<td>Protein supplement</td>
<td>43.0</td>
<td>37.8</td>
</tr>
<tr>
<td>Mineral mixture</td>
<td>3.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Total feed</td>
<td>401.0</td>
<td>444.6</td>
</tr>
<tr>
<td>Feed cost per cwt. gain*</td>
<td>$9.15</td>
<td>$10.34</td>
</tr>
</tbody>
</table>

*Feed prices used: shelled corn, $1.96 per cwt.; Feebar barley (ground), $2.08 per cwt.; tankage, $5.75 per cwt.; sorghum feed, $4.40 per cwt.; dehydrated alfalfa meal, $3.70 per cwt.; vitamin A and D oil, $6.25 per pound; ground feeding limestone, $0.75 per cwt.; steamed bone meal, $1.25 per cwt.; iodized salt, $1.55 per cwt.

The mineral mixture fed in the second trial was the same as that fed in the first except that a trace mineral mixture was added. This mixture was added to the protein supplement and also self-fed free choice.

The barley fed in the first trial had a test weight of 42 pounds per bushel while the corn tested 53.5 pounds per bushel. In the second trial, the corn tested 53 pounds per bushel with 13 percent moisture, and the barley, 45 pounds per bushel.

Feebar Compares Favorably with Other Good Quality Barleys

Greater daily gains were made by the pigs fed the shelled corn, although both lots made good daily gains (Table 1). There was very little difference in total feed required per hundred pounds of gain and in total feed eaten per pig daily. The daily consumption of grain per pig in the ground barley lot was somewhat greater than in the corn lot. However, considerably less protein supplement was consumed in the barley lot than in the corn lot. Consequently, in feed required per hundred pounds of gain, more grain and less protein supplement were required by the barley-fed pigs than by the corn-fed pigs. On the basis of total feed required for a hundred pounds of gain, the ground barley was worth 90 percent as much as the corn.

The feed costs per hundred pounds of gain given for both lots are largely dependent upon the prices paid for the feeds. In this trial, barley cost slightly more per pound than corn. The higher price paid for barley plus the greater requirement per unit of gain resulted in a feed cost of $1.19 more per 100 pounds of gain than for the lot fed shelled corn.

Continued on page 102
By John P. Johansen

South-central Nebraska is a pilot area in regard to irrigation in the easterly parts of the sub-humid Great Plains. South Dakotans who are concerned about the development of irrigation in the James River valley will be interested in observations about irrigation in this region of Nebraska. The area is located about 275 miles south and 75 miles west of Huron, South Dakota. In this region, irrigation is mostly a recent development which includes several types of enterprise and is in process of rapid extension. It may be called a pilot area because it shows the social and economic consequences which may be expected when irrigation is introduced in a long-established farming area. Here, irrigation differs, both in its characteristics and in its consequences, from irrigation developed under arid or semi-arid conditions.

This study is focused upon eight

(Left) Irrigated cane, Huron Development Farm. Photo courtesy Bur. of Rec.

Even a small boy can help irrigate a field of corn with siphon tubes from an elevated ditch. Republican City, Neb. SCS photo
counties located in south-central Nebraska. Four of them—Dawson, Phelps, Kearney and Buffalo—have extensive irrigation, and the other four—Gosper, Furnas, Harlan and Franklin—have, as yet, very little irrigation. Scotts Bluff county located in the western part of Nebraska, has been included in order to make a comparison with an area that has developed an intensive system of irrigation.

The largest area of gravity irrigation in the eastern part of the Great Plains is that of the Tri-county system (which includes parts of Gosper, Phelps, and Kearney counties), also known as the Central Nebraska Public Power and Irrigation District. As its name implies, it is organized to generate hydro-electricity as well as to provide irrigation, and these two purposes involve also allied purposes of water storage and river flow regulation, and the development of recreational facilities on the reservoirs.

Central Nebraska is not an arid region. The average annual precipitation ranges from 20 to 26 inches. But the area is subject to frequent long droughts and poor crops in some years, while in others sufficient rainfall and good crops prevail. Irrigation in this area is largely an optional development which has been adopted because it has been found to result in increased crop

Location of the irrigation area in Nebraska, 275 miles S. and 75 miles W. of Huron
yields, better rotations and more valuable farm production.

The irrigated land in the eight counties mentioned increased from 108,964 acres in 1940 to 237,871 acres in 1950. Land irrigated by Tri-county facilities increased gradually from 44,000 acres in 1942 (the first year of full-scale operations) to 91,477 acres in 1951. Since an ample supply of underground water is available at comparatively low depths in the river valley, irrigation by means of pumped wells has undergone a rapid expansion in Buffalo, Dawson and other counties. The census of irrigation reported 2,382 pumped wells in these eight counties. Most of them are owned and operated by individual farmers.

Irrigation is Semi-intensive

Under arid and semi-arid conditions, irrigation usually brings about a distinct emphasis upon diversified cash crops such as sugar beets, potatoes, dry edible beans, vegetable canning crops, and the like. In the Tri-county area, this emphasis upon specialized cash crops is not present. The acreage devoted to sugar beets or potatoes is relatively small. Some need is felt for a cash crop that fits into the current rotations, but there is no distinct answer as to what it should be. Instead of an intensive irrigation of diversified cash crops, there is an extensive application of water to corn and alfalfa and to some spring grains (oats or barley) which are used as nurse crops for legume seedings.

Where irrigation approaches the traditional type, it usually leads to a strong emphasis upon livestock which may be raised on the farm or purchased for feeding. Livestock strengthens the economy of irrigation by turning feed crops into more valuable livestock products, by furnishing a supply of fertilizer which is necessary to maintain soil fertility and by rounding out farm employment through the year.

In central Nebraska, irrigation still seems to consist of supplementary water applied as extensively as possible to one or two crops—corn and alfalfa—when they most need it in July or August. While the yields of irrigated crops in the Tri-county area are much better than the yields of non-irrigated crops, it is also true that irrigated yields in the Tri-county area are not as high as they could be if a better standard of irrigation was achieved—not only in regard to irrigation practices as such, but also in regard to the use of fertilizers, crop rotations, and the like. Briefly, irrigation in this region of Nebraska is semi-intensive.

Irrigation and the Size of Farms

The census of 1950 makes it possible to distinguish between wholly irrigated farms, partly irrigated farms and non-irrigated farms. A wholly irrigated farm is one in which all of the irrigated cropland was harvested. Other farms which irrigated some of their harvested cropland, but not all of it, are partly irrigated farms. The average size of these farms is given in Table I.

In Central Nebraska, irrigation has not resulted in smaller farms. In Nebraska, generally speaking, and also in the Tri-county area, the average size of partly irrigated farms is a good deal larger than the average size of non-irrigated farms. In other
Table 1. Average Acres per Farm for Wholly Irrigated Farms, Partly Irrigated Farms and Non-irrigated Farms in Nebraska, the Tri-County Area and Scotts Bluff County, 1950

<table>
<thead>
<tr>
<th></th>
<th>Irrigated Farms</th>
<th>Non-irrigated Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole</td>
<td>Partly</td>
</tr>
<tr>
<td></td>
<td>Irrigated Farms</td>
<td>Irrigated Farms</td>
</tr>
<tr>
<td></td>
<td>Acres</td>
<td>Acres</td>
</tr>
<tr>
<td>Nebraska</td>
<td>199.3</td>
<td>554.5</td>
</tr>
<tr>
<td>Tri-County Area</td>
<td>234.5</td>
<td>366.6</td>
</tr>
<tr>
<td>Scotts Bluff County</td>
<td>172.2</td>
<td>454.4</td>
</tr>
</tbody>
</table>

| Cropland Harvested     |                |                     |                  |
| Nebraska               | 106.6          | 216.9               | 180.6            |
| Tri-County Area        | 140.5          | 234.2               | 184.0            |
| Scotts Bluff County    | 104.2          | 136.9               | 107.6            |

words, irrigated farming as a rule is combined with dry-land farming. In Scotts Bluff county where intensively irrigated farms prevail, the non-irrigated farms, which are usually large ranches, have a much larger average acreage. Since irrigation has been established a relatively short time in the Tri-county area, it remains to be seen whether the more intensive types of irrigated farming will make greater headway than the less intensive ones.

Influence of Irrigation on Population

The influence of irrigation upon population and farm settlement must be seen against the background of two general trends. First, a pronounced decline of the farm population has been caused by increased mechanization, which has displaced farm labor, and by the enlarging of farms, which has reduced the number of farms and farm homes. Secondly, there has also taken place a pronounced decline of population in the majority of villages and small towns. It is very significant, therefore, if irrigation can be shown to have had positive results upon population. Furthermore, in the Tri-county area the development of irrigation has probably not had a sufficient period of time so that its influence on population might become fully apparent.

Table 2. Percent of Increase or Decrease in the Farm and Non-Farm Population in South-Central Nebraska Areas With and Without Irrigation, 1940 to 1950

<table>
<thead>
<tr>
<th>Area or County</th>
<th>Percent Increase or Decrease (—)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole Population</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.7</td>
</tr>
<tr>
<td>South-central Nebraska</td>
<td></td>
</tr>
<tr>
<td>Four counties with extensive irrigation†</td>
<td>5.5</td>
</tr>
<tr>
<td>Four counties without extensive irrigation‡</td>
<td>-7.9</td>
</tr>
<tr>
<td>Scotts Bluff county</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Non-farm population includes the urban and the rural-nonfarm population.
†Buffalo, Dawson, Kearney and Phelps.
‡ Gosper, Franklin, Furnas and Harlan.
Town and Country Population Trends

The increase or decrease in the population of two groups of counties in south-central Nebraska is shown in Table 2; four counties with extensive irrigation and four without such irrigation. It is also possible to compare these areas with Scotts Bluff county and with the state of Nebraska. The four counties with extensive irrigation have had a considerably larger increase of the whole population and a considerably smaller decrease of the rural-farm population than were experienced either in the non-irrigated counties, or in Scotts Bluff county, or in the state as a whole. The basic figures, however, are county-wide and do not separate the influence of irrigation from other influences.

The increase of the non-farm population element was much greater in the four counties with extensive irrigation (24.2 percent) than in the adjoining four counties without irrigation (14.4 percent). This population includes (a) urban areas having 2,500 population or more and (b) the rural non-farm population, mostly composed of the smaller towns, villages and hamlets.

Many specific facts could be mustered to indicate the influence which irrigation has had upon villages, towns, and cities of the region. The county seats of Phelps, Kearney and Dawson counties experienced much larger population increases than trade centers of similar size elsewhere in the state. As to the smaller trade centers, distinct population increases occurred there also. While some of them had population reverses, it is rather significant that they held their own as well as they did considering the competition from the larger centers which they are subject to.

Density of Farm Population

Large-scale maps of these counties were used showing the location of farmsteads. These were counted by sections within the irrigated and non-irrigated parts of each county. The rural-farm population was allocated to each area according to the proportion of all farm dwellings. By this method the estimated farm population residing in the irrigated area and in the non-irrigated area was obtained.

In Central Nebraska, there is a considerable difference in density of population between irrigated and non-irrigated areas. In Phelps county the difference is nearly 50 percent higher in the irrigated areas. In Dawson county there is a readily observed difference between the density of the irrigated valley and non-irrigated hills and tablelands. Under arid or semi-arid climatic conditions, the difference in density of settlement is very pronounced. Scotts Bluff county lost 23.3 percent of its farm population from 1940 to 1950.

Continued on page 101

<table>
<thead>
<tr>
<th>County</th>
<th>Whole County</th>
<th>Irrigated Part</th>
<th>Non-Irrigated Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phelps</td>
<td>6.2</td>
<td>7.4</td>
<td>5.0</td>
</tr>
<tr>
<td>Kearney</td>
<td>6.1</td>
<td>8.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Dawson</td>
<td>6.7</td>
<td>9.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Scotts Bluff</td>
<td>13.4</td>
<td>18.7</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Good Records Will Show You Where the Farm is Making Money or Losing Money

By Allen Clark

Farm records for the past year show that the farmers in both north-central and southeastern South Dakota are definitely in a cash receipts-cost squeeze. In southeastern South Dakota, cash sales have gone down a little from the 1951 level and costs have gone up approximately one-half. Farm expenditures are rather uniform in their increase in almost all lines (Table 1).

Labor is in short supply and cost high; machinery is in plentiful supply but new machinery is still quite expensive. Secondhand machinery, however, has gone through a period of price adjustment and is somewhat lower than in 1951 or '52.

Livestock farmers did not fare quite as well in 1952 as did grain farmers because of the support prices for grain; cattlemen, in particular, have suffered because of the combination of a dry year, heavy cattle marketing, and a one-third decline in cattle price.

A Fieldman Suggested

The South Dakota Farm and Ranch Record research project has been in constant operation since
Table 1. A Comparison of Total Cash Sales and Total Cash Expenses on Record-Keeping Farms in North Central South Dakota, 1951-52

<table>
<thead>
<tr>
<th></th>
<th>Average of 52 Farms</th>
<th>Average of 12 Most Profitable Farms</th>
<th>Average of 12 Least Profitable Farms</th>
<th>Average of 52 Farms</th>
<th>Average of 12 Most Profitable Farms</th>
<th>Average of 12 Least Profitable Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cash sales</td>
<td>$15,175</td>
<td>$23,693</td>
<td>$14,374</td>
<td>$16,769</td>
<td>$12,377</td>
<td>$10,939</td>
</tr>
<tr>
<td>Total cash expense</td>
<td>6,766</td>
<td>8,787</td>
<td>10,837</td>
<td>12,272</td>
<td>10,837</td>
<td>10,939</td>
</tr>
<tr>
<td>Net cash income</td>
<td>8,409</td>
<td>14,906</td>
<td>4,037</td>
<td>4,494</td>
<td>1,939</td>
<td>1,939</td>
</tr>
</tbody>
</table>

1942. One of the present difficulties in this project is that of obtaining reliable data, both for the farmer's managerial decisions and for research purposes. Perhaps an answer to this is the type of project that is in operation in a number of other states. These states have a system in which farmers form an association and hire a fieldman who lives right in their area and works with them on farm record problems. The fieldman also prepares the farmer's income tax reports as a part of his job.

A fieldman will give the farmer help with his record work and insure a complete accounting of expense and income items. By helping with the accounting, he also will be in a position to suggest management changes which will increase the farmer's income.

Farm Record Farmers Above Average for Area

When the Farm Record project was started in the north central area of the state, a representative sample of farmers was selected by the county agent and the FHA supervisor. There were some outstanding farmers, many average farmers, and some below average in farming ability. At the present time, the farmers in the association are all superior farmers. There are two reasons for this change: one is that during the early years, the very poor farmers dropped out of the association. They either "did not have time to keep records" or they were dissatisfied with their standing in the group and so dropped out. The so-called "average" farmers have changed rather radically. Some of them have dropped out, those remaining have taken the lesson shown by their farm records and improved their management to the point where they are now well above average for their area.

Several Years' Records Needed

A good set of records will show where the farm is making money and where it is losing. When this is down in black and white, it usually makes it easier to adjust so that more time and effort are being spent in enterprises that are making money and less on enterprises that are either breaking even or losing money. However, several years' records are needed in order to do an accurate and profitable job of adjusting farm practices. Unusual price situations or unusual weather situations may cause the enterprise to shift from profit to non-profit. It is the long-time result that farmers are most interested in. (Project 137. Leader: Allen Clark, Agricultural Economics Dept.)
An iodine deficiency in livestock results from a lack of this element in the soils.

**'Big-Neck' in Calves**

By Chase Wilson

Cows on rations deficient in iodine may give birth to weak, goitrous (often called big-neck) calves. Most such calves are alive at birth, although a few may be still-born. Some are weak and die within a few days; others have approximately normal vigor and are not noticeably affected except for enlargement of the thyroid which may or may not cause difficult breathing because of pressure on the windpipe. If the calf is able to take nourishment, the goiter frequently diminishes in size until it is no longer noticeable, but sometimes it remains throughout adult life. In severe cases, the hair of the calf may be thinner than normal or the animal may be almost hairless.

Ewes receiving insufficient iodine also may give birth to weak lambs which often show thyroid enlargement (big neck) and may be partially woolless. The death rate among such lambs is very high.

Sows may give birth to weak pigs which are often more or less hairless and may be still-born or die within a few hours. Some of the pigs in a litter may be more seriously affected than others.

An iodine deficiency in livestock results from a lack of this trace element in the soils. Crops raised on these soils make normal growth, but when livestock eat these crops the deficiency manifests itself in the form of goiter and in reproductive disturbances and growth failures.
Deficiency Shows Up in Station Dairy Herd

During the period from April 10, 1951 to September 17, 1951, there were six calves born at the College dairy farm that had enlarged thyroids. All six died shortly after birth. Prior to and during this period, the grain ration being consumed by the cows contained 1 percent iodized salt. In other words, 1 pound of iodized salt was added to each 100 pounds of grain, which is the easiest method of feeding iodine to livestock.

The enlarged thyroid glands on these calves indicated an iodine deficiency in the feeds being consumed by their mothers. The oversized glands ranged from a slight enlargement up to nearly 30 times as large as normal. One enlarged thyroid weighed 305.8 grams. This is in contrast to about 10 grams for a normal one. At the time when these abnormal calves were being born, the percentage of iodized salt in the grain ration of the cows was increased from 1.0 to 1.5. Since then, there have been no more calves born with enlarged thyroid, and no deaths resulting.

Survey of State Made

As a result of this experience, the Dairy department made a survey of the state with respect to iodine deficiency. A questionnaire was sent to each county agricultural agent asking whether iodine deficiency symptoms in livestock had been reported in the county. Symptoms asked for were “big-neck” in either lambs or calves, or the birth of hairless pigs.

A total of 51 county agents replied to the questionnaire. Of this group, 22 noted some type of iodine deficiency symptom. All 22 of these reported the birth of hairless pigs. Four of this group also found “big-neck” lambs and four reported the birth of calves with enlarged necks. This questionnaire revealed that 44 of the county agents recommended feeding iodized salt.

Percent of Iodized Salt Increased

With iodine deficiency symptoms being reported from such a wide area in the state, it appears that the county agents are more than justified in recommending to the farmers that they feed iodized salt to their livestock. Minimum amounts of iodine required for the growth and reproduction of farm animals have not been determined specifically for these areas. However, if iodized salt is fed free-choice to livestock, they will govern their intake in such a manner that they will be receiving an adequate amount of iodine. This is the most practical means of feeding it to livestock on a low grain intake.

It may be fed either in the form of block-salt or as loose salt in a trough. In the case of livestock eating larger quantities of grain, the iodized salt should be added to the grain ration. This will insure that each animal gets the required amount. It would seem that a rate of feeding iodized salt at 1½ percent of the total grain should take care of the minimum iodine requirements of South Dakota livestock. This is about one-half percent higher than is generally recommended in other areas. (Project 184. Leader: Chase Wilson, Dairy Dept.)
South Dakota Looks at Irrigation

Continued from page 96

Irrigation has made headway in south-central Nebraska. It has resulted in better crop yields and more assured agricultural production. It has made for an increase of population in communities where it has been developed. Several types of irrigation enterprises are in use, each with its own advantages and disadvantages. They are all of an optional nature, and they must produce satisfactory results if they are to gain ground. This situation implies also that the basic decision to irrigate or not to irrigate must be made by the farmers, individually or as an organization. The choice is theirs.

These and many other points may be learned from a study of irrigation in this region of Nebraska and they are suggestive with respect to the future of irrigation in the James River valley. (Project 222. Research conducted by the South Dakota Agricultural Experiment Station in cooperation with the Bureau of Reclamation, USDI. Leader: J. P. Johannsen, Rural Sociology Dept.)

Drying the Corn Crop

Continued from page 89

17 percent moisture. It was not possible to get tests of corn next to the inlet air passage with the grain probe, but it has been shown in other tests that this corn would be several percent drier. The drying efficiency was not particularly high, but it should be remembered that much of the corn was mature and dry, with only part of the corn of high moisture content. At times, the moisture movement out of the crib was noticeable when steam would condense in the cool air just outside.

Six tests were run indoors to determine drying rates under controlled conditions, using equipment where actual water loss could be noted. Figure 2 shows the drying rate of these trials. (Project 152. Leader: H. H. DeLong, Agricultural Engineering Dept.)
Feebar Barley For Pigs

Continued from page 91

In the second trial (Table 2) somewhat less daily gain was made by both lots of pigs than in the first trial. The corn-fed pigs made slightly greater daily gains, consumed less grain and more protein supplement than the barley-fed pigs. Also, in feed required per hundred pounds of gain, more grain and less protein supplement were required by the barley-fed pigs than by the pigs receiving the shelled corn. The approximate feeding value for the barley, in terms of total feed required per hundred pounds of gain, was 88 percent that of shelled corn. On the basis of feed cost per hundred pounds of gain, the ground barley lot again showed the highest feed cost.

It is of importance that somewhat more waste occurred in the lots fed the ground barley than in the corn-fed lots. More Feebar barley was required than corn for the same gain but the protein supplement consumed with the barley was less as compared to that consumed with the corn. However, the saving in protein supplement was not sufficient to offset the greater cost of the barley. The low intake of protein supplement is true of most feeding trials where barley is compared to corn. In the chemical analysis made of the grains fed in this experiment, the barley was 3 percent higher than corn in crude protein in the first trial and 2 percent higher in the second. This is typical of barleys in general. (Project 85. Leaders: R. F. Wilson and R. C. Wahlstrom, Animal Husbandry Dept.)

