Letter of Transmittal

President John W. Headley
South Dakota State College

Dear President Headley:

In accordance with the Act of Congress approved March 2, 1887, establishing and regulating experiment stations, I have the honor to submit the sixty-ninth annual report of the Agricultural Experiment Station of South Dakota.

Sincerely,

Chief, Division of Agriculture

COVER—Long-range beef cattle breeding research, designed to help cattlemen improve their herds, is in progress in South Dakota. Some of the bulls in this picture will be performance tested in commercial herds. In this way, inbred lines being developed by the Experiment Station can be evaluated and performance of tested and nontested bulls can be compared.
Agricultural Research in South Dakota

Sixty-Ninth Annual Report
July 1, 1955 to June 30, 1956

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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**CORRECTIONS**

Page 27—The graphs for figures 1 and 2 are interchanged.
Page 98—The claypan area of the soil profile is 10, not 2.
Most poultrymen have poultry house ventilation problems. A major problem concerns keeping temperatures high enough in the winter while ventilating to remove excess moisture. Another is keeping summer temperatures in the building low enough to prevent production loss from overheating.

Methods of ventilating poultry houses to remedy these two problems are being studied at this station.

Studies of Rhode Island Red laying flocks by the U. S. Department of Agriculture have shown most efficient production (weight of eggs per pound of feed) occurs at 55° F. Under practical conditions it is impossible to keep the temperature right at 55° F. However, tests have also shown that production is not seriously reduced by temperatures in the range of 45 to 75° F. You will need to conserve heat in the building in the winter and cool it in the summer to keep the temperature within these limits in South Dakota's climate.

Up to now temperature and moisture control studies had been made only in the winter. As with any other temperature control problem, you must supply heat at a rate equal to that at which heat is escaping to maintain a constant temperature. The normal supply of heat in a poultry house comes from (1) heat produced by the hens, (2) solar heat (when the sun is shining), and (3) heat from the earth and decomposition of litter.

**Heat Losses**

Heat is lost by conduction through the walls, windows, and ceiling and heat removed by movement of air through the building, either natural draft or air moved by fans. You must minimize these loss-
es to keep the building warm without artificial heat.

You can reduce losses by conduction with adequate insulation, including storm doors and windows. Insulating will also reduce the tendency of frost or moisture to collect on walls and ceilings. You must use a good vapor barrier on the warm side of the insulation.

Reducing the heat lost by ventilation is more difficult. Some ventilation is needed at all times to remove moisture in the form of water vapor. The water vapor is produced at a rate of about ½ pound per day by each hen.

**Moisture Removal**

The rate of ventilation required to remove all the moisture produced by your flock will depend on the difference between the inside and outside temperatures. As this difference becomes less and as the moisture content of the outside air increases, a faster rate of ventilation is needed. Therefore you must keep a large temperature difference to keep the quantity of ventilating air and heat loss to a minimum. To maintain this large temperature difference, your poultry house needs good insulation and an adequate supply of heat. You can increase the heat supply by enlarging the flock as long as you do not overcrowd the building.

To prevent the litter from becoming wet you must remove the moisture as fast as it is produced. Wet litter causes dirty eggs and can be a factor in disease spreading.

Moisture removal also prevents deterioration of your building by preventing moisture accumulation on and in the walls. This moisture can damage paint, rot wood, and waterlog insulation.

**Use of Fans**

The use of electric fans to move ventilating air has become popular because the fans are easy to control automatically by a thermostat. In most cases the fan is used to take out the warm, moist air, thus drawing in fresh, cold air through special inlets.

For uniform, draft-free ventilation you will need a number of inlets distributed around the outside wall of the building. A few large inlets have seldom given as good results as more smaller ones. A slot in the ceiling next to the side wall that permits fresh air to enter from the attic has proved to be an effective and economical form of inlet with fan exhaust systems.

Exhaust fan systems with two or more air flow rates have been most successful. This permits you to reduce the ventilating rate in cold weather, thereby conserving heat without stopping ventilation. These systems may consist of a single fan with an automatic damper to restrict it in cold weather, a fan with a two-speed motor, or two or more fans arranged so that one stops when the temperature drops.

Although the required rate of ventilation will vary with weather changes, good results have been obtained with fans with a capacity of about 4 cubic feet per minute (cfm) for each hen under normal conditions and 1 cfm per hen for cold conditions. Ventilation should be continuous with the rate adjusted automatically by thermostat.
Heat Exchange

A heat exchanger ventilating system was designed to recover some heat normally lost by ventilation. This unit was installed in the poultry house at the Central Substation, Highmore. It consists of a number of parallel metal tubes enclosed in a duct. Warm air leaves the building through these tubes while cold incoming air passes through the space around the tubes and is warmed before entering the building. Approximately half the heat that would have been lost by ventilating has been recovered in this way. It has kept the building warmer than with conventional ventilating system (see table).

Major problems in operation of the heat exchanger have been power cost and the accumulation of dust in the fans and tubes. Power costs, approximately 45 cents a day (assuming 2½ cents per kilowatt-hour) for the 220-bird flock, could be reduced somewhat with careful designing and streamlining of the ducts. The large quantities of dust are difficult to control as filters clog rapidly and need almost daily

Continued on page 26

Effect of Ventilating System on Temperature in Poultry House

<table>
<thead>
<tr>
<th>Type of System</th>
<th>No. of Readings*</th>
<th>Av. Minimum Temp.</th>
<th>No. Days</th>
<th>% Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Outside</td>
<td>Inside</td>
<td>Below</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Fan System</td>
<td>16</td>
<td>0° F.</td>
<td>25° F.</td>
<td>25°</td>
</tr>
<tr>
<td>Heat Exchanger System</td>
<td>45</td>
<td>0.5° F.</td>
<td>31° F.</td>
<td>30°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Only days on which temperature outside was between —15 and +10° F. are included.
CASH RENT

It may solve the problem of insecure farm tenancy.

RUSSELL L. BERRY and VERNON E. BAU

CASH RENT could be the answer to longer farm tenancy in South Dakota. But are the tenants willing to rent for cash?

We decided to find out before urging landlords to make more cash leases. We were especially interested in cash leases for 3 years or longer. To answer this question, we interviewed a random sample of tenant farmers.

Cash Leasing

Cash leasing could mean longer term leases, which recent surveys indicate tenants want. Even with short-term leases the tenant would have a better chance to keep the farm, as there is less chance for disagreement. The landlord knows what he is to get, and the tenant knows what he is to pay.

A farmer just starting farming may also find the cash lease has merits. He must bear the penalties of his mistakes; but as long as he can pay the rent, the landlord may have little reason to seek a new tenant even though he may do a poor job.

Cash renting does pose problems however. The cash tenant must bear the weather and price risks that the landlord shares under crop-share arrangements.

The Survey Group

Last June we interviewed 59 Moody County farmers—55 were tenants and 4 had recently bought farms. We asked them questions about what they preferred in rental arrangements.

Of these 55 tenants, 78 percent
paid a crop-share rent. Eighty-four percent said they preferred this arrangement. Only 13 percent had cash leases, and only 14 percent said they preferred the cash lease (see table 1).

If only the same number of tenants as are now renting for cash are interested in this arrangement, it appears quite hopeless to encourage cash leasing. But here is the order of the questions—"What kind of rent do you pay?" "What kind of rent do you prefer?"

The easy answer is to say one prefers what he has without thinking the question through. People, as a rule, tend to express satisfaction with what they have. Then too, it may be that most tenants think of the increased management responsibility and the weather and price risks of cash leasing. They may assume also that the lease would be for only 1 year.

If cash leases would give these farmers longer term leases or greater security of tenure, one could expect different answers. Eighty-seven percent of the tenants had 1-year leases (or no agreement as to length), but 80 percent preferred longer term leases. Over 50 percent said they preferred 5-year leases or longer (see table 2).

320-Acre Farm as Model

Our problem was to test the tenants' willingness to rent for cash if they could have a longer term lease. To do this we studied a good 320-acre farm to determine the current dollar value of this landlord's rent. We based this on his average
Table 1. Present and Preferred Rental Payment Methods of Moody County Tenants, 1955

<table>
<thead>
<tr>
<th>Present Kind of Rent</th>
<th>Preferred Kind of Rent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Livestock</td>
</tr>
<tr>
<td></td>
<td>Crop-Share</td>
</tr>
<tr>
<td>Crop-share</td>
<td>41</td>
</tr>
<tr>
<td>Cash</td>
<td>2</td>
</tr>
<tr>
<td>Livestock share</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
</tr>
<tr>
<td>Percentage</td>
<td>84</td>
</tr>
</tbody>
</table>

crop yields for the past 10 years.

The cash rent was set so the landlord would have a 7 percent return on the current value of the farm above his taxes, insurance depreciation, and repairs. Using the 320-acre farm as a model, the same rental rates were assumed for farms of 160, 240, 480, and 640 acres. Then results were handed to the tenant on a card as shown in Exhibit A.

The interviewer made the following statement:

1. Here are five productive farms with improvements which can be leased on either a crop-share or straight cash basis. The average value of crop share is shown as a guide in thinking about these leases. But remember that under the 1-year crop share lease your rent will be 3 of whatever crops you raise and not the dollars shown. On the other hand the cash leases require that you pay each year of lease the fixed number of dollars shown (Exhibit A). Now what is your first choice of these rental arrangements?

In reply 26 percent chose a cash lease of 3 years or longer. Five percent chose a 1-year cash lease and 69 percent said they preferred the 1-year crop-share lease. These answers suggest that enough tenants would be willing to rent for cash to warrant further investigation especially if the tenant gets a longer term lease.

In calculating the cash rents listed, we assumed that about $250 per year would be spent by the landlord for repairs of improvements and an equal amount would have to be set aside for replacement. Thus if the tenant owned the improvements the landlord could reduce the cash rent by about $500 on those farms.

**Straight Cash Rent Without Buildings**

Of the 59 farmers interviewed in this survey, 42 percent thought the most important reason for landlord-
tenant disagreements was over the repair and upkeep of improvement. (Another 32 percent thought that the question of a good job of farming was most important.) Since part-ownership, in which the tenant owns some land with improvements and rents additional unimproved land, represents a possible solution to this problem, the following question was asked:

2. Now suppose you owned 10 acres of land with buildings and you wanted to rent one of the five farms discussed above without improvements. If the landlord's 3% share of the crops remained the same but the landlord would be willing to reduce the cash rents by $500, what would be your first choice of lease?

In reply 44 percent of the tenants chose a cash lease of 3 years or longer, 10 percent chose the 1-year cash lease, and 46 percent the crop-share lease.

This suggests that a possible solution of the difficulties over farm improvements might consist of the landlord selling the improvements to the tenant at the beginning of the lease and permitting him to make whatever changes, alterations, or improvements he desires during the lease. Then when the tenant moves, the tenant could sell the improvements to the next tenant and/or move those that it is practical to move.

This procedure is used on several hundred farms in Illinois, Nebraska, and Kansas. The evidence available suggests that this procedure virtually eliminates what is one of the most serious leasing problems and results in unusually secure tenure for the tenants even though a 1-year cash lease is used.

**Flexible Cash Lease**

Can the tenant's preference for the risk-sharing features of the crop-share lease be met and at the same time the landlord's objection to a longer term lease be overcome? A cash rent lease, in which the rent to be paid in any lease year varies with the price of one or more important farm products, seems to be the answer. This is merely a cash version of the standing rent lease that is well known in other parts of the country. Under the standing rent lease the tenant agrees to pay as rent a fixed or "standing" amount

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**Table 2. Present and Preferred Length of Lease Term of Moody County Farm Tenants, 1955**

<table>
<thead>
<tr>
<th>Present Term in Years</th>
<th>Preferred Term in</th>
<th>1 Year*</th>
<th>2-3 Years†</th>
<th>4-5 Years‡</th>
<th>10-12 Years</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year*</td>
<td>11</td>
<td>10</td>
<td>24</td>
<td>3</td>
<td>48</td>
<td>54</td>
<td>100</td>
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<tr>
<td>2-3 years</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>4-5 years</td>
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<td>2</td>
<td>3</td>
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<td>5</td>
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<td>10-12 years</td>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Total</td>
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<td>13</td>
<td>26</td>
<td>4</td>
<td>54</td>
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<tr>
<td>Percent</td>
<td>20</td>
<td>24</td>
<td>48</td>
<td>7</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

*The 1-year group includes those who wanted no agreement as to length.
†Only two tenants preferred a 2-year lease.
‡Only one tenant preferred a 4-year lease.
of farm produce regardless of crop yields. The tenant stands the production risks but the landlord shares the price risks. The Standard Farm Lease form of the U.S. Department of Agriculture can be used in making a standing rent lease. Copies of this form are usually available from your county extension agent or local vocational agricultural teacher.

The cash version of the standing rent lease is being used in renting the Indian lands on the Pine Ridge and Rosebud Reservations in western South Dakota. Here grazing lands are let for 5-year terms for a base cash rent. However, the rent paid in any year varies with the price of beef.

To test the tenant’s willingness to accept such a flexible cash lease, in which the base cash rent varies with the price of corn, he was handed a card containing the information shown in Exhibit B.

Then the following explanation was made:

3. Now suppose the landlord would be willing to rent the same farms with improvements on either a% crop-share rent or a cash rent as before. However the cash rent is flexible because the rent to be paid in any lease year now varies directly with the price of corn. If corn prices go up the cash rent goes up. If corn prices fall the cash rent falls. For example a 10 percent change in the price of corn will make a 10 percent change in the amount of rent. A 20 percent change in prices will make a 20 percent change in the cash rent to be paid. This gives the tenant some protection against price changes. This costs $1.00 more rent per acre than the straight cash lease but the rent is still less than the average% crop-share rent which remains the same as before. Now what is your first choice of these rental arrangements?

In reply to the question, 38 percent of these tenants chose a flexible cash lease of 3 years or longer, 7 percent chose a 1-year flexible cash lease, and the remaining 55 percent chose the 1-year crop-share lease. Thus about 12 percent more tenants would be willing to rent for a flexible cash rent than they would for the straight cash lease. (Flexible cash rent lease forms of this kind can be secured free of charge from the Agricultural Economics Department, South Dakota State College, Brookings.)

**Flexible Cash Rent Without Improvements**

Improvements on rented farms are important. Because of this and the tendency to move toward a situation in which the tenant owns a tract of land with improvements, the following questions were also asked regarding the flexible cash leases:

4. Now suppose you owned 10 acres of land with buildings and you

<table>
<thead>
<tr>
<th>Type of Lease</th>
<th>Size of Farm, Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 1-year share lease per year (av. value of 2/5 share)</td>
<td>160</td>
</tr>
<tr>
<td>(2) 1-year flexible cash lease</td>
<td>1,760</td>
</tr>
<tr>
<td>(3) 3-year flexible cash lease</td>
<td>1,760</td>
</tr>
<tr>
<td>(4) 5-year flexible cash lease</td>
<td>1,760</td>
</tr>
<tr>
<td>(5) 10-year flexible cash lease</td>
<td>1,760</td>
</tr>
</tbody>
</table>
Table 3. Summary of Tenants’ Choice of Farm Rental Arrangements, Moody County, 1955

<table>
<thead>
<tr>
<th>Length of Lease Term</th>
<th>Straight Cash or Share</th>
<th>Flexible Cash or Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved (%)</td>
<td>Unimproved (%)</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>3 or more years, cash</td>
<td>26</td>
<td>44</td>
</tr>
<tr>
<td>1-year cash</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>1-year crop-share</td>
<td>69</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

wanted to rent one of the five farms discussed above without improvements. If the landlord’s share of the crops remained the same but the landlord would be willing to reduce the flexible cash rents by $500, what would be your first choice of lease?

In reply to this question, 48 percent of the tenants said that they would prefer a flexible cash lease for a term of 3 years or longer. Another 12 percent preferred a 1-year flexible cash lease while 40 percent still preferred the 1-year crop-share lease. For comparison, the answers to the four questions concerning choice of leasing arrangements are summarized in table 3.

From this evidence it appears that enough tenants are interested in cash and flexible cash rents from the standpoint of longer term leases to warrant further study of these possibilities. The remaining problem appears to be, “Who will be willing to lease land to farmers on a cash or flexible cash basis?”

Landlords’ Opinions on Cash Rent

Only 4 percent of 317 landlords replying to a recent questionnaire said that they preferred to lease for a cash rent. Undoubtedly some of this unpopularity is because cash rents are often quite low compared to share rents. This is particularly true in an inflationary period such as we have been in for most of the last 15 years. Share rents adjust automatically to changes in weather and prices. Hence they are popular with landlords.

Of course the standing rent lease and the cash version of the standing rent lease, which causes the rent to fluctuate with farm prices, may overcome part of the difficulty. Flexible cash rent leases that vary the rent with county crop averages rather than the yields of the farm being leased as well as with farm prices have much of the advantages of the crop-share rent and none of the disadvantages.

This is true since the rent varies with the major weather and price factors, neither of which can be controlled by the tenant or the landlord. As a result the landlord does not need the short-term lease to make sure that the tenant does a good job of farming.

In Moody County the proportion of full farm tenants increased slightly from 39.9 percent in 1950 to 40.1 percent in 1955 according to the latest U. S. Census figures. In 1950 over 55 percent of the land in the county was leased to farmers.

Because of this situation and the reluctance of present landlords to

Continued on page 26
BLENDERD SUITINGS

LILLIAN O. LUND, ETHEL L. PHELPS, AND MARY ANN MORRIS

You may frequently see the term "blended fabrics" in textiles literature and modern advertising. It means the fabric is made from yarns of two or more fibers blended together before the yarn is spun.

Until recently most suitings were all wool. Now you can find many blended suitings in ready-to-wear garments and in yard goods. These fabrics may include combinations with wool or rayon or some of the chemically manufactured fibers such as nylon, acetate, Dacron, Orlon, Vicara, and Acrilan.

With such combinations we can extend the use of scarcer or more expensive natural fibers and also modify the characteristics of the fabric. In this way a fabric can be developed that more nearly meets the requirements for its use. These products are not wholly substitutes for all-wool suitings; we should think of them as new members of certain well-established fabric families.

Still Experimental

At the same time you should remember that the production of blended suitings is still in an experimental stage. Many products now on sale are attempts to find satisfactory combinations—materials that will please the user in service, appearance, and price.

These new suitings often are called materials of the future. Their character may change as mill research, consumer acceptance, and the evaluation of the fabrics now available continue.

The South Dakota and Minnesota Agricultural Experiment Stations are cooperating in a study of such suitings. Textile workers at the stations have compared some of

1 Associate home economist at the South Dakota Agricultural Experiment Station, former professor of textiles and clothing, and assistant professor of textiles and clothing at the University of Minnesota, respectively.
Characteristics Studied

When you consider suitings you are probably concerned with how long the material will wear and how it will act during the life of the garment. No single laboratory measure has been developed that can reliably predict wear of a fabric. However, many workers think the strength of a fabric is one of the best measures of wear.

One way fabric strength is measured is bursting strength—the force required to rupture the fabric. Bursting strengths of blends of nylon, rayon, and Dacron with wool and of Dacron and Orlon with rayon are shown in figure 1 along with the bursting strengths of all-wool, all-Dacron, and all-nylon suitings. Weight, thickness, fabric count, and percentage loss in bursting strength due to wetting are given in the table.

*Wool and nylon.* You can see from figure 1 that the strength of the wool and nylon blends, when dry, did not vary uniformly as nylon percentage was increased. Seven and 20 percent of nylon resulted in almost equal increases in strength when compared with the all-wool material. The 20 percent nylon fabric was much stronger than any other nylon-wool combination when wet.

The wet strength, like the dry strength, varied greatly among the nylon-wool combinations. However, the percentage loss of strength due to wetting was much lower for the two fabrics with the highest nylon content. We should note that only relatively small amounts of nylon have been used in these blended fabrics. If larger amounts had
been used we might expect greater changes.

Other workers have reported an increase in the strength of experimental fabrics in which nylon had been blended with wool. Their findings have shown a minimum of 15 percent of nylon is needed to give much strength to the fabric.

* Rayon and wool. Rayon-wool blends also show considerable variation in both wet and dry strength. The fabric with 76 percent rayon was strongest both wet and dry. In this group more rayon than wool was used.

The large variations in bursting strengths of the nylon-wool and rayon-wool fabrics cannot be explained by differences in fabric weight, thickness, or count.

* Dacron and wool. One Dacron-wool blend was compared with the all-wool and all-Dacron fabrics. Since Dacron and wool were used in almost equal amounts it appears that Dacron greatly increases the bursting strength of the blend, both wet and dry. It also reduces the percentage loss of strength due to wet-

### Values for Certain Properties of Blended Suitings

<table>
<thead>
<tr>
<th>Fabric Composition</th>
<th>Weight Oz. Per Sq. Yd.</th>
<th>Thickness 1/1000 Inches</th>
<th>Fabric Count Number Yarns/Inch Warps Fillings</th>
<th>Percentage Loss in Bursting Strength When Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% wool</td>
<td>6.4</td>
<td>19.1</td>
<td>50.9</td>
<td>46.6</td>
</tr>
<tr>
<td>93% wool, 7% nylon</td>
<td>6.8</td>
<td>17.0</td>
<td>50.8</td>
<td>42.4</td>
</tr>
<tr>
<td>90% wool, 10% nylon</td>
<td>5.1</td>
<td>14.0</td>
<td>58.5</td>
<td>46.7</td>
</tr>
<tr>
<td>85% wool, 15% nylon</td>
<td>6.1</td>
<td>18.1</td>
<td>47.2</td>
<td>46.2</td>
</tr>
<tr>
<td>80% wool, 20% nylon</td>
<td>5.2</td>
<td>12.8</td>
<td>58.9</td>
<td>45.9</td>
</tr>
<tr>
<td>46% wool, 54% rayon</td>
<td>6.6</td>
<td>16.1</td>
<td>49.8</td>
<td>40.8</td>
</tr>
<tr>
<td>40% wool, 60% rayon</td>
<td>5.4</td>
<td>17.3</td>
<td>44.0</td>
<td>39.5</td>
</tr>
<tr>
<td>24% wool, 76% rayon</td>
<td>6.6</td>
<td>17.4</td>
<td>57.6</td>
<td>42.5</td>
</tr>
<tr>
<td>14% wool, 86% rayon</td>
<td>6.9</td>
<td>15.8</td>
<td>49.3</td>
<td>40.9</td>
</tr>
<tr>
<td>100% rayon</td>
<td>6.7</td>
<td>15.9</td>
<td>56.0</td>
<td>42.8</td>
</tr>
<tr>
<td>45% wool, 55% Dacron</td>
<td>4.9</td>
<td>13.0</td>
<td>54.7</td>
<td>46.0</td>
</tr>
<tr>
<td>100% Dacron</td>
<td>5.7</td>
<td>15.4</td>
<td>63.7</td>
<td>53.1</td>
</tr>
<tr>
<td>75% rayon, 25% Dacron</td>
<td>6.4</td>
<td>17.0</td>
<td>65.0</td>
<td>53.4</td>
</tr>
<tr>
<td>50% rayon, 50% Dacron</td>
<td>6.1</td>
<td>15.8</td>
<td>64.3</td>
<td>60.4</td>
</tr>
<tr>
<td>60% rayon, 40% Orlon</td>
<td>5.7</td>
<td>15.8</td>
<td>54.0</td>
<td>49.9</td>
</tr>
<tr>
<td>50% rayon, 50% Orlon</td>
<td>5.6</td>
<td>15.0</td>
<td>55.7</td>
<td>51.2</td>
</tr>
</tbody>
</table>
ting to only one-fifth of the all-wool fabric. Other workers have reported that wool seems to be strengthened almost in proportion to the percentage of Dacron used.

One report states that a blend of 65 percent Dacron and 35 percent wool ranks from good to outstanding in almost every fabric characteristic. Another report says a minimum of 20 percent Dacron is needed in the blend to significantly strengthen the fabric.

As with the nylon and rayon blends, weight and thickness have not varied directly with fiber composition, although fiber count tends to increase with increases in Dacron content.

* Dacron and rayon. Two blends of Dacron with rayon have been studied. The wet strength of these fabrics is much greater than that of the all-rayon material but less than half that of the all-Dacron suiting. The fabrics with 25 and 100 percent Dacron were almost as strong when wet as when dry, and the 50 percent blend was stronger wet than dry. These findings differ somewhat from other reports that indicate 50 to 60 percent Dacron is needed with rayon to make significant contributions to fabric properties.

* Orlon and rayon. Orlon increases the strength of rayon-orlon blends and the strength of the blend increases as Orlon content is increased. This increase is more

Continued on page 21

Figure 1. Wet and dry bursting strength in pounds of 16 suiting materials studied.
A NEW WINTER HARDY ELM STRAIN
FOR YOUR WINDBREAKS AND SHELTERBELTS

Chinkota Elm

Paul E. Collins

When you start a new shelterbelt or windbreak or replant in an old one, you will want to consider Chinkota elm, a new strain developed at this station. Chinkota has several advantages over Siberian elm, one of the most common trees in our area. You may not be able to get Chinkota elms now, but it is expected that the supply will be adequate within a few years.

Chinkota elm is better suited to our area because of its winter hardiness. Sudden freezes that injure a high percentage of the common strain will injure only a few Chinkota elms in the same planting. In the winter of 1951-52, total damage to Chinkota elm was less than one-third that of the Siberian elm in an experimental windbreak.

Siberian Elm Most Popular

Shortly after its introduction from Asia in 1908, Siberian elm became one of the most widely planted tree species in the Plains States. Landowners accepted Siberian elm readily because of its fast growth, drought resistance, and ease of establishment. Today, in spite of weaknesses that have shown up, Siberian elm still ranks as the most popular tree species in our Clark-McNary tree distribution program.

* Lacks winter hardiness. A serious weakness of Siberian elm has been its lack of winter hardiness. Its history has been marked with recurring years of injury. One of the most serious was the 1940 Armistice Day storm when a high percentage of trees were killed throughout the central and northern Great Plains.

Usually the weather followed a similar pattern in the years of serious injury. The fall months had adequate moisture and moderate temperatures followed by an abrupt freeze. The degree of winter injury depended on the time and severity of the weather change and the active growing condition of the trees.

* Weather and injury. You can see what happened in those years by the following explanation. Siberian elm will continue to grow in the fall as long as weather conditions are suitable. Its dormancy is brought about by light frosts that gradually build up in frequency and severity. A lack of soil moisture in the fall aids in the process by forcing an ac-
tive growth to stop. If a sharp freeze occurs before dormancy is induced, injury will likely result.

**Developing Chinkota Elm**

Not all the Siberian elm trees were damaged in areas where injury occurred. In addition to differences in site conditions, it was apparent that some trees had the ability to escape serious winter injury. The most logical explanation was that there were genetic differences.

A study of various strains of Siberian elm from different seed sources was begun here in 1944. The results of this study (reported in *South Dakota Farm and Home Research*, Vol. II, No. 2, Winter 1951) bore out the importance of the original seed source in seeking better adapted strains. The Harbin strain hardened its tissues early enough to escape serious injury. The other strains retained their green leaves later, indicating tardiness in developing dormancy and were subject to a sudden freeze.

*Certified stock.* In 1952 we named this strain of Siberian elm Chinkota and released it through the Seed Stocks Division of the college. To insure you true stock, Chinkota elm has since been produced under certification standards. Only seedling stock of this strain that bears the certification tag can be considered high quality seedling trees of known origin.

To check the growth and characteristics of Chinkota elm in a windbreak, we made an experimental planting in 1952. The replicated planting arrangement was designed to compare Chinkota elm with the Siberian elm commonly used in commercial trade. By keeping detailed records we are building a
store of knowledge on the various attributes of these two strains.

* Hardiness tested. The first fall after planting provided a hardiness test for the young trees. The first report of damage came from a nearby nursery that reported a high percentage of its common Siberian elm seedling stock was unfit for sale because of dead tops. Chinkota seedlings dug at the same time showed little or no damage.

No check was made at the station planting until the following spring. When normal leafing out began it was apparent that injury had occurred. The more or less normal leafing of Chinkota elm contrasted sharply with the bare twigs and branches of the common Siberian elm in the adjacent rows.

Since the nursery had reported the damage in the fall, the major injury must have occurred before winter. Temperature records for that period as reported by the Brookings station seem to justify this conclusion. For September 1952, temperature minimums were above freezing except on September 19 (31°F.) and September 23 (25°F.). Daytime maximum temperatures were never below 58°F. in that same period. Thus conditions were ideal for continued growth of the trees with the exception of the 25°F. reading which could have caused some injury.

However, it is more likely that the actively growing elms were injured by the sharp freezes early in October when minimum temperatures of 19, 15, and 15°F. occurred on October 4, 5, and 7. Both strains still had green leaves at that time, but Chinkota elm must have acquired some winter hardiness without visible leaf coloring.

* Injury measured. Alternate trees were sampled to determine the extent of the damage. Two methods of measuring the injury were used. One system was based on damage to the main stem of each tree, the other on over-all damage to the tree as estimated by appearance.

Main stem injury was rated as follows: 1—none, live growth within 2 inches of the tips; 2—slight, damage only to the small tips; 3—moderate, main stem injury but not the full length of the first large lateral branches; 4—severe, main stem killed to the first large laterals; and 5—very severe, main stem killed to within 2 inches of the root collar.

Over-all damage was estimated by a number system also: 1—no or only very slight damage; 2—light damage but not affecting as much as one-fourth of the plant; 3—one-fourth of the plant killed; 4—one-half of the plant killed; 5—three-fourths or more of the plant killed.

You can see the results of the measurements in figures 1 and 2. Main stem damage was slight in Chinkota elm; nearly 90 percent of the trees fell in the slight or no damage categories. The common strain, on the other hand, had nearly 90 percent of its trees in the moderate and more serious categories, and over 65 percent of the trees were killed to the main lateral branches or lower. Only 12 percent escaped serious injury.

* Less injury. Over-all injury ratings were estimates, but by using broad groups we felt that the estimate could be considered reason-
A NEW MARKET
FOR A FARM BY-PRODUCT?

STRAW FOR PAPER PRODUCTION

Winston K. Ullman

An improved pulping process has been developed by the USDA that uses straw as the basic ingredient in the production of box board and corrugating paper. If a plant or plants using this pulping process could be built in South Dakota, a use would have been found for a product produced by farmers that has limited commercial value to them at present.

Research to determine availability of surplus wheat, rye, and flax straw in South Dakota for industrial use is under way. This is a timely study in South Dakota where the dominant industry is agriculture, and a need has been felt for the "balancing of agriculture with industry."

On the basis of work done by the Northern Utilization Research Branch of the Agricultural Research Service, USDA, certain requirements were found necessary if a plant is to be developed in this state. The Agricultural Economics Department has undertaken the research to determine the feasibility of pulp processing plants in this state. This study is divided into three parts.

The first phase—to determine the amount of straw produced—has been completed. The second phase is to determine how much of this straw would be for sale by farmers for pulping. The third phase is to determine where, in the straw production area, there is a town or city able and willing to supply the water, power, and labor required for this new industry.

Determine Straw Grown

* Total straw production. The ratio of pounds of straw per bushel of grain was applied to grain production in each county in the state for 1934 through 1954. Twenty-one years were used to reflect maximum and minimum production or frequency of straw crop failures. The past 10 years, those used for the grain-straw ratio, were used for obtaining average straw production. The years 1934-54 were calculated in the same way as those from 1945-54 but were used only in calculating the number of straw crop failures.
Total straw production was reduced 20 percent to allow for the difference between the total straw produced and the stubble usually left in the field by the windrower. This 20 percent may vary with straw prices and/or harvest conditions of the straw.

* Straw density. The average production of wheat, rye, and flax straw by counties was calculated for the 10-year period, 1945-54. Since size of the counties is not uniform, this has little meaning in determining whether the density of straw production is heavy enough to support a plant. The average production in each county was divided by the number of square miles in the county to arrive at straw production per square mile.

The straw requirement for a pulp plant is an annual supply of 50,000 tons within a 50-mile radius. When converted to production per square mile, this amounts to 6.36 tons. If all wheat, rye, and flax straw produced were surplus, all the counties in the state with the exception of Butte, Custer, Minnehaha, and Lincoln counties would have a straw density per square mile sufficient to supply a plant of this size with straw.

**Surplus Straw Areas**

* Availability. The assumption that all straw produced is available is unrealistic. Flax straw, however, which cannot be worked into the soil satisfactorily, is probably all or nearly all surplus straw. For this reason flax straw was singled out to determine whether any area in the state produced enough flax to supply a plant with flax straw only. Ten counties in northeastern South Dakota produce a flax straw density sufficient to meet this requirement (see flax map).

Total flax straw production in South Dakota
(10 year average, 1945-54)

First figures represent 20% of the 10-year average production. Second figures give available straw per square mile at 20% availability. Shaded areas indicate available straw over 7 tons per square mile. Bracketed figures are years in last 21 when available straw fell below 7 tons per square mile.
Twenty percent available wheat and rye straw production (10 year average, 1945-54)¹

¹First figures give 10-year average production and second figures give average production per square mile. The shaded area indicates counties where average production exceeds 7 tons per square mile.

Ten percent available wheat and rye straw production (10 year average, 1945-54)¹

¹First figures represent 10% of the 10-year average production. Second figures give available straw per square mile at 10% availability. Shaded areas indicate available straw over 7 tons per square mile. Bracketed figures are years in last 21 available straw fell below 7 tons per square mile.
Since all wheat and rye straw produced cannot be classified as surplus straw, assumptions were made as to the amount of straw that might be considered surplus. Assumptions of 10 and 20 percent availability of the total wheat and rye straw were tentatively considered and maps were prepared to illustrate each. On maps illustrating each assumption, all counties with over 7 tons available wheat and rye straw per square mile for a 10-year average were shaded. This served to illustrate locations of concentration and to pinpoint areas that would be most desirable for a plant location from the density and stable production standpoint (see maps).

* Frequency of straw failure. The number of years within the past 21 when straw production fell below 7 tons available straw per square mile was listed within each shaded county. These years, in a broad sense, might be considered years of straw failure. Sufficient straw was produced, but under the rigid assumption of 10 and 20 percent surplus straw such an amount would not be available. It is logical to assume that in years of low farm income a larger percentage of the total straw production would be available than normally. In years of extremely low grain yield, the grain-straw ratio also would have the greatest margin of error in favor of straw production.

* Crop practices. Under normal crop management wheat and rye crops are windrowed and combined. The straw is normally spread by the combine. This returns in one operation the straw nutrients and organic matter to the land.

It is relatively easy to determine the soil nutrients in the straw from previous research and determine the replacement cost of these nutrients in terms of commercial fertilizers. It is impossible to use this method of evaluating organic matter loss. Organic matter is not a commercially available product for soil improvement in any appreciable quantity. It is usually replaced by introducing more grasses and legumes into the normal rotation. This would disturb the cropping practice previously followed if it was done to replace the straw sold.

The possibility of changes in normal grain crop practices was not explored since it was assumed that straw for pulp production would not have a great enough value to warrant changes. A currently recommended practice of using commercial fertilizer to increase grain yield has possibilities as this practice also increases straw production.

This increase in straw production has been measured by the Agronomy Department on fertilizer test plots. By applying 20 pounds of nitrogen per acre to wheat, straw production was increased just over 20 percent. If this practice were generally applied, 20 percent of the wheat straw could be sold without a net loss of organic matter, and no change in cropping program would be necessary to maintain the present organic matter level.

* Harvest procedure. Another factor that will affect the availability of straw is how straw collection will interfere with normal grain
harvest with reference to crop practice, labor supply, and efficiency. Wheat farmers often plow in the mornings or on days that are too damp to combine. As soon as the dew is off and the grain becomes dry enough for storage, farmers combine again. If this practice is to continue, straw collection must be adaptable to this practice and must keep pace with it. The farmer otherwise will prefer to spread his straw rather than retard his normal plowing work schedule. Data will be compiled to measure the compensation that will be necessary to repay the farmer for this inconvenience.

Flax straw represents a different problem to the farmer in that it requires extra effort and cost to remove it or prepare the ground for another crop. It is currently burned, chopped at added expense, or obtained by paper mills in Minnesota from the field. Limited use is made of it for bedding on livestock farms.

The above data are based on secondary sources. The straw that will be available for industrial use will ultimately depend on the decisions of farmers. This study will be continued to determine what percentage of their straw farmers will supply at prices a plant would be able to pay. In areas proven to have sufficient straw production, a search will be made for a plant location with sufficient water, power, and labor for this new industry. (Project NURB. Leader: Winston K. Ullman, Agricultural Economics Dept.)

Blended Suitings

Continued from page 13

marked in the wet than dry fabric, to one-half with 40 percent and one-third with 50 percent Orlon.

Increasing proportions of both Dacron and Orlon with rayon seems to result in increasingly lighter fabrics. No other trend is noticeable except the progressive decrease in percentage loss of strength for rayon-Orlon blends. These findings also differ from reports stating that Orlon and rayon are interchangeable in blends so far as strength is concerned. In some cases the blend may be weaker than all-rayon.

Studies Continue

We can see from this report that blending of new fibers with wool or rayon is not a simple process. Fibers must be chosen to complement each other in nature and amount. In choosing a blended suiting the presence of nylon, Dacron, or Orlon is not in itself a guarantee that you will get maximum satisfaction from the garment. Other things will influence the comfort and satisfaction from blended suitings.

Minnesota and South Dakota workers are continuing their study of these fabrics and will report on their resilience, resistance to abrasion, and permeability to air when the work on these phases of blended suitings is completed. (Project 215. Leader: Lillian O. Lund, Home Economics Dept.)
You might well wonder at all the vegetable varieties in many seed catalogs. And why, with so many varieties now available, do the state experiment stations, the United States Department of Agriculture, and numerous seed companies employ plant breeders to produce still more varieties?

**Yield**

One of the main reasons you choose a variety is for yield. New varieties are constantly being produced that will give you bigger yields and thereby replace older varieties. Often one variety might produce exceptionally well in one state but not in another.

The breeders of a few vegetable crops have followed the lead of field corn breeders in turning to hybrids for increased yields. (A true F₁ hybrid is produced by crossing two inbreds, or plants that have been self-pollinated for several generations.) The results are often phenomenal.

Hybrid sweet corn has already become so popular that it is becoming increasingly difficult to find the old standard varieties listed in seed catalogs. You can also get hybrid tomatoes and onions now.

At Brookings in 1953 the results of a variety trial of onions grown from seed showed Southport Yellow Globe, the only variety in the trial, to have the lowest yield among 22 entries. The other 21 entries were hybrids. Two of the hybrids tested outyielded Southport Yellow Globe, one of the best varieties, 2 to 1. This year we are running trials to find the most suitable onion hybrids grown from transplants.

The phenomenon known as hybrid vigor has also given us increased yields in tomatoes. Figure 1 shows that the highest yielding tomato variety in trials conducted by this station over a 5-year period yielded only 80 percent as well as the hybrid Siouxann. The other varieties shown in the figure are also among the higher yielding varieties for South Dakota. It is interesting to note that the two parents for Siouxann are Sioux and Earliana.

**Earliness**

However, you may not think of yields as only total production for the growing season. The time of harvest is often as closely related to profits as total yield, since the market price for vegetables usually drops as the season progresses.

Early varieties make it possible for you to grow some crops that
Onion hybrids in the trial plots at Brookings, 1955. Early maturity of one hybrid is indicated by the fallen tops. Others are still growing.

**BIGGER YIELDS . HIGHER QUALITY . EARLINESS**

Richard Foskett

could not otherwise be grown in areas with short seasons. Early varieties also enable you to harvest your crop before midsummer droughts in areas where they are prevalent and where irrigation is not feasible.

To obtain earliness, however, we must often sacrifice total yields or quality. Some data (see figure 2) from a sweet pepper variety trial conducted at Brookings in 1953 show an example of this problem. If you consider early yields—fruit harvested through the early part of August—the variety Vinedale gives the best yields. However, during the entire growing season, varieties similar to California Wonder (including the slightly earlier varieties recommended for the area such as Calwonder, Penn Wonder, and Wisconsin Lakes) often produce more because of their larger fruits.

Some of you may not like Vinedale because it does not have the blocky fruits that are more in demand for stuffing and for large salad rings. However, if you do not consider the more conical shape of Vinedale as a disadvantage you will find it an excellent variety for this area. In addition to its earliness, its attractive red peppers are easily obtained by allowing the fruit to ripen.

**Quality**

Quality in a vegetable crop is usually made up of several items. Many of these items are governed by personal and regional preferences that are hard to analyze. A general discussion of quality in vegetable crops is made still more difficult because different crops
have different standards. Let's look at a few of these items that together give us quality.

* **Color.** In beets, carrots, potatoes, and onions color helps to make one variety more desirable than another.

One reason Detroit Dark Red beet is considered a better variety than Crosby's Egyptian or Early Wonder is Detroit Dark Red's deeper red color and less noticeable light colored rings. Varieties with Crosby, Egyptian, or Wonder in their names, however, have the advantage of earliness. They are often a week or more earlier than Detroit Dark Red.

Likewise, Nantes and several strains of Chantenay carrots are deeper in color than Danvers, and therefore more desirable.

Two cases of beauty being only skin deep and having no known ef-

![Figure 1. Yields of Sioux and Earlana are below the hybrid Siouxann. These two varieties are parents of Siouxann. Firesteel is another popular variety.](image)

fect on quality are color in potatoes and onions. Although some persons prefer red or white potatoes, or red, yellow, or white onions, color of the skin does not necessarily denote quality in the product.

* **Tenderness.** Sometimes tenderness, too, can be increased by choosing the right variety. Consider snap beans as an example. Fiber content increases as the pod grows older making the beans tougher. Most new varieties, however, such as Topcrop, do not develop an undesirable amount of fiber as early as the older varieties, such as Bountiful. The term string beans has given way to snap beans or green beans because of the success of plant breeders in eliminating the "strings" in the pods.

* **Texture.** Closely allied to tenderness is texture. Smooth texture in winter squash adds tremendously to the taste. Buttercup and Butternut squashes are new varieties that are superior to most of the old varieties from the standpoint of texture.

* **Aroma.** You should also consider aroma in the vague term "quality." The muskiness of an aromatic muskmelon like Iroquois is indeed an asset.

### Adaptation to Environment

You may be surprised to know that some varieties are chosen because they are adapted to the day-length of an area. Older spinach varieties had a strong tendency to bolt, or produce seedstalks instead of heavy foliage, as the day length and the temperature increased in late spring and early summer. This tendency has been greatly reduced in the variety America.
Day length is also the reason certain varieties of onions that produce large bulbs in the South cannot be grown from seed in the North. However, if these same onions are started early in the spring in greenhouses or in the South and later transplanted to the field in the North they will produce large sized bulbs. Each variety has a certain length of daylight that induces bulb formation and the plant must have attained a large enough size before this critical time is reached to produce a good bulb.

Sugar content, while affected by growing and storage conditions, is an important thing to consider when you select watermelon, sweet corn, pea, and a number of other crop varieties. Often, though, you cannot grow the best varieties of watermelons and sweet corn because of a short growing season. The earliest varieties usually do not develop the sugar content needed for top quality.

Disease resistance is another major reason for vegetable breeding. However, it is so broad in scope that it should be the subject of a separate article. A great deal of work is being done throughout the country to develop resistance to the almost countless number of diseases that attack various vegetable crops in various parts of the country. Diseases are particularly prevalent in warm, humid regions.

**Variety Testing**

Vegetable varieties are often particularly adapted to conditions in a certain area of the country. Sometimes varieties that do well in one part of South Dakota are poorly adapted to other parts of the state. Certain characteristics also assume varying degrees of importance, depending on the purpose for which the crop is grown. For instance, earliness for a market grower; uniformity of ripening time for canners, who like to harvest fields of corn or peas all in one day; a high dry matter percentage for dehydrators; and color for freezing processors are all necessary considerations.

As new growing methods are developed, such as irrigation, you should choose the best adapted varieties and hybrids. To find the better varieties, the station conducts variety trials. This year we are con-
duet ing replicated trials with tomatoes, peppers, muskmelons, and transplant onions. A replicated trial is one in which several plots of each variety are grown and yields are taken for each plot.

When testing a new variety or hybrid that is going to be released, observation plots are used in various parts of the state. This helps determine the suitability of the crop to a number of different conditions. Currently we are trying to get an early tomato for areas with hot, dry summers. We are also cooperating with other stations, testing new releases and potential breeding material, since new varieties or hybrids produced in one state are often valuable to growers in other states. (Project 118. Leader: R. L. Foskett, Horticulture Dept.)

Cash Rent
Continued from page 9

rent for cash, the tenants were asked whether they would favor or oppose the Federal Land Bank leasing land on long-term leases to tenants. Eighty percent favored this idea.

Since insurance companies now lend millions of dollars to farmers on mortgag es, the farmers were also asked if they would favor or oppose insurance companies leasing farms to tenants on long-term leases. Fifty-eight percent also favored this idea.

On the other hand only 35 percent thought that farmers and local businessmen should organize a company to hold and rent land to farmers on long-term leases. Such organizations could undoubtedly attract capital for a net rent of 7 percent or less, which 74 percent of these farmers thought would be "about right" for cash leasing. Even if 1-year cash leases were used the tenants' security of possession and freedom of operation would probably increase because there would be less reason for friction than under the usual share rents. (Projects 147 and 166. Leader: Russell Berry, Agricultural Economics Dept.)

Air Conditioning
Continued from page 3

cleaning or replacement. Plastic element filters, which are easy to clean, are being tried.

Mechanical Refrigeration

A different method of controlling temperature and moisture will be used in 1955-56. This is a mechanical refrigeration system that will act as a heat pump or dehumidifier in winter to dry and to warm exhaust air so that it can be returned.

This machine can be used for summer air conditioning also by simple changes. With this arrangement it is expected that the desired objective of keeping the temperature in the building within the range of 45 to 75°F throughout the year can be achieved. (Project 232. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)
Chinkota Elm
Continued from page 16
ably reliable. According to this rating system, about 90 percent of the Chinkota elm trees suffered less than 25 percent injury. Only two of the 90 trees sampled were injured seriously. More than half of the common strain trees suffered three-fourths or more killing and 80 percent were half killed or worse. Just one received only slight injury.

Survival and height data recorded in the fall of 1953 show only a 42 percent recovery of the most severely injured trees. The average height of the Chinkota elm was 4.8 feet and that of the common Siberian elm 4.6 feet. Ordinarily the common strain would have been higher than Chinkota, but the injury slowed it down. By the fall of 1954 it exceeded Chinkota but only by one-tenth of a foot, 8.5 to 8.4.

We also collected survival data on the two strains in the planting at the Cottonwood substation in 1952. The difference was great. Only 7 percent of the Chinkota elm had to be replaced in 1953; we had to replace 96 percent of the common Siberian elm. The difference in survival was due to winter injury.

These tests show us the superior ability of Chinkota elm to escape injury from the cold. To date, this strain has proved admirably suited to South Dakota conditions. (Project 142. Leader: Paul E. Collins, Horticulture and Forestry Dept.)
Many livestockmen in the southwestern United States self-feed protein supplements to cattle and sheep. They do this by mixing the supplement with salt in proportions that will control the amount the animal will eat.

The amount of salt you will need in the protein supplement will vary depending on such factors as the size of your animals, available feeds, and how much you want them to eat. Levels of 20 to 50 percent salt in the supplement have been used satisfactorily.

You can minimize labor and equipment needs by self-feeding protein supplements. Only about one-fifth as much feed-bunk space is needed when you self-feed, and you will be able to wait longer before refilling the feeders. You can also move the feeders around the range to try to get more uniform grazing with this feeding system.

Self-feeding the protein supplement may result in more uniform consumption of the supplement within a herd or flock. When the supplement is hand-fed in small amounts some animals get little, if any, supplement.

Because self-feeding protein supplements offers some advantages, we conducted an experiment to determine how practical this practice would be with fattening lambs. Other workers stressed the importance of two practices: (1) supplying plenty of good water and (2) starting low and gradually raising the level of salt to the desired amount. We followed these practices in the experiment.

Three Trials

Three trials were conducted, one at the South Dakota Experiment Station, Brookings, and two at the Newell Field Station. Lambs of
A PROTEIN INTAKE REGULATOR —

SALT

good quality were used and full-fed a hay-corn ration with access to fresh water, salt, and a mineral mixture of trace-mineralized salt and bone meal. Brome hay was fed in the trial at Brookings, while alfalfa hay was fed at Newell.

In each trial the control group received its protein supplement as 0.2 pound of soybean oil meal. The lots designated as “salt lots” received a mixture of 1 part salt and 3 parts soybean oil meal in a self-feeder. In all trials a small amount of the grain allowance was mixed with the salt-protein supplement mixture for 1 week to accustom the lambs to the feeders and to dilute the salt concentration in the supplement. Results of the trials are presented in the table.

Use of Salt to Regulate the Amount of Protein Supplement Fattening Lambs Eaten

<table>
<thead>
<tr>
<th></th>
<th>Brookings</th>
<th>Newell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contr. Lot 1</td>
<td>Salt Lot 2</td>
</tr>
<tr>
<td>No. of lambs</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Days fed</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Av. initial wt., lbs.</td>
<td>69.4</td>
<td>70.6</td>
</tr>
<tr>
<td>Av. final wt., lbs.</td>
<td>92.1</td>
<td>95.0</td>
</tr>
<tr>
<td>Gain per lamb, lbs.</td>
<td>22.7</td>
<td>24.4</td>
</tr>
<tr>
<td>Av. daily gain, lbs.</td>
<td>.26</td>
<td>.28</td>
</tr>
<tr>
<td>Av. daily feed consumed, lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelled corn</td>
<td>1.21</td>
<td>1.28</td>
</tr>
<tr>
<td>Hay</td>
<td>1.57</td>
<td>1.57</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>.20</td>
<td>.25</td>
</tr>
<tr>
<td>Feed per 100 pounds gain, lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelled corn</td>
<td>464</td>
<td>457</td>
</tr>
<tr>
<td>Hay</td>
<td>602</td>
<td>561</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>77</td>
<td>89</td>
</tr>
<tr>
<td>Selling price per 100 lbs.</td>
<td>$17.75</td>
<td>$18.00</td>
</tr>
<tr>
<td>Carcass yield, percent</td>
<td>47.3</td>
<td>48.7</td>
</tr>
<tr>
<td>Carcass grade*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prime</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Choice</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Good</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Utility</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

*Only 15 lambs slaughtered per lot in the Newell report. Identification was lost on some lambs.
Results

* Rate of gain. In all three trials, lambs receiving their protein as a mixture of salt and protein gained slightly faster than the control group. These differences are not great enough to be significant but do show that a relatively large intake of salt (0.06 to 0.08 pound per head daily) does not adversely affect the rate of gain.

* Feed consumption and efficiency. Self-feeding the protein supplement by mixing it with salt had no adverse affect on feed consumption. In fact, in two of the three trials slightly more grain was consumed by the lambs self-fed protein supplement than by the lambs in the control lot.

In the trial conducted at the Brookings station, feeding a salt-soybean oil meal mixture (1 part salt to 3 parts soybean meal) resulted in 0.25 pound of soybean meal consumption per head daily as compared to 0.2 pound fed to the control lot. In the two trials conducted at the Newell station, the salt-soybean oil meal mixture limited the soybean oil meal consumption to approximately 0.2 pound.

The amount of corn and hay consumed per 100 pounds gain was less for the self-fed groups in each trial. However, the soybean meal consumed per unit of gain varied and did not favor either treatment.

* Carcass quality. In the trial conducted at the Brookings station, the self-fed lambs graded higher, sold for a slightly higher price, and their carcasses dressed out about 1½ percent more than the control group. In the trials conducted at the Newell station, there was no difference in selling price nor in the carcass grade.

Summary

1. On a mixture of salt and soybean oil meal in the proportion of 1:3 the consumption of soybean meal by fattening lambs on a full feed of corn and hay ranged from 0.20 to 0.25 pound per lamb daily.

2. The consumption of 0.06 to 0.08 pound of salt per lamb daily did not adversely affect rate of gain, feed consumption, carcass grade, or carcass yield.

3. When feeding lambs salt-protein mixtures, you should gradually increase the level of salt to the desired proportion. (Project 248. Leader: R. M. Jordan, Animal Husbandry Dept.)

Salt also regulates the protein intake of cattle.
As we develop and release inbred lines of poultry, we need to know how to best use the inbreds. At present no inbred lines at this or probably any station do as well by themselves as they do when crossed with other lines or strains. Therefore, we are working with combinations of inbreds with other inbred and non-inbred stocks trying to find the best method.

For several years we have been running a series of experiments to help solve this problem. Our facilities consist of 12 test units—three laying houses with four pens each at the Cottonwood, Eureka, and Highmore substations. We mate the parent stock, hatch the eggs, and rear the pullets at the main station in Brookings. The birds are then shipped by truck to the substations before October 1 each year. Records are kept of total eggs laid, size of eggs, deaths, and broodiness for 11 months.

Except for some of the inbred lines, all of our test stocks are from closed flocks kept at the station. In all, nine inbred lines have been used—four developed at South Dakota, four at Minnesota, and one at Nebraska. Laying house performance of 2,145 hens has been measured. We have used White Leghorns, White Plymouth Rocks, Barred Plymouth Rocks, New Hampshires, and Rhode Island Reds. Although we are also testing individual lines, our discussion here concerns only the results of different mating systems.

A breeding program requires accurate record-keeping.
Table 1. Origin of the Mating Types Used in this Study

<table>
<thead>
<tr>
<th>Mating Type</th>
<th>Symbol</th>
<th>Sire</th>
<th>Dam</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purebred</td>
<td>P</td>
<td>Breed A</td>
<td>Breed A</td>
<td>White Plymouth Rock</td>
</tr>
<tr>
<td>Crossbred</td>
<td>C</td>
<td>Breed A</td>
<td>Breed D</td>
<td>White Plymouth Rock</td>
</tr>
<tr>
<td>Topcross</td>
<td>T</td>
<td>Inbred Line</td>
<td>Breed G</td>
<td>SD-I x New Hampshire</td>
</tr>
<tr>
<td>Singlecross</td>
<td>ST</td>
<td>Inbred Line</td>
<td>Breed E</td>
<td>(SD-4 x SD-11) x</td>
</tr>
<tr>
<td>Topcross</td>
<td>x</td>
<td>Inbred Line</td>
<td>Breed G</td>
<td>Barred Plymouth Rock</td>
</tr>
<tr>
<td>Four-way</td>
<td>FX</td>
<td>Inbred Line</td>
<td>SD-I x SD-11 x</td>
<td></td>
</tr>
<tr>
<td>Cross</td>
<td>x</td>
<td>Inbred Line</td>
<td>SD-I x SD-11 x</td>
<td></td>
</tr>
</tbody>
</table>

White Leghorn, New Hampshire, and White Plymouth Rock purebred stocks have been used. Crossbreds include these breeds plus Rhode Island Reds and Barred Plymouth Rocks. Each is represented in about three matings. Topcross matings consist of males from one inbred line being mated to purebred females of a different breed. The inbred lines we used for these topcrosses were White Plymouth Rocks.