Table 2. Ground Feebar Barley Compared to Shelled Yellow Corn
Summary of Results 1950-51

<table>
<thead>
<tr>
<th>10 Pigs in Each Lot</th>
<th>Lot I Shelled Yellow Corn</th>
<th>Lot II Ground Feebar Barley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number days on test</td>
<td>128.8</td>
<td>131.6</td>
</tr>
<tr>
<td>Average initial weight, lbs.</td>
<td>43.2</td>
<td>43.2</td>
</tr>
<tr>
<td>Average final weight, lbs.</td>
<td>223.0</td>
<td>225.0</td>
</tr>
<tr>
<td>Average total gain, lbs.</td>
<td>179.8</td>
<td>181.8</td>
</tr>
<tr>
<td>Average daily gain, lbs.</td>
<td>1.40</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Average daily feed consumed per pig, lbs.
Grain | 4.84 | 5.75 |
Protein supplement | 0.60 | 0.37 |
Mineral | 0.01 | 0.01 |
Total feed | 5.45 | 6.13 |

Feed consumed per 100 lbs. of gain, lbs.
Grain | 346.7 | 416.0 |
Protein supplement | 42.8 | 26.6 |
Mineral mixture | 0.8 | 0.9 |
Total feed | 390.3 | 443.5 |

Feed cost per cwt. gain* | $11.03 | $12.78 |

*Feed prices used: shelled corn, $2.68 per cwt.; Feebar barley (ground), $2.81 per cwt.; tankage, $5.59 per cwt.; soybean meal, $4.25 per cwt.; alfalfa hay (ground), $1.50 per cwt.; ground feeding limestone, $1.30 per cwt.; steamed bonemeal, $5.25 per cwt.; iodized salt plus trace mineral mixture, $2.20 per cwt.
Annual Report
supplementing the quarterly reports
of the
South Dakota Farm and Home Research
for the year ending
June 30, 1953

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

Good Crop Rotations Pay

There is no substitute for a good crop rotation to keep the soil fertile and permanently productive. A good rotation includes a legume or grass, small grains and a row crop. A combination of these crops maintains soil nitrogen and organic matter, controls weeds, conserves moisture and protects the soils from deterioration caused by erosion. Along with a good rotation other established soil management practices should be used, including the return of crop residues and manure to the soil and the use of commercial fertilizer.

One of the most significant effects on the soil of growing corn and small grain crops is the depletion of soil nitrogen. The figure shows the effects of various crop rotations on soil nitrogen depletion. It may be noted that grasses, legumes and crop residues are valuable for reducing the rate of nitrogen depletion.

The crop yields presented in Table 1 show that a rotation which includes a legume (for adding nitrogen to the soil) and the use of phosphate fertilizer is one of the most effective soil management practices for obtaining good yields.

In a rotation which does not include a legume it is essential that nitrogen be supplied in some form. In Table 2 is shown the effect of nitrogen and phosphorus fertilizer, alone and in combination, on the yields of crops in a corn-oats-wheat rotation.

The data in Table 2 show that the use of nitrogen and phosphorus fertilizer is another effective method for in-

| Table 1. Effect of Sweet Clover Rotation on Crop Yields, 1952, Brookings |
|---------------------------------|-----|-----|
|                                 | Corn| Wheat|
| Sweet clover plowed June 15    | 65.0|18.3 |
| Sweet clover plowed June 15 with phosphorus fertilizer | 72.2|24.6 |
| Sweet clover plowed August 1    | 68.7|19.5 |
| Sweet clover plowed August 1 with phosphate fertilizer | 72.6|24.1 |
| No legume, corn-oats-wheat rotation | 65.6|13.2 |
| Continuous corn or wheat       | 52.1|14.6 |

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increasing the productive capacity of the soil.

It is frequently stated that soils of high fertility will produce less when the supply of moisture is limited than soils of low fertility. The fertilizer trials in the spring wheat area of South Dakota showed that in no case did the application of nitrogen or nitrogen and phosphorus reduce the yield of wheat. This area was very short of moisture during the 1952 growing season.

Table 2. Effect of Fertilizers on Crop Yields, Brookings

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Corn Bu./A.</th>
<th>Oats Bu./A.</th>
<th>Wheat Bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0-0</td>
<td>63.3</td>
<td>44.9</td>
<td>13.6</td>
</tr>
<tr>
<td>20-0-0</td>
<td>72.1</td>
<td>55.1</td>
<td>17.1</td>
</tr>
<tr>
<td>20-20-0</td>
<td>76.8</td>
<td>58.1</td>
<td>22.5</td>
</tr>
</tbody>
</table>

*20 lbs. of nitrogen was applied in the form of ammonium nitrate and 20 lbs. of phosphoric acid in the form of triple superphosphate.

Fertility studies on flax indicate that nitrogen derived from the root residues and tops of alfalfa is more effective for increasing yields of flax than fertilizer nitrogen. (Project 46. Leaders: L. F. Puhr and W. W. Worzella, Agronomy Dept.)

Experiment Station Developed Varieties Perform Well

Rushmore wheat, released in 1948, showed more resistance to Race 15B of stem rust in 1952 than any other available spring wheat variety in this state. The use of Rushmore wheat in 1952 probably added $3 million to farm income in South Dakota (based on acreage involved and yield comparisons made in experimental plots in the state).

New bread wheat varieties are being increased and tested. These are derivatives of Rushmore backcrosses and ap-
pear to combine resistance to leaf rust, stem rust and scab.

Several new oat strains showed promise in 1952; two are being increased at this time. One is an early yellow oat that appears suited to the central and western areas of the state; the other, a midseason variety, would fit the northeastern section.

A midseason variety, Clintafe, was released to county Crop Improvement Associations in the spring of 1953. This variety was made available in cooperation with the Iowa Station and the USDA. It is a Clinton backcross, resistant to forms of crown rust to which the Clinton parent is susceptible. It is best suited to southeastern South Dakota.

Redwood and Marine flax continue to show their superiority in productivity and disease resistance. Their widespread adoption has restored much of the 1947 stability of state flax production.

Selections made from a large number of flax crosses to combine the desirable characteristics of yield, adapted plant type and resistance to heat and disease, are now being tested. Colchicine appears to have definite use as a plant breeding tool in flax. (Project 181. Leader: V. A. Dirks, Agronomy Dept.)

Bromegrass and Ree Wheatgrass High in Yield

Improvement of the cultivated grasses, bromegrass, intermediate wheatgrass and crested wheatgrass, is being made through selection for yield, seed set, disease resistance and other desirable characters while a degree of inbreeding is practiced. Desirable new types are also selected from introductions of new varieties and species.

Selection for a large seeded, easily established grass is being made from progenies originating from crosses involving perennial grasses and cereal grains. Cytological and genetical studies are being carried out on these and on colchicine induced variants. In the greenhouse selected clones of the grasses are crossed. Seed from these crosses, as well as seed previously obtained from selected plants in the field, are planted in the greenhouse and later transplanted into the field.

Data from tests conducted at Brookings, Eureka, Highmore and Cottonwood, indicate the superiority of mixtures of grasses and legumes over grass by itself. Ree wheatgrass and bromegrass, in general, have been highest yielding grasses at all locations. (Project 182. Leader: J. Ross, Agronomy Dept.)

Fertilizers and Timely Watering Important When Irrigating

Some of the major objectives in experiments conducted in 1952 were: to determine the most critical periods for irrigation of corn; to study the influence of nitrogen fertilizers on phosphorus availability; to study soybean culture and irrigation; and to continue experiments already in progress on water requirements of crops, and rotation and fertilizer effects on various crops.

It was learned that the "tassel to silk browning" stage in corn development is the most critical with respect to water. Withholding irrigation water at this stage reduced yields by 40 percent. Lack of available soil water in the periods before tasseling and after mid-milk had little effect on yield and quality, whereas lack of water in the silk-browning to mid-milk stage moderately reduced yields.

Band placement of nitrogen fertilizer with phosphate on sugar beets increased the efficiency of fertilizer phosphorus. This increase was approximately 100 percent and is an economical measure in the production of sugar beets on medium- and fine-textured soils. Beet yields in this experiment were increased markedly by the use of nitrogen fertilizer, frequent irrigations and phosphate fertilizer.

In a row-spacing-moisture experiment with soybeans, both irrigated and non-
irrigated soybeans produced higher yields when planted in 18-inch rows than when planted in 9- or 36-inch rows. Average yields of 48 and 41 bushels per acre were obtained with irrigated and non-irrigated beans, respectively, at the 18-inch row spacing.

Rotation and fertilizer experiments continue to show marked response of corn and wheat to nitrogen. Non-irrigated wheat has shown yield increases of about 5 bushels per acre due to alfalfa in the rotation. (Project 173. Leaders: L. O. Fine and R. Campbell, Agronomy Dept., USDA cooperating.)

**Soil Surveys for Irrigation Areas**

The following areas were surveyed and mapped in 1952-53:

1. Spink County basic soil survey—342,400 acres mapped.
2. Hand County basic soil survey—60,000 acres mapped.
3. Brookings County basic soil survey—76,000 acres mapped.
4. Hughes County soil association survey—250,000 acres mapped.
5. Basic soil survey maps were prepared for the Eureka and Highmore substation farms.

Also 800,898 mapped acres of the Spink County basic soil survey were gridded to determine the acreage of each mapping unit. This represents about 83 percent of the total acres in the county. Following gridding, the mapping units were assigned ratings based on soil characteristics indicating the suitability of each soil for gravity and sprinkler irrigation. The results are summarized in the table.

There are 83 percent of the total acres in the county. Following gridding, the mapping units were assigned ratings based on soil characteristics indicating the suitability of each soil for gravity and sprinkler irrigation. The results are summarized in the table.

These figures are subject to correlation analysis, and are not to be taken as final. Also it should be stated that these groupings show the suitability for irrigation of soils over the entire surveyed portion of county; the questions of accessibility of specific tracts of suitable soils to roads and canals, and the combinations of soils into economic farm units have not been taken into consideration. (Project 183. Leaders: F. C. Westin, W. J. Buntley, F. E. Shubeck, A. J. Klingelhoets, and W. C. Moldenhauer, Agronomy Dept.)

**Soil Tests Show Need for Plant Food**

The results of the soil tests made on samples sent by farmers during the past five years were summarized. The summary shows that soils in the eastern part of the state are more likely to have an inadequate supply of available phosphorus, and that few if any are deficient in available potassium. Field experiments conducted throughout the state show that nitrogen is the element most likely to be needed to increase crop yields. In general, the pH of the surface soils is relatively acid. However, chemical tests do not show any need for added lime. These tests are being checked with field experiments. In some areas of the state the number of samples tested has not been great enough to indicate any definite trends in fertility.

Approximately 3,000 soil samples were tested during the year; more than 65 percent of these were submitted by individual farmers. Recommendations for soil fertility maintenance and management, including the use of como—
cial fertilizer where needed, were made on the samples submitted by farmers. (Project 172. Leader: P. L. Carson, Agronomy Dept.)

**Experiment Station Corn Hybrids**

Corn yield tests were conducted at 12 locations in 1952. The purpose of the work was to supply farmers with information on the relative performing ability of the more popular hybrids being sold in the state and is one of the services rendered annually by South Dakota Agricultural Experiment Station.

In 1952 14 tests were planted at the 12 locations, with at least one trial being placed in each of the eight agricultural areas into which the state has been divided. Plots were planted near Spearfish, Newell, Vale, Cottonwood, Eureka, Highmore, Claremont, Redfield, Brookings, Chamberlain, Mitchell, Dell Rapids, and Wakonda.

From 16 to 30 entries were included in each test. Information obtained consisted of yield and percent of moisture at harvest, the latter indicating relative maturities. Lodging was checked in some cases. Two-, three-, four- and five-year averages were also calculated for entries tested more than one year. In 1952, hybrids developed at the Experiment Station produced the highest yields in 8 of the 12 locations tested. The results are given in Circular 97.

In general, precipitation was below average in 1952, but a large subsoil reserve was capable of supplying enough moisture to produce an excellent corn crop that was unusually low in moisture at all locations by harvest time. (Project 151. Leaders: D. B. Shank, D. E. Kratochvil, and G. Nachtigal, Agronomy.)

**Sorghum Yields High Under Drought Conditions**

Sorghum adaptation tests were conducted on 54 grain sorghums and 9 forage types at seven locations in the state to determine their performance under different soil and climatic conditions. A uniform regional sorghum nursery of 34 strains from five states was tested at Brookings, Highmore and Newell.

Information from these trials was obtained on adaptability, height, standability, maturity and yield. The 1952 average grain yields were high even though considerable drought prevailed at four of the locations.

Over 1400 segregating populations and pure lines of grain and forage sorghums were grown in the breeding nursery. About 90 percent of these combination crosses and strains had previously been treated with colchicine. Many new and outstanding types are being produced by treating pure lines and treating F2 crossed progenies with colchicine. (Project 61. Leader: C. J. Franzke, Agronomy Dept.)

**Cold Germination Test and Dates of Planting Sorghum**

All sorghum strains and varieties before being entered in the adaptation tests are subjected to the cold germination test. They were classified into three groups as follows: Group 1, 0 to 12 percent emergence; Group 2, 30 to 44 percent emergence; and Group 3, 55 to 71 percent emergence. It has been observed in the adaptation tests that Group 2 produced very good stands under limited soil moisture conditions, whereas Groups 1 and 3 produced thin stands. Also, Group 3 produced uneven emer-

### Effect of Date of Planting on Sorghum Yield at Brookings, 1952

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Norgum</td>
<td>55.6</td>
<td>54.4</td>
<td>47.7</td>
<td>48.0</td>
<td>40.5</td>
<td>28.5</td>
</tr>
<tr>
<td>Reliance</td>
<td>51.9</td>
<td>49.7</td>
<td>51.3</td>
<td>51.6</td>
<td>50.2</td>
<td>33.1</td>
</tr>
<tr>
<td>Sooner Milo</td>
<td>38.0</td>
<td>36.3</td>
<td>31.8</td>
<td>31.6</td>
<td>25.4</td>
<td>14.5</td>
</tr>
</tbody>
</table>
gence when planted under favorable soil moisture conditions, either because of hard seeds or seed dormancy.

A date of planting test made at weekly intervals was run at Brookings. In general, when weeds were controlled, earlier plantings of grain sorghums produced the higher yields and well matured grain. (Project 112. Leader: C. J. Franzke, Agronomy Dept.)

**Soybean Varieties Improved**

The work under this project has been confined to conducting uniform nursery trials of promising new selections of soybeans at three locations in eastern South Dakota. A total of 37 entries was evaluated for yield, maturity, lodging, height, seed quality, seed size, and shattering. Chemical determinations for percent oil and protein were made at the Regional Laboratory at Urbana, Illinois.

The Experiment Station has participated in the foundation increase and cooperative release of three improved soybean varieties: Hawkeye, Capital, and Blackhawk. This year the initial increase of a strain, W6S-292, from the group 0 nursery grown in Roberts County was started. The strain possesses a 15 percent yield superiority over Ottawa Mandarin, and Capital. In addition, W6S-292 has comparable early maturity, lodging resistance, and quality. (Project 148. Leader: M. W. Adams, Agronomy Dept., USDA cooperating.)

**New Research Pastures Started**

Six 8-acre paddocks have been established with three kinds of pasture as follows: (a) alfalfa-brome, (b) brome-grass and (c) sweet clover-rye. Each pasture is in duplicate and on soil typical for eastern South Dakota. The spring weather was cool so plant growth was slow and the Hereford yearling steers were not placed on the pasture until May 29. Because of the dry season in 1952, the brome and alfalfa plants were quite small in size in the spring. The pasturing during the 1953 season, therefore, will be somewhat lighter to obtain good root reserve and sturdy plant development so that greater production can be obtained in the next three years. The pasture is grazed by using the “put and take” method. The number of animals are increased as more forage is available and reduced as less pasture is produced. The purpose of this method is to utilize the forage as it is produced during each month of the pasture season. By knowing the monthly pasture production of the three pastures under study, together with the native pastures and the supplementary pastures such as rye and sudan grass, it will be possible to plan pasture programs that will provide forage from May through September. (Project 225. Leaders: W. W. Worzella, Agronomy Dept., and G. T. King, Animal Husbandry Dept.)

**Weed Control**

The use of soil sterilant chemicals and the use of 2,4-D in conjunction with competitive crops and with other chemicals was studied for the control of leafy spurge on a 30-acre farm near Gary. Similar trials were conducted on Russian knapweed on an 8-acre farm near Brentford. The use of TCA and several other chemicals for quackgrass control was conducted on a 7-acre farm near Gary. Residual effect of TCA is now being tried.

Several chemicals were tested for their effects on flax and on several annual weeds, especially foxtail and wild oats. Also several annual weed species were analyzed chemically after being treated with 2,4-D in an effort to learn possible effects on livestock that might graze them. Several chemicals were also tested for their effectiveness on death camas at Cottonwood and at Newell. (Project 32. Leader: L. A. Derscheid, Agronomy.)

Drouth Resistance in Barley, see page 55
Corn Hybrid S.D. 220, see page 60
Putting Legumes Back Into the Native Grasslands, see page 23
Is Nitrogen Needed in Western South Dakota?, see page 36
Selenium Poisoning

Field trials with breeding cattle receiving sodium arsenite in their salt as a preventative against selenium poisoning were completed. The arsenic had no effect, either detrimental or beneficial, on the breeding performance of the cows. It was observed in connection with another experiment, however, that on highly seleniferous range the level of arsenic recommended for use may not protect effectively against selenium poisoning, and further studies to clarify this are in progress.

Linseed oil meal counteracts selenium poisoning in rats. This protective effect has been found to be something other than a mere protein effect or an antivitamin B₆ effect. The factor responsible is a heat-stable substance which apparently is destroyed by hot alcohol. Its concentration and isolation will be a fairly slow process, but should yield valuable information concerning control of selenium poisoning.

The two growth stimulators for hogs and poultry, arsanilic acid and 3-nitro, 4-hydroxyphenylarsonic acid, were studied further and found to be definitely effective in giving protection against selenium poisoning in rats. These arsenicals may be effective in controlling selenium poisoning in hogs. Other arsenicals tested during the year (sodium methyl arsenate and calcium methyl arsonate) were not effective selenium counteractants.

Investigations on the manner in which selenium poisons animals have been continued, since such information would be invaluable as an aid to establishing control measures. In addition to rats, molds and yeasts have been used in these studies, since they offer certain advantages over animals for some phases of the work. Some dissimilarities between chronic and acute selenium poisoning, as concerns mode of action of the selenium, appear to exist, but in many respects the two forms of toxicity are alike. These findings may be helpful in establishing the metabolism of selenium by the animal body.

In studies to determine the chemical form of selenium in plants, a crystalline, selenium-containing compound has been isolated from astragalus plants. Work on the identification of this compound is now in progress. Other compounds are being concentrated for purification. Vegetative and seed proteins of wheat are being isolated to study the chemical form of the selenium they contain. Sulfur-containing compounds are also being studied. Radioactive isotopes are being used in this work. (Project 19. Leaders: O. E. Olson, E. I. Whitehead, C. W. Bonhorst, and A. W. Halverson, Station Biochemistry; C. A. Dinkel, Animal Husbandry Dept.)

Nitrate Poisoning

The effect of spraying with herbicides on the nitrate content of plants was studied on weeds planted on nitrogen-fertilized and unfertilized plots. However, these plots did not grow well and therefore the work is being repeated this year.

More cases of nitrate poisoning in cattle have been reported where well water was high in nitrates. Sheep are now being used in a study to determine at what level nitrates in the water become toxic to these animals. Sheep are much more resistant to nitrate poisoning than are cattle. It is surprising to find that they can tolerate quantities of nitrate nitrogen far in excess of what is normally contained in waters which have caused cattle deaths.

This research is still in progress, since there are several factors that need study in connection with this phase of the problem. For instance, although sheep show no outward signs of poisoning at the level of nitrate now being used in the...
water, their blood does occasionally contain some methemoglobin. This is the first sign that the nitrates are becoming toxic. The question arises, what would happen if these animals were fed a forage that contains a non-toxic amount of nitrate along with water that contains nitrates? This question should be answered during the next year. (Project 87. Leaders: E. I. Whitehead and O. E. Olson, Station Biochemistry; G. S. Harshfield, Veterinary; L. Derscheid, Agronomy.)

Cornstalk Poisoning

Studies on the metabolism of nitrogen by corn plants were continued, since past observations have indicated that nitrates are implicated in some cases of cornstalk poisoning. A large number of samples are now being analyzed for several nitrogen fractions. This study, when completed, should yield information on the effect of aeration and of 2,4-D on nitrogen assimilation by corn plants.

Because of the low incidence of cornstalk poisoning cases during recent years, poisonous plant tissues have not been available. This makes progress on this problem very slow. This project will, therefore, be terminated when studies now in progress are completed. (Project 130. Leaders: E. I. Whitehead, F. L. Moyer and O. E. Olson, Station Biochemistry; G. L. Harshfield, Veterinary Dept.; C. M. Nagel, Plant Pathology Dept.)

Barley Proteins

Two years of investigation of the protein composition of barley have been completed. In these studies on Feebar, Odessa and Plains varieties, samples from various parts of the state with protein contents varying from 10.9 to 19.4 percent protein were used. The purpose of these studies was to determine how the different types of protein in this cereal vary as protein content changes. This phase of the work having been completed, the next step is to determine how the individual amino acids of which proteins are composed vary with protein content.

In the studies on protein composition, the first step was to find methods of grinding that would allow for the best analytical results. Hammer-milling through a 0.5 mm. screen was found the most satisfactory, and this method of grinding was used throughout the remaining work.

The results of these studies have been reported in detail in Technical Bulletin 13. It was found that in all three varieties the glutelin and hordein fractions increased with increasing protein content while the salt soluble fraction remained about constant. Depending upon the amino acid composition of these three fractions, the value of barley protein for feeding might be considerably affected by its protein content.

Although slight differences were observed between varieties, it was found that total protein content can be used to predict the amount of the various fractions present with a fairly high degree of accuracy. Shrivel ing of kernels will cause some errors, but these can be corrected by calculating kernel protein content, a very simple procedure. (Project 195. Leaders: A. W. Halverson and O. E. Olson, Station Biochemistry; J. E. Grafius, Agronomy Dept.)

Treatment of Hard Waters for Household, Farm and Dairy Use

The value of certain types of softeners and detergents for use with extremely hard waters has been tested in small scale washings. Much time has been spent during the year in developing techniques that will insure results that are consistent. Using the techniques that were developed, studies on several types of softeners and detergents are now under way.

Tests are being made with waters varying in hardness from 15 grains per gallon (a rather soft water for South Dakota) to 120 grains per gallon (an extremely hard water). It is hoped that
these studies will be helpful in formulating recommendations for laundering under a variety of hard water conditions. Large scale washings will be necessary as a final check on the validity of proposed recommendations. (Project 193. Leaders: O. E. Olson and G. F. Gastler, Station Biochemistry; Lillian Lund, home Economics Dept.; D. F. Breazeale, Dairy Dept.)