Two generations are needed to produce either singlecross topcrosses or four-way crosses. The former are produced by mating two unrelated inbred lines the first year and using the males produced to mate with purebred females, again unrelated. In the example in Table 1, White Plymouth Rock males from line SD-4 were mated to Rhode Island Red females from line SD-11. The second year, the males produced were mated to purebred Barred Plymouth Rock females.

**Performance Before Housing**

When you buy or sell replacement chicks one of your first concerns is the livability, growth, and maturity of the birds until the start of the laying year. If you buy or sell hatching eggs you must also aim for high livability. Figures 1 and 2 were prepared from results collected at Brookings and compare the performance of the different mating types until housed for laying tests.

Using four mating types at each substation, we rated the pens 4, 3, 2, and 1 for top, second, third, and fourth each year. Individual averages were figured for the five

![Figure 1. Hatchability of all eggs set.](image)
mating types, each represented by at least six test pens.

Results in figure 1 are surprising and need some explanation. Best results were from the four-way crosses. The eggs were highly fertile and most of the fertile eggs hatched, resulting in about 90 good chicks for each 100 eggs incubated. Topcrosses showed the poorest performance. The percent of fertile eggs was much lower than all other groups and was the main factor causing fewer chicks. Sometimes hatchability was less than 50 percent.

When comparing purebreds and crossbreds it seems, at first, that there is a wide difference. However, although the purebred eggs hatched well, usually 75 to 85 percent, four of these seven pens were compared with only the topcrosses during the early years of the experiment. This meant that the purebreds would receive higher ratings and their relative performance would be above average when compared with crossbreds.

On the other hand, most of the crossbred test matings were done more recently. They have been competing with hybrids from the inbred lines that have a high performance.

Livability of the birds to housing time is clearly influenced by heterosis, which is the hybrid vigor of offspring from unrelated parents (see figure 2). Purebreds, the only mating type with just one common parental stock, had the highest mortality. Although the other lines were close together, two of the three groups involving inbred lines were superior to the crossbreds, which were themselves slightly better than average.

**Laying-House Performance**

We considered a group sexually mature when it reached 50 percent

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**Figure 2. Growing period livability.**

For explanation of symbols, see table.

**Figure 3. Rate of sexual maturity.**

For explanation of symbols, see table.
In our opinion the best way to rate egg production is to compare production rates on a hen-housed basis. To find this, you simply divide the total eggs laid by the number of females put into the laying pen at the start of the laying year. Figure 4 shows that birds from inbred line crosses greatly outperformed the two non-inbred groups.

Factors which influence hen-housed averages most are adult mortality, hen-day average, and broodiness. In an effort to tell how important each of these is we have broken down the hen-housed average into its parts.

You can see from figure 5 that singlecross toperosses consistently had the highest livability. Next was the topeross group and then the four-way crosses. More hens died in the two non-inbred groups than in any other.

Egg performance measured on a hen-day basis doesn’t take mortality into account. It shows the proportion of eggs laid to the total number possible for the live hens in the pen at all times during the 11-month test period. It is, in reality, a measure of intensity of production. Figure 6 shows that the toperosses and singlecrosses performed better than the four-way crosses and much better than the crossbreds. The purebreds laid at a relatively low rate.

In figure 7 you can see that the broodiness pattern is mixed. The high amount of broodiness shown in these experiments for the four-way crosses was not unique to the South Dakota trials. However, we were surprised to find so few
broody birds in the singlecross topcrosses.

Commercial Use of Findings

The best mating type after the birds were housed was the singlecross topcross. If you are to produce or buy these birds you will probably wonder if they are expensive to produce and what special stocks would be needed to produce the chicks in quantity.

Production Problems. First, let's compare production problems with all of the mating types involved. A crossbred can be produced on a farm where two breeds of non-inbred stock are available—a different breed for each sex. If you are breeding them you will need to keep two separate flocks for parental stock.

On the other hand, if you are a flock owner and producing hatching eggs you will merely have to buy males of a different breed to mate with your females. You could carry on a successful operation by buying replacement stock each year. Usually eggs from crossbreds will hatch at least as well as those from purebreds. However, the most reasonable type of operation from the breeder's standpoint, and perhaps the hatching-egg producer's, would be the supplying of purebreds. This involves keeping only one flock.

Relatively poor reproductive performance of the inbred lines, when maintained as inbreds, raises the cost of producing the other three mating types. You would have to keep a minimum of one inbred line for topcrossing, two for singlecross topcrossing, and four for the four-way crosses. Another factor is that you would have to make plans 2 years in advance so that you would have the singlecrosses for producing the last two mating types. When supplying these three mating types you would also have to return to

Continued on page 56
Living conditions in South Dakota have improved considerably in recent years in spite of problems an increasing population brings. This is particularly true for farm families.

The level of living index for farm families rose from 88 in 1940 to 139 in 1950. Our net farm income increased from $75½ million in 1940 to slightly over $320 million in 1950.

The number of farms with tractors more than doubled during this period. Many farms now have two, three, or more tractors. Farms with motor trucks almost tripled, while farms reporting milking machines and grain combines more than doubled from 1945 to 1950. These items indicate the generally improved condition of the farm operator and his family.

Now, let's take a look at the changes in farm household equipment and facilities during the same period.

From 1940 to 1950 about 10 percent of our rural farm houses were vacated. This decline followed an 8 percent decrease in the number of farms in our state. During the same period we had an increase in the total number of occupied houses—9 percent for towns and 47 percent for cities. It looks like this trend will continue, for the 1954 Agricultural Census shows a further decline in the number of farms.

Sixty-five percent of the farmers owned their homes in 1950, as compared to only 45 percent in 1940.

Some figures in the 1950 Census of Housing may surprise you (see table 1). In 1950, 59 percent of our
homes had no central heating system. Central heating, as used in this census, includes piped steam or hot water and warm air furnaces.

More than half had no bathtub or shower, half had no flush toilet, and less than two-thirds had running water. Twenty-seven percent of our homes had no kitchen sink, 26 percent had no mechanical refrigeration, and 15 percent had no electric lights. Only 4 percent had no radios.

Farmhouse Facilities

In the graph we have classified the homes as urban (or city), rural non-farm (or town), and rural farm (or farm). From this graph we see that city homes had the most of each facility and, except for one, farm homes had the least.

Central Heating. Your health can be affected by the type of heating system in your home. If you cannot regulate the heat, the danger of illness increases and the variations in temperature can cause discomfort. Without central heating it is hard to heat the whole house, especially bedrooms and halls. Slightly more than three-fourths of the farm homes had no central heating.

Running Water. Also important for family health is running water in the house. It is needed for many other facilities too. Water from a faucet facilitates personal cleanliness. It also takes a lot of the work out of washing and cleaning the house. If you want the convenience of an automatic water heater, you have to have running water. We considered running water as any system by which water was piped into the house. About two-thirds of our farm homes had no running water.

Indoor Toilet. You probably realize how important a fully equipped bathroom is to health. Not only does an indoor toilet stimulate more regular habits, but it also is a sanitary method of sewage disposal. In homes without bathrooms the kitchen is used for combing hair, brushing teeth, and washing as well as preparing food. Flush toilets connected with cesspools, septic tanks, and public sewage systems were included as indoor toilets. Eighty-two percent of the farm homes in our state were without this facility.

Bathtub or Shower. Before you can have a bathtub or shower you must have running water. These facilities make personal cleanliness more thorough, more relaxing, and usually more frequent. Of our farm homes, 79 percent were without tub or shower.

Kitchen Sink. The work of carrying out water is done away with if you have a kitchen sink with a drain. Usually, when no sink is in the house, water is thrown over the railing of the back porch onto the lawn. Since most of the water will have particles of food and garbage in it, this tends to attract flies. The
flies are not only a health hazard but also a great inconvenience. Sinks with or without running water were included in this classification. Forty percent of our farm homes had no kitchen sink.

**Mechanical Refrigeration.** There are two advantages in having a mechanical refrigerator—keeping perishable foods and allowing for better health through a more varied diet. Mechanical refrigeration includes any type of refrigerator run on electricity, gas, kerosene, gasoline, or other source of power. There was no mechanical refrigerator in 34 percent of our farm homes, according to the census.

**Electric Lights.** Most of us depend on electricity for many conveniences. It has made better lighting possible, decreasing eye strain and increasing safety in the home. Many labor-saving appliances also run on electricity. In 1950 about one-third of the farm homes had no electric lights or power.

**Radio.** Information that affects our farms, such as market news and weather reports, is made available through radio. The housewife can get new ideas for fixing meals and using appliances from the radio. In addition to its educational value, radio also offers entertainment for the whole family. Before electricity came into many farm homes battery-type radios were used. Since electricity has become available the number of farm homes without radios has dropped to only 3 percent.

**Improvement in Facilities**

We have seen that farm homes had a lot fewer facilities than city homes in 1950. However, the picture looks brighter when we consider the change in percent of farm homes with...
Table 1. Dwellings Reporting the Absence of Selected Facilities by Percent of Total Reporting, South Dakota, 1950

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Total Number Reporting</th>
<th>Percent Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central heating</td>
<td>180,095</td>
<td>58.6</td>
</tr>
<tr>
<td>Bathtub or shower</td>
<td>191,334</td>
<td>51.5</td>
</tr>
<tr>
<td>Flush toilets</td>
<td>192,273</td>
<td>50.1</td>
</tr>
<tr>
<td>Running water</td>
<td>173,269</td>
<td>35.8</td>
</tr>
<tr>
<td>Kitchen sink</td>
<td>180,765</td>
<td>27.3</td>
</tr>
<tr>
<td>Mechanical refrigeration</td>
<td>180,225</td>
<td>26.4</td>
</tr>
<tr>
<td>Electric lights</td>
<td>192,239</td>
<td>14.8</td>
</tr>
<tr>
<td>Radio</td>
<td>180,685</td>
<td>3.9</td>
</tr>
</tbody>
</table>

For every facility listed, the farm homes as compared with town and city homes had the greatest percentage increase from 1940 to 1950. Farm families are not standing still in regard to these conveniences, but the improved facilities for the farm home have lagged behind those for the farm. With the rise in the level of living index for farm families and a continued favorable economic position, we can expect the number of farm homes with these facilities to increase even more. Then the difference between our farm, town, and city homes will tend to disappear. (Project 222. Leader: Robert M. Dimit, Rural Sociology Dept.)

Table 2. Increase or Decrease in Percent of Dwelling Units Possessing Selected Facilities by Residence, South Dakota, 1940 to 1950

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Residence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State (%)</td>
</tr>
<tr>
<td>Central heating</td>
<td>+8.4</td>
</tr>
<tr>
<td>Bathtub or shower</td>
<td>+18.0</td>
</tr>
<tr>
<td>Flush toilets</td>
<td>+16.9</td>
</tr>
<tr>
<td>Running water</td>
<td>+16.6</td>
</tr>
<tr>
<td>Kitchen sink</td>
<td>*</td>
</tr>
<tr>
<td>Mechanical refrigeration</td>
<td>+49.0</td>
</tr>
<tr>
<td>Electric lights</td>
<td>+28.6</td>
</tr>
<tr>
<td>Radio</td>
<td>+11.5</td>
</tr>
</tbody>
</table>

*1940 data not available.
ANY MANUFACTURING processes are developed on a small scale. In this way the experimenter can find and correct his mistakes and perfect the process with minimum expense.

We use the same principle in our silage work. Pilot silos are small experimental silos. With pilot silos we can try different storage methods at less cost than with regular silos. Even more important, we can weigh the small silos to determine spoilage losses.

To keep conditions uniform we build these pilot silos indoors. Here they are free from the effects of wind, rain, storms, and atmospheric changes. Because all conditions are the same, we know that differences in results are due to the variables we use.

Use Three Variables

During the 1954 crop season we built nine pilot silos. As these silos have smaller diameters and a greater percentage of surface area than regular silos, we used a shorter period of time between filling and inspection. The 1954 storage period ran from July 20 to September 30.

The variations studied were (1) dense or light packing, (2) covered or uncovered, and (3) chemically treated or untreated. All silos held about 1,800 pounds and were weighed periodically with a scale and derrick.

We could not find enough difference between dense and light packing so we dropped this part of the study.

There was a large difference between the covered and uncovered
silos. Ninety percent of the weight was retained by the covered silos while the uncovered ones kept only 38 percent of their weight. An enclosed silo treated with phosphoric acid had 91 percent of its original weight at the end of the storage period. A chemical-treated uncovered silo retained 45 percent of its weight.

were the only variables we studied this year.

We continued to use sheet metal side walls on two of the six silos and, in addition, put on plastic tops. One silo had a plastic wrap-around cover. It was put on after the silo was made and sealed with tape. The other three silos were left uncovered.

AN ECONOMICAL WAY TO STUDY WEIGHT LOSSES

Refine Experiments

During the second year, 1955, the pilot silo experiments were refined. We developed a new type of platform scale and increased the size of the silos from 1,800 to about 3,500 pounds. Covered or uncovered and chemical treatment or no treatment

Effects on weight of silage stored by different methods in the pilot silos.

We filled the silos on July 13 and 14 and inspected them on September 13 and 14.

The graphs show the weight losses of these six silos. The results are similar to the first year's work. Keeping out air with covers is more important than chemical treatment.
Chemicals alone do not protect silage from spoilage and weight loss.

**Measure Temperatures**

The temperature of silage is also important. To measure temperatures under different storage methods, we placed a thermocouple wire in the center of each silo. The temperatures were read each week.

In the covered pilot silos temperatures stayed near 80° F. Temperatures in the uncovered silos rose from 80 to about 110° F. Temperatures rose to nearly 130° F. in the uncovered silo with chemical treatment.

**Nutritive Value Is Studied**

However, weight and temperature loss studies, striking as they are, do not tell the complete story of how much of the total nutrients are preserved for animal feed.

The Biochemistry Department analyzes the silage at the beginning and end of the tests to determine changes in nutritive values. Plant pathology workers also take samples at various times to study bacterial action in the silage at different stages. Nutrients may leach from the top to the bottom of the silo. Some substances change into materials with no feed value. Moisture content may or may not change.

Results from both years of the experiments show that you need a good covered silo. By keeping out air, weight loss through spoilage can be kept to a minimum throughout the storage period. (Project 237. Leader: H. H. DeLong. Agricultural Engineering Dept.)

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### 1956 SEED CERTIFICATION LIST

**Spring Wheat;** Lee, Rushmore, Selkirk, N.D. No. 1

**Durum Wheat;** Vernum, Langdon, Yuma, Ramsey

**Winter Wheat;** Minter, Nebred

**Oats;** Andrew, Brunker, Cherokee, Dupree, James (Hulless), Marion, Mo.-0-205, Nemaha, Osage, Vikota, Waubay, Newton, Garry Cl #6662, Ransom

**Barley;** Compana, Custer, Feebar, Kindred, Odessa, Plains, Spartan, Tregal, Velvon-11, B-103

**Flax;** B-5128, Marine, Redwood, Sheyenne

**Forage Sorghum;** Piper Sudan, Rancher, 39-30-S

**Grain Sorghum;** Norghum, Reliance

**Soybeans;** Blackhawk, Capital, Chippewa, Hawkeye, Ottawa Mandarin, Grant, Harosoy

**Rye;** Antelope, Caribou, Pierre

**Alfalfa;** Cossack, Grimm, Ladak, Narragansett, Ranger, Rhizoma, Vernal

**Sweet Clover;** Madrid, Tall White Blossom

**Red Clover;** Dollard

**Birdsfoot Trefoil;** Empire

**Grasses;** Fairway Crested Wheatgrass, Homesteader Bromegrass, Lincoln Bromegrass, Nor'dan Crested Wheatgrass, Red Wheatgrass, Tall Wheatgrass

**Trees;** Chinkota Elm, Harbin Pear, Siouxland, Cottonwood
Each year we plant some $30 million worth of seed in South Dakota. Unfortunately, much of this amount is spent for seed from other states that is not adapted to our conditions, causing many crop failures. The best insurance against these failures is foundation seed of adapted varieties, tailor-made to meet our needs.

The state of South Dakota, through its experiment station at State College, is developing new crops adapted to the different areas of the state. Its scientists produce foundation seed of varieties bred to meet South Dakota's severe winters, drought, heat, disease, and insect conditions. Such seed is of little value unless it is increased and made available to the farmers.

To increase this foundation seed adequately and to safeguard the proper handling of such superior germ plasm produced at public expense, certain basic principles are recognized and followed in South Dakota's program. Every qualified seed grower has an opportunity to obtain such seed or its immediate progeny at a reasonable cost. No small group has a monopoly of access to foundation seed arising from a public investment. The seed meets high standards of purity and germination.

The aim of the foundation seed program is commercial certified seed production based on the foundation seed program. Results expected of this program are good seed and enough seed at a reasonable price to plant the acreage justified by the interests of South Dakota agriculture.

Releasing New Varieties
A new variety is released only when it is distinctly superior to existing commercial varieties in one or more characters, such as yield or disease resistance, and is at least satisfactory in other major requirements. This is arrived at by testing
Breeders at Experiment Station develop new varieties. From 10 to 15 years are necessary to breed a new variety.

Seed allocated to the county belongs to the County Crop Improvement Association and not to any individual. It is re-allocated to growers by members of the CCIA at a regular meeting to which all members are invited. Growers selected grow this seed under certification standards to insure pure seed for the farmers and seedsmen.
Foundation Seed Stocks Division increases the one bushel to several hundred bushels of foundation seed.

A committee consisting of experiment station and extension service personnel allocate foundation seed on the basis of past production records and adaptability.
potential new varieties for yield, survival, disease reaction, and other characters with standard commercial varieties. These tests are made at several locations in the state as well as in the interstate uniform nurseries involving many states.

New varieties used primarily for industrial purposes, such as wheat, barley, flax, and soybeans, are appraised for quality with the trade or industry concerned. After 3 to 5 years of testing, all available information is assembled as to the strain's characteristics, performance, quality, and amount of breeders seed available. This information is reviewed by an Experiment Station Committee on the Release of Improved Germ Plasm and recommendations are made as to approval or rejection.

Consideration is given to the interest of neighboring states, as often the new variety is widely adapted or is being jointly released. This is done to avoid confusion arising from duplication of identifying names given to the same strain.

**Breeders Seed**

From 12 to 15 years are necessary to develop a new variety. Because breeders work with many thousands of different strains, usually less than an ounce of seed of each is available at this stage. When it becomes evident that one of the strains is sufficiently promising to merit release, the breeder increases this to a few pounds or a bushel. The breeders seed is turned over to the Foundation Seed Stocks Division for the production of foundation seed. Also, the Foundation Seed Stocks Division maintains a reasonable reserve of breeders seed, which can at any future date be used to replenish and restore genetically pure foundation seed of the variety.

**Foundation Seed Stocks Division**

To increase foundation seed adequately and to safeguard the proper handling of such superior germ plasm produced at public expense, the Foundation Seed Stocks Division was established in 1944. The Foundation Seed Stocks Division is a non-profit corporation incorporated under provisions established by South Dakota law. It operates under a Memorandum of Agreement approved by the Board of Regents.

The business and affairs of the Foundation Seed Stocks Division are under the control of a board of 11 directors. Six of the directors are members by virtue of their offices, as follows: President of South Dakota State College; Dean of College of Agriculture; Director of Agricultural Experiment Station; Director of Extension Service; Head of Agronomy Department; Extension Agronomist. The remaining five members are nominated by the South Dakota Crop Improvement Association to represent the major crops and production areas of the state.

The members of the Board of Directors can in no way personally benefit from the policies established or the business conducted by the Foundation Seed Stocks Division. The directors serve without compensation except traveling expenses incurred in connection with meetings. The technical supervision of
increasing and processing foundation seed is done by a manager according to the policies set up by the directors.

**Increasing Foundation Seed**

Foundation seed stocks in small grain crops, soybeans, and sorghum represent the direct increase of breeders seed and are the basis of registered and certified seed on a commercial basis. In the production of foundation seed, special care is taken to insure that the few pounds of breeders seed are not wasted. These few pounds are increased under careful supervision to lots of 1,000 bushels or more of small grain or a few hundred pounds of forage crop seed.

This work requires trained men in seed production, as well as close supervision by agronomists, pathologists, and certification personnel, so that only a high quality level of pure seed is assured. Often the seed is sent to Arizona or California and a crop is grown during the winter months, thus greatly speeding up the increase program and making the new variety available a year or two earlier.

In hybrid corn, inbred lines and single crosses developed by the Experiment Station breeder are increased by the Foundation Seed Stocks Division. Inbred lines are handled on a delayed release policy as adopted by the directors of the experiment stations of the North Central Region. South Dakota single crosses are available (1) for the purpose of the production of hybrid combinations released by the Experiment Station and (2) for use in combinations with single crosses of known genetic identity acceptable under the certification standards.

Special equipment and facilities must be available to adequately process and store foundation seed from a wide variety of crops. In the early stages of foundation seed production the supply is small and special equipment is required, especially in cleaning and processing grass and legume seed.

Many new strains of different crops, varying from a few pounds to several hundred bushels, must be handled properly so as to keep the seed pure and assure the farmers of the state a source of pure, clean, and sound foundation seed. At the beginning of this article is shown the new foundation seed stock cleaning and processing building. It has recently been built on South Dakota State College land from the income of the Foundation Seed Stocks Division and not from state appropriations.

**Allocation to Counties**

Foundation seed is allocated to the various counties in the state on the basis of adaptability and past production record of the crop in the county. County allocations are made by a committee of Experiment Station and Extension Service personnel to county crop improvement associations after a thorough study of past county production records and experimental test results. After the seed allotments are made by the committee, a complete list of the allotments made to counties is sent to every county in the state. County crop improvement associations have the privilege to reject or accept any part of the

*Continued on page 51*
WHICH TYPE OF FEED FOR YOUR DAIRY CALVES?

- Oat Silage,
- Alfalfa-Brome Silage, or
- Alfalfa-Brome Hay

HOWARD H. VOELKER

DAIRYMEN COMMONLY avoid feed-
ing silage to young dairy calves—especially calves fed milk. The
main reason silage has not been recom-

mended is that dairymen think it tends to increase diarrhea
troubles in calves. However, there
is little experimental evidence to
back up this idea. We started a
study to learn more about silage as
a dairy calf feed.

Feeding Experiments

We ran two trials using 28 Hol-
stein and Brown Swiss calves (6 to
7 in a group) comparing oat silage
with alfalfa-brome hay in the first
and wilted alfalfa-brome silage with
sun-cured, green, leafy alfalfa-
brome hay in the second. The alfal-
ga-brome mixture contained mostly
alfalfa with a small amount of
brome grass.

The oat silage was cut in the soft
dough stage and was not wilted.
The oats had started to lodge and
was made into silage to protect the
new seeding. This procedure will
give you more feed to the acre if
poor weather and oat diseases de-
crease possibilities of a good grain
crop. The plants were green, finely
cut, and made silage with a pleasant
odor, similar to good corn silage.

The alfalfa-brome silage was
wilted before we ensiled it. When
cut, it was in the full bloom stage

The calf below is being fed silage.
and contained 55 percent leaves with a stem length of 14 inches.

The alfalfa-brome hay was similar in height and was sun-cured without rain. It kept most of its leaves and was green colored.

We fed the hay and silage to calves in individual pens. Each calf received all it would eat each day, starting at 2 weeks of age. We continued the first trial for 12 weeks, the second for 16 weeks.

During the first month whole milk was fed. Then skim milk was fed at the rate of 1 pound for every 12 to 15 pounds of body weight daily. The concentrate mixture of corn, oats, soybean oil meal, bone meal, and trace mineralized salt contained 19 percent initial protein. As the calves became older we reduced it to 15 percent protein. We fed the concentrate mixture free choice, as we fed the silage and hay free choice, to see which feeds and how much of each would be eaten.

**Results of Trials**

We found that the calves ate the oat and alfalfa-brome silages readily. There were few cases of scurrying. The group of calves fed the oat silage were especially free from digestive disorders. Growth and feed data are given in table 1 on the following page.

We found that growth was about normal in calves fed either kind of roughage, perhaps slightly favoring the hay. The differences in body weight gains between the two trials are due mainly to the difference in feeding duration. Body measurements, including height at shoulders, heartgirth, barrel circumference, and length of body, showed that calves fed hay grew slightly faster. However, you should remember that this was good quality hay that we compared to the silages.

**Chemical Composition of the Feeds**

The oat silage, on a dry basis, was about equal to the alfalfa-brome in fat. It was slightly higher in crude fiber and lower in protein than the alfalfa-brome feeds. It was lower in carotene (vitamin A) than the hay. Chemical composition of the feeds is shown in table 2 on the following page.

These calves are on the alfalfa-brome ration in the feeding experiments.
Table 1. Body Weight Gains and Feed Consumption

<table>
<thead>
<tr>
<th>Roughage Group</th>
<th>Experiment I</th>
<th>Experiment II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alfalfa</td>
<td>Alfalfa</td>
</tr>
<tr>
<td></td>
<td>Brome Hay</td>
<td>Brome Hay</td>
</tr>
<tr>
<td>Oat Silage (lbs.)</td>
<td>1.19</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>2.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Average daily gain</td>
<td>1.19</td>
<td>1.27</td>
</tr>
</tbody>
</table>
| Average daily roughage consumed | 2.2   | 1.5
| Dry matter from roughage | 0.6    | 1.4
| Average daily grain consumed | 2.6   | 2.2

Deficiencies of Silage

In the first trial we examined the carcasses of the male calves at 12 weeks. Several of the calves fed oat silage had enlarged rib ends. Cross sections of the long bones in the front legs showed less thickness in the shell portion of the bone tissue in the oat silage-fed calves and enlarged marrow cavities compared to the hay-fed calves. We kept the calves inside at all times during the experiment, so there may have been a vitamin D deficiency in the oat silage ration. If you supplement the ration with cod liver oil or wilt the oats before ensiling you may remedy this deficiency of vitamin D.

A second difficulty one runs into when feeding either oat or alfalfa-brome silage is that the calves can’t consume as much dry matter as they do with hay. The young calf is limited in its digestive capacity. Therefore the nutrient use from silage, which is bulky, is limited.

You must also feed silage daily or feed refusal and spoilage will increase. However, if you supplement the silage properly it can be used successfully for feeding calves and the cost is comparatively low. (Project 227. Leader: Howard H. Voelker, Dairy Husbandry Dept.)

Table 2. Chemical Content of Silages and Hay (in Percent)

<table>
<thead>
<tr>
<th></th>
<th>Oat Silage</th>
<th>Alfalfa-Brome Silage</th>
<th>Alfalfa-Brome Hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture:</td>
<td>Wet Basis</td>
<td>Dry Basis</td>
<td>Wet Basis</td>
</tr>
<tr>
<td>As fed</td>
<td>74.0</td>
<td>60.2</td>
<td>93</td>
</tr>
<tr>
<td>As analyzed</td>
<td>72.2</td>
<td>50.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Ether extract</td>
<td>1.4</td>
<td>4.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>8.3</td>
<td>30.0</td>
<td>24.8</td>
</tr>
<tr>
<td>Protein</td>
<td>4.0</td>
<td>14.5</td>
<td>18.8</td>
</tr>
<tr>
<td>Ash</td>
<td>2.8</td>
<td>9.9</td>
<td>10.8</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>11.3</td>
<td>40.7</td>
<td>40.8</td>
</tr>
<tr>
<td>Carotene (meg/g)</td>
<td>54</td>
<td>65</td>
<td>92</td>
</tr>
</tbody>
</table>
Foundation Seed
Continued from page 47
allotment and request additional seed when available.

Selecting Growers in the County
Foundation seed allocated to the county belongs to the County Crop Improvement Association and not to any individual in the county. It is re-allocated to experienced growers by members of the County Crop Improvement Association at a regular meeting to which all members are invited. Since anyone can belong to an association, any experienced and qualified grower has an opportunity to obtain such seed.

The growers chosen from among themselves must grow this seed under certification standards and growers agreement. This is necessary so that the valuable seed is not lost and that the largest possible increase is made for redistribution to other farmers in the county.

Not only must the grower have clean land, cleaning and storing facilities, and comply with standards and procedures of certification to produce pure seed, but also he must comply with the plan of increasing and distributing this seed as adopted by his County Crop Improvement Association.

Foundation Seed Is Basis of Sound Seed Production Program
Foundation seed is the basis for a sound commercial certified seed production program. Even though it is planted on a very small percent of the acreage of the crop, foundation seed represents adapted varieties of high quality seed of known genetic identity. The end result, of course, is certified seed produced by farmers and commercial seedsmen in quantities sufficient to plant all the needed acres of the crop in the state at a reasonable price.

In a sound seed production program, all parties involved play important roles to serve all of the people of the state. The Experiment Station, with its departments of agronomy, horticulture, plant pathology, entomology, agricultural chemistry, and animal husbandry, in cooperation with USDA, develops and appraises new varieties and combinations.

The Foundation Seed Stocks Division increases and impartially distributes breeders and foundation seed. The seed grower produces adapted foundation and certified seed of high quality. The seedsmen grow foundation and certified seed and render essential marketing services such as processing, storage, advertising, and selling.

Public interest and good sense require that they work together to serve farmers, industries related to agriculture, and through these, all the people.

The foundation seed program is designed solely for the purpose of advancing the use of adapted crop varieties and other plant materials in the state and the maintenance of good trade practices which benefit both the vendor and user of such materials. As a result of such a program, the user of such seed, for whom this program exists, benefits from his investment. This is because he is assured of receiving high quality seed of known genetic identity of the best available crop varieties for conditions in his area.
Ensiling grass in stacks has become common on our South Dakota farms in the last few years. There are many reasons for this.

Materials for preparing the site and for forms used during filling cost little, if anything. It is rather simple to put up the stacks and you can feed from them efficiently with self-feeders or mechanical equipment. You can usually locate the stack to simplify feeding operations. During rainy weather it may be more practical to ensile grass than to put it up as hay, and if you have no silo structure available, stacking offers a solution.

These advantages are obvious. However, we must consider many other factors before we can make a sound evaluation of stacking grass silage. Of these factors, we are examining (1) the chemical composition of stacked grass silage and how it affects the nutritive value, (2) the importance of spoilage losses, (3) losses in nutrients, and (4) the effect of length of storage on spoilage and nutrient losses.

Study Many Stacks

In doing this work we have used many stacks. Some were long while others were round. We used alfalfa in all of the stacks but one—a stack of oats silage which we shall discuss separately.

The grass was cut and windrowed, field chopped before wilting, and blown into stacks. Each stack was packed throughout the filling by tractor, truck, or tramping. We used snow fence for forms.

Samples were taken several times during filling to determine the chemical composition of the fresh grass. To measure the loss of nutrients from different points in the stack, we weighed samples of silage in burlap bags and placed them in
One phase in analyzing silage is determining the protein content by means of chemical procedure.

position. We determined the moisture content and chemical composition of these bags for comparison with the contents at feeding time.

**Determine Chemical Composition**

Spoilage occurs in silage where the surface is exposed to air. In the stacks we used, the spoiled area was 6 to 24 inches in from the top and sides. The types of spoilage varied from dry and moldy on the outside to spots of wet, soft material 1 to 2 feet under the surface. The rest of each stack appeared unspoiled.

During the first year we analyzed samples from several stacks. Samples from an upright silo were also analyzed. The average composition for each type of silage as compared to the original grass is given in table 1.

Chemical composition for the two types of silage is not the same, but when you consider the analyses for the fresh grass the differences are small. An important nutrient not included in this study is carotene (vitamin A). However, results from other experimental work do show silage from the upright type of silo contains much more of this nutrient.

More recent work has confirmed the results in table 1, and it appears that, except for carotene, the unspoiled portion of the stack has a chemical composition similar to silage stored in an upright silo.

Chemical composition, however, is not a highly accurate guide to nutritive value. More heat is generated in the stack than in the upright silo. This may or may not affect the digestibility of the nutrients present. Feeding experiments by the Animal Husbandry Department indicate that it does. Further work, including digestion trials, is planned to answer this question.

**Nutrients in Spoiled Silage**

Spoiled silage is not palatable and your animals will refuse much of it. However, if you mix the dried spoiled material with the good silage it may be eaten.

Results shown in table 2 indicate the unspoiled silage is more nutritious than spoiled, especially in energy, being higher in ether and nitrogen-free extracts. The crude protein contents are similar, but the spoiled material usually has an ammonia odor, which indicates much protein decomposition.

**Nutrient Losses**

No matter how you ensile grass there will be nutrient losses. The very process that makes silage from grass requires that nitrogen-
free extract be used by bacteria producing the acids that preserve the silage. This is known as loss through fermentation.

Under the best conditions, with exposure to air at a practical minimum, fermentation losses probably amount to 5 percent or more of the ensiled dry matter. As exposure to air increases the amount of fermentation increases; all the nutrients except the ash (minerals) may be lost.

Spoilage, juice run-off, and, in open silos, leaching and “blow away” also reduce the yield of edible silage. We are now making a thorough study of nutrient losses in many methods of storage. Only a few results concerning stack silos are discussed here.

During the first season’s work we checked the nutrient losses from various parts of several stacks by using the burlap bag technique. As many points in these stacks were studied, the findings summarized in Table 3 show the general nature of losses.

The results in Table 3 are averages for several samples. They do not show the amount of spoiled silage but only the dry matter lost from leaching, juice run-off, or fermentation during the 6-month period. Results of mineral analyses show that except for the top of the stacks, leaching and juice run-off was small. Most of the dry matter was lost through fermentation as various nutrients were changed to gases which escaped into the air.

You can see from Table 3 that contact with air greatly increases fermentation losses, and even in the center they are quite large. However, results from the upright silo...
show that losses of 15 percent of the dry matter from fermentation and juice run-off may also occur throughout. Nevertheless, the large surface area of the stack, which increases spoilage and fermentation losses, should seriously reduce the yield from the stack type silo. Results of other work being done indicate that this is true.

**Losses Increase With Storage Time**

Normally, you will feed the silage during the winter after you put it up. What happens if you don’t? You can see from the results in table 4 that long-time storage is a poor policy.

On June 25, 1953, we ensiled a stack of about 27 tons of fresh grass. We let it stand until August 13 of the following year and then weighed it to determine the amount of edible and spoiled silage. The

<table>
<thead>
<tr>
<th>Table 4. Recovery of Grass Silage from an Open Stack After 14 Months Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pounds</strong></td>
</tr>
<tr>
<td>(moisture-Dry Matter free basis)</td>
</tr>
<tr>
<td>Grass ensiled</td>
</tr>
<tr>
<td>Edible silage</td>
</tr>
<tr>
<td>Losses:</td>
</tr>
<tr>
<td>Spoilage</td>
</tr>
<tr>
<td>Other (fermentation, juice run-off, leaching and “blow away”)</td>
</tr>
</tbody>
</table>

amount of dry matter was determined at the beginning and end of the storage period.

Although such a long storage period for the stack is bad, for short period storage the stack may be excellent. For instance, if you ensile the grass in mid-summer for feeding during periods of poor pasture that soon follow, dry matter losses

This stack was opened for feeding with a manure loader on the front of a tractor.
should be at a minimum. The Dairy Department put up a long stack of oat silage on July 9. On July 20 pastures were short and they started self-feeding from the stack. At that time there was little if any spoilage and the silage had an excellent odor and taste. The average dry matter loss at the north end of the stack where feeding started was too small to measure.

Forty-two days later all but about a sixth of the stack had been eaten. By this time the average loss in dry matter near the south end of the stack was 24 percent (not including a small amount of spoilage). Although losses in nutrients had occurred during the feeding period, they had been minimized by starting feeding early.

More Information to Follow

This report points out only some of the many phases of the study of nutrients in stacked silage that are under examination. We will give you more complete results later, along with results for other methods of storage. You will need these additional results along with information from feeding and digestion trials, labor requirement studies, and other considerations to fully evaluate the stack silo and to compare it with other types of storage for grass. (Project 237D. Leader: O. E. Olson, Station Biochemistry Dept.)

Poultry Breeding
Continued from page 35

the inbred lines for basic stock each year. The purebreds, however, can be selected continuously.

Inbred Mating Types. Despite difficulties in mating types involving inbreds, the most economical of these groups would probably be the singlecross topcrosses—the best performers. An advantage of singlecross topcrosses over singlecrosses is their better hatchability. Therefore your chick cost could be reduced. The singlecross topcrosses also had a lower adult mortality and less broody hens than topcrosses.

Although the four-way cross eggs hatched better than those from singlecross topcross matings, that was the only way the four-way cross was better. Thus, from the standpoint of hatchability, initial chick cost might be lower. However, the actual production of hatching eggs from the singlecross topcrosses would probably more than make up for this saving. The necessity of keeping four inbred lines of breeder stocks at the same time would greatly increase the cost of hatching eggs in the four-way crosses which in turn would make the chicks more costly.

Another way the production of singlecross topcrosses is more economical is that only the males involve inbred lines. As you need only a few males for hatching-egg production, the cost of birds from inbred lines would be relatively low.

Finally, we should point out that different inbred lines have varying combining abilities. Due to the release of relatively few inbred lines, the supply of stocks for the commercial producer is limited. (Project 287. Leaders: Walter Morgan and Wm. Kohlmeier, Poultry Dept.)
Farmers in South Dakota are caught in a price-cost squeeze. Prices one gets for his products have gone down without an equal decrease in the cost of items he needs for farming. This price-cost squeeze is not only affecting you directly through a lower income, it is also beginning to affect the businesses you depend on in your daily farming operations.

The farm machinery retailer, from whom you get your machinery, repair parts, and service, is caught in a price-cost squeeze of his own. Prices he has to pay the manufacturer have gone up while prices he gets have not increased accordingly because of the decline in the farmer's ability to pay.

There are about 715 retail farm equipment dealers in South Dakota. After 10 years of "good times," they are now finding their incomes dropping rapidly. In some cases dealers are selling out or closing shop. In
the past 2 years about 8 percent went out of business. Of these, more than half went out of business completely—the rest dropped their machinery lines and are now concentrating on the sale of some other line such as cars, hardware, service, and repairs.

Study Is Under Way

We are making a study of farm equipment retailing. The things we hope to find from this study are the pattern of retail distribution of farm machinery, what problems dealers face, and what can be done to improve marketing channels for retailing farm machinery.

Keeping the retail marketing efficient concerns not only the dealers but also those who buy machinery from the dealers. If the present trend of business failures keeps up, two things could happen. First, many more dealers, especially those who started their businesses since World War II, will go out of business. Some of these dealers are probably not efficient. So for the sake of their future income and welfare as well as from the standpoint of the over-all cost of distributing farm machinery they should close up. However, as more dealers quit, the amount and convenience of service for your machinery will go down.

The second thing that might happen is machinery manufacturers may take over the retailing of their farm equipment. Nearly half of the 103 dealers interviewed are concerned with what they think is a tendency for manufacturers to set up their own retail outlets.

If this should happen, as these dealers believe it will, your bargaining position when buying machinery will probably decrease. Now you deal with an independent dealer who operates on a margin above the cost of the machinery from the manufacturer. A farmer, by shrewd bargaining, can and does decrease the amount earned by the dealer. If you bargain directly with the manufacturer through his retail outlets, you may have a harder time lowering the retail margin.

Problems of Dealers

What are the problems that these small, independent businessmen face, and what, if anything can be done to solve them?

Credit on Parts and Service. One of the biggest problems dealers in some parts of the state face is credit. Most dealers give credit to their customers for repairs and service. This credit is usually interest-free. At a recent meeting of machinery dealers in southeastern South Dakota, 53 dealers discussed the problem. These 53 dealers had an average of $10,169 worth of debts outstanding on open accounts.

The Minnesota Plan. The proposal they were discussing deserves attention. The credit plan they were considering is known as the Minnesota plan among men in the industry. The idea behind the plan is for all machinery dealers in an area to get together and agree to make all bills payable on or before the 10th of the month following purchase with interest to be charged on all past due amounts. The interest rates are set higher than banks to encourage farmers to borrow from banks.
An important part of the plan is the customer credit card, which is kept in the dealer's files. The card has spaces for the terms of the agreement and how the farmer wishes to pay.

Another part of the plan is the use of a post-dated check drawn on the customer's bank and paying to the order of the implement firm for the amount of the purchase. If the check cannot be cashed on the agreed payment date, it then reverts to a promissory note. Interest is then charged and the customer is liable for the attorneys fees for collecting the account.

This plan has been in operation for a year in southern Minnesota. Dealers there report considerable success with the program. However, most of the dealers in the area must cooperate if the plan is to succeed. As soon as a few dealers break away from it, they will have an advantage in selling machinery and the other dealers will have to follow suit.

This plan will probably make less credit available to farmers from machinery dealers. However, it may mean that dealers who otherwise could not, will be able to keep their business and service establishments.

Convenient access to parts and repairs aids farmers. The farm machinery retailers offer these important services.

Credit for Major Purchases. We find that when farmers buy major pieces of machinery on time the simple interest rate charged by dealers varies greatly.

We first asked dealers what simple rate of interest they charged on loans for machinery bought on time. One said 5 percent, 14 said 6 percent, 20 said 7 percent, 35 said 8 percent, 13 said 9 percent, 1 said 10 percent, and 5 said 11 percent.

Then we asked the dealers what a farmer's payments would be if:

1. He bought a $300 piece of machinery, made a down payment of $100, and paid off the balance in 12 monthly installments.
2. He bought a $300 piece of machinery, made a down payment of $100, and paid off the balance in 2 semi-annual installments.
3. He bought a $2,100 piece of machinery, made a down payment of $700, and paid off the balance in 24 monthly installments.
4. He bought a $2,100 piece of machinery, made a down payment of $700, and paid off the balance in 2 annual installments.

We figured the simple rate of interest actually charged on the basis of answers to these questions. You can find the approximate simple interest rate on an installment purchase by taking the total interest paid and dividing by half the amount of the purchase. Results are given in table I.

You can see several things from the table. Machinery dealers are not charging the interest rate they think they are. In some cases they...
Table 1. Simple Interest Rate and Repayment Plans of South Dakota Farm Machinery Dealers, 1955

<table>
<thead>
<tr>
<th>Simple Interest Rate (%)</th>
<th>$200-12 Monthly Installments</th>
<th>$200-2 Semi-Annual Installments</th>
<th>$1,400-24 Monthly Installments</th>
<th>$1,400-2 Annual Installments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. Reporting</td>
<td>% of Total</td>
<td>No. Reporting</td>
<td>% of Total</td>
</tr>
<tr>
<td>4 and under</td>
<td>3</td>
<td>4.1</td>
<td>19</td>
<td>24.4</td>
</tr>
<tr>
<td>5-8</td>
<td>38</td>
<td>52.0</td>
<td>32</td>
<td>41.0</td>
</tr>
<tr>
<td>9-12</td>
<td>24</td>
<td>32.9</td>
<td>23</td>
<td>29.5</td>
</tr>
<tr>
<td>Over 12</td>
<td>8</td>
<td>11.0</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>100.0</td>
<td>78</td>
<td>100.0</td>
</tr>
</tbody>
</table>

are charging less, in some cases more. You might do well to shop for credit terms when you buy machinery.

Here is an important thing to consider. When you pay over 8 percent interest, which was the rate for more than 30 percent of the dealers reporting, it becomes a fairly large part of the total cost of the machine. Getting credit at a lower cost may be just as important in dollars and cents as getting the machine for a lower initial cost.

**Model Numbers.** The manufacturers of machinery could solve some of the dealers' problems. For example, practically all dealers complained that model numbers are not permanently stamped on some of the machines. In many cases they are just painted on and by the time repairs are needed the model number disappears. Permanently stamping the model number would let the retailer give you better and faster service.

**The “Scalper.”** Many dealers complained about the so-called "scalper"—an individual who sells machinery, usually at low prices, without having an establishment to service the machinery he sells. If you buy from such a seller, you must decide whether the savings you get in terms of lower initial cost is greater than the disadvantage of losing the service you get from an established dealer.

**Tax Collections.** Several dealers complained about being unpaid tax collectors of the state. What they meant was their job of collecting sales tax. The dealers feel that the sales tax on farm machinery should be collected by the court house as it is with automobiles. However, the nature of the sales tax is such that the state must call on retailers to collect the tax.

**Management.** Other problems these dealers face can be solved by good management practices. For example, frequent audits and inventories are needed if a manager is to know what is happening to his establishment. There are several dealers who have never had their books audited. This can only result in poor management decisions based on inadequate knowledge. Only the dealer himself can improve this situation.

If these problems can be solved you will benefit as well as the dealers. You will find your costs are lower and your services faster and better. (Project 266. Leader: R. L. Kristjanson, Agricultural Economics Dept.)
You may lose one third of your crop through

Spoilage and Microorganisms

IN ALFALFA SILAGE

George Semeniuk

Spoilage of alfalfa or alfalfa-grass silage put up in stacks, bunkers, trenches, or pits often runs as high as 30 percent. There can also be this much spoilage in poorly built upright silos.

You might find several types of spoilage in your silage. Some is moldy or putrid and some dark and burned smelling, lacking the desirable greenish-yellow color, sour odor, and sour taste of good silage.

You usually find good silage in the lower center of stacks or center of silos. Around this good silage there may be the dark, burned silage. The moldy silage is usually in the outer parts and the putrid silage near the bottom.

By tightly packing forage when putting it up in large stacks, you can cut down the amount of spoilage, but even then there can be a lot. The best way to produce good silage and cut down spoilage is to enclose the stack tightly with a durable plastic covering.

Fermentations by the wrong microorganisms cause spoilage. Fermentations of this type result when too much air gets

The cut-away stack below shows different types of spoilage.
into the stack and there is not enough carbohydrate in the high protein forage.

Stacks, bunkers, trenches, pits, and upright silos all have a lot of surface area. Air can penetrate into the silage for short distances. This promotes the rapid growth of protein digesting and weakly acid-producing microorganisms. These are not the type of microorganisms that produce good silage.

Heat is also produced by these same microorganisms. And as the temperature goes up, new kinds of microorganisms develop that raise the temperature even higher—149 to 162° F. near the outside. Under such heat the surface rapidly becomes dry and porous, letting air get deeper into the stack. This promotes still more spoilage.

Traditionally, forages low in carbohydrates and high in protein are hard to ensile without spoilage. Therefore, various ways have been devised to correct this deficiency. One of these is to add carbohydrates, such as black-strap molasses, to help strongly acid-producing bacteria develop rapidly. This prevents the development of protein digesting or putrifying bacteria in the stack.

Another way is to add strong mineral acid to slow or stop the development of weakly acid-producing and putrifactive bacteria and promote the development of the strongly acid-producing bacteria.

However, success has been variable, perhaps partly because not enough of the additives have been used and partly because conditions were not air-tight enough during ensiling. Nevertheless, many good silages have been obtained by these methods.

But many good silages have also shown up, seemingly by chance, when no supplement has been added. If you could get good silage with no supplement by providing the right conditions cheaply, this would be the most desirable. One way to find these conditions is to learn the progress of spoilage in the stacks.

**Progress of Spoilage in Stacks**

During the past summer we followed the progress of spoilage in

*Outdoor stack covered with a plastic sheet and sealed at the bottom with dirt.*
ensiling alfalfa put up in one large circular stack and in one large, partly-covered bunker. We took samples from these at different times to depths of 3 feet. These samples were examined for changes in color, odor, acidity, and number and kinds of microorganisms.

The large circular stack was put up June 14 to 16, 1955. It was tightly packed, 30 feet in diameter, 8 feet high, and held about 150 tons of alfalfa of about 67 percent moisture.

Within 2 days the temperature rose to around 149° F. in the outer 6 inches. After 23 days the same temperature was found in the outer 1 to 2 feet. The temperature stayed lower in the center of the stack, but even here it reached 100 to 115° F. within 20 days and 121° F. 4 to 5 feet in from the sides by 40 days.

Except for the outer portions, the temperature stayed at 80 to 90° F. across the lower 2 feet of the stack.

With such variations in temperature you can expect different kinds of fermentations in different parts of the stack. Therefore you will get different qualities of silage from the different parts.

Table 1 shows that this is true. You can consider the dark brown silage with burned or buntly odors shown in the table as spoiled. However, you can find different degrees of spoilage within these samples.

The pH readings show that the degree of acidity never got very strong in any part of the stack. From what we've said, one probably would expect large numbers of putrefactive bacteria. Yet, none were found.

Most of the microorganisms found in the stack after 2 days were nonsporing types that do not need free oxygen (facultatively anaerobic) and must have medium temperatures (mesophilic). We found them in about equal numbers at all three levels. After 2 days they rapidly disappeared, especially at 13 and 31 inches. Some nonsporing bacteria that need free oxygen (aerobic) and live at high temperatures (thermophilic) were found near the surface at first. Later we found them deeper in the stack as the temperature increased.

The bunker type stack was less tightly packed. You can consider the dark brown silage with burned or buntly odors shown in the table as spoiled. However, you can find different degrees of spoilage within these samples.

Table 1. Some Characteristics of Silage at Depths of 6, 13, and 31 Inches Midway Up a Circular Stack

<table>
<thead>
<tr>
<th>Days After</th>
<th>pH*</th>
<th>Color</th>
<th>Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensiling 6 in.</td>
<td>13 in.</td>
<td>31 in.</td>
<td>6 in.</td>
</tr>
<tr>
<td>2</td>
<td>5.1</td>
<td>5.1 Gr.Y.</td>
<td>Gr.Y.</td>
</tr>
<tr>
<td>9</td>
<td>5.2</td>
<td>5.1</td>
<td>4.9 L.Br.Y.</td>
</tr>
<tr>
<td>15</td>
<td>7.1</td>
<td>5.0</td>
<td>5.0 Br.Y.-M.</td>
</tr>
</tbody>
</table>

*Values progressively lower than 7 indicate greater acidity and values progressively higher than 7 indicate greater alkalinity.

Gr.—greenish, Y.—yellow, L.—light, Br.—brownish, M.—moldy, Md.—moderately, Dk.—dark.
N.—nearly, Fr.—fresh, Sl.—slightly, Burn.—burned, Ac.—acid, Bun.—bunty, Str.—strongly, F.—faintly, P.—putrid.
CONTROLLING THE

Buffalo Treehopper

H. C. SEVERIN

THE BUFFALO TREEHOPPER [Stictocephala bubalis (F.)] is found in all parts of South Dakota. We are concerned with this insect, not because of its feeding habits but because of the way it lays its eggs.

The eggs are laid in short slits made by the female in 2- or 3-year-old twigs or trunks. You can see the result in figure 1. The twigs or trunk of the tree becomes rough and gnarled. Apple trees are most severely damaged but pears, plums, elms, poplars, and willows may also be seriously damaged.

And yet, you can control almost all of this injury through proper orchard management.

Life History and Habits

The adult treehoppers are greenish, four-winged bugs about three-eighths of an inch long. They are roughly triangular and have two short, sharp, horn-like growths on their shoulders, giving them a fanciful resemblance to the head of a buffalo.

Although the wings are well developed, the insect seems reluctant to leave the area where it was hatched.

The adult treehoppers begin to appear in early July and are abundant by the end of the month. They remain numerous until fall and then disappear with cold weather.

An ovipositor is attached under the back end of the female's abdomen. This is what she uses to cut the slits through the bark into the sapwood. She then lays her eggs in these slits.

Four to 12 eggs are laid in each slit. The paired slits are about a fourth of an inch apart. Because of the way they are made, the bark between them dies, leaving an oval or circular scar. The scar enlarges as the tree grows. If enough eggs are
layed in a twig, it becomes dwarfed, deformed, and weak. These twigs easily break off in the wind and may be readily attacked by fungous diseases.

The eggs hatch the following May. The young or nymphs are very small. They move to the ground where they feed on the sap of succulent plants. During the next 6 weeks the nymphs pass through five stages. When the nymphs are fully grown they molt once more and transform into adults.

Control

The best way to control the buffalo treehopper is to practice clean cultivation in your orchard during June. This eliminates the food supply of the nymphs and they will not be able to survive.

Should you not practice clean cultivation, do not plant such crops as alfalfa, potatoes, or a clover in your orchard. Nymphs of the buffalo treehopper prefer to feed on these plants.

If you don’t cultivate the orchard, use a DDT spray. Use 3 pounds of a 50 percent wettable DDT powder per 100 gallons of water for this spray. Spray the cover crop, weeds, and grasses in the orchard and a border 100 feet wide on all sides of it. Apply the spray from about August 1 in southern South Dakota to about August 10 in northern South Dakota or the Black Hills.

Don’t feed DDT-treated foliage to milk cows, poultry, or to meat animals within 90 days of slaughter. (Project 142. Leader: H. C. Severin, Entomology-Zoology Dept.)

Figure 1. Apple twigs injured by egg-laying activity of buffalo treehopper. A. Injury two years old. B. Injury several years old.

Figure 2. Life history of buffalo treehopper. A. Adult, top view; B. Adult, side view; C. Slits cut into apple twig; D. Bark cut away to show eggs in slits; E. Nymph. (After Gilbertson.)
Experiments of 15 to 25 years ago have shown us that pigs fed corn and protein supplement free-choice can balance their rations in protein needs.

During recent years we have made many new nutritional discoveries. The use of B vitamins and antibiotics, in particular, have let us lower the recommendations for protein in swine rations. Also, soybean oil meal has recently become a major protein supplement for swine. We have found that it is an excellent protein supplement when properly supplemented with minerals, vitamins, and antibiotics.

However, many experiment stations and hog producers have noted that soybean oil meal and other protein supplements made up largely of soybean oil meal are often eaten in excessive amounts if offered free-choice. Your feed costs go up when your pigs eat more protein supplement than they need to balance the protein deficiencies of farm grains. You could correct this palatability problem with a complete mixed ration, but this takes special equipment.

Because of these many changes in our nutritional practices during the past two decades, we have conducted an experiment on feeding methods. The following trials were undertaken to get more information on the relative merits of free-choice feeding compared to feeding complete mixed rations both in dry-lot and on pasture.

Dry-Lot Trial

In this trial we divided 40 pure-bred weanling pigs as equally as possible, according to litter, weight, and age, into four groups. All lots were kept in concrete-floored pens connected with 14- by 20-foot concrete feeding floors. Each lot had a...

Here Are 6 Points for You to Consider When Feeding Your Pigs

1. Pigs fed in dry-lot needed slightly less feed per 100 pounds of gain when fed free-choice.
2. The main advantage of a ground and mixed ration compared to free-choice feeding seemed to be a slight increase in rate of gain.
3. Less protein supplement was consumed in the mixed rations. However, the cost of grinding...
self-feeder and automatic waterer.

The pigs in lot 1 (control lot) were self-fed a basal ration free-choice consisting of shelled No. 2 yellow corn and protein supplement A. The composition of the protein supplement is given in table 1. We fed lot 2 in the same manner but fed the protein supplement as pellets. A complete, ground and mixed ration was fed to lot 3. This ration contained 82.5 percent ground corn, and 17.5 percent protein supplement A until the pigs averaged 100 pounds. Then it was changed to 90.7 percent corn and 9.3 percent supplement. Lot 4 was fed the same ration as lot 3 but the ration was pelleted.

**Results and Discussion**

You can see the results of the dry-lot trial in table 2. During the early part of the feeding period lot 4, which received the pelleted ration, did not gain as well as the other three lots. We found almost no difference in rate of gain of lots 1, 2, and 3.

From 100 pounds to market weight the pigs in lot 3, fed the complete ground and mixed ration, gained fastest. For the entire period this lot also had the fastest gain while lot 4 was the slowest.