**Chemicals for Marking Hogs**

This study is concerned with the development of a rapid, easy method of marking hogs. The method to be developed demands speed and simplicity of application, resistance of the mark to removal by washing, permanence under all weather conditions for at least four weeks and no staining of the fat or of the skin beyond what can be removed by the normal slaughtering procedures. In addition, the mark must be visible on hogs of all colors.

Thus far, three dyes have been used with some success as concerns visibility, ease of application and permanence. Others will be tried, and those found to be most promising will be tested as to removal at slaughter. Methods of application are being studied with the aim of finding the most convenient and reliable means of marking. (Project 235. Leaders: O. E. Olson and C. W. Bonhorst, Station Biochemistry; R. C. Wahlstrom, Animal Husbandry Dept.)

**Carotene Losses in Stored Poultry Feeds**, see page 17

**Self-Feeding Grass Silage from the Stack**, see page 66

**Crop Insects**

**Tree Hoppers and Their Control**

Many species of adult tree hoppers feed upon the sap of trees and many lay their eggs in the twigs of these host trees. Other tree hoppers, as adults and nymphs, feed upon the sap of herbaceous plants and some of these species lay their eggs in the stems of these plants.

Though not too much information is available on tree hoppers, it is known that the principal damage is caused by the egg-laying activities and by the feeding habits of the adults or nymphs.

A manuscript on tree hoppers and their control is in preparation and will be submitted for publication as a technical bulletin during the next year. (Project 220. Leader: H. C. Severin, Entomology Dept.)

**Grasshopper Studies**

When spraying or dusting by plane for grasshopper control, it was recommended in the past that the swath width covered by the ordinary plane be not wider than 45 to 50 feet, that the wind velocity be low when operating the plane (5 miles per hour or less preferably), that the operator or pilot when dusting or spraying travel with or against the winds and not crosswise of it, and that he fly within 3 to 5 feet of the tops of the plants that were to be treated. Also drift of the spray or dust was considered highly undesirable.

It now develops that drift of the spray
or dust may be advantageous, at least within limits and under certain conditions. Excellent control of grasshoppers has been obtained by flying across the wind so that the effective swath width was increased to 150 feet. This was true both in spraying and dusting.

However, more experience and data are necessary before recommendations can be made. Some of the needed data are:

1. Maximum velocity of wind at which a pilot can operate and still do a satisfactory job when (a) spraying, or (b) dusting;

2. Concentration of insecticide to use when swath width is increased to 75, 100, and 150 feet;

3. Most desirable height of flight above plants when flying crosswind when wind has velocity of 10, 12, or 15 miles per hour;

4. Relation of increase in swath width through drift and velocity of wind;

5. Most desirable formulations of spray or dusts to use at different wind velocities;

6. Advantages and disadvantages of increasing swath width by using drift of the spray or dust.

Dieldrin, when used at the rate of 2 to 4 ounces per acre gave effective control of grasshoppers. Two ounces of the insecticide per acre, when used as a spray, gave practically 100 percent control when the grasshoppers were small, while 4 ounces per acre when used as a dust gave better than 95 percent control. When the grasshoppers are adult and a quick kill is wanted, 4 ounces of dieldrin per acre used as a spray is recommended. Residual action of dieldrin extended over a period of 50 days. This is an advantage when residual action is wanted and a distinct disadvantage when residual action is not desirable. If a crop grower considers using dieldrin, he should understand the hazards connected with its use, as well as its good qualities and purposes.

The effects of the use of dieldrin, toxaphene, chlordane, and aldrin were studied on injurious insects other than grasshoppers and also on the beneficial insects that may be found in different fields of small grain, corn, sorghum, alfalfa, sweet clover, and grasslands. While many harmful insects are controlled through these insecticides, others are not. Further, many beneficial insects such as parasites and predaceous species and most pollinators are also destroyed.

In other words, the balance in nature in a sprayed or dusted field may be seriously upset by the use of these insecticides. Under such conditions, the harmful species not controlled by the insecticides may be favored to such an extent that they become a serious problem.

Insecticides such as these considered here should be used carefully and wisely if the maximum beneficial results are to be obtained. (Project 18. Leader: H. C. Severin, Entomology Dept.)

The Corn Borer Tax, see page 51
Willows and Poplars for You or the Beetles? see page 75

Evaluating sweet corn hybrids in the field
Fruits, Vegetables and Shelterbelts

Summer Drought Responsible for Winter Injury to Strawberries and Raspberries

The long dry spell in the late summer months of 1952 might have been responsible for the poor strawberry and raspberry crop of 1953. Plants had shown much evidence of the dry condition during August, and winter injury had been reported from many areas. Killing off of the entire top of raspberry plants had been mentioned in some reports, and strawberries came through the winter in a weakened condition. The plants lacked vigor and grew slowly. Of the fruit crops, strawberries and raspberries seemed to be the only ones to suffer winter injury in that year.

In the Station experimental plots, Latham raspberries and several strawberry varieties were watered during August. These plants suffered the least winter injury ever observed, which can be attributed to the application of water during the dry summer months. (Project 145. Leader: S. A. McCrory, Horticulture Dept.)

Evaluation Studies on Hansen Foundation Orchard

One of the research projects connected with the genetic material that is being preserved in the Hansen Foundation Orchard is concerned with breeding winter hardiness into quality fruit. Since most of the genetic material in the Foundation Orchard has shown great winter hardiness, it is valuable in these breeding experiments. Some interesting observations have been made this year, but not enough data are as yet available to warrant detailed report.

Another important factor to be considered in breeding is disease resistance. As fire-blight is one of the most troublesome diseases on fruit trees, any material in the Hansen collection that shows resistance to fire-blight is of interest to the fruit breeder. Some of the plants in the collection were free of fire-blight, while others were badly infected this past summer. Those varieties known as the "Russian Collection" were generally free of the disease. Since these are supposed to be the best of the varieties in Russia, they may offer much promise to the fruit breeder. (Project 174. Leader: S. A. McCrory, Horticulture Dept.)

Tomato Yields Affected by Transplanting

The effect that age of plants at the time of transplanting and date of transplanting has on early and total yields of Sioux tomatoes was studied in 1952.

Tomato seeds were planted in the greenhouse on the following dates: March 1, 10, 20, 31, and April 10 and 20. The plantings were made in the field on May 12 and 24.

When transplanting was done on May 12, the highest yields were obtained from plants seeded on March 31 and April 10. When transplanting was done on May 24, the highest yields came from the April 10 and 21 seedings.

Highest early and total yields were obtained when the transplanting was done at the early dates. (Project 118. Leader: R. L. Foskett, Horticulture Dept.)

Sweet Corn Hybrids from South Dakota Inbreds

Eleven sweet corn hybrids, utilizing South Dakota inbred lines, were produced in quantity in 1952. The pollen parent for all these hybrids was inbred line 176, a Bantam type which produces a good quality hybrid in many combinations. It has vigorous plants, that are somewhat smut resistant, and good pollen producers. Selfed seed was also obtained from 12 inbred lines.

Two of the hybrids produced in 1952 appear especially promising for market gardens. They are 908 x 176 and 909 x...
Two previously produced hybrids, 226 x 909 and 908 x 909 are being considered for release as home garden varieties.

Several South Dakota hybrids are being grown at Brookings in 1953 along with the best commercial hybrids to observe their relative values. In addition to the plots at Brookings, the most promising hybrids are being grown throughout the state to obtain information concerning their adaptability. (Project 68. Leader: R. L. Foskett, Horticulture Dept.)

Ornamental Crabapples, see page 58
Garden Tomatoes from August to December, see page 49
Break That South Dakota Wind, see page 10

Plant Diseases

Potato Disease Control

Potato Fungicide Trials. The four fungicidal materials which had given best results in previous years (Cop-O-Zinc, Dithane Z-78, Phygon XL, and Yellow Cuprocide) were applied to Bliss Triumph potatoes. Eight applications were made, and even though early blight did become moderately severe in the check rows, the total harvested tuber yield was not significantly influenced by any of the four treatments. Neither was there found a distinct difference in number of foliage lesions produced on the plants treated with the different materials.

Potato Scab Resistance. Thirty-seven lines and varieties of potatoes were evaluated for resistance to scab the summer of 1952. Data pertaining to foliage characteristics, tuber size, shape, color, and specific gravity were also collected. Several of these lines are being re-tested in 1953 as well as 159 other lines obtained from the USDA, Louisiana, and North Dakota during the fall of 1952. As soon as it has been definitely established as to which of these lines exhibit distinct and consistent resistance, they will be incorporated into yield tests.

Yield of Scab Resistant Lines. In the experiment at Garden City, 31 varieties and lines were grown. During the course of the summer several environmental difficulties were encountered which rendered the data unreliable. The average yield of all varieties was considerably below that of the Brookings plot which included 21 varieties and lines. At Brookings, La Soda (345 bushels per acre) produced significantly higher than all other varieties except Bliss Triumph (318 bushels per acre), Cherokee (293 bushels per acre), Sequoia (299 bushels per acre), and White Cloud (281 bushels per acre). Cherokee, Columbia Russet, CS 6316, Kennebec, and Yampa were, in that order, highest in specific gravity, while the first three of these varieties were most resistant to scab.

Variety yield experiments for 1953, including 19 named varieties, were planted at Brookings, Garden City, and Redfield. Identical plots were planted at the Redfield Experiment Farm under irrigated and dryland conditions.

South Dakota was accepted last fall as a cooperator in the North Central Regional Potato Breeders group, which is working toward the introduction of new and better potato varieties adapted to this eight state region. For 1953 25 lines and varieties were submitted for testing in each state by the cooperating breeders, including two varieties released during the winter of 1952-53. At planting time, several lines appeared to have promise, but a full evaluation cannot be made until after the 1953 harvest.

Potato Viruses. During the summer of 1952, an apparently unreported virus of potato was observed and collected near Garden City. Some work was done with it in the greenhouse during the fol-
lowing winter but more extensive re-
search must be completed before the full
details of the disease, including its con-
trol, can be determined. (Project 107.
Leader: A. A. Cook, Plant Pathology
Dept.)

Sorghum Diseases

Fungicidal seed treatments for sor-
ghum have been evaluated in South Da-
kota since 1942 in an attempt to increase
the stands of early planted sorghum.
Thirty-three fungicides were tested, but
not all of them in any one year. New
fungicides were added to the list and in-
effective ones were removed with each
succeeding year of the tests.

All of the fungicides were tested at
Brookings, during the 4-year period
1948-51, and selected fungicides were
tested at Highmore in the main sor-
ghum production area of the state in
1951 and 1952. Most of the fungicides
were applied as dusts. A few were ap-
plied as slurries and some as soil treat-
ments in the row.

Significant correlations between stand
and yield were found in 13 of the 14
plantings from which data were avail-
able. The average correlation coefficient
between stand and yield for all of the
early planting dates was significant at
the 1 percent level. It is apparent that the
stand counts of early plantings were, in
every case, good estimates of the yields
obtained and can be used with confi-
dence in screening additional fungicides.

The seed treatment materials which
gave significant increases in yields over
comparable controls in 1952 were Arasan
mixed with soil, Carbide and Carbon
compounds 224 and 640, and copper car-
bonate. The slurry application of Arasan
was more effective than the dust applica-
tion. The reverse was true for Carbide
and Carbon compound 224.

In 1952 Arasan and Carbide and Car-
bon compounds 224 and 640 were added
to the soil in the row at the rate of 4.4
pounds per acre at planting time. Seeds
planted in both treated and untreated
rows. Yields in soil treated with Arasan
or Carbide and Carbon compound 640
were similar to yields of comparably
treated seed in untreated soil. The pre-
esence of Carbide and Carbon compound
224 in the soil markedly decreased the
yield compared to the yield in untreated
soil. (Project 110. Leader: C. M. Nagel,
Plant Pathology Dept.)

Corn Diseases and Their Control

In field experiments 450 corn lines
were tested for resistance to root rot, and
150 lines were indexed for disease reac-
tion in the greenhouse.

Root rot reaction under field condi-
tions was complicated by the unusu-
ally dry conditions which prevailed the
latter half of the season.

Corn root rot was prevalent on corn
throughout the corn growing areas of
the state and considerable lodging was
observed in the southeastern section of
the state. (Project 185. Leader: C. M.
Nagel, Plant Pathology Dept.)

Seedling Blight and Root-rots of Forage
and Cereal Grasses

Greenhouse experiments revealed
marked differences among barley vari-
eties in reaction to photoperiods. Some
varieties were exposed to comparatively
short photoperiods, others to long ones.
Relation of variety to phototype is
thought to play a part in determining
varietal tolerance to pythium root rot.
The weight of roots produced in the
greenhouse in a 15-hour photoperiod
under inoculation was correlated with
grain yields in the root rot nursery. It is
inferred that a reliable differentiation of
varieties in the greenhouse is dependent
upon proper light relations, and that
field results are limited in application to
areas of similar latitude and time of
planting.

The investigations to determine
sources of resistance to the root rot dis-
eases of small grain, particularly barley,
were continued. Twelve hundred and
forty-five strains of barley were grown in each of three root rot disease nurseries in Tripp, Douglas, and Brookings counties in 1952. The seed was obtained from the Plant Introduction Station, USDA and consisted of a world collection of barley seed. The most serious root rot occurred in Tripp County and approximately 100 selections were made from this material for further greenhouse and field testing. (Project 115. Leader: C. M. Nagel, Plant Pathology Dept.)

Foliage Diseases of Small Grains

Twelve organic chemicals in strengths of one-thousandth molar solutions or suspensions of the fungicidal agents were applied as sprays in 1952 to field plots of Marquis and Thatcher wheat, Moore and Montcalm barley, and Brunker and Richland oats. They were applied first on June 24 at the rate of 80 gallons to the acre after leaf rust had gotten started on all grains and varieties, and again on July 1 and July 10 at the rate of 120 gallons to the acre. Each of the grains were main plots of 4 rows, 48 feet long, the varieties sub-plots, and the spray treatments sub-sub-plots. There were four replications.

The compounds tested were o—tolu-enesulfonylamide, a—naphthol, p—tolu-enesulfonylamide, p—aminobenzenesulfonylamide, chloramine T., sodium o—benzoic sulfimide, Phygon, Orthocide 75, Dithane D14, pure maleic hydrazide, Manzate and Maleic Hydrazide 30. None of the compounds affected the normal development of either leaf or stem rusts on any grain or variety. The grain rusts started earlier than normal in South Dakota during 1952 and they were present in epiphytotic proportions before the grain season ended. Failure to control rust development with some of these compounds may have been due to the weak concentrations used.

Greenhouse tests of these and other chemicals in one-hundredth molar concentrations showed good to complete control of stem rust on Brunker oat seedlings with Vancide 51, Dithane D14, Manzate, Zerlate, Fermate, Phygon and Orthocide 75, but not with any of the other above-mentioned chemicals. Ammonium, calcium and sodium sulfamates failed to control this rust at 0.01 molar concentration but they did at 0.05 molar concentration.

The new stem rust strain 15-B has become more prevalent and destructive each season since its appearance in South Dakota in 1950. A few fields were damaged to the extent that they were not harvested. Two hundred and seventy-two varieties and strains of wheat were grown in the rust disease nursery in 1952 to determine their reaction to 15-B as well as to other strains of stem rust, leaf rust and the major fungus diseases. The results indicated varying degrees of resistance with marked resistance to 15-B. Those that possessed the most resistance were non-commercial types, except in the case of Rushmore, which is a variety produced by this station that showed evidence of tolerance to 15-B.

The research on wheat mosaic viruses was continued with special emphasis on insect-vectors as agents of dissemination. (Project 204. Leader: George Semeniuk, Plant Pathology Dept.)

Foliage Diseases of Tomatoes

Tomato Fungicide Trials. Victor tomato plants were treated eight times with each of four fungicides (Cop-O-Zinc, Dithane Z-78, Phygon XL, and Yellow Cuprocide) in 1952 to control disease. Early and late blight were not found, even on the check plants, throughout the course of the summer. Bacterial spot and speck were both moderately severe on all plants, regardless of treatment. No significant differences were found in total yield.

Tomato Leafspot. In 1952, arrangements were made to cooperate with the national program for screening tomato collections for resistance to several diseases. Since some work had been done
here previously with Septoria leafspot, South Dakota was asked to participate in this phase of the program. Inoculations were made to 144 collections, including five species, two sub-species, and several commercial varieties and suspected interspecific crosses.

Isolates of the leafspot fungus from Canada, Indiana, South Carolina, South Dakota, and Wisconsin were used in comparable experiments. The most resistant collections and commercial varieties have proved interspecifically sterile (sterile between species), although a program involving resistant lines from South Carolina may prove more successful. The main difficulty remaining is that it has not been possible to increase fruit size and maintain satisfactory resistance.

In analyzing the data from the above experiments, it was determined that the fungus isolates from various states differed significantly in ability to induce disease. Those from Wisconsin and Indiana ranked highest in virulence, then came those from Canada and South Carolina. Isolates from South Dakota ranked lowest in virulence. (Project 146. Leader, A. A. Cook, Plant Pathology Dept.)

Diseases of Alfalfa and Other Forage Legumes and Their Control

Seven major diseases were observed on alfalfa in the state in 1952; namely, common leaf spot (Pseudopeziza medicagoe), yellow leaf blotch (Pseudopeziza jonesii), spring blackstem and leaf spot (Ascochyta imperfecta), summer blackstem and leaf spot (Cercospora zebrina) downy mildew (Perennospora trifoliorum), bacterial wilt (Corynebacterium insidiosum) and crown rot (multiplicity of agents).

Except for light amounts of summer blackstem and leaf spot, and downy mildew in the eastern part of the state, the other named diseases were responsible for reduced stands, extensive defoliation and seed yield losses in many fields throughout that area. Yellow leaf blotch and spring blackstem were abundant and were the principal diseases in the non-irrigated regions immediately east of the Black Hills. Greenhouse and laboratory methods are being developed and utilized in evaluating the resistance to these diseases of the various alfalfas that are currently under study by breeders as sources of new varieties.

Sweet clover diseases in the state comprise the following: leaf spot (Leptosphaeria pratensis), summer blackstem and leaf spot (Cercospora zebrina), spring blackstem and leaf spot (Ascochyta caulicola and Ascochyta meliloti) and virus. Several fields of sweet clover near Elk Point showed 90 percent stunted plants from a mosaic disease that was readily transmissible to other sweet clover plants. (Project 230. Leader: George Semeniuk, Plant Pathology Dept.)

Tree Diseases

Cottonwood leaf rust was somewhat less destructive in 1952 than in the previous 10-year period. The winter of 1952-53 was one which caused considerable winter injury to many species of trees including cottonwoods. Three strains of cottonwoods in the tree disease nursery which were not previously affected by winter injury were damaged the past winter.

The leaf rust resistant strain now being increased for distribution showed no evidence of winter injury. Approximately 11,000 cuttings of this clone were turned over to the Foundation Seed Stocks Division this spring for increase and ultimate distribution.

Certification standards have been developed and all leaf rust resistant cottonwood tree stock will be grown under certified standards, similar to certification procedures followed with small grains. (Project 142. Leader: C. M. Nagel, Plant Pathology Dept.)
Livestock Production

Purdue Supplement A and Soybean Meal for Fattening Cattle

There is a trend for beef cattle producers to utilize large quantities of roughage in economical production of beef. Results have shown that highly desirable amounts of beef can be produced on a per acre basis if the roughage is adequately supplemented.