The most efficient gains were made by lot 2, which was fed free-choice with the protein supplement pelleted. Lot 4 needed the most feed per unit of gain but we think at least part of the poor efficiency, as well as slower gains, was because they scoured while other lots did not.

We did not try to weigh the feed wasted, but pigs fed the pelleted ration seemed to waste the most. We have noticed this in other trials too, but many workers claim less feed is wasted when the feed is pelleted.
Table 1. Composition of Protein Supplements

<table>
<thead>
<tr>
<th>Supplement</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent soybean oil meal</td>
<td>50</td>
<td>49</td>
</tr>
<tr>
<td>Tankage (60 percent protein)</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>Steamed bone meal</td>
<td>1.5</td>
<td>—</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>1.5</td>
<td>—</td>
</tr>
<tr>
<td>Trace mineralized salt</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Antibiotic supplement*</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Vitamin supplement†</td>
<td>+</td>
<td>—</td>
</tr>
</tbody>
</table>

*Furnished 60 gm. of aureomycin per ton of supplement A and 60 gm. of terramycin per ton of supplement B.
†Furnished 12 gm. of riboflavin, 24 gm. of pantothenic acid, 54 gm. of niacin, 60 gm. of choline, and 45 mg. of vitamin B12 per ton of supplement.

You can see in table 2 that both lots fed free-choice consumed more protein supplement than we put in the complete mixed rations. This was rather surprising, as we found that a mixture of equal parts of soybean meal and tankage was not consumed in excessive amounts in other trials.

Feed costs paralleled feed efficiency, with lot 2 having the lowest feed costs and lot 4 the highest. Feed costs were almost equal between lot 1, fed shelled corn and protein supplement free choice, and lot 3, fed the complete ground and mixed ration. The extra cost of the higher protein ration eaten by lot 1

Table 2. Results of Feeding Growing-Fattening Pigs Free-Choice or Complete Mixed Rations in Dry-Lot

<table>
<thead>
<tr>
<th>Lot No. and Method of Feeding</th>
<th>1 Free-Choice</th>
<th>2 Free-Choice Supplement Pelleted</th>
<th>3 Mixed Ration</th>
<th>4 Mixed Ration Pelleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of pigs</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>8*</td>
</tr>
<tr>
<td>No. days fed</td>
<td>116</td>
<td>109</td>
<td>107</td>
<td>123</td>
</tr>
<tr>
<td>Av. initial wt., lbs.</td>
<td>30.5</td>
<td>30.5</td>
<td>30.6</td>
<td>29.8</td>
</tr>
<tr>
<td>Av. final wt., lbs.</td>
<td>207.4</td>
<td>206.2</td>
<td>208.3</td>
<td>206.3</td>
</tr>
<tr>
<td>Av. daily gain, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start to 100 lbs.</td>
<td>1.37</td>
<td>1.36</td>
<td>1.32</td>
<td>1.18</td>
</tr>
<tr>
<td>100 lbs. to final wt.</td>
<td>1.64</td>
<td>1.84</td>
<td>1.98</td>
<td>1.68</td>
</tr>
<tr>
<td>Start to final wt.</td>
<td>1.53</td>
<td>1.61</td>
<td>1.66</td>
<td>1.44</td>
</tr>
<tr>
<td>Feed/cwt. gain, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>269.2</td>
<td>245.6</td>
<td>296.6</td>
<td>306.6</td>
</tr>
<tr>
<td>Protein supplement</td>
<td>64.7</td>
<td>63.6</td>
<td>40.8</td>
<td>41.6</td>
</tr>
<tr>
<td>Total feed</td>
<td>333.9</td>
<td>309.2</td>
<td>337.4</td>
<td>348.2</td>
</tr>
<tr>
<td>Feed cost/cwt. gain†</td>
<td>$9.78</td>
<td>$9.32</td>
<td>$9.86</td>
<td>$11.12</td>
</tr>
</tbody>
</table>

*Two pigs died of causes not due to ration treatment.
†Feed prices per cwt.: Shelled corn $2.54, oats $2.01, soybean meal $3.52, tankage $4.49, trace mineralized salt $2.30, steamed bone meal $4.85, ground limestone $0.83, antibiotics $0.12 per gram and vitamin supplement $0.40 per lb. Other costs per cwt. were: grinding $0.08, mixing $0.05, and pelleting $0.30.
was offset by the cost of grinding and mixing the ration fed lot 3.

**Pasture Trial**

We used 48 purebred pigs weighing about 32 pounds for this trial. Twelve pigs were put in each of four 2-acre alfalfa pasture plots. Shelter and shade were provided by portable houses. We put a self-feeder and a self-waterer on each plot and small mineral feeders on the free-choice plots. The mineral supplement was made up of equal parts of trace mineralized salt, steamed bone meal, and ground limestone.

Lot 1 was self-fed shelled corn and protein supplement B free-choice. Lot 2 received a grain mixture of 2 parts ground corn and 1 part ground oats and protein supplement B free-choice. A complete mixed ration was fed to lot 3. It was composed of 88 percent ground corn and 12 percent supplement B until the pigs weighed 100 pounds and 92 percent corn and 8 percent supplement from 100 pounds to market weight. We gave lot 4 a complete mixed ration of 90 percent corn and oats mixture and 10 percent supplement B to 100 pounds and then 94.2 percent of the grain mixture and 5.8 percent of the supplement. The grain mixture was 2 parts corn and 1 part oats.

**Results and Discussion**

The results of this trial are given in table 3. Lot 3, fed the mixed ration with corn as the only grain, gained slightly faster during both stages of the trial. Although the differences were not great, the two lots fed the complete mixed rations gained faster than the lots fed free-choice from weaning to 100 pounds.

About 10 percent less feed was needed by the pigs fed the com-

**Table 3. Results of Feeding Free-Choice or Complete Mixed Rations on Pasture**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of pigs*</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>No. days fed</td>
<td>124</td>
<td>121</td>
<td>117</td>
<td>122</td>
</tr>
<tr>
<td>Av. initial wt., lbs.</td>
<td>32.4</td>
<td>31.5</td>
<td>31.2</td>
<td>32.0</td>
</tr>
<tr>
<td>Av. final wt., lbs.</td>
<td>210.0</td>
<td>209.3</td>
<td>216.4</td>
<td>208.8</td>
</tr>
<tr>
<td>Av. daily gain, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start to 100 lbs.</td>
<td>1.23</td>
<td>1.19</td>
<td>1.29</td>
<td>1.27</td>
</tr>
<tr>
<td>100 lbs. to final wt.</td>
<td>1.59</td>
<td>1.72</td>
<td>1.85</td>
<td>1.61</td>
</tr>
<tr>
<td>Start to final wt.</td>
<td>1.43</td>
<td>1.47</td>
<td>1.58</td>
<td>1.45</td>
</tr>
<tr>
<td>Feed/cwt. gain, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>280.2</td>
<td>213.7</td>
<td>314.7</td>
<td>195.3</td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td>106.8</td>
<td></td>
<td>97.6</td>
</tr>
<tr>
<td>Protein supplement</td>
<td>63.4</td>
<td>34.5</td>
<td>32.8</td>
<td>23.3</td>
</tr>
<tr>
<td>Total feed</td>
<td>343.6</td>
<td>355.0</td>
<td>347.5</td>
<td>316.2</td>
</tr>
<tr>
<td>Feed cost/cwt. gain†</td>
<td>$9.89</td>
<td>$9.49</td>
<td>$10.14</td>
<td>$8.62</td>
</tr>
</tbody>
</table>

*Two pigs from lot 1 and 1 from each of lots 3 and 4 died from heat prostration.
†See table 2 for feed prices used, pasture costs not included.
NITRATE poisoning is a recurring problem, especially in times of drought. Last November, 26 head of cattle fed oat hay containing 5.9 percent potassium nitrate died, and in December, 17 head fed sudan grass containing 4.9 percent potassium nitrate died—examples of the seriousness of the problem.

Nitrate poisoning of cattle and other cud-chewing animals is due to the accumulation of nitrogen in the nitrate form in forages. We consider 1.5 percent potassium nitrate (air dry sample basis) toxic for ruminant animals.

Nitrate nitrogen is changed to the nitrite form by microorganisms in the paunch (rumen). The nitrite nitrogen then changes normal hemoglobin, the red, oxygen-carrying part of the blood, to methemoglobin. Methemoglobin does not carry oxygen, so if there is enough nitrite, the animal dies of suffocation.

An animal may die within a few hours after eating high nitrate forage.

Veterinarians often use methylene blue to treat nitrate poisoning of cattle and sheep.

**Nitrate Content of Plants**

Nitrate is the main source of available nitrogen for growing plants. The biochemical process by which nitrogen compounds in the soil are changed to nitrates is called nitrification.

Legume crops have not caused livestock losses due to nitrate poisoning. Native grasses and hays rarely contain much nitrate. However, oats, barley, wheat, or rye hay, and corn or sorghum fodder have sometimes been found to have toxic amounts of nitrates.
Sugar beets are treated with 2,4-D to find the effect of the spray on nitrate accumulation.

An ever-present problem—especially in dry times . . .

In studies with oats and corn, we have found that these plants accumulate a lot of nitrate as young plants. Their nitrate content goes down rapidly as the plant shoots, flowers, and matures seed.

If the normal growth is stopped by drought, the plants are left with the large amount of nitrates. This is often the case when drought-damaged corn is cut for fodder or a green oat-hay is prepared. When you ensile corn with enough moisture to allow normal fermentation, most of the nitrate present is usually destroyed.

While adequate soil nitrate and drought damage are the main causes of high nitrate forages, other factors are also involved. Short daylight periods slow down the use of stored nitrates by plants. Soil without enough available minor elements such as molybdenum, manganese, and copper, which are needed for normal function of plant enzymes, may cause nitrate accumulation.

**Effect of Herbicide Sprays**

If herbicides are improperly applied they can affect the nitrate contents of plants. In one case sugar beets were sprayed with a toxaphene mixture to control a late brood of web worm. However, the spray mixture had been contaminated with 2,4-D. When the sugar beet tops were fed to 70 head of cattle, 41 showed symptoms of poisoning. Of these, 19 died and 18 treated with methylene blue recovered. We found that the sprayed beet tops contained 4.5 percent potassium nitrate. Unsprayed beet tops from nearby fields contained only 0.22 percent.

We made a number of field tests with several crop and weed species, treating the plants with various herbicide sprays. Generally, the herbicide treatment produced small increases in the nitrate content of the plants, but results were far from clear-cut.
Many factors in the field can affect the nitrate content of plants. To have better control of these conditions, we grew the plants indoors, using a controlled lighting system. This way we were able to correctly determine the effect of herbicide sprays.

In all of these experiments we applied nitrate nitrogen equivalent to 50 pounds nitrogen per acre, and sprayed with 2,4-D. The spray was equal to about half that recommended for the control of mustards. The results of three experiments are given in table 1.

These figures are the average nitrate content for all plants in each group. You can see that mustard plants responded differently than sugar beets. In mustard plants nitrate seems to accumulate faster. However, mustard plants, both sprayed and unsprayed, seemed to use more of the excess nitrate than sugar beets, but the nitrate content of the sprayed plants stayed higher than the control plants.

In the treated sugar beets, the nitrate content of the tops was still high at the last sampling, but the control plants decreased in nitrate content. Trial 1 showed foxtail was not affected.

The nitrate content of all of these plants is much higher than when they are grown outdoors in full sun.

In trials 2 and 3 we studied the effect of light intensity on nitrate content. The 11-day sampling figures for trial 3 are shown in table 2. They are the average nitrate values for the three replications of each treatment.

Notice that as light intensity increased, the nitrate content of the plants decreased. The highest light intensity was only equal to about one-tenth that received by plants growing in full sunlight.

These herbicide sprays are valuable new aids in farm management and these studies are not critical of them. However, they do point out that you must follow the recommended spraying methods care-
Table 2. The Effect of 2,4-D Spray and Light Intensity on the Nitrate Content of Mustard and Sugar Beet Plants 11 Days After Spray Treatment

<table>
<thead>
<tr>
<th>Plant</th>
<th>Light Intensity (Foot Candles)</th>
<th>Potassium Nitrate (Air-Dry Basis)</th>
<th>Unsprayed</th>
<th>Sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mustard</td>
<td>630</td>
<td>15.6</td>
<td>20.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>940</td>
<td>15.5</td>
<td>19.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1240</td>
<td>13.7</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>Sugar Beet</td>
<td>630</td>
<td>8.3</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>940</td>
<td>7.2</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1240</td>
<td>6.2</td>
<td>6.8</td>
<td></td>
</tr>
</tbody>
</table>

fully. If herbicides are not properly applied the plants may be stunted or distorted but not killed. Then there is a chance that enough nitrates may accumulate in some plant species to make the field unsafe for grazing.

Nitrate in Water

We have found several samples of farm well water which are high in nitrate, containing as much as 0.35 percent potassium nitrate. These samples were analyzed in connection with cattle deaths. Water with the equivalent of 0.35 percent potassium nitrate would provide more than one-third pound of nitrate salt per day to dairy cows.

In the fall of 1953 and again in the spring of 1954, we collected samples of water from 31 undrained ponds and small lakes in northeastern South Dakota. Nitrate nitrogen was not found in water from any of these supplies. Therefore, we do not believe that such water supplies will cause trouble.

In an experiment using sheep as test animals, we tried to determine the effects of nitrate in water on methemoglobin formation. Three sheep were used in the control group and three were given water with 0.05 percent sodium nitrate. The nitrate content of the water was raised weekly to 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, and 0.9 percent.

We took blood samples three times a week from both groups. An occasional sample showed methemoglobin but only in small amounts.

Sheep seem to be quite tolerant to nitrates in water. Some experiments have shown that the sheep's feed affects their response to nitrate nitrogen. Well-fed sheep were less affected by nitrates (supplied by stomach tubes).

However, since cattle seem more sensitive to nitrates than sheep, we are continuing work on this problem of nitrates in the water supply, particularly in connection with forages that contain less than 1.5 percent potassium nitrate. In this way we can determine the combined effects of nitrate in the water and feed.

Will Test Samples

If you want to know the feeding quality of a forage from the standpoint of nitrate content, you can have it analyzed by the Station Biochemistry Department at South Dakota State College for a small charge. The sample you send should be representative of the forage so that we can make correct recommendations.

When you are in doubt about a forage, it is a good idea to feed it to a cull animal. Watch it closely for several days for any symptoms of distress before you feed the forage to the herd. (Project 87. Leader: E. I. Whitehead, Station Biochemistry Dept.)
Here's a unique story that began in 1911. The result may be a new carpet of green for South Dakota pastures and ranges.

M. W. Adams

Woven into the dark green fabric of the history of alfalfa is a golden yellow thread—the unique and arresting story of creeping alfalfa. In the beginning we trace this thread to a few seedbearing plants collected on the steppes of Siberia by Professor Niels Ebbesen Hansen, South Dakota's famous plant explorer of the early 1900's.

Dr. Hansen disclaimed that he was "either a prophet or the son of a prophet" when he forecast that the alfalfas brought from Siberia might be successfully introduced "as wild plants into the native ranges of the Prairie Northwest, where they will probably be able to hold their own with any plants now found there."

Dr. Hansen further stated in 1911, "To increase the carrying capacity of our present rough lands, now unfit for cultivation, by bringing in as a wild plant the yellow-flowered Siberian alfalfa, is certainly a work worthwhile."

These statements show a vision and a challenge which have become bench marks to modern alfalfa breeders. We have fallen heir not only to this vision and challenge, but also to plant materials by which they soon may be realized.

Laterally-Spreading Roots

The golden thread next appears among a few plants in the alfalfa nursery of Agronomist Sam Carver at Highmore, S. D. The time was 1912. Many of Dr. Hansen's introductions were being studied by Carver. But a number of plants of S.P.I. 28071 from Orenburg, Russia were unlike any others. Carver observed that these plants had laterally-spreading roots extending from 30 to 36 inches from the mother plant and which then produced stem buds that grew to the surface of the soil and leafed out as green shoots.

The lateral roots were 4 to 10 inches below and parallel to the soil surface, of small diameter, and marked at irregular intervals by slight swellings. New stem buds
Dr. N. E. Hansen collected alfalfa from areas of extreme drought and cold.

grew from these tuber-like enlargements and frequently roots also originated here (see figure 1).

Agronomists Garver and R. A. Oakley saw that these plants were low-growing, spreading types not suitable for hay, but they suggested in 1917 that such plants might sometime be used by breeders seeking pasture or range types for grazing purposes.

This suggestion, like Dr. Hansen’s, fell on infertile soil and the golden thread seemingly disappeared for almost three decades. These were the years of Grimm, Cossack, and the hardy, productive Ladak alfalfas.

Then, in Saskatchewan, Canada, Agronomist S. E. Clarke found that the only alfalfa plants that came through the dry years in his nurseries were from the Siberian alfalfa and a few hybrids between it and Ladak.

Prominent among these hybrids were a small number of creepers like those described by Garver. This material has formed the basis of a plant breeding program in Canada and some of it has recently been reintroduced by the South Dakota Experiment Station.

Plants in Perkins County

But the thread had not been forever lost in South Dakota. In the summer of 1950 agronomists at the South Dakota Experiment Station visited an old field of Cossack alfalfa on the Henry Kruse farm in Perkins County. Beside it was a planting of Hansen’s Siberian alfalfa—the yellow-flowered Semipalatinsk. Both fields dated back to 1911-12.

Among the Cossack plants, now considerably reduced in stand and inter-grown with western wheatgrass, were found eight creeping alfalfa plants (see figures 2 and 3). We now think these plants are hybrids between the Cossack and carriers of the creeping trait from the Semipalatinsk.

About this time the Experiment Station launched a program of al-
falfa research and breeding, accepting the challenge to produce a long-lived hardy alfalfa to grow with grass for grazing on the prairies and range pastures of the northern plains.

The rediscovered root-proliferating type of alfalfa, because of its proven hardiness and ability to spread by underground roots, was selected as the foundation stock in the new program.

Parent and progeny nurseries of root-proliferating alfalfa selections

Figure 2. (Left) Upper plant—root-creeping type of alfalfa. Lower plant—standard alfalfa type. Both plants are about the same age. Note yardsticks.

Figure 3. (Below) Above ground the creeping type (background) and the non-creeping type (foreground) show distinct differences in vegetative vigor and growth form.
have now been grown at the Range Field Station, Cottonwood, and the main Station at Brookings for four years. We have selected plants which are disease resistant, strongly creeping, and whose offspring show the creeping trait most often and most pronounced.

Some families (the intercross offspring of a single female plant) have relatively few creeping-type plants. A few families are made up almost wholly of the creeping type. (See figures 4 and 5 and table 1.)

However, in the material we have worked with so far, the most widely creeping parents have not given the most aggressive offspring. This tendency can be measured as a correlation. For two nurseries involving 24

Continued on page 85

Table 1. Summary of Performance of Creeping-Rooted Alfalfa Selections and of Their Intercross Progeny for “Creep”

<table>
<thead>
<tr>
<th>Selection</th>
<th>Creep (in.)</th>
<th>Creep (in.)</th>
<th>Creep (Av. of 40 Plants Ea.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK1</td>
<td>35.05</td>
<td>30.3</td>
<td>78.9</td>
</tr>
<tr>
<td>CK2</td>
<td>33.58</td>
<td>33.0</td>
<td>92.3</td>
</tr>
<tr>
<td>CK3</td>
<td>27.00</td>
<td>30.7</td>
<td>76.9</td>
</tr>
<tr>
<td>CK4</td>
<td>27.06</td>
<td>27.0</td>
<td>53.8</td>
</tr>
<tr>
<td>CK5</td>
<td>32.83</td>
<td>33.0</td>
<td>78.9</td>
</tr>
<tr>
<td>CK6</td>
<td>30.78</td>
<td>32.0</td>
<td>75.0</td>
</tr>
<tr>
<td>CK7</td>
<td>26.80</td>
<td>30.1</td>
<td>74.4</td>
</tr>
<tr>
<td>CK8</td>
<td>32.57</td>
<td>32.5</td>
<td>87.2</td>
</tr>
<tr>
<td>CK9</td>
<td>35.73</td>
<td>33.3</td>
<td>78.9</td>
</tr>
<tr>
<td>CK10</td>
<td>34.00</td>
<td>27.7</td>
<td>83.8</td>
</tr>
<tr>
<td>CK11</td>
<td>29.95</td>
<td>29.0</td>
<td>72.5</td>
</tr>
<tr>
<td>CK12</td>
<td>38.42</td>
<td>32.6</td>
<td>70.0</td>
</tr>
<tr>
<td>CK13</td>
<td>36.30</td>
<td>30.7</td>
<td>94.4</td>
</tr>
<tr>
<td>CK14</td>
<td>33.00</td>
<td>32.2</td>
<td>57.9</td>
</tr>
<tr>
<td>CK15</td>
<td>36.68</td>
<td>31.5</td>
<td>90.0</td>
</tr>
<tr>
<td>CK16</td>
<td>32.05</td>
<td>30.3</td>
<td>70.3</td>
</tr>
<tr>
<td>CK17</td>
<td>33.35</td>
<td>34.4</td>
<td>84.6</td>
</tr>
<tr>
<td>CK18</td>
<td>31.88</td>
<td>34.5</td>
<td>92.1</td>
</tr>
<tr>
<td>CK19</td>
<td>31.00</td>
<td>35.6</td>
<td>97.5</td>
</tr>
<tr>
<td>CK20</td>
<td>39.31</td>
<td>34.5</td>
<td>84.2</td>
</tr>
<tr>
<td>CK21</td>
<td>43.95</td>
<td>35.2</td>
<td>50.0</td>
</tr>
<tr>
<td>CK22</td>
<td>42.85</td>
<td>30.0</td>
<td>65.0</td>
</tr>
<tr>
<td>CK23</td>
<td>non-creep</td>
<td>32.8</td>
<td>48.7</td>
</tr>
<tr>
<td>CK29</td>
<td>34.21</td>
<td>29.3</td>
<td>76.5</td>
</tr>
</tbody>
</table>

Figure 4. (Left) Portions of two intercross families showing mostly creeping-type plants: CK 18, right; CK 19, left.

Figure 5. (Right) Portions of two intercross families showing differences in percentage creeping plants: right, CK 15—90 percent creeping; left, CK 16—40 percent creeping.
There is no apparent benefit from feeding your fattening lambs bentonite. That's the conclusion from trials involving 457 lambs at Brookings and Newell during three winters (1952-54). Differences in rate of gain, feed efficiency, and carcass grade and yield were of no practical importance.

Sodium bentonite, a natural occurring volcanic ash that swells when wet, has been used as the binding material in range pellets for some time. It absorbs nearly five times its weight in water and contributes no energy value to the ration.

Some have felt that bentonite would expand the surface of the feed when it absorbed water and digestive juices in the digestive tract. These people reasoned that this would improve feed utilization by increasing the surface on which digestive juices, enzymes, and bacteria could act.

To determine the value of sodium bentonite in lamb feeding rations, we began a series of feeding trials. In all of these trials we fed the lambs in the treated lots sodium bentonite (0.1 pound per lamb daily) mixed with the protein supplement. We fed the control lambs the same ration without bentonite.

The First Trial

We conducted the first trial at Brookings in 1952. The results of this trial are shown in table 1. We used two lots of 25 western feeder lambs and full-fed them shelled corn, brome hay, and 0.2 pounds of soybean meal. For the treated lot we mixed sodium bentonite with the soybean meal at a ratio of 1 to 2.

The bentonite was powdered and therefore very dusty. Yet the lambs ate it readily and consumed slightly more grain per day than the control lambs. The lambs receiving bentonite showed 0.27 pound more daily gain than the controls.

In this trial 26 pounds of sodium bentonite replaced 25 pounds of concentrates and 38 pounds of hay for each 100 pounds gain. Little difference was noted in carcass grade and yield.

The Second Trials

In 1953 we conducted trials at Brookings and Newell. We used a coarser, granular form of bentonite to get away from the dustiness of the powdered bentonite. A sum-
mary of the results is shown in table 1.

We full-fed lambs in the Brookings trial shelled corn, brome hay, and 0.2 pound soybean meal. We used four lots of 10 lambs each. Two of these lots served as controls while the remaining lots received 0.1 pound of bentonite daily.

In this trial we obtained no benefit from adding bentonite to the ration. There was no difference in daily feed consumption, rate of gain, or feed efficiency between the

---

**Table 1. Effect of Bentonite in Lamb Fattening Rations**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Powdered</td>
<td>Granular</td>
<td>Granular</td>
</tr>
<tr>
<td></td>
<td>Bentonite*</td>
<td>Bentonite*</td>
<td>Bentonite*†</td>
</tr>
<tr>
<td>No. of lambs</td>
<td>25</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Days on feed</td>
<td>81</td>
<td>81</td>
<td>87</td>
</tr>
<tr>
<td>Av. initial wt., lbs.</td>
<td>71.9</td>
<td>70.2</td>
<td>70.7</td>
</tr>
<tr>
<td>Av. final wt., lbs.</td>
<td>100.6</td>
<td>101.1</td>
<td>103.4</td>
</tr>
<tr>
<td>Av. daily gain per lamb, lb.</td>
<td>0.354</td>
<td>0.381</td>
<td>0.375</td>
</tr>
<tr>
<td>Death loss</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Av. daily feed:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain, lbs.</td>
<td>1.38</td>
<td>1.42</td>
<td>1.41</td>
</tr>
<tr>
<td>Hay, lbs.</td>
<td>1.84</td>
<td>1.84</td>
<td>1.73</td>
</tr>
<tr>
<td>Soybean meal, lbs.</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Bentonite, lbs.</td>
<td></td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Feed per 100 lbs. gain:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain, lbs.</td>
<td>385.0</td>
<td>368.0</td>
<td>376.1</td>
</tr>
<tr>
<td>Hay, lbs.</td>
<td>520.0</td>
<td>482.0</td>
<td>461.4</td>
</tr>
<tr>
<td>Soybean meal, lbs.</td>
<td>56.0</td>
<td>52.0</td>
<td>53.4</td>
</tr>
<tr>
<td>Bentonite, lbs.</td>
<td></td>
<td>26.0</td>
<td>26.7</td>
</tr>
<tr>
<td>Carcass grade:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prime</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice</td>
<td>17</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Carcass yield</td>
<td>49.1</td>
<td>49.1</td>
<td>47.0</td>
</tr>
</tbody>
</table>

*Bentonite and soybean meal mixed in proportion of 1:2.
†The bentonite-soybean meal mixture was pelleted.
control and treated lots. However, the bentonite-fed lambs had a higher carcass yield than the controls.

The bentonite-soybean meal mixture fed to the treated lots at Newell was pelleted to aid in feeding. We fed 20 feeder lambs in each of four lots—two control and two treated lots. We full-fed these lambs barley, alfalfa hay, and 0.2 pound of soybean meal.

The bentonite-fed lambs ate somewhat less total daily feed than the control lambs, but they ate a higher proportion of grain to roughage. This type of ration suggests a more rapid rate of gain; however, the bentonite-fed lambs gained slightly less than the control lambs. The total amount of feed required per 100 pounds of gain was nearly the same for both groups.

**The Third Trials**

Since results of the second trials were the opposite of those obtained with powdered bentonite, we conducted trials at Brookings and Newell during 1954 in which both forms of bentonite were used. A summary of the results is shown in table 2.