During the winter of 1952 and 1953, 40 head of yearling feeder cattle were divided into four lots, consisting of three heifers and seven steers each. All lots were fed corn silage and all were offered salt, bonemeal, and limestone free choice. The corn silage fed to Lots 2 and 4 was supplemented with Purdue A; whereas, the corn silage fed in Lots 1 and 3 was supplemented with a soybean meal and ground corn mix. Purdue supplement A was fed at the rate of 3.5 pounds daily and was composed of:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean oil meal</td>
<td>2.25</td>
</tr>
<tr>
<td>Molasses feed (45% molasses)</td>
<td>1.00</td>
</tr>
<tr>
<td>Bonemeal</td>
<td>0.18</td>
</tr>
<tr>
<td>Salt with cobalt</td>
<td>0.06</td>
</tr>
<tr>
<td>Vitamin A and D concentrate</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.50</strong></td>
</tr>
</tbody>
</table>

The soybean oil meal and corn mix was fed at the rate of 3.25 pounds daily and contained:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean oil meal</td>
<td>2.25</td>
</tr>
<tr>
<td>Ground shelled corn</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.25</strong></td>
</tr>
</tbody>
</table>

Comparisons of Purdue A and Soybean Meal as Supplements to Corn Silage for Fattening Cattle

<table>
<thead>
<tr>
<th>7 Steers and 3 Heifers in Each Lot Fed for 140 Days</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot I: Corn Silage, Soybean Meal and Corn Mix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average initial weight (lbs.)</td>
<td>796</td>
<td>795</td>
<td>798</td>
<td>797</td>
</tr>
<tr>
<td>Average final weight (lbs.)</td>
<td>1034</td>
<td>1039</td>
<td>1032</td>
<td>1053</td>
</tr>
<tr>
<td>Total gain per head (lbs.)</td>
<td>238</td>
<td>234</td>
<td>234</td>
<td>256</td>
</tr>
<tr>
<td>Average daily gain (lbs.)</td>
<td>1.70</td>
<td>1.75</td>
<td>1.67</td>
<td>1.83</td>
</tr>
<tr>
<td>Average daily ration (lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn silage</td>
<td>41.90</td>
<td>41.90</td>
<td>41.90</td>
<td>41.90</td>
</tr>
<tr>
<td>Purdue A</td>
<td>3.63</td>
<td>3.63</td>
<td>3.63</td>
<td>3.63</td>
</tr>
<tr>
<td>Soybean meal and corn mix</td>
<td>3.37</td>
<td></td>
<td>3.37</td>
<td></td>
</tr>
<tr>
<td>Salt, bonemeal, and limestone</td>
<td>0.15</td>
<td>0.05</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>Feed per cwt. of gain (lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn silage</td>
<td>2458.7</td>
<td>2400.4</td>
<td>2513.5</td>
<td>2288.0</td>
</tr>
<tr>
<td>Purdue A</td>
<td>208.1</td>
<td></td>
<td>202.3</td>
<td>198.3</td>
</tr>
<tr>
<td>Soybean meal and corn mix</td>
<td>197.9</td>
<td>2.9</td>
<td>4.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Salt, bonemeal, and limestone</td>
<td>9.1</td>
<td>2.9</td>
<td>4.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Costs and returns (dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed cost per cwt. of gain*</td>
<td>18.10</td>
<td>19.86</td>
<td>18.28</td>
<td>18.97</td>
</tr>
<tr>
<td>Average marketing cost per head</td>
<td>2.18</td>
<td>2.20</td>
<td>2.16</td>
<td>2.22</td>
</tr>
<tr>
<td>Average selling price per cwt.</td>
<td>19.92</td>
<td>19.61</td>
<td>19.74</td>
<td>19.52</td>
</tr>
<tr>
<td>Selling price per head</td>
<td>186.99</td>
<td>195.83</td>
<td>194.12</td>
<td>196.84</td>
</tr>
<tr>
<td>Total costs per head†</td>
<td>220.38</td>
<td>225.56</td>
<td>220.50</td>
<td>226.12</td>
</tr>
<tr>
<td>Loss per head</td>
<td>23.39</td>
<td>29.73</td>
<td>26.38</td>
<td>29.28</td>
</tr>
<tr>
<td>Carcass grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of choice carcasses</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Number of good carcasses</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Average dressing percent</td>
<td>57.48</td>
<td>56.53</td>
<td>57.34</td>
<td>56.40</td>
</tr>
<tr>
<td>Average shrink (lbs.)</td>
<td>45.2</td>
<td>40.7</td>
<td>48.1</td>
<td>44.5</td>
</tr>
</tbody>
</table>

*Feed prices used are as follows: corn silage, $8.00 per ton; Purdue A, $93.00 per ton; soybean meal, $94.00 per ton; ground shelled corn, $1.40 per bushel; salt, $1.30 per cwt.; bonemeal, $5.45 per cwt.; and limestone, $1.00 per cwt.
†This cost includes cost of feeder at $22.00 per cwt., plus feed and marketing costs. No costs such as labor, bedding, housing, interest, etc., have been added.
Average Rate of Gain of Progeny Groups of Bulls and Average Yearling Weights of Their Half Sisters

<table>
<thead>
<tr>
<th>Sire No.</th>
<th>No. of Progeny in Group</th>
<th>Bulls Rate of Gain</th>
<th>Rank</th>
<th>No. of Progeny in Group</th>
<th>Heifers Wt.</th>
<th>Yearling Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>219</td>
<td>7</td>
<td>2.24</td>
<td>2</td>
<td>8</td>
<td>734</td>
<td>1</td>
</tr>
<tr>
<td>101</td>
<td>14</td>
<td>2.33</td>
<td>4</td>
<td>15</td>
<td>728</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
<td>2.19</td>
<td>3</td>
<td>6</td>
<td>696</td>
<td>3</td>
</tr>
<tr>
<td>022</td>
<td>8</td>
<td>2.04</td>
<td>8</td>
<td>9</td>
<td>690</td>
<td>4</td>
</tr>
<tr>
<td>401</td>
<td>3</td>
<td>2.22</td>
<td>6</td>
<td>4</td>
<td>673</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>2.07</td>
<td>5</td>
<td>18</td>
<td>668</td>
<td>6</td>
</tr>
<tr>
<td>601</td>
<td>10</td>
<td>2.13</td>
<td>9</td>
<td>19</td>
<td>651</td>
<td>7</td>
</tr>
<tr>
<td>026</td>
<td>10</td>
<td>2.09</td>
<td>7</td>
<td>7</td>
<td>646</td>
<td>8</td>
</tr>
<tr>
<td>23</td>
<td>8</td>
<td>2.35</td>
<td>1</td>
<td>11</td>
<td>635</td>
<td>9</td>
</tr>
<tr>
<td>013</td>
<td>5</td>
<td>2.25</td>
<td>1</td>
<td>2</td>
<td>635</td>
<td>9</td>
</tr>
<tr>
<td>402</td>
<td>6</td>
<td>2.16</td>
<td>10</td>
<td>8</td>
<td>595</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>no bulls tested</td>
<td></td>
<td></td>
<td>no heifers tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>10</td>
<td>1.97</td>
<td></td>
<td>no heifers tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>001</td>
<td>4</td>
<td>2.25</td>
<td></td>
<td>no heifers tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>003</td>
<td>2</td>
<td>2.25</td>
<td></td>
<td>no heifers tested</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All animals, in all lots, received the same amount of soybean oil meal in their supplement, since both Purdue supplement A and the soybean corn mix contained 2.25 pounds of soybean oil meal.

A small amount of corn was added to the soybean oil meal fed Lots 1 and 3 in order to make it more comparable with Purdue supplement A as to total digestible nutrients.

The cattle fed in this experiment were long yearlings which weighed about 795 pounds in November when the trial was started. These cattle had been carried under good grazing conditions during the summer, then were fed brome and alfalfa hay with about 3 pounds of oats daily per head for a period of six weeks prior to the test.

If there had been any indication that cattle receiving different supplements would consume varied amounts of silage, the rate of silage feeding would have been regulated to allow maximum consumption. There appeared to be no difference in maximum silage consumption by cattle getting the different supplements. Therefore, corn silage was fed in equal amounts to all four lots.

Results of the 140-day feeding trial are given in the table. There was very little difference in the rate of gain of cattle on different supplements. Approximate gain of 1.7 pounds per day resulted from cattle getting 42 pounds of corn silage a day plus supplements. There was no great difference in selling price or live market grades on the cattle at the close of the experiment.

No definite pattern of differences in carcass grades was observed in cattle from different lots. Thirty-two carcasses graded choice and eight graded good. Under prices which prevailed this year, financial losses resulted in all lots of this feeding trial. This was due largely to the fact that choice slaughter cattle sold for less per hundred pounds than was the purchase price of feeders per hundred pounds. (Project 143. Leader: W. C. McCone, Animal Husbandry Dept.)

**Progeny Testing and the Range Producer**

The published results of the beef breeding project in past years have dealt mainly with the feed lot performance of sire groups of steers and bulls. These results have indicated sizeable differences between bulls in their ability to sire calves that will gain rapidly and efficiently.

Some ranchers have questioned the value of feed lot testing for range conditions. Enough data are available now to give an indication of the relationship
that exists between feed lot testing and performance on grass, although the quantity of data is not sufficient to be considered proof of this relationship.

The replacement heifers, half-sisters of the bull calves tested in the feed lot, are carried under fairly typical range management. They are wintered on hay and cake, and, in some years, they receive a small amount of grain. The aim is to keep them growing and bring them through the winter in good shape but not fat. They are carried on grass alone the summer they are yearlings.

The data accumulated to date include 110 heifers from 12 different sires for which the yearling weight is available. The average weight, corrected for age differences and year differences, of the heifers from different sires appear in the table. The average rate of gain, corrected for age and year differences, of their half brothers also appear in the table. (Project 167. Leader: C. A. Dinkel, Animal Husbandry Dept.; A. J. Foxley, Supt., Antelope Range Field Station; Jean Kern, Supt., Cottonwood Range Field Station; Wayne Gloe, Supt., Reed’s Ranch.)

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**Vitamin A Supplement for Range Cows**

Fifty-four grade yearling Hereford heifers were assigned to six lots and fed 1 pound per head daily of a 38 percent protein supplement containing added phosphorus and 0, 7000, or 21000 USP units of vitamin A from December 16 to May 11, 1953. These heifers were winter-grazed in typical range pastures and were moved from pasture to pasture every two weeks to compensate for pasture differences. Because of snow cover, the cattle were fed an average of 14.7 pounds of late-cut prairie hay for 32 days. This hay contained from 2.28 to 6.20 mg. of carotene per pound.

The cattle were weighed each 28 days. There were no large differences in weight gains between lots. Blood samples were taken December 4, January 29, and March 12 and analyzed for plasma vitamin A, carotene, and phosphorus. The results are shown in the accompanying table.

The increase in plasma vitamin A and carotene levels between the second and third bleeding dates was probably due to extensive hay feeding during this per-

---

| Vitamin A, Carotene, and Phosphorus in the Blood Plasma of Heifers Winter-Grazed on the Range and Supplemented with Various Levels of Vitamin A |
| --- | --- | --- | --- | --- | --- |
| Treatment | No Vitamin A | 1000 U.S.P. Units of Vitamin A Per 100 Lbs. Body Wt. | 3000 U.S.P. Units of Vitamin A Per 100 Lbs. Body Wt. |
| **Plasma vitamin A, mcg., %** | | | | | | |
| December 5 | 18.8 | 18.8 | 20.4 | 20.0 | 18.7 | 18.4 |
| January 29 | 14.0 | 17.1 | 16.4 | 17.8 | 17.8 | 18.9 |
| Change | -4.8 | -1.7 | -4.0 | -2.2 | -0.9 | +0.5 |
| March 12 | 17.0 | 16.8 | 21.7 | 21.2 | 23.7 | 25.4 |
| Change | +3.0 | -0.3 | +5.3 | +3.4 | +5.9 | +6.5 |
| **Plasma carotene, mcg., %** | | | | | | |
| December 5 | 31.4 | 36.1 | 35.6 | 37.1 | 39.9 | 35.2 |
| January 29 | 9.9 | 9.8 | 11.9 | 12.6 | 11.8 | 8.9 |
| Change | -21.5 | -26.3 | -23.7 | -24.5 | -28.1 | -26.3 |
| March 12 | 16.8 | 18.0 | 18.4 | 15.3 | 17.1 | 15.3 |
| Change | +6.9 | +8.2 | +6.5 | +2.7 | +5.3 | +6.4 |
| **Plasma phosphorus, mcg., %** | | | | | | |
| December 5 | 6.22 | 6.08 | 7.08 | 6.35 | 5.79 | 6.32 |
| January 29 | 8.03 | 7.07 | 8.00 | 7.98 | 6.76 | 6.98 |
| Change | +1.81 | +0.99 | +0.92 | +1.63 | +0.97 | +0.66 |
| March 12 | 7.66 | 6.33 | 8.40 | 7.37 | 6.42 | 7.19 |
| Change | +0.37 | -0.74 | +0.40 | -0.61 | -0.34 | -0.21 |
Summary of Stocking Rates and Animal Production Data in Summer Grazing Trials, May 6 to December 4, 1952

<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>366</td>
</tr>
<tr>
<td>Number of days grazed*</td>
<td>196</td>
<td>196</td>
<td>196</td>
</tr>
<tr>
<td>Amount of grazing furnished, cow days</td>
<td>2887.2</td>
<td>3068.2</td>
<td>3068.2</td>
</tr>
<tr>
<td>Stocking rate, acres per AUM</td>
<td>1.66</td>
<td>2.60</td>
<td>3.50</td>
</tr>
<tr>
<td>Total gain of cattle on pasture (calculated), lbs.†</td>
<td>1422</td>
<td>2036</td>
<td>3905</td>
</tr>
<tr>
<td>Total gain per acre (calculated), lbs. †</td>
<td>8.9</td>
<td>7.7</td>
<td>10.7</td>
</tr>
</tbody>
</table>

NOTE: The rainfall from April 1 to September 30, 1952 was 11.36 inches. The average rainfall for this period is 11.77 inches.

The cattle were out of the pastures from August 11 to 16 (5 days) and from October 27 to November 7 (11 days).

Includes the calculated gains of extra animals which were placed in the pastures from July 1 to August 11.

iod. An analysis of variance showed the difference between lot averages of plasma vitamin A to be highly significant.

No production data were obtained. This study is being continued with the same animals on the same treatments.

(Project 217. Leaders: J. K. Lewis, Animal Husbandry Dept.; O. E. Olson and A. Halverson, Station Biochemistry; Jean M. Kern, Cottonwood Range Field Station.)

Summer Grazing of Beef Cows for Calf Production

Six pastures at the Cottonwood Range Field Station have been grazed heavily, moderately, or lightly from about May 1 to December 1 each year since 1942. These pastures were stocked on May 6 with eight cows and their calves except one of the heavily-grazed replicates which was stocked with seven cows and their calves. Following favorable June rains an extra cow was added to each pasture on July 1.

The cows were quite old and it was decided to sell the dry cows in August, the wet cows in the fall and buy a uniform set of yearling heifers. After the dry cows were sold in August, grazing pressure was maintained constant by stocking the lightly-grazed pastures with yearling heifers from the breeding herd and re-grouping the cows with calves on the heavily and moderately grazed pastures. These animals were removed from the experiment on October 27 and replaced by yearling grade Hereford heifers which were permanently allotted.

A summary of the stocking rates and animal production data are shown in the accompanying table. Detailed forage production studies and chemical analyses are being conducted; however, results are not yet available. (Project 216. Leaders: J. K. Lewis, Animal Husbandry Dept.; O. E. Olson, Station Biochemistry; and Jean M. Kern, Cottonwood Range Field Station.)

Nutritive Value of Prairie Hay Cut at Different Stages of Maturity

Winter feeding trials with calves were conducted for the third year. The calves were fed prairie hay cut at different stages of maturity which was supplemented with a protein supplement to equalize the level of protein in the total ration. The stages of maturity when the hays were harvested were early (heading), medium (seed ripe), and late (after frost). One lot of calves was wintered on each kind of hay with soybean meal as the protein supplement, and one lot of calves was fed early-cut hay unsupplemented. The soybean meal was fed in amounts to give about 10 percent protein in the total ration.

The feeding trials were started the latter part of November at the Cottonwood, Eureka, and Highmore substations. The feeding period at each station was 140 days. A summary of the results is shown in the table.

The rate of gain was good and quite similar at the Cottonwood and Eureka
substations when each hay was supplemented in this manner. However, the gain was somewhat lower with the early-cut and medium-cut hay at Highmore. Delaying the cutting date of the hay reduced its value considerably since more protein supplement was required to get gains equal to those on early-cut hay.

The gain made by calves fed the early-cut hay without a protein supplement varied widely between the substations. Unless the early-cut hay is of high quality a protein supplement appears advisable.

Digestion trials were conducted to compare the effect of various supplements (alfalfa meal and dried brewers yeast) on the digestibility of a good quality and poor quality hay. Both sheep and cattle were used in these trials. This phase of the project has not been completed. (Project 120. Leaders: L. B. Emhry and G. T. King, Animal Husbandry Dept.; O. E. Olson, Station Biochemistry Dept.; J. G. Ross, Agronomy Dept.)

A Supervised Pasture System

A supervised pasture system was set up in 1953. It is designed to test pasture yields, month by month, and to measure weight gains made by steers on the pasture.

Six eight-acre paddocks have been established with three kinds of pastures. The three pasture mixtures are brome, alfalfa-brome, and sweet clover-rye. Fences and corrals have been built and well water provided. Satisfactory stands have been established and grade Hereford yearling steers were allotted at random to each paddock on May 28, 1953. The calves were sprayed for flies before going on pasture and have fresh well water and mineral consisting of salt and steamed bone meal free choice. Rotation within paddocks is practiced based upon forage growth rather than a time interval.

The experiment will be repeated in 1954. (Project 225. Leaders: W. W. Worzella, Agronomy Dept., and General T. King, Animal Husbandry Dept.)

Results of Calf-Wintering Trials with Early, Medium, and Late Prairie Hay Supplemented with Soybean Meal to Equalize Protein Level

<table>
<thead>
<tr>
<th></th>
<th>Early Hay</th>
<th>Medium Hay</th>
<th>Late Hay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Supplement</td>
<td>SBOM</td>
<td>SBOM</td>
</tr>
<tr>
<td><strong>Cottonwood (6 heifers and 4 steers per lot)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average initial weight (lbs.)</td>
<td>348.5</td>
<td>353.9</td>
<td>354.4</td>
</tr>
<tr>
<td>Average daily gain (lbs.)</td>
<td>0.30</td>
<td>0.91</td>
<td>0.99</td>
</tr>
<tr>
<td>Average daily ration (lbs.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>12.3</td>
<td>12.9</td>
<td>12.6</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>1.27</td>
<td>1.63</td>
<td>2.27</td>
</tr>
<tr>
<td>Pellets fed per ton of hay</td>
<td>196.8</td>
<td>258.6</td>
<td>389.2</td>
</tr>
<tr>
<td><strong>Eureka (10 steers per lot)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average initial weight (lbs.)</td>
<td>378.6</td>
<td>378.7</td>
<td>378.9</td>
</tr>
<tr>
<td>Average daily gain (lbs.)</td>
<td>0.55</td>
<td>1.04</td>
<td>1.07</td>
</tr>
<tr>
<td>Average daily ration (lbs.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>13.0</td>
<td>11.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>1.33</td>
<td>1.70</td>
<td>2.02</td>
</tr>
<tr>
<td>Pellets per ton of hay</td>
<td>223.0</td>
<td>284.4</td>
<td>350.8</td>
</tr>
<tr>
<td><strong>Highmore (10 steers per lot)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average initial weight (lbs.)</td>
<td>411.1</td>
<td>410.9</td>
<td>411.4</td>
</tr>
<tr>
<td>Average daily gain (lbs.)</td>
<td>0.11</td>
<td>0.58</td>
<td>0.69</td>
</tr>
<tr>
<td>Average daily ration (lbs.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>12.1</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>1.21</td>
<td>1.26</td>
<td>2.04</td>
</tr>
<tr>
<td>Pellets per ton of hay</td>
<td>201.8</td>
<td>210.6</td>
<td>340.4</td>
</tr>
</tbody>
</table>
Value of Trace Mineral Supplements with Prairie Hay

The effect of trace minerals (cobalt, copper, manganese), on rate of gain and digestibility of the ration by yearling steers when fed a poor quality prairie hay was studied for the second year. Six steers were fed a pellet containing about 32 percent protein with soybean meal as the major source of protein. Six other steers were fed a pellet with approximately the same protein and energy level, but containing 5 percent urea. One-half of the steers in each group were fed the pellets to which 2 mg. of cobalt, 10 mg. of copper and 60 mg. of manganese had been added per pound of supplement. All steers were given a full feed of hay and 2 to 3 pounds of supplement daily depending upon size.

The average daily gain for the six steers fed the trace minerals was 0.39 pound. Those not receiving the added trace minerals gained an average of 0.51 pound daily. The gain made by the steers fed the protein supplement with 5 percent urea was fully equal to the gain made by the steers fed the supplement without urea, but with more soybean meal.

Carotene as carrot oil was added to all pellets and tests made on the stability of the carotene. Carotene loss was greater in the feed with 5 percent urea than in the feed without urea, but with more soybean meal (expeller process). Trace minerals increased carotene destruction but only to a small degree. In further tests on carotene stability it was shown that urea had little if any effect on carotene stability, but soybean meal apparently had a protective action. (Project 218. Leaders: L. B. Embry, Animal Husbandry Dept.; O. E. Olson, A. W. Halverson, Station Biochemistry Dept.)

Development of a Higher Producing Tailless Breed of Sheep

Selection for the improvement of both wool and mutton qualities of the present no-tail breed of sheep has been continued. During the coming year greater emphasis will be placed on a study of the genetics of the taillessness of this breed. Quantitative and qualitative studies relative to the milk production and the growth rate of the lambs is being carried on. (Project 9. Leaders: A. L. Musson and R. M. Jordan, Animal Husbandry Dept.)

Levels and Length of Time of Concentrate Feeding

Wintering ewes under range conditions at the Antelope Range Field Station has been in progress for two years to determine the optimum level of supplemental feeding of bred range ewes for maximum net returns in lamb and wool. The first year’s work was done with three lots, 80 ewes per lot, feeding 0.2 pound per head daily of 40 percent protein, 20 percent protein, and 40 percent protein the last six weeks of pregnancy. The work in progress now consists of four lots with 100 ewes per lot. Three lots are fed the same rations and for the same length of time as the year before.

The fourth lot is fed 0.4 pound 20 percent protein pellet the entire feeding period.

The ewes are grazed as a band and cut for feeding once a day. They are fed 2½ pounds native hay per head daily when grazing is impractical due to weather conditions. Fresh well water, iodized salt, and a mineral mix of equal parts dicalcium phosphate and salt are fed free choice. The ewes are pasture bred as a band beginning November 1 and ending December 15.

During the first year the most striking difference was in the number of ewes lambing in the three lots. There were twice as many ewes which did not lamb in Lot 2 (0.2 pound of a 20 percent protein supplement per head daily) and Lot 3 (0.2 pound 40 percent protein supplement per head daily the last 6 weeks before lambing) as in Lot 1, fed 0.2 pound 40 percent protein supplement per head daily during the entire feeding period.
Noticeably larger ewe gains occurred in Lot 1 while in Lot 3 all the gain was made the last 40 days of winter treatment. This was true to a great extent the past winter.

The following table summarizes the results of the 1952-53 experiment.

The greatest difference between ewes fed 0.2 pound of the 40 percent (Lot 1) and the 20 percent (Lot 2) protein supplement the entire period was in the number of ewes lambing. In Lot 1, 97 of the 100 ewes lambed while only 94 lambed in Lot 2. Cost of the supplement per ewe was 14 cents higher for the ewes in Lot 1.

When 0.2 pound of the 40 percent protein supplement was fed only the last 6 weeks before lambing (Lot 3), the ewe gains were reduced. The number of ewes lambing was less than for those fed the 40 percent protein supplement the entire feeding period (Lot 1), but greater than those in Lot 2. Cost of supplementation was considerably reduced by this method of supplemental feeding.

Ewes fed 0.4 pound of the 20 percent protein supplement per head daily for the entire feeding period (Lot 4) made the greatest total gain and produced the most wool. The number of ewes lambing was one less than in Lot 1 but more ewes in Lot 4 had twins. Cost of supplementation per ewe was considerably greater than for the other lots.

The project will be repeated during 1953-54. (Project 159. Leaders: G. T. King, L. B. Embry, J. K. Lewis, Animal Husbandry Dept.; A. J. Foxley, Superintendent, Antelope Range Field Station.)