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**Table 2. Effect of Bentonite in Lamb Fattening Rations—Summary of Trials Conducted at Brookings and Newell (1954)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Brookings</th>
<th></th>
<th>Newell</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Powdered Bentonite*</td>
<td>Granular Bentonite*</td>
<td>Control</td>
</tr>
<tr>
<td>No. of lambs</td>
<td>47</td>
<td>49</td>
<td>50</td>
<td>47</td>
</tr>
<tr>
<td>Days on feed</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>116</td>
</tr>
<tr>
<td>Av. initial wt., lbs.</td>
<td>66.5</td>
<td>66.7</td>
<td>66.3</td>
<td>57.9</td>
</tr>
<tr>
<td>Av. final wt., lbs.</td>
<td>101.0</td>
<td>101.3</td>
<td>101.2</td>
<td>105.3</td>
</tr>
<tr>
<td>Av. da. gain per lamb, lbs.</td>
<td>0.355</td>
<td>0.350</td>
<td>0.360</td>
<td>0.410</td>
</tr>
<tr>
<td>Death loss</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Av. daily feed:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelled corn</td>
<td>1.24</td>
<td>1.24</td>
<td>1.21</td>
<td>1.25</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>1.63</td>
<td>1.58</td>
<td>1.57</td>
<td>1.53</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.15</td>
</tr>
<tr>
<td>Bentonite</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Feed per 100 lbs. gain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelled corn</td>
<td>352.0</td>
<td>352.5</td>
<td>338.5</td>
<td>300.5</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>464.5</td>
<td>448.5</td>
<td>441.0</td>
<td>368.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>28.5</td>
<td>28.0</td>
<td>27.5</td>
<td>36.0</td>
</tr>
<tr>
<td>Bentonite</td>
<td>28.0</td>
<td>27.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass grade:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prime</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Choice</td>
<td>38</td>
<td>39</td>
<td>37</td>
<td>36</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Carcass yield</td>
<td>52.3</td>
<td>51.2</td>
<td>51.4</td>
<td>51.2</td>
</tr>
</tbody>
</table>

* Bentonite and soybean meal mixed in proportion of 1:1.
† Bentonite and soybean meal mixed in proportion of 2:3.
Spoilage in Silage
Continued from page 63

Spoilage progress of this stack in table 2. We took samples from the exposed end of the stack. Progress was similar to the circular stack but more rapid. Not much acidity developed at any of the depths, and consequently putrificactive bacteria, judged by odor, were quite active. Thermophilic bacteria were slightly more numerous in this stack.

Progress of Spoilage in Pilot Silos

In further tests of spoilage we used small experimental stacks. These were about 5 feet in diameter and 6½ feet high. Each one held about 2 tons of silage. We put them up in a shed on July 13, 1955. Two men packed them by tramping.

After 2 months we opened them and determined the extent of spoilage. Stacks enclosed in a plastic cover or metal sheet did not heat. They settled 30 percent and were good quality throughout.

Stacks left uncovered heated from the start and settled 42 percent. They showed the same type of spoilage as the large outdoor stacks, except for less yellow-green silage.

By adding chemicals to the uncovered stacks, we increased the amount of good silage in the lower center from about 3 percent to about 12 percent for those treated with sorbic acid and to 13 percent for those treated with sodium metabisulphite.

The silage enclosed by plastic or metal sheet has a clean acid odor like sauerkraut. The pH was between 4.1 and 5.1. Few mesophilic bacteria were found and none to only a few thermophilic ones were found.

The wide band of dark brown silage around the good silage in the open stacks had a pungent to flat burned odor. The pH was 4.6 (5.4 with sodium metabisulphite added). It had moderate numbers of thermophilic bacteria. A thin upper layer of brown silage between this and the outside moldy layer also possessed a pungent burned odor, but its acidity was near neutral. It carried many aerobic, spore-forming, thermophilic bacteria. The outside moldy layer, as in field stacks, was strongly alkaline, with a pH of 8.1.

The work we have done so far indicates that the best way you can insure good silage is to keep out air and prevent loss of moisture. A durable plastic cover that seals the stack completely to the ground seems to do the job. (Project 237C. Leader: George Semeniuk, Plant Pathology Dept.)

Table 2. Some Characteristics of Silage at Depths of 8, 14, and 32 Inches From the Exposed End of a Bunker Stack

<table>
<thead>
<tr>
<th>Days After</th>
<th>pH*</th>
<th>Color†</th>
<th>Odor‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensiling 8 in.</td>
<td>14 in.</td>
<td>32 in.</td>
<td>8 in.</td>
</tr>
<tr>
<td>14</td>
<td>5.2</td>
<td>6.0</td>
<td>6.8</td>
</tr>
</tbody>
</table>

*†‡—See footnotes in table 1.
You may find your real property taxes are harder to pay some years than others. The reason this is true for South Dakota farmers is there’s no connection between

**Property Taxes and Farm Income**

**John E. Thompson**

The farmer in South Dakota often finds it harder to pay his property taxes in one year than in another. This is true, to some extent at least, for other individuals or groups as well.

However, the farmer is especially bothered by this problem because of his changing income. Good weather and high prices may increase his production and income. In another year conditions may reverse and the farmer finds himself faced with a lower income.

As the farm property levies are not affected by farm income, these changing conditions make the taxes much harder to pay in some years.

You are probably aware of this condition. However, you may not realize how much farm income fluctuates or what has happened to real estate taxes in relation to income in our state. We have gathered information on farm real estate taxes and farm income for 1940 and 1945-54 to find how these two are related (see table 1).

In the table you can see that taxes have risen sharply from 1946 to 1954. Only in 1954 did farm real estate taxes go down from the previous year. In contrast, the net income has been unsteady, going from a high of $471.1 million in 1948 to a low of $242 million in 1949. The 1949 net income was about one-half as large as in 1948. However, taxes increased by more than $2 million.

You can see how much harder it was to pay the taxes in 1949.

In recent years the number of farms have decreased in our state so fewer farmers shared in the farm income and in paying the taxes. We reduced the net income figures and farm real estate tax estimates to an average farm figure by dividing by the number of farms in
the state to make up for this difference.

The purchasing power of the dollar has also gone down during this time, further lowering the real value of the net income. However, no adjustment was made for this as we felt that it was not necessary to show the general relationship between net farm income and farm real estate taxes.

To make it easier to compare these figures we reduced them to index numbers with 1946 equal to 100. You can see the comparison graphically in the chart.

From the chart you can see the highly erratic net farm income pattern for our state in contrast to the increasing but more uniform farm real estate taxes for the period. You will notice that for 1947, 1948, and 1951 it was easier to pay taxes than in the other years.

You may now wonder how we can get more uniformity between net farm income and farm real estate taxes. It would be hard to suggest, with any hope of achievement, a plan that would adjust farm income to correspond more closely to farm real estate taxes. We can not control farm prices effectively, nor can we control farm production. Therefore, adjusting farm real estate taxes to our changing farm income is more practical.

The problem of reducing the difference between farm real estate tax payments and net income will tend to get worse in the future as more tax revenue is needed. The higher the property taxes go in relation to net income, the harder they will be to pay. Therefore, one solution may be to look for sources other than the property tax when more tax revenue is needed. Either an increase in the sales tax or a state income tax will tend to take more from the farmer when his income is high and less when it is low. Of the two, the income tax will usually be more effective in relating tax burden to ability to pay.

Another method that might be used is to exempt personal property from taxation. This may require substituting some other type of revenue to make up for the loss. Even so, farmers would probably be better off with the change as they are heavy personal property tax payers.

A third possibility is to change the method of school financing. Schools are the major recipients of revenue raised by property levies. Such levies can be reduced, or at least not raised, if some other source is used for school support or if schools can be operated more ef-
sufficiently under the present plan. In either case the property tax burden on farmers would be reduced.

Finally, farm property tax mill rates could be tied to the farmers’ parity price ratio or some other indicator of farmers’ financial well-being. Such a plan would reduce stability of revenue from the property tax. However, the state could build reserves when farm income is up to use when the income drops.

(.Project 262. Leader: Max Myers, Agricultural Economics Dept.)

Table 1. A Comparison of Farm Income and Farm Real Estate Tax Data for South Dakota—1940, 1946-54

| Year | Cash Farm Income in S. Dak. (Gross)* | Costs of Farm Production† | Net Inc. from Farm Production | Net Inc. as % of Cash Farm Income | Farm Real Est. Taxes§ | Net Inc. Before Real Est. Taxes || Av. Farm Inc. Before Real Est. Taxes* || Av. Farm Real Est. Taxes** |
|------|--------------------------------------|---------------------------|-------------------------------|----------------------------------|----------------------|---------------||----------------||----------------||------------------|
| 1940 | 139.5 (millions)                     | 64 (millions)             | 75.5 (millions)               | 54.1                            | 9.6 (millions)        | 85.1 (millions) | $1,175 (million) | 132 (million)   | 171 (million)    |
| 1946 | 502.8 (millions)                     | 183 (millions)            | 319.8 (millions)              | 63.6                            | 11.7 (millions)       | 331.5 (million) | 4,857 (million) | 208 (million)   | 223 (million)    |
| 1947 | 679.6 (millions)                     | 236 (millions)            | 443.6 (millions)              | 65.3                            | 14.2 (millions)       | 457.8 (million) | 6,752 (million) | 208 (million)   | 223 (million)    |
| 1948 | 655.1 (millions)                     | 184 (millions)            | 471.1 (millions)              | 71.9                            | 15.0 (millions)       | 486.1 (million) | 7,217 (million) | 223 (million)   | 223 (million)    |
| 1949 | 559.0 (millions)                     | 317 (millions)            | 242.0 (millions)              | 43.3                            | 17.3 (millions)       | 259.3 (million) | 3,876 (million) | 259 (million)   | 259 (million)    |
| 1950 | 510.3 (millions)                     | 190 (millions)            | 320.3 (millions)              | 62.8                            | 18.2 (millions)       | 338.5 (million) | 5,094 (million) | 274 (million)   | 274 (million)    |
| 1951 | 604.4 (millions)                     | 187 (millions)            | 417.4 (millions)              | 69.1                            | 19.1 (millions)       | 436.5 (million) | 6,629 (million) | 290 (million)   | 290 (million)    |
| 1952 | 565.0 (millions)                     | 311 (millions)            | 254.0 (millions)              | 45.0                            | 19.6 (millions)       | 273.6 (million) | 4,193 (million) | 300 (million)   | 300 (million)    |
| 1953 | 533.7 (millions)                     | 243 (millions)            | 290.7 (millions)              | 54.5                            | 21.7 (millions)       | 312.4 (million) | 4,832 (million) | 336 (million)   | 336 (million)    |
| 1954 | 536.7 (millions)                     | 281 (millions)            | 255.7 (millions)              | 47.6                            | 21.2 (millions)       | 276.9 (million) | 4,323 (million) | 331 (million)   | 331 (million)    |

*U. S. Department of Agriculture, Agricultural Statistics and recent releases of the U. S. Department of Agriculture's The Farm Income Situation.
†Difference between gross cash farm income (column 2) and net farm income (column 4).
‡U. S. Department of Commerce, Survey of Current Business.
§U. S. Department of Agriculture, Agricultural Statistics and recent releases of the U. S. Department of Agriculture's Taxes Levied on Farm Real Estate by years. Data is for Year of Levy.
||Obtained by dividing net income by estimated number of farms in South Dakota (Bureau of Census Farm Population Estimates).
**Obtained by dividing farm real estate taxes by estimated number of farms in South Dakota (Bureau of Census Farm Population Estimates).

Bentonite

Continued from page 80

We fed six lots of lambs at each station, 25 lambs per lot at Brookings and 24 per Lot at Newell. We full-fed these lambs shelled corn and alfalfa hay. At Brookings we fed them 0.1 pound of soybean meal and at Newell 0.15 pound.

There was little difference in daily feed consumption between the control and treated lots. The lambs fed powdered bentonite ate the bentonite-soybean meal mixture as readily as those receiving the granular bentonite or those fed only the protein supplement.

The differences in daily rate of grain and feed consumed per hundred pounds of gain were in favor of the lambs fed the granular bentonite. These differences were quite small and of little practical importance. (Project 233. Leader: Leon F. Bush, Animal Husbandry Dept.)
Pig Rations
Continued from page 69

plete mixed ration containing the corn and oats mixture (lot 4). It is hard to explain why this group was so much more efficient than the others, although the amount of feed required by lots 1, 2, and 3 is somewhat high for pasture-fed pigs.

Lot 1, fed shelled corn and supplement free-choice, consumed more protein than we consider necessary to balance the ration. Including oats in the ration seemed to decrease the need for protein supplement.

Feed costs were lowest for lot 4 because of the difference in feed efficiency. The price relationship between corn and oats during the trial also favored the feeding of oats. (Project 268. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

Creeping Alfalfa
Continued from page 77

parents and almost 2,000 offspring, the parent-progeny correlation for the degree of creep was 0.34 (not significant). Therefore, we have based our selection on superior families instead of superior individuals alone.

For resistance to common leafspot of alfalfa (described in the Winter 1954 issue of South Dakota Farm and Home Research), we have been able to select effectively on an individual merit basis (see table 2).

Over-all progress has been somewhat slower than where selection for all traits can be made on the individual basis. Nevertheless, satisfactory advance has been made in two generations of selection, and experimental synthetic strains are being produced now for more extensive testing.

The golden yellow thread, symbolic of the root-creeping type of alfalfa, has now led to superior selections and strains in the hands of plant breeders. The destiny of this thread may soon be a new carpet of green gold for our South Dakota ranges and pastures. (Project 74. Leader: M. W. Adams, Agronomy Dept.)

Table 2. Reaction of Creeping-Rooted Selections and Their Intercross Progeny to Alfalfa Rust and Common Leafspot

<table>
<thead>
<tr>
<th>Selection Number</th>
<th>Rust Score</th>
<th>Leafspot Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 = Resistant</td>
<td>5 = Susceptible</td>
</tr>
<tr>
<td>CK1</td>
<td>4.34</td>
<td>3.86</td>
</tr>
<tr>
<td>CK2</td>
<td>3.30</td>
<td>2.99</td>
</tr>
<tr>
<td>CK3</td>
<td>3.03</td>
<td>2.88</td>
</tr>
<tr>
<td>CK4</td>
<td>2.29</td>
<td>2.65</td>
</tr>
<tr>
<td>CK5</td>
<td>4.04</td>
<td>3.14</td>
</tr>
<tr>
<td>CK6</td>
<td>2.80</td>
<td>2.50</td>
</tr>
<tr>
<td>CK7</td>
<td>2.36</td>
<td>2.69</td>
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<td>CK8</td>
<td>4.21</td>
<td>3.74</td>
</tr>
<tr>
<td>CK9</td>
<td>4.34</td>
<td>3.61</td>
</tr>
<tr>
<td>CK10</td>
<td>4.30</td>
<td>4.04</td>
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<tr>
<td>CK11</td>
<td>3.98</td>
<td>4.00</td>
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<td>CK12</td>
<td>4.36</td>
<td>3.94</td>
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<td>CK13</td>
<td>2.43</td>
<td>3.21</td>
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<td>1.67</td>
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<td>2.61</td>
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<td>3.63</td>
<td>3.62</td>
</tr>
<tr>
<td>CK18</td>
<td>4.46</td>
<td>3.96</td>
</tr>
<tr>
<td>CK19</td>
<td>5.00</td>
<td>4.08</td>
</tr>
<tr>
<td>CK20</td>
<td>3.52</td>
<td>3.94</td>
</tr>
<tr>
<td>CK21</td>
<td>4.20</td>
<td>2.95</td>
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<tr>
<td>CK22</td>
<td>4.29</td>
<td>3.82</td>
</tr>
<tr>
<td>CK23</td>
<td>4.53</td>
<td>3.82</td>
</tr>
<tr>
<td>CK24</td>
<td>1.20</td>
<td>2.39</td>
</tr>
</tbody>
</table>
They proved themselves in
our climate last winter—
inexpensive, easy-to-build

Plastic
Greenhouses

Jesse M. Rawson

The last census shows that we use and enjoy only a fourth as many flowers and plants as the United States as a whole.

Some people blame this on our weather. Others say we don't have enough interest or that the idea is still new in many areas of our state. But the main reason is simply that good flowers and plants aren't available.

Our widely scattered population has made it unprofitable to start greenhouses in all but the larger cities. The large investment needed to build a greenhouse is too much for many communities to support.

Now cost no longer needs to be a barrier to starting in the greenhouse or nursery business. We've been testing a plastic greenhouse for the last year and it grows excellent plants. You can build a plastic greenhouse for about a tenth of the cost of the glass type.

The main fault is that the plastic deteriorates during the summer. You have to replace it every year. However, the cost of the plastic is low and it is cheaper to replace the plastic annually than the glass normally broken each year. Also, except for an occasional hail storm, glass breakage is worst in the winter when replacement is difficult. You replace the plastic in the fall when the weather is still good.

For small growers or growers in small communities the value of a plastic greenhouse is apparent. However, established growers can also make good use of the new building. One or more plastic greenhouses could be built to handle the spring plant business. In addition to the low cost the plastic greenhouse also gives great flexibility. For instance, in the spring, hot beds can be attached to the house and, by changing the pipes around, they can be heated with the same burner as the house. The plastic can be
replaced in the summer with aster cloth and you can grow such flowers as asters and dahlias which benefit from partial shade.

The flexibility isn't restricted to the larger grower, though. You can use the burner to heat brooder houses, farm workshops, farrowing pens, and other buildings on your farm.

The first crop grown under the plastic was chrysanthemums. We used 400 potted plants timed to bloom in late November and early December. The clay pots were set on the ground. These plants were as good as plants grown under glass.

We are now growing calceolarias, petunias, primroses, schizanthus, and garden chrysanthemums in the house. All are growing satisfactorily. While plastic does not transmit light as well as glass, the plants have not “stretched” or shown signs of lack of light. One advantage is that light is diffused so there are no shadows in the house.

Humidity has been high all winter in the house. A film of moisture has always been present on the inside layer of plastic. This has cut watering in half. To date, we've had no trouble with mildew or other diseases which thrive under high humidity.

The October 29 storm showed us that the house can stand wind. Even though winds reached 55 miles per hour, there was no damage.

The idea for plastic greenhouses comes from the University of Kentucky. The Department of Horticulture there developed and tested the first ones. However, until now no tests had been made this far north. We adapted the original plans to fit our needs. You may want to make other changes to suit your needs.

A local grower has recently built a plastic greenhouse using these modifications. He put in a poured concrete foundation instead of the posts and 2 x 6 inch sill plate. The heater was put outside in a separate box, thus taking up no floor space in the building. He built benches around the walls in preference to ground beds. The stack from the vacuum blower was placed horizontally through the wall, thus exhausting gasses more directly.

If you run into any problems or have any questions about building a plastic greenhouse, write the Hor-
ticulture and Forestry Department, South Dakota State College, College Station, Brookings.

Costs

A major advantage of the plastic greenhouse is its low cost. While costs will vary somewhat in different areas, here's about what a plastic greenhouse 18 x 40 feet will cost.

Heater, blower, and thermostat $225.00
Pipe, elbows, etc. (6" galvanized) 85.00
Installation of gas tank 25.00
Tank rent (1 year) 24.00
Tubing, fittings, etc. from tank to burner 12.00
Lumber No. 1 fir 95.00
Lath 5.00
Polyethylene plastic 45.00
Brackets, turnbuckles, and misc. 27.00
Nails and tacker staples 5.00

$548.00

For about $150 more you can double the size of the house, as the first five items would be the same for an 80-foot house.

Propane (L-P) gas costs about 13½ cents a gallon. Cost of heating for the 10-week period beginning October 24 at the above rate was $1.06 per day. We consider this a good test period because November and December 1955 were extremely cold.

Construction

Our greenhouse was 18 x 40 feet in size. We laid out the site and dug the post holes at 4-foot intervals along the sides and ends.

At the corners, every 8 feet along the sides, and on both sides of the doors we put up 4 x 4 posts. We used a 2 x 4 post between the 4 x 4's along the sides and nailed a 2 x 4 plate at the top of each post. The plates were made by joining two 2 x 4's near the center of the house. A 2 x 6 baseboard was put around

The picture below shows how evenly the light is distributed in the plastic house.
the outside at ground level and a 1 x 6 was put on the inside. The sides and ends were pre-fabricated and raised into position as units.

All wood touching the ground was treated with a wood preservative of copper napthenate or chromated zinc chloride. One should not use pentachlorophenol or other phenolic compounds as their fumes will kill or severely injure plants.

After squaring the sides and ends we put up the 2 x 4 ridge. The ridge is held by 2 x 2 sash bars at 2 foot intervals. We gave the roof a 40-degree slope for better snow slippage. Two longitudinal purlins were put under the sash bars on each side of the roof. To give the house more strength and hold the sides together, we placed 2 x 2 cross braces across the house above the upper longitudinal purlin. For additional bracing we stretched No. 9 wire diagonally from the ridge to the plate on each side of the roof. It was held in place with large screw eyes and tightened with turnbuckles. The doors and ventilators were made of inch material.

Before putting on the polyethylene plastic we removed slivers and rough spots on the wood to reduce the chance of tearing the plastic. The outside layer was 3 mil (0.003 inch thick) polyethylene 50 inches wide. We put it on horizontally across the sash bars and lapped about 3 inches. The plastic was held in place with staples and nailed.
lath. We used 6 penny, 2 headed nails so we could remove them easily.

For the inner layer we used 0.0015 inch thick polyethylene. It was tacked on the inside of the sash bars and uprights, making a dead air space between the two layers of plastic. Instead of laths to secure the inner plastic we used 2-inch strips of roofing felt and tacked it to the wood.

**Heating**

A new type L-P bottled gas burning heater was installed after the house was covered. It has two parts, a vacuum blower and a 160,000 BTU burner with a thermostatic control. The gas can not escape into the room, for the blower starts before the burner. If the pilot light goes off, the gas flow shuts off automatically.

It is desirable to use about 225 feet of 6-inch pipe for greatest heat efficiency. In addition to length of pipe, it is recommended to run the pipe around the perimeter of the greenhouse. With an 80-foot house you would place the burner at one end and the blower at the opposite end. With a 40-foot house, the pipe has to run double to get in 225 feet. Then both burner and blower are at the same end.

All joints were sealed with furnace cement and asbestos paper. With the vacuum-type system the pipes don't have to be level, so we put them underground at the door. They are 8 inches from the inside wall and the bottom one is 4 inches off the floor.

By placing the pipes near the floor, cold air entering the building through the walls is warmed before it reaches the plants. As the heat slows down at the elbows, more heat is given off and the cold corners are warmed. By simply adding elbows and pipe, cold spots which may develop can be eliminated.

The temperature range depends on the thermostat. At first there was only a 3-degree spread. However, this has increased considerably as the thermostat is becoming less efficient. We think this is because the thermostat isn't well adapted to the moist air in greenhouses.

To provide the air need for combustion, we ran a 10-inch intake pipe through the wall near the burner. It is recommended that you provide 1 square inch of fresh air intake for each 1,000 BTU of heater capacity.

The advantages of this house as we see it now are low original cost, reasonable heating and maintenance costs, great flexibility, ability to withstands wind, snow, and hail, and the need for less frequent watering. (Project 286. Leader: Jesse M. Rawson, Horticulture Dept.)
You can add color and variety to your meals with South Dakota-grown plums. They also contribute variable amounts of ascorbic acid as well as small amounts of other vitamins and minerals.

Many varieties of plum trees are suited for our climate. You may be familiar with the small, tart red or purplish fruit of the wild plum tree that grows along ravines or in pastures, groves, and shelterbelts. Cultivated varieties have been developed that can be grown in this state. These trees are hardy and produce fruit that can be used for eating fresh, cooking, or preserving for winter use.

Plum trees are usually small, often about the size of a large bush. They start to bear younger than apple trees and are good producers, though not as long-lived as many fruit trees. As they are stone fruit trees, you should keep them cleanly cultivated.

Most plum trees are not self-pollinating so you'll need another tree for a pollinator. Pollinizers may also bear good fruit. Recommended pollinizers are South Dakota and Kaga for true plum trees and Compass and Nicollett for cherry-plum hybrids.

Plums make delicious jelly.
Plum Varieties

Here are the varieties, suitable to South Dakota, you will want to consider when you select plums for your orchard.

WILD PLUM

South Dakota—probably the best known native wild plum. It is especially hardy, serves as a good pollinizer, and produces a delicious fruit with red skin and yellow flesh.

PLUM-PLUM HYBRIDS

Waneta—a hybrid of the Japanese (California) and the native wild plum. The Waneta is large, purplish-red, very juicy, and sweet.

Underwood—a hardy, early-ripening tree which produces large, red, sweet, juicy fruit.

Kaga—a hybrid of the wild plum and the apricot plum of China. Serves as a good pollinizer and produces an apricot-flavored plum for eating fresh or cooking.

Tecumsch—especially hardy and early ripening. Bright red or bluish-red skin and yellow flesh.

CHERRY-PLUM HYBRIDS

Sapa—a very productive, early-bearing bush tree which bears a dark, almost black-to-the-pit plum. Delicious for eating fresh, cooking, or jelly-making.

Opata—deliciously sweet to eat fresh. It has a light greenish flesh and blue skin.

Honeydew—an early ripening hybrid with light greenish flesh and a shiny dark purple skin. Delici-

Table 1. Ascorbic Acid Content of Plums Grown at the South Dakota Experiment Station

<table>
<thead>
<tr>
<th>Variety</th>
<th>Color</th>
<th>Ascorbic Acid (mg./gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Skin</td>
<td>Flesh</td>
</tr>
<tr>
<td>Champa</td>
<td>Dark purple</td>
<td>Light</td>
</tr>
<tr>
<td>Tawena</td>
<td>Bright red</td>
<td>Light</td>
</tr>
<tr>
<td>Honeydew</td>
<td>Medium purple</td>
<td>Light</td>
</tr>
<tr>
<td>Sapa</td>
<td>Purple</td>
<td>Dark</td>
</tr>
<tr>
<td>Etope</td>
<td>Dark purple</td>
<td>Dark</td>
</tr>
<tr>
<td>Enopa</td>
<td>Purple</td>
<td>Light</td>
</tr>
<tr>
<td>Ojibwa</td>
<td>Red</td>
<td>Light</td>
</tr>
<tr>
<td>Cheresota</td>
<td>Dark red</td>
<td>Light</td>
</tr>
<tr>
<td>Opata</td>
<td>Medium purple</td>
<td>Light</td>
</tr>
<tr>
<td>Febling</td>
<td>Bright red</td>
<td>Light</td>
</tr>
<tr>
<td>San Sota</td>
<td>Red &amp; yellow</td>
<td>Light</td>
</tr>
<tr>
<td>Underwood</td>
<td>Red &amp; yellow</td>
<td>Light</td>
</tr>
<tr>
<td>Wastista</td>
<td>Red &amp; yellow</td>
<td>Light</td>
</tr>
</tbody>
</table>

*Held in frozen storage for approximately 1 year.
Plum slump—a colorful hot dessert.

Plums contain varying amounts of ascorbic acid, as well as small amounts of other vitamins and minerals. We made ascorbic acid tests on 13 varieties grown by the Horticulture Department in 1952. Amounts of ascorbic acid per 100 grams of fresh fruit varied from slightly over 6 grams to more than 17 grams (see table 1). About a year later we ran tests on plums that had been frozen. We found that they lost very little of their ascorbic acid during frozen storage.

How To Freeze Plums

Plums freeze well either whole or pitted with sugar added. If you have little storage space, you should pit the plums before freezing. However, freezing plums whole and unsugared has certain advantages. The color in light-fleshed varieties will be better preserved and there is less time from the tree to the freezer.

Use only well-ripened, fresh plums for freezing. Here are the general preparations.

Whole plums, plain—Wash the plums and remove any over-ripe or partially spoiled plums. Shake off excess moisture and pack in freezer cartons. Freeze immediately. Pitting is easily done by halving or quartering while still frozen, just prior to using.

Pitted plums, sugared—Wash the plums and remove spoiled or over-ripe plums. Halve or quarter plums and remove pits. Add 1 part sugar to 6 parts plums. Pack in freezer cartons and freeze immediately. This amount of sugar will not completely sweeten most varieties so additional sugar can be added when preparing plum dishes.

Plum Recipes

Though these South Dakota-grown plums are seldom seen in stores, you may have or want to plant some on your farm, particularly in a shelterbelt. Therefore, we've developed and standardized some recipes for their use.

PLUM COBBLER

1/4 cup butter

1 1/2 cups sugar

1 cup flour

1/2 tsp. salt

1/2 cup milk

1 1/2 tsp. double acting baking powder

2 cups plums (pitted, fresh or frozen)

2 tsp. lemon juice

1/2 cups boiling water and juice

Cream butter and 1/2 cup sugar. Sift together flour, salt, and baking powder. Add milk and dry ingredients alternately to creamed mixture. Spread batter in 4x6x3 inch pan (or 8x8x2 inch pan). Cover with plums. Sprinkle 1 cup sugar and lemon juice over plums. Pour the boiling water and juice on top of the plums. Bake at 350°F. for 1 hour.

Continued on page 116
The cropping systems normally used in east central South Dakota are primarily nitrogen-depleting. That is, the combined operations of tillage, seedbed preparation, and actual crop removal tend to steadily decrease the nitrogen content of the soil.

This progressive decrease of the total nitrogen in the soil is reflected in the amount of nitrogen that occurs in simple forms available for crop use. In time the level of available nitrogen becomes so low that crop yields and quality are seriously reduced. The soils are then known as "nitrogen-deficient soils."

Table 1. Reduction in Total Nitrogen Content of Soils in the James River Basin as a Result of Cropping

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Original or Virgin (% Total)</th>
<th>After Cultivation (% Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houdek loam</td>
<td>0.279</td>
<td>0.169</td>
</tr>
<tr>
<td>Beotia silt loam</td>
<td>0.290</td>
<td>0.204</td>
</tr>
<tr>
<td>Harmony silty clay</td>
<td>0.340</td>
<td>0.294</td>
</tr>
<tr>
<td>Cavour silt loam</td>
<td>0.292</td>
<td>0.199</td>
</tr>
</tbody>
</table>


On fields where return of crop residues, growth of legumes, and return of farm manures have been faithfully practiced, nitrogen deficiencies are seldom observed. With our extensive type of farming, however, only a part of each farm normally receives this kind of attention.

To illustrate how serious this reduction in nitrogen content of soils is, a few analyses are quoted in table 1, showing what has happened as a result of cropping for the past 60 or 70 years.

It is seen that the total nitrogen content of the above soils has dropped as much as 43 percent as a result of cropping operations. In practically all soils, the fractions of the soil nitrogen lost first are the more easily decomposed, leaving resistant, less easily mineralized compounds, further aggravating the nitrogen problem. Thus, both the reduction in total amount of soil nitrogen potentially available to crops and the loss of the best parts first combine to leave us in a predicament which now requires im-

Joint employee: Agronomist, S. D. Experiment Station, and Soil Scientist with the Soil and Water Conservation Research Branch, USDA.
mediate attention on practically all of our land in the east central part of the state.

The question naturally arises, how can we determine the nitrogen needs of crops, and how can we meet these needs?

There are at least five means of detecting and evaluating the nitrogen needs, as follows:

1. The appearance of plant deficiency symptoms—firing of lower leaves of corn or a pale green color of most any crop in the active growth stages.

2. Reduced or declining yields of crops when drought or other factors are not directly responsible.

3. The use of field test plots.

4. Soil tests and soil treatment history.

5. Plant tissue analyses and tests.

Field test plots are used extensively and soil and plant tissue tests are put to limited use in study of nitrogen needs of soils in the James River Basin by Agronomy Department and U. S. Department of Agriculture personnel. Results and general recommendations from experiments in the northern part of the basin conducted on development farms operated by the U.S. Bureau of Reclamation are presented to help farmers understand this fertility problem. Much of the data are from irrigated crops and thus are of value to present and prospective irrigators in the area.

Short Term Experiments

Table 2 presents the yield responses of several 1-year experiments conducted at the Huron and Redfield development farms with various crops in recent years.

The data of table 2 indicate the general trend of diminishing return for each added increment of nitrogen with most crops; however, results vary with crop, year, and location. The fact that fallowing makes soil nitrogen available to the succeeding crop is well illustrated by the lack of fertilizer response of corn after fallow.

Long Term Experiments

Longer term rotation experiments, also combining various fertilizer applications, have been conducted at Redfield since 1949. The nitrogen responses of corn and wheat obtained in two rotations, one of which was irrigated and one not irrigated, are shown in figure 1.

This is the way potatoes responded to fertilizer in the James River Basin. Nitrogen made quite a difference.
Figure 1. Seven-year average effect of nitrogen fertilizer on corn and wheat yields on Beotia silt loam, Redfield (1949-55), in irrigated and non-irrigated rotations.

It is noted that the response to nitrogen is much less in the 4-year rotations having 2 of the 4 years in alfalfa than in the 2-year rotations with no alfalfa. This is as expected and is true of the irrigated and non-irrigated crops alike. The trend of decreasing response with time in the legume rotations has been very definite, to the point that in the last 3 years corn has not shown any significant response. Yields were even slightly depressed in 1953 and 1954. Wheat yields were also slightly depressed in 1955. However, the first 4 years that the experiments were run, paying responses occurred in all rotations, irrigated or non-irrigated.

The best return for money expended on fertilizer is indicated by the use of 30 pounds of nitrogen on non-irrigated wheat, with no alfalfa in the rotation. In this case, an average wheat yield increase of 9 bushels per acre was obtained. The poorest return is for nitrogen applied on corn after alfalfa. It will be noted from figure 1 that corn yields (not irrigated) averaged better on land not previously cropped to alfalfa than on land in alfalfa immediately preceding corn. This is true because in 1952 and 1955 corn was a failure due to drought on land where it followed alfalfa, and the zero yields are included in these averages. Non-irrigated corn not following alfalfa, however, produced good yields in 1952 and 1955. In years of more normal rainfall, corn following alfalfa
Table 2. Crop Responses to Nitrogen Fertilizers

<table>
<thead>
<tr>
<th>Location</th>
<th>Crop</th>
<th>Soil</th>
<th>N Rate</th>
<th>% Incr</th>
<th>N Rate</th>
<th>% Incr</th>
<th>N Rate</th>
<th>% Incr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huron*</td>
<td>Brome grass</td>
<td>Houdek loam</td>
<td>40</td>
<td>135</td>
<td>80</td>
<td>228</td>
<td>160</td>
<td>249</td>
</tr>
<tr>
<td>Huron*</td>
<td>Rec wheatgrass</td>
<td>Houdek loam</td>
<td>40</td>
<td>134</td>
<td>80</td>
<td>174</td>
<td>160</td>
<td>233</td>
</tr>
<tr>
<td>Redfield*</td>
<td>Brome grass</td>
<td>Beotia silt loam</td>
<td>40</td>
<td>119</td>
<td>80</td>
<td>184</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redfield*</td>
<td>Orchard grass</td>
<td>Beotia silt loam</td>
<td>40</td>
<td>49</td>
<td>80</td>
<td>121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redfield†</td>
<td>Potatoes</td>
<td>Beotia silt loam</td>
<td>60</td>
<td>43</td>
<td>120</td>
<td>70</td>
<td>180</td>
<td>90</td>
</tr>
<tr>
<td>Redfield*</td>
<td>Corn</td>
<td>Beotia silt loam</td>
<td>50</td>
<td>51</td>
<td>100</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redfield‡</td>
<td>Corn</td>
<td>Beotia silt loam</td>
<td>40</td>
<td>3.2</td>
<td>80</td>
<td>4.4</td>
<td>120</td>
<td>-5.3</td>
</tr>
</tbody>
</table>

*Irrigated.
†Average of five varieties.
‡Not irrigated, but following 1 year of fallow; control plots yielded 75 bu/A.

has outyielded corn on land where alfalfa has not been grown. In these experiments, the alfalfa is plowed in May and thus severely depletes soil moisture before corn planting.

The place of nitrogen fertilizer use in the James River Basin at this time appears to be primarily on small grains; secondly on tame grass hay or pasture when adequate moisture is present or irrigation will be used; and thirdly, on corn and other row crops when a legume has not been on the land in the 2 or 3 years immediately preceding. The amount to be applied in any case, of course, must be determined from soil test information, cropping history, knowledge of the soil type, and moisture conditions.


NEW PUBLICATIONS

C123 Better Agriculture Through Research
Shows the accomplishments of nearly 70 years of agricultural research in South Dakota. An interesting history with numerous pictures.

C124 Agricultural Research at the Central Substation
Reports research progress at the Highmore substation. Valuable information for farmers and ranchers in central South Dakota.

B456 Preventing Selenium Poisoning in Growing and Fattening Pigs
Organic arsenicals give protection against selenium poisoning in growing and fattening pigs. Recommendations and precautions for their use are presented.
Claypan soil is found on much of the level land in the James River Valley. This soil tends to depress crop growth. It is a solonetz complex soil and is also found occasionally in other parts of the state—mostly west of the James River Valley.

The claypan soil is usually associated with other soils. Therefore, even though the terrain looks uniform, farmers get a patchwork effect in crops that grow in these areas. In dry years, especially, crops will vary greatly in height and vigor (see figure 1).

During the summer of 1953 the Experiment Station leased 10 acres near Plankinton for a claypan research farm. The soil on this farm is a Cavour-Bonilla-Cresbard complex.

Of the three soils, Cavour is least favorable for crop growth. It is characterized by a leached gray layer (A$_2$ horizon) at from 4 to 10 inches below the surface and by a very compact claypan layer (B$_n$ horizon) just below the leached layer. The research farm has a high percentage of Cavour soil—found in the shallow swales.

Bonilla soil is the best of the three soils for crop production. This deep, friable soil is found on the gentle rises in the experiment area. When found by itself, Bonilla soil has no serious limitations. However, when it occurs with Cavour, problems arise, for each soil needs a different type of management.

Cresbard is an intermediate soil for crop production. It has a leached gray layer similar to Cavour (but usually at a slightly greater depth in the profile); however, the subsoil is more friable.

In the spring of 1954 we divided the research farm into plots. Most of the acreage is being used in a
rotation experiment. Ten rotations, four major crops, two levels of phosphorus, and two times of fertilizer application are included in the experiment. Each is replicated four times for a total of 640 plots. The rotations and crops are shown in table 1.

Conducting the Experiments

Each of the major plots (1/30 acre) is split in half. We apply 30 pounds of phosphorus pentoxide per acre to half of the plot. The other half receives no phosphorus. The sub-plots are also split. With the fertilized plots, one-half of the plot is fertilized in the fall and the other half in the spring before planting time. Legume crops in the rotation were planted in April 1954 with oats as a nurse crop. Fair to good legume stands were attained in all cases. All other crops were grown for the first time in 1955.

During the summer of 1954 we sampled the soils in the rotation experiment. Auger samples were taken from the 0- to 7-inch and 7- to 16-inch levels from each plot. Enough sample was taken for both physical and chemical studies. Soil cores and natural clods were collected from the B$_2$ horizon (the claypan when present).

Figure 1. A claypan area is revealed by the shorter, paler corn (center).

In 1955 we harvested all the plots for yield data. We can make only a few comparisons now because crops in some of the rotations will not be following the right crops until 1957. These yield comparisons are: (1) the effect of fertilizer on crop yields, (2) the effect of manure on crop yields, (3) the effect of subsoiling, and (4) the benefit of sweet clover and alfalfa as green manure crops. One should consider that the results were obtained from only 1 year’s data.

Effect of Fertilizer. Thirty pounds of nitrogen fertilizer increased the yield of wheat 2 bushels, rye 6 bushels, and oats 14 bushels per acre. Corn was so badly damaged by borers and drought
Table 1. Crop Rotation in the Claypan Experiment

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Crops in Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Rye</td>
<td>Corn</td>
</tr>
<tr>
<td>2—Rye</td>
<td>Corn</td>
</tr>
<tr>
<td>3—Rye</td>
<td>Corn</td>
</tr>
<tr>
<td>4—Rye</td>
<td>Corn</td>
</tr>
<tr>
<td>5—Rye+N*</td>
<td>Corn+N</td>
</tr>
<tr>
<td>6—Rye</td>
<td>Corn+M†</td>
</tr>
<tr>
<td>7—Rye+N†</td>
<td>Corn+N</td>
</tr>
<tr>
<td>8—Alfalfa</td>
<td>Corn</td>
</tr>
<tr>
<td>9—Oats+Sw. Cl.</td>
<td>Sorghum</td>
</tr>
<tr>
<td>10—Oats+Sw. Cl.</td>
<td>Oats+Alf.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crops in Rotation</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats+Alf.</td>
<td>5—Rye+N*</td>
</tr>
<tr>
<td>Oats+Sw. Cl.</td>
<td>6—Rye</td>
</tr>
<tr>
<td>Oats</td>
<td>7—Rye+N†</td>
</tr>
<tr>
<td>Oats+Alf.</td>
<td>8—Alfalfa</td>
</tr>
<tr>
<td>Oats+Alf.</td>
<td>9—Oats+Sw. Cl.</td>
</tr>
<tr>
<td>Oats+Alf.</td>
<td>10—Oats+Sw. Cl.</td>
</tr>
</tbody>
</table>

*The nitrogen in rotations 5 and 7 is applied to each crop in the rotation at the rate of 30 pounds per acre.
†The soil in rotation 7 is chiseled at 4-foot intervals to a depth of 20 inches after the rye and oats crops are harvested.
‡The manure in rotation 6 is applied at the rate of 15 tons per acre before corn and 5 tons per acre before wheat.

that we didn’t take grain yields. Forage yields from corn were not significantly affected by the use of nitrogen fertilizer. Phosphorus did not affect the yield of any of the four grain crops or the alfalfa. Alfalfa averaged 2.5 tons of hay and 85 pounds of seed (third crop) per acre without fertilizer. This was probably the best cash crop on the experiment in 1955.

Effect of Manure. Manure did not increase the yield of corn forage or wheat in 1955. There were no detrimental effects either, although the past summer was especially hot and dry in July and August.

Effect of Subsoiling. We couldn’t make a fair comparison between corn on subsoiled land and corn on land not subsoiled because only forage was harvested. There was no difference between the two treatments when forage yields were compared. Wheat yields were not increased by subsoiling either.

Effect of Green Manure. There was no increase in stover yield when corn followed sweet clover green manure or in grain yield when wheat followed an alfalfa green manure crop. Both green manure crops were turned under in the fall of 1954. The corn forage yield was considerably less when corn followed sweet clover. We expect benefits from green manure in more normal years and after the rotations have been run longer.

Fertilizer Experiments On Outlying Farms

A number of fertilizer experiments also have been placed in other areas on soil similar to that for the rotation experiment. The purpose is to determine the rate and kind of fertilizer to use on claypan soils.

Rye Experiments. We ran two experiments with rye in 1955. In one case rye followed fallow and in the other rye followed oat stubble.
Yield results are shown in table 2.

When rye followed oat stubble, the return from fertilizer was spectacular. The higher nitrogen treatments (40 and 60 pounds) increased yields 11 to 12 bushels per acre. As 40 pounds of nitrogen cost about $6, this gave a good return when only nitrogen (40-0-0) was used.

There was little, if any, response to phosphorus.

Rye following fallow yielded about 12 bushels more per acre than well-fertilizer rye following stubble. The main reason for this extra yield was that more moisture was stored by fallowing. Enough nitrogen was released by fallowing and there was enough available phosphorus in the soil to produce a crop of rye.

**Placement Experiments.** Two experiments were run to compare applying fertilizer with the seed and broadcasting after planting. The one with wheat was done in 1954 and the one with oats in 1955. The experiments were split plot in design and replicated four times. Each major treatment (fertilizer rate) was split in such a way that the fertilizer was drilled with the seed on one half and broadcast on the surface after seeding on the other half. The fertilizer carriers were ammonium nitrate, treble super-phosphate, and potassium chloride. Both the oats and wheat were on stubble ground.

As in the rye experiment, nitrogen was the most limiting element. Wheat yields were tripled by higher rates of nitrogen in 1954, and oats yields were increased by as much as 50 percent by the same rates in 1955 (see table 3). Neither phosphorus nor potassium had a significant effect on yield, but there appeared to be a slight trend for phosphorus to increase yields in both years.

In 1954, drilling fertilizer with the seed was the most beneficial for wheat. An average of about 2 bushels per acre more was obtained by applying the fertilizer with the seed than by broadcasting. There was no difference between the two methods on the oats in 1955.

A number of other experiments in the state show that mixed fertilizers usually give greater yield increases when placed with the seed. However, it has been noticed that nitrogen fertilizer can damage germination of small grains. So to be safe, it is suggested that nitrogen fertilizers (especially at high rates) not be placed in close contact with the seed. Corn is even more sensitive to this type of damage.

Table 2. Effect of Fertilizer on Yield of Rye

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Yield in Bu/A After Fallow</th>
<th>After Stubble</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0-0</td>
<td>41.5</td>
<td>16.9</td>
</tr>
<tr>
<td>0-40-0</td>
<td>39.3</td>
<td>15.2</td>
</tr>
<tr>
<td>20-40-0</td>
<td>44.4</td>
<td>24.6</td>
</tr>
<tr>
<td>40-40-0</td>
<td>43.6</td>
<td>29.4</td>
</tr>
<tr>
<td>60-40-0</td>
<td>43.3</td>
<td>29.0</td>
</tr>
<tr>
<td>40-0-0</td>
<td>41.3</td>
<td>28.0</td>
</tr>
<tr>
<td>40-20-0</td>
<td>43.0</td>
<td>28.1</td>
</tr>
<tr>
<td>40-60-0</td>
<td>44.4</td>
<td>29.4</td>
</tr>
</tbody>
</table>

*L.S.D. at 5% not significant

*The first figure refers to pounds nitrogen, the second to pounds phosphorus pentoxide, and the third to pounds potassium oxide applied per acre.
RESEARCH IS UNDER WAY TO CONTROL PASTURE AND RANGE

GRASS DISEASES

C. J. MANKIN and J. G. ROSS

Forage and range grasses are attacked by many destructive diseases caused by fungi and bacteria. Leaf spots destroy leaves; seedling blights cause poor seedling stands; root rots seriously reduce the yield and vigor of the plants; and smuts and ergot destroy seed.

These grass diseases not only reduce the yields but also the nutritive value of hay and pastures. They weaken plants to drought and winter injury and lower the yield of seed so much that volunteer reseeding on the range is greatly reduced.

We are carrying on research aimed at controlling these diseases. The Plant Pathology Department is conducting the research in cooperation with the grass breeders in the Agronomy Department.

Leaf Diseases

Brome grass is one of our important hay and pasture grasses in South Dakota. Therefore, we are trying to find ways to control the major leaf diseases of this forage grass (see figures 1-4).

The most destructive leaf killing disease of brome grass is brown leaf spot (Helminthosporium bromi) shown on the cover. Through breeding, testing, and selection for dis-

Figure 3. Purple brown spot on brome. Brown leaf spot resistant selections are susceptible.

Figure 4. Eye spot on brome. Not widespread but damaging to some clonal lines or stains.

Figure 5. Seedlings of crested wheatgrass in pot at left are infected by seedling blight.
ease resistance we can get satisfactory resistance. In greenhouse experiments we have inoculated different strains of brome grass with brown leaf spot. The disease is not able to produce the large type spots that typically develop in the strains commonly grown by farmers. The resistance reduces damage and the leaves stay alive and green until harvested or mature.

Unfortunately, however, many of the plants resistant to brown leaf spot are quite susceptible to purple brown spot (Stagonospora bromi) shown in figure 3. For the most part purple brown spot is a minor disease but it could become important if the brown leaf spot resistant selections were widely grown. We know of variation in susceptibility for most brome leaf spot diseases (Selenophoma leaf blotch caused by Selenophoma bromigetui, bacterial blight—Xanthomonas translucens var. cerealis, and eye spot—Ovularia pusilia), but so far satisfactory resistance has not been introduced into a commercial strain.

Seedling Blight
Bad weather or poor seed are often blamed for poor stands of grass when the real trouble is often
Table 1. The Effect of Seed Treatment on the Stand of Wheatgrass Varieties Grown at Brookings, South Dakota

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiram</td>
<td>6 oz. Slurry</td>
<td>54.1</td>
<td>133.4</td>
<td>119.0</td>
<td>105.4</td>
<td>148.0</td>
<td>93.6</td>
</tr>
<tr>
<td>Arasan</td>
<td>6 oz. Slurry</td>
<td>54.6</td>
<td>137.4</td>
<td>121.0</td>
<td>105.2</td>
<td>158.0</td>
<td>101.2</td>
</tr>
<tr>
<td>Orthocide 75</td>
<td>4 oz. Dust</td>
<td>54.0</td>
<td>135.0</td>
<td>138.0</td>
<td>120.0</td>
<td>202.0</td>
<td>127.8</td>
</tr>
<tr>
<td>Agrox</td>
<td>1/8 oz. Dust</td>
<td>75.1</td>
<td>188.6</td>
<td>168.0</td>
<td>146.0</td>
<td>156.0</td>
<td>98.7</td>
</tr>
<tr>
<td>Ck. (No treatment)</td>
<td></td>
<td>39.8</td>
<td>100.0</td>
<td>115.0</td>
<td>100.0</td>
<td>158.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Caused by soil-borne fungi that attack and kill the germinating seed or young plant. This trouble can be serious and is difficult to control (see figures 5 and 6).

Here's how serious it can be. During the regrassing program of the 1930's, grass seed was sown on 153,000 acres. The stands were unsatisfactory, even after reseeding three or four times.

This failure was largely due to seedling blight, a soil-borne seedling disease. Drought was only one of the limiting factors in getting stands. We soon found that when field soil from the areas was brought into the greenhouses and planted to the same seed, the seedlings still failed, even when properly watered. However, when the same soil was treated to kill the disease organisms, the seed germinated normally and produced good stands of vigorous plants.

Seed treatment is not the whole answer to the problem of seedling blight, but you can get some improvement in the stand of crested wheatgrass and other wheatgrass species by treating the seed with fungicides such as arasan, orthocide 75, or agrox (see table 1).

In 1954 we got very good response to seed treatment and the stand was increased from 33 to 88 percent. However, we got no increase in stand in 1955. Tall wheatgrass and Ree wheatgrass responded the same way. Although one can sometimes get better stands by treating seed, he can not completely control the seedling blight because seed treatment protects only during emergence and not against late developing root rots.

Greenhouse tests have shown that certain selections of crested wheatgrass produce and maintain acceptable stands when grown in soil infested with some of the blight producing organisms. Since this resistance seems to be genetic, further breeding, testing, and selection may give strains of crested wheatgrass that are resistant to seedling blight.

Before we can make more rapid progress, we need information about the distribution, persistence, and interrelationship, and number of organisms that make up the com-
plex soil fungi that cause seedling blight of grasses. We must also find the effect of moisture and temperature on seedling blight development.

**Mature Root Rot**

The problem of root rot of mature grasses is important from the standpoint of maintaining vigorous grassland. We know that the depletion of stands in range grasses is often due to various root-rotting soil organisms.

The control of these diseases poses a difficult problem. Practical methods of control are needed. This prevents the use of certain possible control measures, especially on large land areas such as the range. So far little has been done about the possibility of root rot resistance. However, this is worth considering.

The limited amount of work done toward controlling root rot in mature plants indicates that the judicious use of fertilizers offers the most promise. Fertilizing pastures and seed fields is valuable, but fertilizing ranges might not always be economically feasible. However, work along such lines might give us valuable information about the control of mature root rot.

**Diseases Affecting the Seed**

The smuts and ergot are the main diseases that destroy grass seed when the heads are being produced. The smuts mainly infect the heads and destroy the seed, but they may also attack the leaves and stem (see figure 7). Ergot always destroys the seed (see figure 8). The seed-destroying diseases are important in range grasses because one wants some voluntary reseeding.

Smuts are quite common and widely distributed on range grasses in South Dakota. Generally, little attention has been given to the control of grass smuts. Many grass smuts can be controlled by seed treatment. When the need arises, smut resistant strains may be developed since it seems that genetic resistance is present in various species of range grass.

Like the smuts, ergot is widespread on range grasses in more or less abundance. The ergot fungus not only destroys the seed but also produces an alkaloid that is poisonous to livestock. Ergot may also be responsible for abortion in cattle grazing on the range or fed hay which has toxic amounts of ergot in the heads.

**The Research Under Way**

We are studying the nature, development, and distribution of the various foliage diseases of brome grass and seedling blight of crested wheatgrass. Isolations from diseased field plants have been made and pure cultures of the organisms are used to produce the disease in the greenhouse. We can then rate the disease-resistant qualities of individual selections. The disease reaction of individual selections to infection under field conditions is being evaluated each year.

Through breeding, testing, and selection, the prospects of increasing disease resistance in brome grass and crested wheatgrass for your grasslands and pastures seem quite good. (Project 250. Leaders: C. J. Mankin, Plant Pathology Dept.; and J. G. Ross, Agronomy Dept.)
Ten years ago an infectious disease of cattle called sporadic bovine encephalomyelitis (SBE) was recognized in South Dakota for the first time. Since then this disease has shown up in several herds in the eastern part of the state—but usually not over four or five outbreaks a year.

SBE was first diagnosed in Iowa in 1940 and proved to be an infectious disease caused by a virus.

**Cause of SBE**

Since the recognition of SBE in South Dakota, the Veterinary Department has been conducting experimental work on the disease. Early findings agreed with those of Iowa. By transferring five strains of virus recovered from outbreaks to chicken embryos, SBE virus has been kept for laboratory work. One strain recovered from an outbreak in 1947 has been transferred from embryo to embryo over 100 times.

The virus has been kept infective more than a year by freezing infected embryo fluids and tissues. While penicillin and streptomycin do not reduce infectivity, terramycin and aureomycin treatments of the virus either lower or destroy infectivity. The virus is quickly destroyed by common chemical disinfectants.

Through the cooperation of Dr. H. A. Wenner, University of Kansas Medical School, who conducted tests with viruses from South Dakota and Missouri cases of SBE, the virus has been identified as being in the psittacosis group. This virus is similar in many of its characteristics to the agents that cause psittacosis among a large number of birds as well as in domestic fowl and man.

**Symptoms**

When an outbreak of SBE occurs, it has been noted that more of the young animals than adults develop symptoms. These symptoms are also more severe and the death loss higher among calves. In 21 herds totaling 1,774 animals, 5 percent of the yearlings and adults and 25 percent of the calves developed symptoms. Of these, 28 percent died.

The first symptom is a rise of 2 to 4 degrees in body temperature. The owner usually doesn't detect this, but as the disease progresses, inactivity and depression show up.
One may notice some loss of coordination, and the animal may look stiff and knuckle over at the fetlocks. In severe cases, paralysis keeps the animal from getting to its feet. It may lie with its head drawn back. While the death rate is high among those with serious paralytic symptoms, the milder cases make a slow but complete recovery.

Symptoms have almost always been mild in calves infected experimentally. In those given the virus by mouth, it was 12 to 14 days before a rise in temperature was noticed. When the virus was injected into the abdominal cavity (intraperitoneally) or under the skin (subcutaneously), it took 5 to 7 days; and when the virus was injected into the bloodstream (intravenously), the temperature rose in 2 to 4 days. Only one calf of about 40 used in the experiment developed paralysis. In many, fever was the only symptom. These cases would not have been detected in a farm herd.