Summer Grazing Studies with Sheep

In November 1951, 400 range ewes were permanently assigned at random to four methods of winter supplementation and to four methods of summer grazing, considering age and weight. Winter and summer treatments were balanced. These ewes were bred as a band, fed during the winter as described under project 159, shed lambed, placed in fenced pastures on May 1, and removed November 4, 1952.

The pasture treatments were light grazing season-long, moderate grazing season-long, heavy grazing season-long, and moderate grazing rotated weekly in a four unit rotation. The ewes were given access to a 1:1 mixture of salt and dicalcium phosphate and to well water.

The ewes were weighed each 28 days and sheared on June 10. The lambs were weighed at birth and each 28 days after May 1 until they were weaned September 23. The results are shown in the accompanying table. Weaning weights are not corrected for age or twinning effect.

Summary for Range Ewe Wintering Experiment, Nov. 4, 1952 to April 1, 1953

<table>
<thead>
<tr>
<th></th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III*</th>
<th>Lot IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2 Lb. 40% Protein Pellet</td>
<td>0.2 Lb. 20% Protein Pellet</td>
<td>0.2 Lb. 40% Protein Pellet</td>
<td>0.4 Lb. 20% Protein Pellet</td>
</tr>
<tr>
<td>Number ewes per lot</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Average initial weight per ewe, lbs.</td>
<td>134.0</td>
<td>138.8</td>
<td>133.9</td>
<td>134.4</td>
</tr>
<tr>
<td>Average final weight per ewe, lbs.</td>
<td>145.2</td>
<td>147.6</td>
<td>142.4</td>
<td>146.8</td>
</tr>
<tr>
<td>Average gain per ewe, lb.</td>
<td>11.2</td>
<td>8.8</td>
<td>8.5</td>
<td>12.4</td>
</tr>
<tr>
<td>Average fleece weight per ewe, lbs.</td>
<td>9.9</td>
<td>10.6</td>
<td>10.0</td>
<td>10.7</td>
</tr>
<tr>
<td>Number of ewes lambing</td>
<td>97</td>
<td>94</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Total number of lambs born</td>
<td>124</td>
<td>126</td>
<td>126</td>
<td>126</td>
</tr>
<tr>
<td>Average birth weight per lamb, lb.</td>
<td>9.3</td>
<td>9.3</td>
<td>9.3</td>
<td>9.5</td>
</tr>
<tr>
<td>Lamb crop, % of ewes bred</td>
<td>124.0</td>
<td>126.0</td>
<td>126.0</td>
<td>126.0</td>
</tr>
<tr>
<td>Lamb crop, % of ewes lambed</td>
<td>127.8</td>
<td>134.0</td>
<td>131.3</td>
<td>131.3</td>
</tr>
<tr>
<td>Number of ewe death losses</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Supplement feed cost per ewe</td>
<td>1.57</td>
<td>1.43</td>
<td>0.25</td>
<td>2.84</td>
</tr>
<tr>
<td>Total supplement per ewe, lb.</td>
<td>29.4</td>
<td>29.4</td>
<td>4.6</td>
<td>58.8</td>
</tr>
</tbody>
</table>

*Fed last 6 weeks of pregnancy (February 18 to April 17).
### Summer Grazing Studies with Sheep (May 1 to November 4, 1952—188 days)

<table>
<thead>
<tr>
<th>Grazing Season-long</th>
<th>Light Grazing</th>
<th>Moderate Grazing</th>
<th>Heavy Grazing</th>
<th>Moderate Grazing Rotated Weekly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres in pasture</td>
<td>524</td>
<td>408</td>
<td>254</td>
<td>408</td>
</tr>
<tr>
<td>Number of ewes grazed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Stocking rate, acres per ewe per month</td>
<td>0.87</td>
<td>0.68</td>
<td>0.42</td>
<td>0.68</td>
</tr>
<tr>
<td>Utilization, visual estimate, %</td>
<td>30</td>
<td>55</td>
<td>68</td>
<td>46</td>
</tr>
<tr>
<td>Number of record ewes completing year*</td>
<td>68</td>
<td>68</td>
<td>67</td>
<td>64</td>
</tr>
<tr>
<td>Average weight Dec. 5, 1951, lbs.</td>
<td>134.4</td>
<td>136.0</td>
<td>138.2</td>
<td>136.6</td>
</tr>
<tr>
<td>Average weight May 1, 1952, lbs.</td>
<td>114.6</td>
<td>114.3</td>
<td>117.7</td>
<td>114.8</td>
</tr>
<tr>
<td>Average weight Nov. 4, 1952, lbs.</td>
<td>134.8</td>
<td>140.0</td>
<td>133.0</td>
<td>139.1</td>
</tr>
<tr>
<td>Average summer gain, lbs.</td>
<td>20.2</td>
<td>25.7</td>
<td>15.3</td>
<td>24.3</td>
</tr>
<tr>
<td>Average yearly gain, lbs.</td>
<td>0.4</td>
<td>4.0</td>
<td>-5.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Average age of ewes, years</td>
<td>4.6</td>
<td>4.6</td>
<td>4.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Average grease fleece weight, lbs.</td>
<td>9.3</td>
<td>9.6</td>
<td>9.8</td>
<td>9.7</td>
</tr>
<tr>
<td>Number of dry ewes</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Number of lambs born</td>
<td>84</td>
<td>73</td>
<td>80</td>
<td>74</td>
</tr>
<tr>
<td>Number of lambs died before May 1</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Number of lambs died on pasture</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Average weaning weight, lbs.</td>
<td>80.1</td>
<td>83.4</td>
<td>75.4</td>
<td>72.4</td>
</tr>
<tr>
<td>Average weaning age, days</td>
<td>164.6</td>
<td>167.8</td>
<td>166.6</td>
<td>168.1</td>
</tr>
<tr>
<td>Number of twins born</td>
<td>42</td>
<td>22</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>Number of twins weaned (as twins)</td>
<td>24</td>
<td>12</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Number of twins raised as singles</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Average weaning weight of twins, lbs.</td>
<td>68.3</td>
<td>70.6</td>
<td>64.4</td>
<td>64.2</td>
</tr>
<tr>
<td>Average weaning age of twins, lbs.</td>
<td>158.9</td>
<td>159.0</td>
<td>161.3</td>
<td>170.4</td>
</tr>
<tr>
<td>Pounds of lamb weaned per ewe completing experiment</td>
<td>81.3</td>
<td>81.0</td>
<td>76.5</td>
<td>75.8</td>
</tr>
</tbody>
</table>

*Data are reported for those ewes which were wintered under project 159. The other ewes were used as harvesters of forage and their records are not shown in this summary.

**NOTE:** It was a very dry summer. Rainfall from May 1 to October 31 was 7.81 inches.

This experiment is being continued, using permanently allotted animals which are culled only because of age or unsoundness. Replacement ewe lambs are selected from the lots in which they will be placed. (Project 177. Leaders: J. K. Lewis and G. T. King, Animal Husbandry Dept.; A. J. Foxley, Antelope Range.)

### Thyroprotein Fails to Increase Milk Production of Ewes

Protomone, a synthetic compound which has thyroid acting properties, has been used successfully to increase the milk production of lactating cows and goats. Milk production increases from 25 to 50 percent have been obtained. Its effect on lactating ewes as measured by the increased growth rate of suckling lambs has been studied at this station during the past three years. Two grams of thyroprotein fed to Hampshire ewes that were suckling lambs failed to increase the amount of milk produced as measured by increased growth rate of the lamb. In addition ewes receiving thyroprotein lost more weight than the control group. (Project 205. Leader: R. M. Jordan, Animal Husbandry Dept.)

### Effect of Hormones on Fattening Lambs

Previous work at this station has shown that subcutaneous implantations of 12 mg. of stilbestrol increased the rate of growth and feed efficiency of fattening lambs by about 20 to 30 percent. In all cases stilbestrol has lowered the carcass grade and yield of the lambs. Earlier closure of the break joint and more difficulty in the removal of the pelt at time of slaughter is also apparent. Other adverse effects noticed in field studies are an in-
flammation of urinary tract, causing retention of the urine and prolapse of the vagina and rectum which usually results in death of the lambs.

The effect of smaller doses of stilbestrol (6 mg.) on fattening lambs has been studied. Growth response from 6 mg. of stilbestrol was as great as when 12 mg. of stilbestrol was used. However, 6 mg. failed to minimize the adverse effects of stilbestrol. Combination of stilbestrol and progesterone was implanted into fattening lambs and increased growth rate and feed efficiency were obtained. Further studies with the uses of combinations of various hormones will be continued. (Project 199. Leader: R. M. Jordan, Animal Husbandry Dept.)

Aureomycin Increases Growth Rate of Suckling Lambs

A ration containing aureomycin was fed in a creep to suckling lambs. At the level fed, each lamb received approximately 10 mg. of aureomycin daily. The aureomycin supplemented lambs gained 0.1 pound a day faster than the control lambs.

Three other trials were conducted in which lambs ranging from day-old lambs to 10-day-old lambs were implanted with 80 mg. of aureomycin. In the first trial, the lambs that received a subcutaneous implantation of 80 mg. of aureomycin gained slightly faster. In the other trials there was no difference in rate of gain between the control lambs and those treated with aureomycin. These data suggest that aureomycin must be administered orally to be effective and that the administration of it under the skin cannot be relied upon to benefit young lambs. (Project 206. Leader: R. M. Jordan, Animal Husbandry Dept.)

Grass Silage and Corn Silage Comparisons for Fattening Lambs

Experiments at the Station suggest that either alfalfa silage or good quality corn silage can be substituted for a large portion of the roughage usually fed fattening lambs. A comparison of lambs full fed shell corn and either alfalfa hay, alfalfa silage, or corn silage as a roughage (with approximately ½ pound of alfalfa hay fed the lots receiving silage) resulted in excellent gains made by the lambs in all three lots. However, those receiving either alfalfa silage or corn silage gained slightly more than the lambs receiving alfalfa hay as their roughage. Alfalfa silage proved very palatable to lambs and their daily consumption was slightly greater than was the case in the lot which received corn silage as a roughage.

A system of deferred feeding of fattening lambs is being studied. During the first 50 to 60 days the lambs received 4 to 5 pounds of either alfalfa silage or corn silage and little or no concentrate. During the next 60 days the concentrate feeding was increased. This system of feeding enables one to feed large quantities of roughage to fattening lambs during the 120- to 150-day feeding period. An average daily gain of 0.25 to 0.35 pounds per lamb daily has been obtained. During the past year, lambs fed alfalfa silage gained faster than lambs receiving corn silage. Because market demands favor fat lambs weighing 105 pounds or less, lightweight feeder lambs (65 pounds) fit into a deferred feeding program better than heavyweight feeder lambs (80-85 pounds). (Project 223. Leader: R. M. Jordan, Animal Husbandry Dept.)

Effect of Surface Active Agents on Rate of Gain and Feed Efficiency

The use of surface active agents to increase the rate of gain has been studied at this station during the past year. Two trials have been conducted in which a protein supplement containing 3 percent etho-fat C15 (surface active agent) was compared with plain soybean meal as a protein supplement for fattening lambs. In both trials the surface active agent had virtually no effect on the amount of feed consumed, rate of gain,
feed efficiency or carcass quality of fattening lambs.

Sodium bentonite, a volcanic ash mined in South Dakota, also has surface reducing properties and in addition will adsorb many times its own weight in water. Sodium bentonite was mixed with the protein supplements and fed to fattening lambs at the rate of one-third bentonite and two-thirds protein supplement. Slightly greater feed was consumed by the lambs receiving bentonite in their protein supplement than was the case of the control lot. They gained slightly faster and required somewhat less feed per 100 pounds of gain than the control lambs. These trials will be continued this coming year. (Project 233. Leader: R. M. Jordan, Animal Husbandry Dept.)

The Optimum Level of Feeding Ewe Lambs

No new work was conducted on this project in 1952-53. Data collected in previous years will be statistically analyzed and published at a later date. (Project 161. Leaders: G. T. King and L. B. Embry, Animal Husbandry; H. E. Weakly, Superintendent, Newell Field Station.)

Irrigated Pastures for Cattle and Sheep

The carrying capacity of irrigated alfalfa brome pastures and the amount of lamb and beef that can be produced per acre is being studied at the Newell substation. The cattle were rotated at approximately 2-week intervals and the pasture was irrigated at about 1-month intervals. There was little trouble from trampling or puddling due to the cattle or sheep pasturing on land that was somewhat muddy. Relatively uniform grazing over the pasture area and satisfactory gains per acre were obtained. Several years of research will be required before any conclusions can be drawn from this work. (Project 229. Leaders: R. M. Jordan, J. K. Lewis, Animal Husbandry Dept.; H. E. Weakly, U. S. Newell Field Station; W. W. Worzella, Agronomy.)

Swine Production for the Irrigated Areas of South Dakota

The objectives of this project are improved swine breeding, feeding, and management practices for the irrigated areas of South Dakota. Only the breeding phase is being emphasized at present. This work is being conducted with one inbred Hampshire line.

In the 1952 season the 13 litters averaged 8.2 pigs at farrowing and 3.0 pigs at weaning. At weaning (56 days) the pigs averaged 35.7 pounds and 174 pounds at 154 days. The average inbreeding coefficient for the sows was 26 and 34 for the litters. For the 1953 season, four gilts from outbred sources were incorporated in the line. Data for this season are as yet unavailable.

The line is being further tested as to combining ability. (Project 132. Leaders: C. P. Wilder, Animal Husbandry Dept.; Harry E. Weakly, U. S. Newell Field Station.)

Systems of Breeding Swine Research Conducted at Brookings and North Central Substation, Eureka

Research is being conducted at Brookings and at the North Central substation on swine to increase selection efficiency and to study the effectiveness of some of the mating systems. The criteria for measuring the different systems are sow productivity, pig gaining ability, and carcass desirability.

For the 1952 season five breeding groups were carried at Brookings. These five groups represented four mating systems — inbreeding, outbreeding, line crossing, and breed-line crossing. Again this year the breed-line crosses (composed of inbred lines from the Hampshire, Landrace, Duroc and Poland China breeds) proved superior. The accompanying table shows the performance of the various groups. (Project 124. Leaders: C. P. Wilder, Animal Husbandry Dept.; Albert Dittman, North Central Substation, Eureka.)
### Summary of Results of Swine Breeding Experiments for 1952

<table>
<thead>
<tr>
<th></th>
<th>4-Breed Line Cross</th>
<th>4-Breed Line Cross</th>
<th>P. G. Inbred</th>
<th>P. G. Inbred</th>
<th>Durroc Inbred</th>
<th>Durroc Inbred</th>
<th>P. G. Outbred</th>
<th>P. G. Outbred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of litters</td>
<td>8</td>
<td>17</td>
<td>13</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average inbreeding (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sows</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Litters</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number pigs per litter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farrowed</td>
<td>7.6</td>
<td>11.6</td>
<td>6.0</td>
<td>8.6</td>
<td>8.9</td>
<td>8.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaned</td>
<td>5.6</td>
<td>9.0</td>
<td>4.9</td>
<td>6.2</td>
<td>7.3</td>
<td>7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average weight per pig (lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth</td>
<td>2.45</td>
<td>2.69</td>
<td>2.42</td>
<td>2.56</td>
<td>2.63</td>
<td>2.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaning</td>
<td>29.9</td>
<td>32.2</td>
<td>29.5</td>
<td>30.0</td>
<td>30.8</td>
<td>30.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>154 days</td>
<td>153</td>
<td>174</td>
<td>164</td>
<td>170</td>
<td>161</td>
<td>161</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average litter weight (lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth</td>
<td>18.7</td>
<td>31.3</td>
<td>14.5</td>
<td>22.1</td>
<td>23.5</td>
<td>23.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaning</td>
<td>168</td>
<td>290</td>
<td>145</td>
<td>186</td>
<td>223</td>
<td>223</td>
<td></td>
<td></td>
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<tr>
<td>154 days</td>
<td>820</td>
<td>1556</td>
<td>773</td>
<td>1043</td>
<td>1117</td>
<td>1117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of animals</td>
<td>5</td>
<td>23</td>
<td>9</td>
<td>10</td>
<td>19</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age in days</td>
<td>183</td>
<td>181</td>
<td>185</td>
<td>182</td>
<td>182</td>
<td>182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average slaughter weight (lbs.)</td>
<td></td>
<td>209</td>
<td>208</td>
<td>207</td>
<td>209</td>
<td>209</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average dressing (%)</td>
<td>74.4</td>
<td>72.7</td>
<td>72.5</td>
<td>72.3</td>
<td>73.6</td>
<td>73.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of backfat measures (in.)</td>
<td></td>
<td>1.4</td>
<td>1.7</td>
<td>1.5</td>
<td>1.8</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of probe measures (in.)</td>
<td>1.4</td>
<td>1.6</td>
<td>1.5</td>
<td>1.7</td>
<td>1.6</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average length of carcass (in.)</td>
<td>29.5</td>
<td>30.0</td>
<td>29.9</td>
<td>29.1</td>
<td>28.8</td>
<td>28.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average depth of carcass (in.)</td>
<td>14.1</td>
<td>13.8</td>
<td>13.7</td>
<td>13.8</td>
<td>13.6</td>
<td>13.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Comparisons of Spring, Summer and Fall Farrowed Pigs

A comparison of the one-litter farrowing system with the two-litter farrowing system and comparing the results of farrowing at different seasons of the year has been the purpose of this experiment. The project will be completed with the marketing of the 1953 spring pigs which were farrowed in early March by sows having their second litter.

During the past year livability of pigs from farrowing to weaning was the highest for April farrowed pigs. The percentage of summer farrowed pigs marketed was lowest due to a necrotic enteritis outbreak in that lot. Highest prices were received for fall farrowed pigs. The data collected for the 5-year period this project has been in progress will be analyzed and published at a later date. (Project 168. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

### Antibiotic Implantations and Injections in Baby Pigs

Four litters of pigs were used in the first trial to determine the effect of implanting a 25 mg. pellet of terramycin in the neck of 3- and 4-day old pigs. A total of 36 pigs were used; half of each litter being left as controls and half implanted with the pellet. The pigs were weighed weekly until they reached 56 days of age.

There was very little difference in the rate of gain between the controls and the implanted pigs at any time during the trial and no benefit appeared to be derived from the implanted pellet.

In the second trial, six litters of pigs were divided into three groups one of which served as a control. Another group received 300 mg. of penicillin in sesame oil, injected intramuscularly 4 days after birth and the third group received 150 mg. in a like manner at 4, 14, and 24 days of age. The pigs were all weighed at these periods and again at
56 days. The results obtained indicate no advantage from this type of antibiotic supplementation for pigs which are still nursing. (Project 212. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

Artificial Milk for Baby Pigs

A total of 56 baby pigs have been removed from their dams at 4, 9, and 20 days of age and reared on artificial milk. No death losses were encountered when the pigs were removed at 9 or 20 days of age, but 5 out of 18 pigs died when they were removed at 4 days of age. Satisfactory weaning weights were obtained in all cases.

Cost data indicate that this method of raising baby pigs is more expensive than leaving them to nurse the sow if the artificial milk costs over 20 cents per pound. (Project 236. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

Effect of Antibiotics and B-Vitamins on the Growth of Pigs

The effect of the addition of five B-vitamins, penicillin, or a combination of the two, to a mixed basal ration of corn, soybean meal, tankage and minerals is being studied at three different protein levels. Ninety-six weanling Duroc pigs are being used in this experiment involving levels of protein at 18, 16 and 14 percent from weaning to 100 pounds live weight, and 14, 12 and 10 percent from 100 to 200 pounds.

Results of a preliminary trial conducted during the winter of 1952-53 indicated that pigs fed a 14 percent protein ration supplemented with B-vitamins and penicillin did equally as well as pigs fed an 18 percent protein ration similarly supplemented. Both of these groups gained significantly faster than the pigs receiving the same rations without the antibiotic-vitamin supplement. The overall summary of this work was published in the 1953 Feeders' Day Report. (Project 238. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)
Dairy Production

Use of Identical Twins for Studying Genetic and Environmental Factors

Four pairs of identical twins were used in a controlled housing experiment. The even numbered twins from each pair were maintained in a room with the temperature about 50°F, while the mate was kept in an individual pen in an open shed where the temperature ranged from −18°F to +60°F. No abnormalities were noticed in any of the animals. None were ill nor did any of the animals in the open shed show abnormal reactions to any environmental condition.

In so far as efficiency in feed consumption was concerned, there was a difference in favor of the outside group. The outside group gained on the average of 294 pounds and 6½ cm. in height on 3209 pounds of hay and 3230 pounds of silage. The inside group gained on the average of 221 pounds and 5 cm. in height on 3338 pounds of hay and 3885 pounds of silage.

Semen samples from two bulls were collected weekly and analyses made to determine if there were any detrimental effects on semen production resulting from outside housing. The results of the analyses are presented in the table:

As shown by the table, there seems to be very little difference in the semen analysis of the bull outside and the one inside. This is in agreement with results from last year and suggests that temperature probably is not a factor in semen production. (Project 191. Leader: Arthur E. Dracy, Dairy Husbandry Dept.)

<table>
<thead>
<tr>
<th></th>
<th>Outside</th>
<th>Inside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in cc.</td>
<td>6.2</td>
<td>7.06</td>
</tr>
<tr>
<td>Motility</td>
<td>4.37</td>
<td>3.7</td>
</tr>
<tr>
<td>pH</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Concentration per cc.</td>
<td>1,950,000</td>
<td>1,660,000</td>
</tr>
<tr>
<td>Dead alive as number alive per cc.</td>
<td>1,801,940</td>
<td>1,311,838</td>
</tr>
<tr>
<td>Abnormal sperm per cc.</td>
<td>35,858</td>
<td>30,942</td>
</tr>
</tbody>
</table>

Progesterone and Relaxin as Aids in Ova Transfer

Readjusting the heat periods with progesterone appears to have no ill effects if the recovery of fertilized ova is any criterion of normal fertility.

Continued experiments using relaxin to dilate the cows’ cervices have yielded various results. When treated with one injection of 1500 guinea pig units (G.P.U.) the cervix was expanded up to 1 inch in all but one case. Hourly injections of 1500 G.P.U. for 6 hours showed no additional relaxation when compared to one injection. One cow was injected with 1500 G.P.U. of relaxin every 3 hours for 96 hours. At 12 hours after the first injection, the cervix was dilated 1 inch and at 96 hours, 1½ inch. Two animals were injected with 1500 G.P.U. of relaxin during estrus. Six hours post estrus the cervix dilation was 1½ and 1¼ inches respectively.

One heifer was given 9000 G.P.U. of relaxin during difficult labor. In a matter of minutes the pelvis appeared more relaxed and the calf was born. Also in a limited number of observations, the pelvic ligaments appeared to be relaxed.

There is a possibility that recycling the estrus period of cows can be regulated so that a cow can be brought in heat and bred within a predicted time. This may prove advantageous for artificial insemination. (Project 189. Leader: Arthur E. Dracy, Dairy Husbandry Dept.)
Milking Machine Sanitation
Work was continued in the use of flush type cleaning of the combine milk er at the College dairy farm. The quality of the raw milk has remained high throughout the past year. Further work on this type of cleaning is being carried out at the present time.

A method of circulation cleaning has been perfected for the cleaning of dairy equipment in the College milk processing plant. The circulation of acid cleaning materials followed by circulating alkaline cleaning agents has made it possible to maintain the pipelines and plate cooler in satisfactory condition with a marked reduction in hand labor.

It is estimated that there has been a saving of approximately one hour of hand labor each day, since disassembly and reassembly of the pipelines is necessary only periodically. The pipelines are usually taken down once a week for inspection and any necessary hand brushing is done at that time. The high quality of the pasteurized milk has been maintained since this method of cleaning has been used. (Project 155. Leader: R. J. Baker, Dairy Husbandry Dept.)

Improvement of Dairy Cattle Through Breeding
The College dairy herd was analyzed to determine the effect of twinning on milk production and fertility. Since 1900 70 cows have had twins. These 70 cows were all tested for milk and butterfat production. The records were put on a 2X, 305 day, mature equivalent basis. They were then totaled and averaged as shown in the table.

To be settled back with calf after dropping the twins, each cow required 1.83 services. The cows required 1.55 services for each of the other pregnancies.

Milk and butterfat production records were collected this past year for each cow in the College Holstein herd which is being used on the current breeding project. This called for testing different systems of mating such as inbreeding and outcrossing. There have now been 11 daughters born that were sired by the bull used on the project last year. (Project 184. Leader: Chase Wilson, Dairy Husbandry Dept.)

<table>
<thead>
<tr>
<th></th>
<th>Milk Lbs.</th>
<th>Butterfat Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before carrying twins</td>
<td>10,963</td>
<td>3.66</td>
</tr>
<tr>
<td>While carrying twins</td>
<td>11,644</td>
<td>3.34</td>
</tr>
<tr>
<td>Following twinning</td>
<td>9,673</td>
<td>3.51</td>
</tr>
<tr>
<td>Subsequent years</td>
<td>10,324</td>
<td>3.74</td>
</tr>
</tbody>
</table>

Improved Pastures for Dairy Cattle
Approximately 50 acres have now been seeded to a combination of bromegrass and alfalfa. The seeded mixture was at the rate of 10 pounds of alfalfa and 13 pounds of bromegrass seed per acre. It was sown May 4 and 5, 1953. Oats were seeded at the rate of 1 bushel per acre to serve as a nurse crop for the bromegrass and alfalfa.

It is planned to make the oats into silage. The pasture mixture will be ready for the cows to graze by early summer 1954. Carrying capacity, milk production, milk dollars per acre and cow health will be studied. An 8-acre bromegrass pasture will be used as a control check. (Project 234. Leader: Chase Wilson, Dairy Husbandry Dept.)

Self-Feeding Grass Silage from the Stack, see page 66
Cottage Cheese, see page 72
Big-Neck in Calves, see page 99
Reproductive Performance of Poultry

In the tests described all birds were brooded and reared together at the Experiment Station at Brookings. All birds in any one test were thus reared under as nearly identical conditions as possible so that variation due to environmental effects upon production and mortality would be at a minimum. At the time of housing the birds were hauled by truck to outlying substations and 55 pullets were housed per pen according to breeding method. The first group described was housed at Eureka, the second at Cottonwood and the third at Highmore.

In one performance test conducted this year, topcross progeny from inbred White Plymouth Rock males mated to New Hampsbires were superior in egg production when compared with crossbred progeny. Crossbreds were produced by mating non-inbred White Plymouth Rock males of the strain from which the inbred line was developed to comparable New Hampshire females.

Both groups laid much better than the pen of New Hampsbires serving as a control, but not as well as a pen of experimental hybrids. After eight months of lay, the experimental hybrids had an advantage of about 3½ eggs per bird housed over the topcrosses, due in part to their earlier maturity and possibly to a slightly lower mortality. The slight advantage the experimental hybrids have in egg production would be more than offset by the larger egg size of the topcrosses if eggs were sold on a graded basis.

There appeared to be no consistent differences in egg size or percentage of small eggs (less than 23 ounces per dozen) produced by the topcrosses and crossbreds. Both were superior to the New Hampsbires and experimental hybrids in this respect. Differences in mortality among the four groups were very small.

In a second test, the performance of two experimental hybrids was compared with that of a pen of crossbreds (Rhode Island Red X Barred Plymouth Rock) and a pen of Single Comb White Leghorns obtained from a commercial hatchery which served as a control pen. The crossbreds have exceeded all other groups in egg production and livability and have been superior to all except the Leghorns in egg size and percentage of small eggs produced. Mortality has been excessive in the Leghorns and production has been poor.

In the third test, the progeny of single cross males (Inbred White Leghorn X Inbred White Plymouth Rock) mated to outbred White Leghorns and the progeny of the same type male mated to outbred Rhode Island Red females were compared with a pen of commercial hybrids and a pen of crossbreds (Rhode Island Red X Barred Plymouth Rocks). While performance of the crossbreds was good, it was considerably below that of the other three groups. After eight months of production, the differences in total egg production among the other three groups were small, although the commercial hybrids have laid a few more eggs than the single cross topcrosses.

Egg size has been somewhat better in the commercial hybrids than in the single cross topcrosses, but livability has been better in the latter. Because of the relative economy of producing single cross topcrosses, since but two inbred lines would have to be maintained, it appears that this system of breeding should be studied further. (Project 194. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry Dept.)

Reproductive Performance of Turkey Hens

Vitamin B₁₂ is required in a turkey breeder diet for high hatchability of fertile eggs from Broad Breasted Bronze hens and for prompt emergence of the
poults from the shell. It is also necessary for manifestation, under certain conditions, of a beneficial carry-over effect on growth of progeny to four weeks of age. Crystalline aureomycin HCl added to the vegetable type breeder diet appears to have exerted a beneficial effect upon progeny growth under certain conditions, possibly as a result of synthesis and carry-over of an unidentified factor.

Although the addition of vitamin B₁₂ to a breeder diet containing animal proteins did not influence hatchability of fertile eggs from Beltsville Small White hens, a beneficial effect upon progeny growth under certain conditions was noted. (Project 96. Leaders: C. W. Carlson, D. G. Jones, Wm. Kohlmeyer, Poultry Dept.; O. E. Olson, Station Biochemistry Dept.)

Effects of Inbreeding on Economic Qualities of Poultry

Inbreeding work has been continued in four lines of inbred White Plymouth Rocks and one line each of Barred Plymouth Rocks and Rhode Island Reds. Fertility was lower on the average in these groups than in the previous year, even with artificial insemination, but at least part of this decline was probably due to the poor condition of the males following a respiratory disorder.

Even though the parent stock was normal, a high incidence of crossbeaks, most of which are detectable at hatching, was observed in the Barred Plymouth Rocks. This condition, apparently hereditary, appears to be distinctly different from the type seen in White Plymouth Rocks which cannot be detected until the chicks are 6 to 8 weeks of age or older.

Inbreeding work was begun in one line of Leghorns and two crossbred lines. The two crossbred lines were made up either wholly or in part from some of the less common breeds and varieties of chickens so that a greater diversity of germ plasm might be available for crossing and hybridization purposes.

Stock produced from topcross matings of two inbred lines of White Plymouth Rocks and one of Rhode Island Reds has performed satisfactorily at the Regional Poultry Breeding Laboratory at Lafayette, Indiana. Livability in the laying house, which is one of the most serious problems confronting the poultyman today, was excellent in all three topcrosses with the laying year two-thirds completed.

Hatching eggs from six different single-cross matings were shipped to the Regional Poultry Breeding Laboratory this year for comparison with single crosses produced at other stations. Males from two inbred lines of Leghorns from the Minnesota station were used in four of the six single-cross matings.

This station provided males from the Rhode Island Red inbred line to the North Dakota, Nebraska, Minnesota and Wisconsin experiment stations. (Project 179. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry Dept.; D. C. Warren, B.A.I. cooperating.)

Control of Selenium Poisoning in Poultry

Earlier work has shown that when arsenic, as sodium arsenite, was added to the feed or to the drinking water provided for chickens and other animals, the toxic effect of feeding seleniferous grains was counteracted. However, this treatment did not prevent reduced hatchability and development of abnormal embryos when eggs from turkey hens fed a seleniferous diet were incubated. Attempts to counteract selenium poisoning in turkeys by using arsanilic acid and 3-nitro 4 hydroxyphenylarsenic acid were unsuccessful.

Recent work with chicks shows that growth rate was improved on either a normal or a seleniferous diet when additions of arsanilic acid or 3-nitro 4 hydroxyphenylarsenic acid, at levels of 90 grams per ton, were made. When arsenic, as sodium arsenite, was added at 10 parts per million, a similar growth response was obtained. Other trials showed
that a higher level of arsanilic acid (360 grams per ton) gave no growth stimulus with a normal control diet, but it did result in additional improvement in growth when a toxic diet was used.

This indicates that the higher level of arsanilic acid was effectively reducing the toxic effect of the seleniferous feed.

It also appears that the response of chicks to a seleniferous ration may vary with the breed or type of chick used as well as with the breeder ration fed to the parent stock. (Project 28. Leaders: C. W. Carlson, Wm. Kohlmeyer, Poultry Dept.; O. E. Olson, Station Biochemistry Dept.)

Supplementation of Cereal Grains for Poultry

Results of the work on this project is summarized as follows:

1. Growing turkeys from 12 to 24 weeks of age may utilize up to 80 percent oats in diets of either 16 percent or 19 percent protein without materially reducing the growth rate, although feed efficiency was 25 percent and 10 percent better, respectively, when corn was used as the main energy source. Luxuriant green forage consisting of oats and rape was available to all turkeys; however, those receiving the diets containing oats utilized a greater proportion of the forage. Body composition, as determined by chemical analysis for protein and fat, was not adversely affected by oats, although corn appeared to produce a carcass showing a darker yellow pigmentation.

2. White Plymouth Rock pullets receiving a 26 percent protein mash-and-grain diet of the high energy type produced more eggs on less feed during the winter and early spring months than did similar pullets on 20 percent protein mash-and-grain diets of either the high or medium energy types. Pullets receiving an addition of crystalline procaine penicillin G in the mash to approximate 2 grams per ton of diet produced significantly more eggs than did the controls in this same period.

New Hampshire pullets performed as well on a high energy all-mash diet as on the 26 percent protein mash-and-grain diet and somewhat better egg production was noted in each case when similar hens received similar diets containing crystalline procaine penicillin G. Barred Plymouth Rock pullets receiving crystalline aureomycin HCl at 50 grams per ton of diet were kept alive and in production longer than pullets receiving the control diet. The pullets given the aureomycin supplement showed 23 percent incidence of ocular leucosis and many, although of similar age and breeding, were physically inferior at housing time.

3. Diets made up of single cereals of high protein content, and balanced accordingly with soybean meal, minerals and vitamins did not support as rapid growth of chicks as did diets similarly formulated using cereals of lower protein content. (Project 52. Leaders: C. W. Carlson, R. A. Wilcox, Wm. Kohlmeyer, Poultry Dept.; O. E. Olson, Station Biochemistry Dept.)

Turkey Poults Need Phosphorus, see page 3
Forage Crops for Turkeys, see page 83
Livestock and Poultry Diseases and Parasites

**Sporadic Bovine Encephalomyelitis**

Two additional outbreaks of sporadic bovine encephalomyelitis (SBE) were diagnosed during the past year, making a total of 18 herds known to be infected since 1945. It is probable that this infection is more prevalent than is indicated by the positive diagnoses, for cases with mild symptoms are easily overlooked.

Some further study has been made of the virus which causes SBE. The disease agent has been identified as a member of the *psittacosis-lymphogranuloma* group of viruses by serological tests. Elementary bodies can be demonstrated in exudate of diseased animals and the yolk sac of inoculated chicken embryos.

Several sulfonamides and antibiotics have been tested to determine their effect on the infectivity of the virus for chicken embryos. Sulfathiazole showed partial but not complete inhibitory effect. Sulfamerazine, sulfadiazine and p-aminobenzoic acid had no effect. Terramycin and Aureomycin had good inhibitory action on infectivity with no effect from penicillin and streptomycin. Too few actual cases in cattle have been treated with the antibiotics to determine their usefulness in the field. There is no evidence at present that the virus will infect man.

Infection with SBE has been produced in susceptible calves of dairy breeds by giving the specific virus by mouth, subcutaneously, intraperitoneally and intranasally. All of the experimentally infected calves developed fever and slight depression. Symptoms were generally mild and none of the experimental calves died of the disease.

On post mortem, the lesions were similar regardless of the route of inoculation, consisting of inflammation of peritoneal, pleural and pericardial surfaces. Inflammatory changes in the brain were either mild or absent. Virus was demonstrated in the circulating blood of two cases during the period of fever. The results of calf inoculations support the observation in field cases that the virus shows its greatest affinity for the serous membranes of the body cavities rather than the brain. The name "encephalomyelitis" does not convey the complete nature of the disease. (Project 171. Leader: G. S. Harshfield, Veterinary Dept.)

**Fowl Cholera**

Experiments, involving several groups of chicks, have been conducted since 1950 to determine the effect of rations supplemented with antibiotics at growth promoting levels upon the susceptibility of chickens to experimental fowl cholera. In early trials, it was observed that chicks fed the antibiotic supplemented rations were more susceptible. This was indicated by a higher death rate in those groups for the first four days after the chicks were experimentally infected. However, by seven days the death rate was nearly the same as for the control groups.

In later trials the results were contradictory. The chicks receiving the standard ration without antibiotics, in most instances, were more susceptible than those receiving the antibiotic supplemented rations. It was concluded that antibiotics, at the very low levels they are used in rations for promotion of growth, do not significantly influence the course of fowl cholera infection and do not provide a means of prevention of the disease.

One trial has been completed, comparing antibiotics at therapeutic or treatment levels with sulfonamides in chicken rations for the prevention of experimental fowl cholera. The chicks were fed a standard ration without medication for seven weeks. At that age they were divided into separate pens and started on medicated feed. After 48 hours each bird was inoculated with approximately 100 average lethal doses of fowl cholera organisms.

The chicks in pens which received
penicillin and streptomycin died at about
the same rate as the control group on
standard non-medicated feed. The death
loss was 82 percent to 95 percent of the
chicks in the three pens. No deaths from
fowl cholera occurred in the pens which
received terramycin, sulfadiazine or
sulfamerazine. Further experiments are
underway to test other antibiotics and
determine their usefulness in the treat-
ment of flock outbreaks of fowl cholera.

Work is being continued on an anti-
gen to be used with whole blood in an
agglutination test to detect carriers of
fowl cholera. A small flock of chickens
undergoing an outbreak of chronic fowl
cholera was obtained for testing and
bacteriological examinations. Almost
half of the birds reacted when tested
with the antigen. On the bacteriological
examination, made post mortem, fowl
cholera organisms were recovered from
86 percent of the reactors. None of the
non-reacting birds gave positive cultures.
Further evaluation of the test as a control
weapon in flocks with chronic fowl choler
seems warranted. (Project 141. Leader:
T. A. Dorsey, Veterinary Dept.)

Newcastle Disease of Poultry

The work on this project deals pri-
marily with diagnosis. By use of the
serological test known as the hemagglu-
tination inhibition (HI) test it is possible
to differentiate Newcastle disease from
several other respiratory diseases of
poultry.

Outbreaks of Newcastle disease have
occurred at approximately the same rate
during the past two years with the high-
est incidence in spring and fall months.
These seasons correspond to the periods
of greatest movement of poultry (from
hatcheries to farms and from farms to
market). (Project 170. Leader: G. S.
Harshfield, Veterinary Dept.)

Screw-worms and Secondary Maggots

True screw-worms were received dur-
ing the past year from veterinarians who
took them from livestock located near
Presho, Gregory, Newell, and Mitchell,
South Dakota. In each instance, the
screw-worms were sent to the Station in
September, 1952, or later in the year.
Remedial measures were applied in each
case to the infested livestock and the in-
festations were wiped out.

The true screw-worm is a fly in the
maggot stage that resembles some of the
large blue-bottle flies. This fly cannot
survive winters in South Dakota, but
does survive the winter in some of the
most southern states.

The flies lay egg-masses near wounds
and each mass may contain 200 eggs or
more. The eggs hatch usually within 12
to 24 hours and the resulting maggots
invade the wound, forming bleeding
pockets in the flesh. In five to eight days
the maggots become full-grown and they
then leave the wound, drop to the soil,
and change into the pupal stage. After
about a week in warm weather, the
pupae give rise to flies. Five days later
the flies mate and then the females are
ready to lay eggs and to start another
generation.

The number of generations that are
produced in South Dakota will depend
largely upon the time the screw-worms
first make their appearance in the state.
Should the worms make their appear-
ance in May, and if the infestation is not
discovered and wiped out, a generation
of the pest may be produced every two
or three weeks. On the other hand, if the
screw-worms do not appear until Sep-
tember, time will permit for only one or
two generations of the worms until
heavy frosts kill off the pests.

Wounds attract the egg-laying flies.
Such wounds usually are the result of
castrating, dehorning, shear cuts, wire
cuts, bruises, bites resulting from the
feeding of blood-sucking flies or ticks,
etc. The navel of new-born animals is
also a favorite place for the flies to lay
their eggs.

Screw-worms enter South Dakota
usually through the shipment of infested
cattle into the state. Or if the pest has

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made its way in this manner into a neighboring state, the flies may fly into South Dakota and start an infestation.

Remedial measures, after the screw-worms are in an animal, consist of a persistent use of E. Q. 335 or Smear 62. Preventive measures consist of avoiding the cause of any wound formation, or, if such is impossible, treating the wounds with one of the above-mentioned smears. Dehorning, branding, marking, or docking should, if possible, be done during the season when screw-worms and other flies are not present. All cattle shipped into the state and especially those from the deep South should be thoroughly examined for screw-worms, and if found infested should be treated.

Numerous samples of infestation by secondary maggots were received from veterinarians, farmers and county agents for identification. At times some of these infestations caused serious damage to the animals infested. However, through proper treatment the infestations were always eliminated. (Project 220. Leader: H. C. Severin, Entomology Dept.)

Cattle Grub Control

During the winter of 1953, cattle in South Dakota were again quite heavily infested with both species of cattle grubs (H. lineatum and H. bovis). The seasonal appearance of the grubs in the backs of cattle was a little earlier in 1953 than it was the previous year. In western South Dakota (Meade and Pennington counties) the common grub made its first appearance in the backs of cattle during the last week in January, with the peak of abundance about February 20. In central South Dakota (Hughes and Hyde counties) the peak of abundance of the common grub occurred about March 1.

While a few specimens of the northern grub appeared in the backs of cattle when the common grub was in its peak of abundance, the bulk of the northern grubs appeared later and extended over a period of about a month and a half. In the Hughes-Hyde County area, grubs stopped coming into the backs of the cattle by April 20, while in the Meade-Pennington County area this took place about 10 days earlier.

The control operations in the two experimental cattle grub areas were begun shortly after the first appearance of the grubs in the backs of the cattle and the last treatments were made by about May 1, 1953. Since the fiscal year July 1, 1952 to June 30, 1953 was to be the last year of experimental control work on an area basis, no expansion of either of the two areas was considered. The Meade-Pennington County control area at the end of the experiment covered about 10½ townships, while the Hughes-Hyde County control area included about 12 townships. During the past year population reduction studies, seasonal history observations and the effects of the treatments were made following the plans observed in former years. However, the organization work developed during the project was turned over to the county agents and the ranchers.

In the Hughes-Hyde County area, studies in 1953 show that grub populations of herds located in or near the center of the area were 88 percent below untreated herds located outside of the boundaries of the control area. This was true in spite of the fact that severe winter conditions (heavy snows) in 1952 hampered the work of treating the cattle throughout much of the season with the consequence that only about one-third of the herds in the area were treated.

Since little treatment took place in the winter and spring of 1952, a rise in grub population might well be expected in 1953, but how much of an increase could not be predicted. Evidently prevailing weather conditions in the winter and spring of 1952 did not favor the survival of the grubs after they emerged from the cattle, the survival of the puparia or the survival of the egg-laying flies, for the grub populations were not significantly higher during the year 1953.

In the Meade-Pennington County
control area, the weather during the treatment season of 1952 was not too bad and consequently the ranchers could and did treat their cattle for grub control. The 1953 grub population data in this area show that herds located in the center of the area had 94 percent fewer grubs than untreated herds outside the area.

It is felt that, considering the control methods available and the weather during the treatment season, the percent of grub reduction in both control areas has reached about the maximum that can be obtained. Cattle grub control on a community or area basis is both workable and practical. However, the program requires the efforts and cooperation of all concerned within the area. Success or failure of the undertaking is dependent upon such cooperation.

A manuscript covering the grub control project since its beginning is now in preparation. (Project 163. Leaders: W. L. Berndt, J. A. Lofgren, P. H. Kohler, Entomology; I. H. Roberts, USDA-BAI cooperating.)

Fly Control

The control of flies, especially house flies and stable flies, in and around farm buildings has become increasingly difficult in recent years. Stable flies have always been difficult to control by chemical applications, and house flies in many areas are now so resistant to standard insecticides as to make obsolete the highly effective methods of a few years ago.

Laboratory tests on the Brookings 1952 strain of DDT-resistant houseflies (collected at the College dairy barn) demonstrated no significant differences as regards susceptibility to DDT, to gamma BHC, or to heptachlor as compared with the 1951 strain. Field tests, however, indicated an increased resistance to gamma BHC when used as a residual application. DDT applications were completely unsuccessful against the 1952 strain of resistant flies.

Space sprays, consisting of various mixtures of pyrethrins and piperonyl butoxide, were very successful against the above-mentioned houseflies, but the cost in materials and labor of such sprays (which must be repeated frequently) makes this technic relatively unpopular.

An attempt to modify the screen wire strip method of fly control by suspending strands of baling cord in front of windows was not especially successful. Further modifications of this method, which permits the use of highly toxic insecticides, may prove effective under other circumstances.

Further observations on applications of cable type backrubbers have been made during 1952-53. Attempts to reduce the concentration of DDT have indicated that 3 percent solutions in fuel oil are too low for effective action, and that 5 percent is probably the lowest concentration that should be used.

Comparisons of stable fly control by means of the backrubber and standard high pressure spraying, each with DDT, have indicated no significant difference between these two methods of application. Although this is in agreement with previous observations, further data on this point are available.

An attempt to evaluate the application of a fly repellent (butoxy polypropylene glycol) by means of the backrubber was inconclusive. (Project 186. Leader: Wm. M. Rogoff, Entomology.)

Control of Swine Mange

A research paper on swine mange control (with Dr. I. H. Roberts of the USDA, BAI) has been accepted for publication by the Journal of the American Veterinary Medical Association. Successful eradication of swine mange with 0.1 percent lindane was reported. It was also reported that 0.25 percent chlordane, 0.3 percent toxaphene, 0.25 percent Neotran, and 0.1 percent Aramite failed to eradicate sarcoptic mites on swine. (Project 186. Leader: Wm. M. Rogoff, Entomology Dept.)

Worm Infestation in Range Sheep, see page 138.
Sprinkler Irrigation Possibilities

Field application efficiency of the different types of sprinklers under various water management practices has been investigated during the year.

It was found that the rate of water application and the amount of water applied per irrigation greatly affected the irrigation efficiency. To obtain the higher efficiencies, the application rate should be near the optimum water intake rate of the soil and the entire root zone should be filled to field capacity in order to minimize surface evaporation losses. Frequent light water applications may require up to twice as much irrigation water per season.

Wind, as well as low relative humidities, definitely lowers the application efficiency. Little can be done to control these factors except by installation of a system that is sufficiently large so that irrigation can be discontinued when adverse conditions prevail.

It was found that the larger the rated wetted diameter of a given sprinkler head, the less the effect of wind on the distribution pattern. Preliminary work underway on the perforated type of pipe for water application indicates that the distribution of water is not as uniform with this pipe as with slow revolving sprinkler heads when wind velocities are low. However, the effect of wind with this method is not nearly as severe on the distribution pattern as with the rotating sprinkler heads. Wind has an effect on the locale of the falling water, but with proper movement of the lateral line during irrigation, water can be applied more evenly with this method when wind velocities exceed approximately 8 miles per hour. (Project 192: Leader: J. L. Wiersma, Agricultural Engineering Dept.)

Temporary Silos for Grass Silage

The trend toward grassland farming in South Dakota is leading more farmers to use grass silage. As yet many farmers do not have permanent silos and are forced to use temporary silos. Although the feed value of corn and grass silage in permanent structures is quite well established, there is little information on comparative values of silages made in temporary structures from the standpoint of feed value, losses, and costs.

A project to study the handling, storage, and feeding value of grass silage was initiated on May 1, 1953. Several departments including Agricultural Economics, Agricultural Engineering, Agronomy, Animal Husbandry, Dairy, Plant Pathology, and Station Biochemistry will work cooperatively on this project. The study will be carried on for

Above-ground trench silo with a bottom width of 12 feet, top width of 16 feet and a depth of 8 feet
Comparisons will be made of labor requirements, feeding values, costs and losses in six different methods of storage. The six types of storage that will be employed are: (1) a glass-lined steel upright silo, (2) a permanent upright silo, (3) an above-ground trench silo, (4) a trench silo, (5) temporary stacks and (6) silage placed in piles.

The construction of an above-ground trench silo and a trench silo was undertaken by the Agricultural Engineering department as their phase of work in the project.

A record will be kept of the cost of making grass silage by the methods used and will be compared with other methods, both for the long grass silage and the chopped forage.

Other observations include temperature measurement within each of the silos by means of thermocouples. This will give a relative indication of the amount of oxygen present which determines the extent of spoilage. Construction details are also being observed closely for any excessive deflections or failures.

It is hoped that this study will lead to more definite information regarding the type of silo in relation to its cost, the quality of silage that can be expected from it and the ease of handling and feeding. (Project 237. Leader: Gerald C. Zoerb, Agricultural Engineering Dept.)

Lightweight Concrete Aggregate From South Dakota Shales

Research conducted the past three years on utilizing processed shale for a lightweight concrete aggregate, has resulted in a new industry for several North Central states. The shale expansion process developed in the laboratory involves sizing and heating the shale to such a temperature that the surface becomes semi-molten or pyroplastic and the shale particles bloat or expand producing an aggregate having a desirable cellular structure.

To date, over 70 various shales from throughout the state have been tested for expansion and several have been found to have excellent bloating properties. Further investigations are being carried on.

Several manufacturing plants using a rotary kiln have been constructed and put into operation this past year. These plants have been constructed as a direct result of research data released by this experiment station. Many light-weight concrete block and ready-mix concrete manufacturers in South Dakota and sur-
rounding states are using this light-weight aggregate at the present time. (Project 203. Leader: Dennis L. Moe, Agricultural Engineering Dept.)

Data Summarized for Buildings Handbook

"Application of New Materials and Design in Farm Buildings," is a North Central Regional project. One of the phases of this project is that of assembling and publishing all known information about farm building materials and design data. The South Dakota Agricultural Experiment Station was assigned the assembling and compiling of such information for the building material called rammed earth.

During the past two years this assignment has been completed and 25 pages of tables, technical information, plans and specifications have been assembled from the South Dakota Experiment Station research work and from all other possible sources. This material is now ready for distribution and it will be included in the future Agricultural Engineering Farm Structures Materials Handbook. (Project 203. Leader: H. H. DeLong, Agricultural Engineering Dept.)

Storage of High Moisture Corn

The Agricultural Engineering department secured a 3 HP size crop drier of the heat exchanger type, in June of 1952. This was used for trials in hay drying during the early summer months. A wagon-type drier was constructed, but the drying of hay, load by load, on the wagon was not found practical. The college farm purchased a 7 HP size, direct-fired crop drier during the summer and both machines were available for corn drying in the fall. The season produced mature corn and most of it was dry enough to crib at picking time. One field, however, averaged 23.9 percent moisture, and although much of this corn was mature, some ears had as much as 30 percent moisture.

Two 1700 bushel cylindrical wire cribs were equipped with central air distribution ducts. The small drier with heat exchanger type of furnace was used during early December, but burner trouble caused much delay in completely drying this crib down to 17 percent moisture content. The large 7 HP drier used in the second crib gave a more satisfactory test. This drier was run from November 21 through December 5, with a total running time of 15 hours, (the burner ran 13½ hours). On these days the outdoor temperatures were uniform and varied from 25 to 42° F. The burner raised the temperature of the air entering the crib to above 150°.

One hundred and twenty gallons of fuel were consumed at a cost of $16.80. Power costs for the 7½ HP motor were estimated at $2.10, with electric power valued at 2 cents per kwh. The outer layer of corn was dried to an average of 17 percent moisture content. Although it was difficult to secure a sample of the corn from the inner part of the crib, it is usual to have such corn several percent drier than the corn on the outside.

The drying efficiency in this experiment was not particularly high but it must be remembered that much of the corn was mature and it was only a small percentage of immature corn which needed to be dried. At times moisture movement was apparent, for on cool days steam could be seen condensing in the air as it left the crib.

The project is now closed and a bulletin in preparation. The bulletin will also include research in feeding of soft corn to livestock. (Project 152. Leader: H. H. DeLong, Agricultural Engineering Dept.)

Septic Tanks and Cisterns of Concrete Silo Staves

The three septic tanks built of concrete silo staves, and the one of concrete block, which have been in operation from four to six years, were inspected during the summer of 1952. All but one
were pumped out in order to facilitate inspection, although only the tank at Cottonwood was seriously in need of pumping. This tank had been in operation five years, and for a part of that time had been serving two families.

All the tanks had been operating satisfactorily, and no visible signs of deterioration were evident. No leaks had developed.

Problems had arisen in the disposal of effluent both at Cottonwood and at Highmore. The gravel filter at Highmore was clogged, apparently due to the rather high clay content of the gravel. The gravel was replaced with crushed stone, and the renewed filter has operated satisfactorily since. At Cottonwood the open outlet, which had created an odor problem, was replaced by a gravel filter. The lower tile line of the filter discharges to the surface. This filter also has operated satisfactorily throughout the winter and spring, and no odors were noticed in quite hot weather as late as May 30. However, it will not be assumed that the odor nuisance has been corrected until at least one full summer has passed.

The cistern in the Agricultural Engineering building was pumped out and cleaned. It appeared to be in good condition. Refilling was delayed for several weeks, and when finally refilled, some leakage occurred. It is believed this was due to dehydration of the waterproofing material, as the leakage gradually lessened and finally stopped within two weeks of refilling.

Instructions for construction of the septic tanks and cistern have been published in Circular 99. During the year this project was closed, but observations will be made periodically in the future. (Project 165. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)

**Poultry House Ventilation**

The poultry house at Highmore was completed and put into use in the fall of 1952. The flock has performed very well during the past season, and moisture has not been a problem. Freezing temperatures occurred twice in the building during the past winter.

The ventilating system installed in this building was a two-fan system, consisting of a small fan which ran continuously (except during extremely cold temperatures) and a larger fan (about three times the capacity of the small one) which only operated when the temperature in the building was above 35°F. This system appears to be giving good results, although supplementary heat must be used to keep waterers from freezing occasionally.

Some farmer-owned ventilating systems have been inspected during the year. They included both poultry house and dairy stable installations. Although all owners reported a great improvement due to the installation of fan ventilating systems, most of them were not obtaining full benefits, due to: (1) lack of adequate insulation in the building, (2) lack of proper inlets—or too many poorly fitted doors, (3) unwillingness to trust the thermostat; most installations were equipped with a manual switch, and in many cases this switch was “off” even though ventilation was needed and temperatures in the buildings were high enough to permit the fans to operate.

A heat exchanger ventilating system installed in a poultry house near Holabird was inspected. This unit had operated satisfactorily, although dust proved to be a problem.

The design of a heat exchanger ventilating system for a 300-bird flock has been started, and some materials and measuring equipment have been obtained. (Project 232. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)

New Type of Septic Tanks and Cisterns Prove Successful, see page 33

Drying the Corn Crop, see page 86
Market News for Poultry and Poultry Products

A study of local price and market information available to farmers selling poultry and eggs revealed that newspapers and radio broadcasts frequently did not furnish accurate price quotations for eggs and poultry in 1951.

Egg price quotations in newspapers were usually one or several cents below the prices actually paid by dealers.

In the fall of 1951 the Agricultural Economics Department in cooperation with the Extension Service issued a weekly turkey market report to test the feasibility of an improved market news service for the South Dakota poultry industry. This experiment showed that such a report for turkeys is feasible, but that it would be preferable to report turkey prices and markets for an area larger than South Dakota because of the small volume of turkeys handled in this state.

In the fall of 1952 the South Dakota State Department of Agriculture began to publish semi-weekly poultry and egg reports which gave prices paid for eggs and poultry, including turkeys, by area in South Dakota. A more detailed report has been published in Bulletin 428. (Project 175. Leaders: E. Feder, Agricultural Economics Dept.; W. Kohlmeyer, Poultry Husbandry Dept.)

Marketing Dairy Products

Dairying in South Dakota has been a minor farm enterprise concerned primarily with the sale of farm separated cream to be used in making butter. Today the major economic problem of the dairy industry in South Dakota is adjustment to a rapidly changing pattern of utilization of milk and to the impact of various levels of relative prices. The most spectacular change in the consumption of dairy products is the decrease in consumption of butter.

The state's dairy industry faces three major alternatives. First, to shift from the sale of farm separated cream to the sale of whole milk by farmers and to allow dairy plants to produce either milk for fluid consumption or for manufactured dairy products. Secondly, to remain primarily a butter producing state and make improvements in the procurement and processing of farm separated cream. This would include consolidation of plants so as to achieve greater efficiencies through larger output per plant. Thirdly, to give up dairying in areas that are not well suited for it.

As to the first alternative, there has been a slight shift from farm separated cream to the sale of whole milk over the past few years, particularly in the eastern part of the state. However, this involves relatively small physical quantities of milk. The major proportion of milk produced in South Dakota is still marketed as farm separated cream. Approximately 90 percent of milk produced was sold as cream in 1950.

In most parts of the state, and even in eastern South Dakota, a shift to whole milk sales encountered strong obstacles. The major obstacles are climate—which prevents the regular collection of whole milk on truck routes during part of the year—and sparsity of production—meaning small production of milk per acre, which increases the costs of procurement. In some areas of the state such a shift to whole milk sales by farmers appears impossible. It may be tentatively concluded that in areas of less than 2 pounds of butterfat per acre of farm land the best alternative for farmers pro-
ducing milk would be to continue to sell it in the form of farm separated cream.

The expansion of several fluid milk markets in this state has resulted in a considerable change in the pattern of distribution of bottled milk and cream for fluid consumption. The introduction of the paper container has resulted in a considerable expansion in volume in a number of fluid milk plants. As a consequence these plants have begun to distribute bottled milk outside of their own market.

The implications of this change are discussed in a regional bulletin to be published soon which incorporates information obtained in South Dakota. (Project 201. Leaders: E. Feder, Agricultural Economics Dept.; D. F. Breazeale, Dairy Dept.)

The Best Time to Market Livestock

The purpose of this project is to determine the best time to market various classes of livestock taking into consideration both physical and economic factors. Seasonal trends are prepared for various economic conditions, and budgets for various feeding systems will be prepared to determine which system is most advantageous.

Data on feed inputs under various feeding systems are available from other studies made at the Station, and price series have been compiled from published statistics from State and Federal Agencies. (Project 226. Leader: O. Nervik. Agricultural Economics Dept.)

Methods and Costs in the Retail Distribution of Meat and Meat Products

Retail distribution takes about 16 to 24 cents of the consumer's meat dollar. It seems logical that if savings are to be effected in the marketing system, the greatest opportunities exist in improving the efficiency at the retail level.

The purpose of this study is to determine the methods and practices followed, the volume of meat handled, and the relationship of meat sales to total sales. This will provide basic information for any work related to the improvement of efficiency in retailing of meat.

This is a part of a regional study including 11 states in the North Central Region. As South Dakota's contribution to it, detailed information on retail meat marketing during May 1953 has been obtained from 38 stores. (Project 228. Leader: O. Nervik, Agricultural Economics Dept.)

Grain Marketing Problems

Grain marketing becomes much more complicated for the farmer and the elevator operator as additional crops and varieties are grown. Farm owner-operators and tenants differ as to time and methods of marketing grain. These are among the findings of a survey of grain marketing practices and problems in South Dakota which has been completed.

The survey was conducted to find what the major marketing problems are. Work is being conducted on storage problems and detailed study will be initiated on several other aspects of grain marketing. (Project 224. Leader: R. D. Tompkin, Agricultural Economics Dept.)

Economic Research of Proposed Irrigation Development

Irrigation development, such as the proposed Oahe Irrigation project in South Dakota, should take into account several economic considerations. Some such considerations which are being studied are as follows:

An attempt is being made to determine the market outlook—local, national and international—for the agricultural commodities which are adapted to production under irrigation in the Missouri Basin, and to determine the probable need for additional marketing facilities.

Price and consumption data have been assembled from published sources to be used in determining the competitive po-
sition of the Oahe area if irrigation is introduced.

Also taken into consideration, in cooperative research with the Bureau of Reclamation, are the impacts on the commercial economy of South Dakota, resulting from agricultural and resource development in the Oahe Unit. A complete inventory of business establishments in the Oahe area has been made and estimates have been prepared of the commercial expansion which can be expected if the Oahe irrigation project is completed. This is an area of study which is relatively new and where research methods are still imperfect. For this reason, the emphasis has been on developing research methods which can be used in solving problems of this kind. (Project 197. Leaders: O. Nervik and J. E. Thompson, Agricultural Economics Dept.)

**Economic Trends**

It is necessary to know what has happened and is happening to our agriculture in order to plan for the present and the future.

As the 1950 Census data became available a manuscript was prepared on “Fifty Years of South Dakota Agriculture.” Special attention was devoted to the marked increases in size of farm business and to changes in the tenure pattern in the direction of increased owner-operatorship.

Changes in the land market in eight counties have been followed through 1952. Only a few recent instances of speculative pressure on land prices have been noted.

Continued study of farm mortgage foreclosures and redemptions shows that there were only 11 foreclosures on 1,752 acres, and five redemptions, on 2,000 acres in South Dakota in 1952.

To help farm business planning and as a service to other researchers a study is being made of weather records in South Dakota. Using the punched card method, it has been possible to calculate frost probability dates for spring and fall for 12 locations. This information will assist farmers in choosing crop varieties. (Project 157. Leaders: G. Lundy and R. Penegra, Agricultural Economics Dept.)

**What Are the Costs and Benefits of Irrigation?**

During the past year physical input-output data on livestock feeding have been revised. Labor, power and machinery requirements have been published, and crop yield data for specific crop rotations for both dry-land and irrigated conditions have been prepared.

These data are being used to determine the costs and benefits of irrigation. The 114 farms selected by random sampling in Oahe area in 1950 have been stratified by size of their major enterprise into five groups. Then five farms were selected at random from each group for further study—particularly on specific livestock management practices.

The information secured from these farms is being used to work out budgets for two typical farms in each major type-of-farming group. Then budgets will be made for the farms under their present organization. These budgets will be compared with budgets showing the effects of improved dry-land farming and irrigation.

By comparing these farm budgets the income potentialities of irrigation and the desirable patterns of crops and livestock will be shown.

During the past year an investigation of different types of district organizations for irrigation development has been made, and a preliminary report has been prepared. A pamphlet on water laws has recently been published. Some of this work has been done in cooperation with the University of South Dakota and the Legislative Research Council.

Reservoirs needed for flood control, power development and irrigation pose the problem of just compensation for the landowners. A comparative study of the land acquisition methods of three federal
agencies—the Corps of Engineers, Bureau of Reclamation and the Tennessee Valley Authority—is being made. This work will be completed during the next year. (Project 198. Leader: R. L. Berry, Agricultural Economics Dept.)

Financing of Agricultural Cooperatives

In the past few years the dollar volume of business of cooperatives has shown a tremendous increase. This created a definite need for both more permanent and more temporary capital.

Cooperatives are being financed largely by their members. However, the per member investment in cooperatives is relatively low when compared to the member’s other investments in production facilities.

Deferred patronage refunds are employed extensively as a method of financing by cooperatives, and the majority of the members prefer this method over all other methods. However, some members seem to have objections to the methods used in handling deferred patronage refunds.

The above observations are based on a study of the financing methods of South Dakota cooperatives. Sixty cooperatives were personally contacted to gather information. In addition, 150 members were interviewed to obtain their reaction to the financing methods used by their cooperatives. (Project 231. Leader: O. Nervik, Agricultural Economics Dept.)

Improving Farm Credit

Improving the farm credit situation in South Dakota involves analyzing the sources, terms, and uses of farm credit and the repayment record, past and present, on both real estate and non-real estate loans made by several types of lending institutions. This will result in formulation of recommendations for farmers and for both public and private lending institutions which will, if put into operation, increase the efficiency of farm credit.

Increased efficiency in the use of farm credit is essential, both to the national welfare and the welfare of agriculture. Real estate and production loans to farmers must be large enough and made under rates and terms which will enable them to overcome capital rationing and to produce efficiently; that is, agricultural credit programs must meet the legitimate credit needs of farmers. Lending in agriculture must be conducted in such a manner that neither borrower nor lender are over-extended, particularly in periods of declining prices.

A study of the FHA Farm Ownership loan program showed that the chief value of the program rested in the opportunistic function—providing farmers with the means for overcoming capital rationing and economic uncertainty at propitious stages in the economic cycle. A group of 30 farm-ownership program clients (1940) were compared with a group of 30 non-clients who had similar financial and social circumstances. The client group, by means of farm-ownership loans, were able to achieve farm ownership 2.5 years earlier, on an average, than non-clients (25 out of 30) who achieved this status.

Clients, by 1951, controlled larger acreages and owned a larger proportion of the acreage controlled, attained a higher level of living and a greater net worth, and had made larger capital accumulations between 1940 and 1951 than non-clients.

A study of farm bankruptcies and of state and federal laws pertaining to handling mortgage delinquencies and bankruptcies is being made. Since the expiration of the Frazier Lemke Act (Section 75 of the US Bankruptcy Code) in 1949, farmers do not have the benefit of special legislation in cases of financial distress.

The purpose of the study is to examine the effectiveness of the expired legislation and to determine whether there exists a need for new bankruptcy and moratorium laws to fit the special need of farmers and how they can be improved to the
mutual advantage of debtors and creditors. It is important that debtor and bankruptcy legislation should be adequate for dealing with serious economic depressions in event they should occur again. (Project 240. Leader: M. Myers, Agricultural Economics Dept.)

Town-Country Trade Relations

Dynamic changes are taking place in the shapes and sizes of farm areas surrounding trade centers; some trade areas are increasing in size at the expense of others. There has been a decrease of 125 trade centers since 1931 and a decrease of 215 centers since 1911. Sample studies for various sized towns, for 1931 and 1951, indicate changes and adjustments in the kinds of services offered by trade centers. There is a relationship between the number of services a town offers (the size of a town) and the size of its trade area. This study is concerned with the changes in these relationships and their trends.

What towns are increasing and which ones are decreasing in size? What changes and adjustments are being made in the various sized towns with respect to the numbers and kinds of services offered? What are the potentialities and limitations of the various sized towns? What are the implications of these changes for farmers and businessmen?

These trends are being studied from the economic institutions and services listed in the Dun & Bradstreet Reports for 1941 and 1951. Three hundred eighty-eight different economic institutions and services have been classified on approximately 35,000 I.B.M. cards on the basis of the trade center, the size of the town, the county, the economic area, and the proximity of the center to cities of 5,000 or more. These data are being correlated with data published in Bulletins 274 and 279 on the same subject at 10-year intervals from 1901 to 1931; therefore, the present project will complete a 50-year study of town-country trade relations in South Dakota. (Project 219. Leader: D. Chittick, Rural Sociology Dept.)

Lessons Learned on the Belle Fourche Irrigation Project

On May 10, 1904, the Belle Fourche Irrigation Project, Butte County, South Dakota was approved by the Secretary of the Interior of the United States and Reclamation funds were set aside for its construction. Early in 1954, 50 years later, a study of this Project's development, its problems, and the solution of these problems will be published.

The main objective of this research is to determine the significant lessons learned from the experience of the irrigation farmers on the Belle Fourche Project. As it is one of the oldest Federal irrigation projects in the nation, the experience of South Dakota farmers on it should prove invaluable to those persons considering further irrigation development within the state. (Project 64. Leaders: W. F. Kumlien and M. P. Riley, Rural Sociology Dept.)

Why Short-Term Leases? see page 14
From Tenancy to Farm Ownership, see page 42
How Much Forage Pays? see page 63
Profit or Loss, see page 97
South Dakota Looks at Irrigation, see page 92
Plums for Jelly Making

Twenty-three varieties of plums from the Horticulture department which were analyzed for ascorbic acid content showed amounts of this vitamin ranging from 5.1 to 17.7 mg. per 100 grams of the fresh fruit. Champa, Tawena, Honeydew and Sapa were the varieties showing the highest ascorbic acid values.

The jellimeter tests on juice extracted from 11 varieties of the plums indicated sufficient pectin for making jelly. However there were differences in the quality of the jelly. Etopa, Sapa and Enopa varieties produced superior flavored jellies, while 14-3N rated superior in shape and texture. Light-fleshed varieties such as 14-3W, Enopa, Cheresota and Honeydew made clearer, lighter colored jellies. Further work is needed to complete the evaluation of these varieties of plums for jelly making. Development of recipes using plums is being continued. (Project 210. Leaders: L. Burrill and B. Alsup, Home Economics Dept.)

What South Dakota Women Eat

Studies on what South Dakota women eat have been in progress during the past several years. To date, more than 400 24-hour recall diets and 78 7-day weighed dietary records have been collected from women 30 years of age and older.

The nutrient content of these diets has been computed from tables of food composition, and comparisons with the recommended allowances of the National Research Council have been made. These suggest that considerable numbers of women in the state are consuming diets which supply less than one-half of the recommended allowance of calcium, vitamin A, and ascorbic acid. Except possibly for the older age groups, fewer women reported diets low in protein and vitamins of the B-complex.

During the past year, the diets have been studied to determine the contribution which certain foods and food groups make to the total energy value of the diet. Meats, meat substitutes, such as eggs, cheese, milk, and dried beans, cereal products, fats, potatoes, vitamin-rich fruits and vegetables, and sweets and desserts were some of the food groups studied. Fats, cereals, desserts and sweets furnished the major portion of the energy value of the food.

Another part of the study has been a tabulation of the number of times selected foods and food groups appeared in the diets of these women. Although the tabulations are not complete for all groups of women, a few preliminary observations are of interest. For example, from the 24-hour recall diets, about two-thirds of the women reported eating one or more between-meal snacks on the test day; about one-third of the women reported no vitamin-rich fruit and one-half of them had no vitamin-rich vegetable. In contrast, fewer than 10 percent reported less than one serving of meat. Among the breakfast cereals, cooked oatmeal and the ready-to-eat wheat cereals were served most frequently. Beef was the most popular meat; corn, peas, beans, and carrots the favorite cooked vegetables while lettuce topped the list of vegetables served raw. More detailed reports of these dietary studies are being prepared for publication.


Heat Transfer of Wool Materials

In a study of the amount of heat which is transferred through wool fabrics two groups of materials are being used; three
weights of all wool serge, and a series of five flannels containing various percentages of new and reused wool. Measurements are being made on the new materials, on unworn materials after varying numbers of dry cleaning, and on worn materials after varying amounts of wear with corresponding amounts of dry cleaning.

When these data are collected they will be expressed as coefficients of conductivity which permit a comparison of the effect on the individual materials of cleaning and of wear with cleaning without regard to their thickness. (Project 196. Leaders: L. O. Lund, Home Economics Dept., in cooperation with E. L. Phelps, Minnesota Agricultural Experiment Station.)

Wool Blended with Chemically Manufactured Fibers

Suitings are now being made from blends of wool and the new chemically manufactured fibers. The consumer is eager to know what these blends have to offer as compared with the all-wool suitings. In order to collect data with which to make such comparisons, several blended suitings are being purchased as they become available on the market. These are being studied from the standpoint of physical characteristics as measured in the laboratory. (Project 215. Leaders: L. O. Lund, Home Economics Dept., in cooperation with E. L. Phelps, Minnesota Agricultural Experiment Station.)

Substation Report

Cottonwood Range Field Station

Jeann M. Kern, Superintendent

Vitamin A Supplementation for Range Cows

Study of the effect of adding vitamin A to a basal ration of range grass and 1 pound of a 38-percent supplement was continued. This year 54 grade yearling Herefords were involved in the experiment. For a detailed report see page 120. (Project 217. Leaders: J. K. Lewis, Animal Husbandry; O. E. Olson, A. Halverson, Station Biochemistry.)

Summer Grazing of Beef Cows for Calf Production

Intensities of grazing studies were continued. Some of the old cows were sold in August when they were dry. For a more detailed report, which includes a table showing the results of the trials, see page 121. (Project 216. Leaders: J. K. Lewis, Animal Husbandry; O. E. Olson, Station Biochemistry; J. G. Ross, Agronomy.)

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 of maturity. For a more detailed report, which includes a table showing the results of the trials, see page 121. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry Dept.; O. E. Olson, Station Biochemistry; J. G. Ross, Agronomy.)

Progeny Testing and the Range Producer

Progeny testing for beef breeding purposes has been done in the feed lot for a number of years. This year data are available that give an indication of the relationship of feed lot performance with performance on the range.

The half sisters of the bull calves tested in the feed lot were carried under typical range conditions. The data accumulated include records of 110 heifers from 12 different sires. For a detailed report see page 119. (Project 167. Leader: C. A. Dinkel, Animal Husbandry Dept.)
Reproductive Performance of Poultry

The study of how different breeding methods affect the reproductive performance of poultry has been continued. For a detailed report see page 132. (Project 194. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry.)

Septic Tanks and Cisterns of Concrete Silo Staves

The project on new building methods for septic tanks and cisterns was closed during the year. For a report of observations made this year see page 141. (Project 165. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)

Corn Performance Trials

At the Cottonwood Station 25 hybrids and open-pollinated varieties of corn were planted on May 17, 1952. Because of the drought condition the corn failed and plots were not harvested. (Project 60. Leaders: D. B. Shank and D. Kratochvil, Agronomy Dept.)

Legume and Grass Research

Two quarterly articles, “Putting Legumes into the Native Grasslands” by M. W. Adams and “Is Nitrogen Needed in Western South Dakota?” by B. L. Brage report the soils and legume and grass work at Cottonwood, Eureka, and Highmore. The articles are on pages 23 and 36. (Projects 4 and 74. Leaders: M. W. Adams and B. L. Brage, Agronomy Dept.)

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 bean. The results indicate that mid-season small grain varieties have yielded the best. Reliance and Norguim grain sorghums yielded double and almost treble compared to out-of-state varieties. (Projects, 25, 61, 181, 182. Leaders: J. E. Grafius, V. A. Dirks, C. J. Franzke, J. G. Ross, Agronomy Dept.)

Central Substation, Highmore

WADE R. PRINGLE, Superintendent

Reproductive Performance of Poultry

The study of how different breeding methods affect the reproductive performance of poultry has been continued. For a detailed report see page 132. (Project 194. Leaders: D. G. Jones, Wm. Kohlmeyer, Poultry.)

Septic Tanks and Cisterns of Concrete Silo Staves

The project on new building methods for septic tanks and cisterns was closed during the year. For a report of observations made this year see page 141. (Project 165. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)

Poultry House Ventilation

The poultry house at Highmore was completed and put into use in the fall of 1952. The flock has performed very well during the past season, and moisture has not been a problem. Freezing temperatures occurred twice in the building during the past winter. The ventilating system that was installed also worked satisfactorily. For a more detailed report see page 142. (Project 232. Leader: R. T. C. Rokeby, Agricultural Engineering.)

Legume and Grass Research

Two quarterly articles, “Putting Legumes Into the Native Grasslands” by M. W. Adams and “Is Nitrogen Needed in Western South Dakota?” by B. L. Brage report the soils and legumes and grass work at Cottonwood, Eureka, and Highmore. The articles are on pages 23 and 36. (Projects 4 and 74. Leaders: M. W. Adams and B. L. Brage, Agronomy.)

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indicate that mid-season small grain varieties have yielded the best. Reliance and Norghum grain sorghums yielded double and almost treble compared to out-of-state varieties. (Projects: 25, 61, 181, 182. Leaders: J. E. Grafius, V. A. Dirks, C. J. Franzke, J. G. Ross, Agronomy Dept.)

**S.D. 220 Hybrid Corn Best at Highmore and Eureka**

Twenty-five corn hybrids and varieties were tested at Highmore. S.D. 220, a new hybrid corn released from the Experiment Station in 1952, outyielded the best hybrids and open-pollinated varieties available in the area. A detailed report of the corn performance trials was published in Circular 97. “South Dakota Corn Performance Test, 1952.” (Project 66. Leaders: D. B. Shank and D. Kratochvil, Agronomy Dept.)

**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 of maturity. For a more detailed report, which includes a table showing the results of the trials, see page 121. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry; O. E. Olson, Station Biochemistry; J. G. Ross, Agronomy.)

**Sorghum Seed Treatment**

The sorghum seed treatment experiments which have been conducted at Brookings and Highmore for several years were continued. For a detailed report see page 115. (Project 110. Leader: C. M. Nagel, Plant Pathology Dept.)

**North Central Substation, Eureka**

**Albert Dittman, Superintendent**

**Nutritive Value of Prairie Hay Cut at Different Stages**

Trials have been continued to compare the feeding value of prairie hay cut at various stages of maturity. For a detailed report, which includes a table showing the results of the trials, see page 121. (Project 120. Leaders: L. B. Embry and G. T. King, Animal Husbandry; O. E. Olson, Station Biochemistry; J. G. Ross, Agronomy.)

**Systems of Breeding Swine**

Research in swine breeding was continued at Brookings and at the Eureka substation. For a detailed report see page 127. (Project 124. Leader: C. P. Wilder, Animal Husbandry Dept.)

**Reproductive Performance of Poultry**

Study of how different breeding methods affect the reproductive performance of poultry has been continued. For a detailed report see page 132. (Project 194. Leader: D. G. Jones, Wm. Kohlmeyer, Poultry Dept.)

**Legume and Grass Research**

Two quarterly articles, “Putting Legumes into the Native Grasslands” and “Is Nitrogen Needed in Western South Dakota?” report the soils and legume and grass work at Cottonwood, Eureka and Highmore. The articles are on pages 23 and 36. (Projects 4 and 74. Leaders: M. W. Adams and B. L. Brage, Agronomy Dept.)

**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 bean. The results indicate that mid-season small grain varieties have yielded the best. Reliance and Norghum grain sorghums yielded double and almost treble compared to out-of-state varieties. (Projects: 25, 61, 181, 182. Leaders: J. E. Grafius, V. A. Dirks, C. J. Franzke, J. G. Ross, Agronomy Dept.)

**S.D. 220 Hybrid Corn**

Twenty-two hybrids and varieties were tested at Eureka. S.D. 220, a new hybrid corn released from the Experiment Station in 1952, outyielded the best hybrids and open-pollinated varieties available in the area. A detailed report of the corn performance trials was published in Circular 97. “South Dakota Corn Performance Test, 1952.” (Project 66. Leaders: D. B. Shank and D. Kratochvil, Agronomy Dept.)
ment Station in 1952, had the highest yield when compared with the best hybrids and open-pollinated varieties available in the area. A detailed report of the corn performance trials was published in Circular 97, “South Dakota Corn Performance Tests, 1952.” (Project 66. Leaders: D. B. Shank and D. Kratochvil, Agronomy Dept.)

**U. S. Newell Field Station**

**Harry E. Weakly, Superintendent**

**Optimum Level of Feeding for Ewe Lambs**

No new work was conducted on this project. Data will be analyzed and published at a later date. (Project 161. Leaders: G. T. King and L. B. Embry, Animal Husbandry Dept.)

**Irrigated Pastures for Cattle and Sheep**

The carrying capacity of irrigated alfalfa-brome pastures and the amount of lamb and beef that can be produced per acre is being studied. The cattle were rotated at approximately 2-week intervals and the pasture was irrigated at about 1-month intervals. There was little trouble from trampling or puddling caused by cattle or sheep pasturing on somewhat muddy land.

Relatively uniform grazing and satisfactory gains per acre were obtained. (Project 229. Leaders: R. M. Jordan, J. K. Lewis, Animal Husbandry; W. W. Worzella, Agronomy.)

**Swine Production for Irrigated Areas**

Work on this project is being continued. In the 1952 season the 13 litters averaged 8.2 pigs at farrowing and 3.0 pigs at weaning. At weaning the pigs averaged 35.7 pounds. For a more detailed report see page 127. (Project 132. Leader: C. P. Wilder, Animal Husbandry.)

**Antelope Range Field Station**

**Arthur J. Foxley, Superintendent**

**Progeny Testing and the Range Producer**

Progeny testing for beef breeding purposes has been done in the feed lot for a number of years. This year, data are available that give an indication of the relationship of feed lot performance with performance on the range.

The half sisters of the bull calves tested in the feed lot were carried under fairly typical range conditions at Cottonwood and at the Antelope Range Field Station. The data accumulated include 110 heifers from 12 different sires. For detailed report see page 119. (Project 167. Leader: C. A. Dinkel, Animal Husbandry Dept.)

**Summer Grazing Studies with Sheep**

The grazing experiment with 400 range ewes, which was started in 1951, is being continued. For a more detailed report see page 124. (Project 177. Leaders: J. K. Lewis and G. T. King, Animal Husbandry Dept.)

**Concentrate Feeding for Wintering Bred Range Ewes**

Wintering range ewes under range conditions to determine optimum level of supplemental feeding has been in progress for two years. This year, four lots, with 100 ewes in each lot, were fed different amounts of protein over the entire feeding period and over the last six weeks of pregnancy only. For a detailed report see page 123. (Project 159. Leaders G. T. King, L. B. Embry, J. K. Lewis, Animal Husbandry Dept.)

**Sheep Parasite Control**

The study of internal parasite infestation in sheep has been continued. For a detailed report see the article, “Worm Infestation in Range Sheep” on page 30. (Project 139. Leader: G. S. Harshfield, Veterinary Dept.)
Publications

Bulletins


Technical Bulletins

By A. W. Halverson and O. E. Olson.

Circulars


Journal Articles By Staff Members

Agronomy


Animal Husbandry

Dairy

Entomology

Home Economics

Plant Pathology

Poultry

Station Biochemistry

Veterinary

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Experiment Station Staff

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Honorable Mrs. H. T. Dory
Honorable Frank Cundill
Honorable Eric Heidebrek
Honorable L. W. Robinson
Howard
Watertown
Isabel
Custer
Mitchell

Executive
Honorable Mrs. H. T. Dory
Honorable Frank Cundill
John W. Headley
A. M. Eberle, M.S.
I. B. Johnson, M.Agr.
R. A. Larson
Elya O. Feuerhelm
Regent Member
Regent Member
President
Dean of Agriculture
Director
Treasurer
Secretary

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Gabriel Lundy, M.S.
Ernest Feder, Ph.D.
Ottar Nervik, Ph.D.
Ralph D. Tompkin, M.S.
Allan R. Clark, M.S.
Rex Helfenstine, M.S.
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Agronomist
Associate
Associate
Assistant
Assistant
Agr. Economist
Agronomist
Assistant
Assistant
Assistant
Assistant

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J. L. Wiersma, M.S.
Dennis L. Moe, M.S.
T. R. Rokery, M.S.
G. C. Zorb, M.S.
Leonard J. Erie, B.S.
Neil Demick, B.S.
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Assistant
Assistant
Assistant
Assistant
Assistant
Irriga. Engineer
(BAE, USDA)

Agronomy
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L. F. Peter, Ph.D.
J. E. Grafius, Ph.D.
C. J. Franzke, B.S.
D. B. Shank, Ph.D.
L. O. Fine, Ph.D.
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Agronomist Emeritus
Agronomist
Agronomist
Associate
Associate
Associate

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R. F. Wilson, Ph.D.
C. A. Dinkell, M.S.
Turner Wright, B.S.
J. W. Wilson, M.S., L.L.D.
R. M. Jordan, Ph.D.
L. B. Embry, Ph.D.
R. C. Wahlstrom, Ph.D.
Ellis A. Pierce, M.S.
W. G. McConaie, M.S.
C. P. Wilden, M.S.
G. T. King, M.S.
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Animal Husbandman
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Associate
Associate
Asso. Prof. Emeritus
Director Emeritus
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Associate
Associate
Assistant
Assistant
Assistant
Assistant
Assistant

Dairy
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Arthur E. Dracy, Ph.D.
Chase C. Wilson, Ph.D.
Roscoe J. Baker, Ph.D.
E. Bartle, M.S.
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Associate
Associate
Assistant

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G. B. Spawn, Ph.D.
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Assistant

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Linda Burkell, Ph.D.
Lillian Lund, M.S.
E. Beth Alsup, M.S.
Home Economist
Nutritionist
Assistant
Assistant

155
Horticulture
S. A. McCrory, M.S. Horticulturist
Solomon Cook, Ph.D. Assistant
Paul E. Collins, M.S. Assistant
R. L. Foskett, Ph.D. Assistant
R. M. Peterson, Ph.D. Assistant

Plant Pathology
C. M. Nagel, Ph.D. Plant Pathologist
Geo. Semeniuk, Ph.D. Pathologist
Allyn Cook, Ph.D. Assistant
C. J. Mankin, Ph.D. Assistant

Poultry
Wm. Kohlmeyer, M.S. Poultry Husbandman
Dean G. Jones, Ph.D. Associate
C. W. Carlson, Ph.D. Associate
Robert A. Wilcox, M.S. Assistant

Publications
Mrs. Marjorie King, B.S. Station Editor

Rural Sociology
W. F. Kumlien, Ph.D. Rural Sociologist
Douglas Chittick, M.S. Assistant
John P. Johansen, Ph.D. Research Associate

Station Biochemistry
Oscar E. Olson, Ph.D. Station Chemist
E. I. Whitehead, M.S. Assoc. Chemist
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A. W. Halverson, Ph.D. Assoc. Biochemist
Geo. Gastler, M.S. Asst. Chemist
Frances Myers, M.S. Asst. Chemist
L. D. Kamstra, M.S. Asst. Chemist
Catharine Hendrick, B.S. Assoc. Biochemist

Veterinary
G. S. Harshfield, D.V.M., M.S. Veterinarian
T. A. Dorsey, D.V.M. Associate
J. B. Taylor, D.V.M. Assistant
Elaine J. Kerner, B.S. Technician

Substations
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

RESIGNATIONS

Agricultural Economics
R. W. Thompson, Assistant Economist March 31, 1953

Agronomy
Glen E. Nachtigal, Assistant Agronomist August 30, 1952
Marvin E. Jensen, Assistant Agronomist September 15, 1952
J. M. Beardsley, Assistant Agronomist December 31, 1952
J. E. Grafius, Agronomist May 31, 1953

Animal Husbandry
R. F. Wilson, Associate Animal Husbandman September 30, 1952

Horticulture
Solomon Cook, Assistant Horticulturist October 4, 1952
Marcus Maxon, Assistant Horticulturist July 1, 1952

DECEASED

Animal Husbandry
J. W. Wilson, Director Emeritus February 26, 1953

APPOINTMENTS

Agricultural Economics
Canute M. Johnson, Assistant Economist November 1, 1952

Agronomy
D. E. Kratochvil, Assistant Agronomist September 16, 1952
Frank Wiersma, Assistant Agronomist February 1, 1953

Animal Husbandry
A. L. Musson, Head, Animal Husbandman September 15, 1952
F. E. Crandall, Assistant Animal Husbandman July 15, 1952
R. C. Wahlstrom, Associate Animal Husbandman October 6, 1952

Horticulture
R. L. Foskett, Assistant Horticulturist January 1, 1953
R. M. Peterson, Assistant Horticulturist January 1, 1953

Plant Pathology
C. J. Mankin, Assistant Plant Pathologist May 7, 1953
### Financial Report — Agricultural Experiment Station

**July 1, 1952 to June 30, 1953**

#### FEDERAL RESEARCH FUNDS

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#### EXPENDITURES

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<td><strong>TOTAL</strong></td>
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<td>$15,000.00</td>
<td>$60,000.00</td>
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<td>$54,640.61</td>
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### STATE RESEARCH FUNDS

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<th>Purnell</th>
<th>Bankhead-Jones 5</th>
<th>Bankhead-Jones 9</th>
<th>Total</th>
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<tbody>
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<td>Appropriations</td>
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<td>$15,000.00</td>
<td>$60,000.00</td>
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<td>$54,640.61</td>
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**GRAND TOTAL**

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<th>Bankhead-Jones 5</th>
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<th>Total</th>
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<td>$60,000.00</td>
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<td>9,074.88</td>
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</tbody>
</table>
| **TOTAL**                          | $15,000.00 | $15,000.00 | $60,000.00 | $26,510.78       | $54,640.61       | $268,073.00    | $232,730.75