Diagnosis

SBE is best diagnosed by a post mortem examination. There is always an inflammation in the abdominal cavity and usually in the thorax and heart sac. Upon opening the body cavities, one finds a yellowish fibrinous network covering surfaces of organs and an increased amount of yellow watery fluid. In calves experimentally infected, the inflammation in the body cavities has always been pronounced even though symptoms were often very mild.

The paralysis is caused by inflammation of the spinal cord and brain (encephalomyelitis) and the membranes covering them.

Spread of the Disease

One of the puzzling problems in the study of SBE is the sporadic nature of the disease—the way it shows up in single and scattered cases. No outbreaks in South Dakota have spread to neighboring herds, and after an outbreak subsided, the disease hasn't appeared again in the herd.

In several cases, animals were added to the herd before the outbreak. This suggests the possibility of carrier animals that spread the virus in feces or other body excretions. If carrier animals exist, infection probably occurs through the mouth or nasal passages.

By injecting water extract of feces into guinea pigs, it has been demonstrated that virus was present in 5 of 7 calves that had been in-

One of the calves used in the trials.
Claypan Soils Continued from 101

### Table 3. Response of Wheat and Oats to Fertilizer and Method of Application

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<td>15.6</td>
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</table>

**L.S.D. at 5% level**

3.5 6.4 11.4 9.6

*See footnote in table 2.

**Corn Experiments.** We placed a randomized block experiment with four replications on corn in 1954 and 1955. The corn followed oats both years. All fertilizer was broadcast and disked in before the corn was planted. In 1954 there was adequate moisture during the first part of the season, but the soil became dry during the rest of the season. A dry period in May 1955 made it difficult to get a stand and another dry period in July and August injured the remaining plants.

Table 4 shows that fertilizer neither increased nor decreased yields either year, although one might expect a decrease in a dry year like 1955.

By late June 1954 the fertilized corn seemed more vigorous than did the corn without fertilizer. But by late summer the soil had supplied enough available nitrogen to the unfertilized corn, and the height and the apparent vigor of these plants were about equal to the fertilized.

It is quite common to get no yield increase from fertilizer on corn in central and western South Dakota. Generally one will be ahead if he fertilizes small grains instead, for they are usually more responsive in these areas. This wouldn't necessarily be true under irrigation. (Project 4 NC-17, Leader: B. L. Brage, Agronomy Dept.)

### Table 4. Effect of Fertilizer on the Yield of Corn

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<th>Treatment*</th>
<th>1954 Bu/A</th>
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<td>60-40-0</td>
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<td>40-0-0</td>
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</tr>
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<td>40-20-0</td>
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</tr>
<tr>
<td>40-60-0</td>
<td>51.1</td>
<td>25.3</td>
</tr>
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</table>

**L.S.D. at 5% level**

Not significant

*See footnote in table 2.*
"There is a difference in phosphates" says the ad of a manufacturer of feeding grade phosphate. The ad was referring to the availability of phosphorus—whether or not the farm animal would be able to digest and use the phosphorus in the supplement.

Results from several of our 1955 experiments agree with this statement. These experiments are part of a study we have been carrying on the past 5 years.

**Use Eighteen Samples**

We used 18 samples of phosphate for supplementing a low-phosphorus turkey diet. Four were high purity types used by pharmacies and chemical laboratories. The others were samples of products on the market that you could use in mixing animal or poultry feeds. The phosphates were classified by either source or processing of the raw material.

Of the high purity phosphates, Dicalcium Phosphate USP XIV was used in every experiment as a control to give us a basis for comparison. All of the phosphates were chemically analyzed for calcium and phosphorus and we figured the amount of each that would supply 0.25 percent of phosphorus in the diet from these analyses.

No fish meal or meat scraps were used, but otherwise the general ration was like regular turkey starting diets. It was as low in naturally oc-
curing phosphorus as we could make it without removing other regular ingredients. By chemical analysis, we found that it contained about 0.55 percent naturally occurring phosphorus. About one-third of this was phytin phosphorus, which is not digested by poultry.

We then divided the ration into the different diets and added the phosphates, bringing the total phosphorus of each to 0.8 percent. This is less than the recommended 1.0 percent but this recommended level includes extra phosphorus as a margin of safety. When only 0.8 percent phosphorus is in a diet, it must all be available for best growth and bone development.

The turkey poultos we used were hatched from eggs from the college Beltsville Small White turkey breeding flock. Eighteen to twenty-two poultos, depending on the number hatched, were wingbanded and put into each pen of the electrically heated battery brooders. Two pens in each brooder received each of the diets. The poultos had free access to the diet and water at all times.

**Analyze Bones**

At 4 weeks of age, the poultos were weighed and killed and the tibia

<table>
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<tr>
<th>Phosphate Source</th>
<th>Weight*</th>
<th>Bone Ash*</th>
<th>Combined*</th>
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<tr>
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<tr>
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<td>14</td>
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</table>

*The amount of response (increase of weight and bone ash) to the addition of 0.25% of Dicalcium Phosphate USP XIV to the poult diet was arbitrarily set equal to 100. The amount of response resulting from the addition of 0.25% phosphorus from the other phosphates to the diet was compared with the control (USP dicalcium phosphate) response.
bone was removed from the left leg for bone ash analysis. We used the weights of the poult's and the bone ash values as measures of the availability of the phosphorus in the supplements.

We started a new experiment every 2 weeks with the first beginning in March and the last ending in August.

The weather changed a lot in these months and affected the growth and eating habits of the poult's. However, the two control pens of the USP dicalcium phosphate diet in each experiment took care of the weather effect. The weight and bone ash values of the other poult's were compared to these control poult's in each experiment, so one phosphate can be compared with any other (see table 1).

You can see from this table that the "Colloidal" phosphates are very low in the amount of phosphorus the turkey poult can use. The imported rock phosphates are better but still seem quite poor. The defluorinated phosphates and the commercial dicalcium phosphates vary a lot between samples. We think this is due to differences in the raw material used and in the treatment and processing of this material by the different companies. Certain impurities, such as iron, aluminum, magnesium, or fluorine, may also affect growth and bone development. The impurities vary according to source of the raw material and to the processing method.

The ideal supplement is one in which all of the phosphorus can be used by the turkey poult. Of the samples we tested, the best results were from defluorinated phosphate sample 4 and commercial dicalcium phosphate samples 7, 8 or 10. These four were very good for both growth and bone development. (Project 221. Leader: R. A. Wilcox, Poultry Dept.)

NEW PUBLICATIONS

C122 Weed Control Research in South Dakota
Presents information on various methods of weed control. Discusses a number of chemicals as well as how to adjust sprayers and measure chemicals.

C125 Weed Control Equipment
Seed cleaners, cultivating equipment, and weed sprayers are discussed in this valuable publication.

C127 Reducing Winter Injury in Red Raspberries
Presents experimental results of various methods tried in preventing winter injury in raspberries. Suggests several practices that you may want to try.
"A man apparently healthful, leaves his work and goes to his trader and orders a suit of grave clothes. 'I have the sickness,' he says. He is measured for the suit, and by the time it is finished the buyer is often ready to wear it through the long sleep.'

This is how a former superintendent of the South Dakota State Board of Health described the deadly effects of tuberculosis among South Dakota Indians in 1906. He said they were "withering to extinction with tuberculosis." There was hardly a home on the reservations where the dread infection did not exist.

Since that time some progress has been made in controlling the disease on the reservations, although tuberculosis is still a leading cause of death among South Dakota Indians. The death rate from the disease in 1954 was still more than 20 times as high for Indians as for the general population of the state.

**Spread of Tuberculosis**

**Direct Causes.** Crowded living conditions on the reservations are one of the main causes of the high
rate of tuberculosis. The houses are very small, many having only one room. Eating, sleeping, and visiting have to be carried on in a limited space, greatly increasing close contacts and thus providing proper conditions for the spread of the disease germs.

Most of the houses are also poorly built and hard to heat. When it's cold the family is likely to gather around the stove to keep warm, further increasing the close contact in families.

Poor sanitation in the small homes likewise encourages the spread of tuberculosis. Cleanliness is much more difficult to attain when people are crowded into a small living area. Running water and bathrooms are often lacking. Water may have to be hauled from wells some distance away.

Malnutrition seems to be another factor contributing to the prevalence of tuberculosis on reservations. An inadequate diet tends to lower disease resistance. This is particularly true among young mothers who might have been exposed to the germs many years before, but were able to resist the disease until they began to bear children. This seems to be the reason why women suffer a higher mortality rate from tuberculosis than men.

**Indirect Causes.** Even more important in some cases than direct causes is a lack of knowledge about tuberculosis. Therefore, the Indians may neglect treatment when it is needed. When the disease reaches an advanced stage, they may look for magic cures from unscientific medical practitioners among their people.

Attitudes which influence the behavior of many of the reservation Indians are still closely tied to the old Indian culture. Failure to recognize the early symptoms of tuberculosis is often a result of their attitude that there must be some outward evidence before there is any real illness. This attitude may be a reason why some leave the hospital against medical advice while the germ is still active.

The resignation to death when tuberculosis reaches an advanced stage is also a persistent attitude of the old culture. As death approaches the Indians want to be with their families for comfort and attention, and the family tries to give them affection and happiness before they die.

**Institutional Treatment**

In June 1955 we conducted a series of interviews at the Sioux Sanatorium in Rapid City. Twenty-two men and fifteen women were inter-
viewed. No attempt was made to interview critically ill patients or those who did not wish to cooperate. Most of the patients were young adults; 22 were under 20 years of age and two were over 50.

The patients were largely from the major reservations in South Dakota. Fourteen were from Pine Ridge and twelve were from Rosebud and Cheyenne River.

Female patients were mostly young married women. Ten were housewives, two were unemployed single women, two were students, and one was a domestic worker.

Most of the men were unskilled laborers or farmers and ranchers. Only two were semi-skilled or white-collar workers, four were students, four were unemployed, seven were common laborers, and eight were small scale farmers or ranchers.

**Understanding of Tuberculosis.**

To determine their understanding of the disease, we asked the patients, "What is the cause of your illness?" Over half knew only that they had a spot on their lungs or "the coughing disease." The rest knew that it was caused by germs, but their knowledge varied from this fact to an adequate understanding of how the germs caused the disease. A small number believed they had no disease.

Although their knowledge of the cause of their illness was limited, almost all of the patients interviewed were satisfied with the treatment in the sanatorium. A few who were dissatisfied said that they didn't like the confinement or that in spite of treatment they hadn't shown any improvement.

Almost a third of the patients interviewed had a parent, brother, or sister who had received treatment at the sanatorium or who had died from tuberculosis.

**Isolation from Family.** Over half of the patients interviewed said they had never had a visit from any member of their family since entering the sanatorium. Only two were visited as often as once a week.

As the patients did not know when they would be released, their plans for the future were vague. Almost half had no plans at all. Some were going to attend school, get married, or return to their farm or previous job. A few hoped to get a job or improve their work skills from a rehabilitation program.

Only a very small number of the patients felt that they were needed at home to provide financial support or other household needs. Many stated that their families were not dependent upon them or could get along with the help of other family members or relatives. The married patients with children often mentioned that their families were living with relatives. The lack of family responsibilities was most apparent among the unmarried males.

**Controlling Tuberculosis**

Tuberculosis can be controlled just as effectively among Indians as it has been controlled among the rest of the population of South Dakota. From the results of this study, it seems that the best method would be to provide better health education.

The conclusion of the 1952 Conference on Tuberculosis Among In-
diants is a challenge: “Our Indians, many of who have been so long neglected, are just as entitled to health protection and educational advantages as any other citizens of our country. Until both have been provided for them, our country will not have fulfilled its obligation to this minority group.” (Project 273.

Leader: Vernon Malan, Rural Sociology Dept.)


2Foard, Fred T., “Conference on Tuberculosis Among Indians, the Tuberculosis Problem Among Indians,” Transactions of the Forty-eighth Annual Meeting of the National Tuberculosis Association, 1952.

SBE of Cattle

Continued from page 107

oculated with SBE virus and in 12 of 14 normal calves. However, it is possible that the virus found in the feces of normal calves is a type that will not infect cattle.

In New York, a virus belonging to the psittacosis group was found in a high percent of apparently healthy cattle. This virus was infective for guinea pigs but would not cause infection in cattle, except when inoculated into calves deprived of colostrum.

Calf Inoculations

Inoculation trials were made in cattle to further study the relation of SBE virus and the virus found in the feces of normal calves. Four calves were inoculated with fecal strains of virus. They were later autopsied. No evidence of infection was found in two calves, each inoculated with a different strain of virus. The other two calves, inoculated with a third strain of fecal virus, showed inflammations typical of SBE. There were SBE-infected calves in the same stable when this strain was recovered, so the “normal” calf providing this strain may have taken SBE virus into the digestive tract.

Cattle experimentally infected with SBE that recover have proven immune when inoculated again. However, seven calves inoculated with strains of virus recovered from normal calves developed lesions typical of SBE when later inoculated with SBE virus. They were not immunized by the virus from feces.

Two other calves were inoculated with virus recovered from feces of a calf 5 to 6 weeks after infection with SBE. They were immune when tested later. One calf was inoculated with virus from feces of a “normal” calf that shared a pen with an SBE infected calf. This calf was also immune later.

Results indicate that virus strains from the feces of normal cattle not exposed to SBE virus are non-infective and do not stimulate immunity against SBE virus. There is also evidence that SBE virus was present in the feces of a calf that recovered from experimentally produced SBE and also in the feces of its pen mate, which had constant contact but had not been inoculated. (Project 171. Leader: G. S. Harshfield, Veterinary Dept.)
PLUM SLUMP
Baking powder biscuits (any recipe using 1 cup flour)
2 cups plums (frozen with sugar)
1/2 cup sugar
1/4 cup water
1/8 tsp. cinnamon

Prepare biscuits. Combine plums, sugar, water, and cinnamon in a saucepan. Cover tightly and cook slowly to the boiling point. When boiling, cover with biscuits, place a tightly fitting cover on pan and continue to cook over slow heat for 25 minutes. Remove biscuits and pour cooked plum sauce over them. Serve hot with cream, whipped cream, or ice cream.

PLUM SNOW
1 pkg. unflavored gelatin dissolved in 1/4 cup cold water
3/4 cup hot water
2 cups plum puree (canned or frozen)
sugar to taste
2 egg whites, unbeaten

Dissolve gelatin in cold water. Add hot water. Stir until completely dissolved. Add plum puree and sugar. Chill until slightly thickened. Place in bowl of ice cold water, add egg whites and whip until fluffy and thick. Spoon lightly into sherbet dishes or glass bowl. Chill until firm. Serve with soft custard sauce or whipped cream if desired.

PLUM SHERBET
1/2 cup water
1/2 cup granulated sugar
2 cups plum puree (pulp and juice) or if plums are very tart use 1 cup plum puree and 1 cup sweetened apple sauce.
11/2 tbsp. lemon juice (optional)
1/16 tsp. salt
1/2 cup top milk or cream*

Cook water and sugar slowly for 10 minutes. Cool. Run plums through food mill or strainer. Measure. Add lemon juice, salt, sugar syrup, and top milk or cream. Pour into freezing tray and freeze until firm. Remove to mixing bowl and whip with electric or hand beater until mix becomes light and creamy. Return to tray and finish freezing.

*Note: Cream gives a smoother sherbet with less chance of tiny ice crystals forming in the sherbet.

JELLIES AND JAMs
Plums are very good for making jelly or jam either alone or combined with apple. Most plums contain enough pectin to gel without adding commercial pectin. Suggested proportions are 11/4 cups sugar to 1 cup juice obtained by the usual double extraction method. The color of the product will vary from a deep yellow to deep purple depending upon the variety of plums used. Plum pulp can be used in combination with apple pulp for a very acceptable plum-apple butter. (Project 210, Leaders: Lida Burrill and Beth Alsup, Home Economics Dept.)
Reports on major research projects for many of the departments appear in the forepart of this publication. Titles of these reports are also listed in their respective divisions with a page reference. In this way the work of the station in a given field appears under a single heading. Work at the substations is included here too—there is no separate substation report.

Agricultural Biochemistry

Farm Water Problems

To determine whether certain types of products, or combinations of them, might be more effective in helping the housewife keep white fabrics white even when laundering in hard water, a study of these problems has been started.

White cotton tea towels are collected and laundered in water of varying degrees of hardness and using a variety of laundry products. The whiteness of the towels is read periodically, and comparisons can be made as to the effectiveness of different types of laundry products in hard water. Another set of towels exactly like the used ones are laundered along with those which are in use but remain in the laboratory and serve as controls for comparison. An additional set of new towels is also provided so that comparisons can be made among new, laundered, and used towels.

After 15 days of use and 15 launderings, it is possible to see a considerable loss of whiteness of the towels receiving certain treatments. It is planned to carry these through at least 25 or 30 times of use and then whiteness retention and wear can be determined.

During the past year a taste panel has been evaluating the flavor and color of coffee brewed from 12 different natural waters collected from various sections of South Dakota. Another series of artificial mineral waters of 0, 30, 60, and 120 grams per gallon of various chemical compounds commonly found in the natural waters has also been used in making coffee. Laboratory measurements of the acidity or alkalinity of the water and of the coffee have been made. Turbidity or cloudiness is still another characteristic which has been investigated. These data are being summarized and studied for possible interrelationships of these many factors. Similar studies with both black and green tea are in progress.

It is possible that methods now being tested on city water supplies for the reduction of the mineral content of water may be applied on a small scale to farm water supplies. Desalting equipment based on the principle of the movement of ions through membranes under the influence of an electric current has been built and is ready for experimental trials.

A problem in dugouts used for water storage has developed and is receiving at-
tention. In some cases dugout waters have been found to have an extremely high content of soluble salts, making them unfit for livestock. The salts present in greatest amounts are sodium and magnesium sulfates. Investigations are now under way to determine why this situation develops in the cases that it does and what might be done to prevent it. (Project 275. Leaders: L. O. Lund and L. M. Burrill, Home Economics Dept.; H. H. DeLong, Agricultural Engineering Dept.; G. F. Gastler and O. E. Olson, Biochemistry Dept.)

Cobalt Investigations

The analysis of samples from several parts of the state for cobalt was continued. Western wheatgrass collected during early July was again used as a basis for comparing the cobalt status of the various areas, but other samples were also analyzed.

At every location there were analyses on western wheatgrasses lower than 0.07 parts per million of cobalt, the level considered critical for cattle.

When several kinds of plants from the same location were analyzed, most were found to be higher in cobalt than western wheatgrass. Furthermore, when prairie hay, containing a mixture of plants, was analyzed, it was found to be higher in its cobalt content than western wheatgrass at the same location, and to contain more than 0.07 parts per million. It does not appear, then, that widespread areas of cobalt deficient soils occur in this state. (Project 19. Leader: G. F. Gastler, Biochemistry Dept.)

Selenium Poisoning

Two Organic arsenicals, arsanilic acid and 3-nitro-4-hydroxyphenylarsanic acid, have been tested in five separate experiments and found to afford swine good protection against selenium poisoning. Recommendations for their use with growing-fattening pigs have been published. Linseed oil meal also gave some protection against selenium toxicity, but did not give as good weight gains as soybean oil meal.

With cattle, linseed oil meal at 2 pounds per head per day gave no protection against selenium poisoning. Sodium arsenite fed in the salt at a level of 35 p.p.m. of arsenic was not noticeably effective either, probably because in this form arsenic must be supplied at such a low level to be safe. The organic arsenicals mentioned above are now being tested since it appears from preliminary experiments that they are safe at fairly high levels and since they have been found effective in chickens as well as in swine.

The amino acid, methionine, and some related compounds have been found to give some protection against selenium poisoning in rats. The degree of protection is not large, however, and these chemicals appear to have no practical value in controlling the poisoning. They may be helpful, nevertheless, in clarification of the toxic action of selenium.

Basic research on the protective effect of arsenic against selenium has indicated that prevention of passage through certain cell walls may be involved. If so, arsenic may protect by keeping selenium from reaching the locus of its toxic action. Basic research on linseed oil meal indicates that a non-protein component is active against selenium and efforts to identify it are still in progress. With plants, large scale chromatographic purification of selenium compounds is under way in an effort toward identifying their chemical structure. (Project 19. Leaders: O. E. Olson, E. I. Whitehead, C. W. Bonhorst, A. W. Halverson, Biochemistry Dept.; C. A. Dinkel, R. C. Wahlstrom, Animal Husbandry Dept.)

Nutrients in Stack Silage, see page 52

Nitrate Poisoning, see page 70
Crop Insects

European Corn Borer

The European corn borer has now been recorded (specimen records) from all but two counties in South Dakota. It is without doubt distributed over the entire state.

The feasibility of the use of insecticides as an emergency control measure has been established. However, because of the inconvenience of mixing sprays and application of sprays and dusts these control measures seem to have had a rather slow rate of adoption by farmers.

New types of insecticides, in the form of granules, are now on the market. Granular insecticides will be tested this season.

Parasite introductions have been made over the past 5 or 6 years. It appears that at least two species, *Lydella griseascens*, a fly, and *Horogenes punctorum*, a wasp-like insect, have become established. A third species, *Symopsis sp.*, introduced in western Minnesota and western Iowa, has apparently spread into South Dakota and is established in the entire eastern part of this state. (Project 187. Leader: Gerald B. Spawn, Entomology-Zoology Dept.)

Investigations of the Alfalfa Insect Situation in South Dakota

Alfalfa weevil control experiments using granular insecticides have been set up in Butte and Lawrence Counties. The insecticides were applied before the alfalfa began its first spring growth and the results are to be compared with the insecticides applied as sprays at the recommended dosages. Hay yield data will be taken in mid-June.
Twenty colonies of honey bees have been established for use in alfalfa pollination studies in Brookings County. These studies will be conducted on second crop alfalfa (second growth).

A 30-acre field of alfalfa has been reserved for second crop seed production in Brookings County. This field will be used to test the various insecticides, proper dosages, and proper timing of their application under South Dakota conditions.

A small stock pile of various insecticides suitable for use in aphid control on legumes has been made in readiness for possible tests to be initiated if the spotted alfalfa aphid continues its present path and infests South Dakota alfalfa in economic numbers. (Project 288. Leader: R. J. Walstrom, Entomology-Zoology Dept.)

Emergency Outbreaks of Insects and Their Control

Screw-worms and Secondary Maggots. Seven samples of secondary maggots were received from farmers, county agents or veterinarians for identification during the past fiscal year. No true screw-worms were submitted to us for identification during the past year.

The Tree-hopper or Membracidae. An additional 200 tree-hopper specimens were collected during the past year from areas where no previous collection had been made or where but few specimens had been taken. Approximately 5,000 tree-hopper specimens have been collected in South Dakota thus far. The collection is sufficiently large to give adequate information regarding the distribution in the state of each species. The most harmful species that occur in South Dakota are the Buffalo Tree-hopper (Sictio cephala bubalis (Fahr.) and the Flat footed Tree-hopper (Campylenchia latipes (Say)).

The Lady Beetles or Coccinellidae. Another 500 specimens of lady beetles were collected in South Dakota during the past fiscal year. More than 10,000 specimens of Coccinellidae have been collected in South Dakota thus far and these have all been identified. The collections were made in practically every county of the state and now include nearly all, if not all, species that occur in South Dakota.

Insect Pest Surveys of the Substations. An insect pest survey was made last year of the Substations at Cottonwood, Eureka, Highmore, and Antelope Range and of the government station at Newell. The stations at Highmore and at Antelope Range were visited twice, once in June and a second time in September. Outbreaks and impending outbreaks of harmful insects were noted and all concerned with such outbreaks were notified by written report. The report also contained recommendations for the control of the pests. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

Buffalo Treehopper, see page 64

Crops and Soils

Maintaining Soil Fertility

Experiments are in progress comparing the various methods of supplying and maintaining the nitrogen levels in the soil with special emphasis on legumes and nitrogen fertilizers. Twelve new crop rotations are under way comparing the efficiency and economy of nitrogen fertilizers with various kinds of legume rotations.
Another phase of the nitrogen problem is the amount of fertilizer nitrogen which is carried over to the second crop after application or the residual effects of nitrogen fertilizer. It has been found in eastern South Dakota that there is an appreciable carry-over of nitrogen to the second year which increases crop yields, especially when the year of application of the nitrogen fertilizer has below normal rainfall.

Experiments are under way to determine whether there is any loss of fertilizer nitrogen by fall application under the more humid conditions of eastern South Dakota. The 1955 results show that the time of application had little or no influence on yield. Fertilizer treatments, however, gave highly significant wheat yield increase.

Crop yields are influenced by many practices which include tillage, fertilizer, crop residues and manures. Experimental results show that where the fertility of the soil is improved by crop residues, fertilizers, and manure, the highest yields of crops are obtained. Subsurface tillage alone and with residue produced somewhat larger yields of wheat than the corresponding treatments with plowing. Even under the drought conditions which prevailed in the spring of 1955, the better yields of small grains were obtained where the fertility of the soil was maintained at optimum levels (Fig. 1). (Project 46. Leaders: L. F. Puhr and W. W. Worzella, Agronomy Dept.)

Soil Testing Expands Rapidly

Over 7,600 soil samples were analyzed during the past year, approximately 97 percent of which were submitted by, or for individual farmers. Several fertilizer companies or distributors have evidenced considerable interest in the soil testing program, and have assisted farmers in obtaining and submitting samples.

Cooperation with the National Soil Test Work Group was continued in the evaluation and development of more accurate methods of determining the nitrogen supplying ability of soils. South Dakota farmers continued to express an interest in irrigation by submitting 80 water and numerous soil samples for analysis. (Project 172. Leaders: P. L. Carson, R. C. Dodge, Agronomy Dept.)

Brookings County Soil Survey Completed

A soil survey of Brookings County has been completed and will soon be published in two forms: (1) A Soil Survey Series designed for farmer use containing air photo soil maps along with soil management information and short soil descriptions, and (2) a documentary report containing soil maps of the entire county, along with complete soil descriptions and soil management information. The documentary report is designed for users desiring soils information for the entire county.

In the past year 398 square miles of soils were mapped in Brookings County and 294 square miles in Hand County by state soil surveyors. After the soils are classified and their boundaries plotted, the dominant soil types are sampled and analyzed in the laboratory. Last summer 31 complete profiles were sampled and analyzed. (Project 183. Leaders: F. C. Westin, G. J. Buntley, E. M. White, Agronomy Dept., in cooperation with the Soil Conservation Service.)

New Research Farms Started Near Menno and Watertown

Agronomic practices which will influence the efficiency and stability of crop production are being investigated on the research farms located near Menno and Watertown. Experimental work now under way includes (1) effect of fertilizer and nurse crop in establishing stands of bromegrass and stands of alfalfa, (2) effect of wide row spacing and intertillage to obtain seed crops of
bromegrass and alfalfa, (3) a comparison of nitrogen from legumes to nitrogen from commercial fertilizer to increase crop yields, (4) experiments to determine which is the most efficient method of commercial fertilizer use—a small amount applied every year or a large amount applied once in 5 years, (5) minimum tillage or "once over tillage" with corn, (6) a comparison of different nitrogen fertilizer carriers for corn and small grain, and (7) determine the residual effect on grain crop yields from plowing under stands of alfalfa of varying ages. (Project 256. Leaders: F. E. Shubeck and Q. Kingsley, Agronomy Dept.)

Physical Properties of Soil Studied

The organic matter content of many South Dakota soils has declined to as little as 50-55 percent of the original content under 60 to 80 years of farming. Changes in the structure of the soils are associated with these farming operations. It is believed that the structural changes have progressed to the point of reduced productivity of the soil.

Investigations are under way to determine the extent of the changes in the physical properties of the soil associated with different management practices. The physical properties of the soil such as aggregate stability, bulk density, air permeability, aeration porosity, water permeability, and water retention, are being studied on soils which have been under different management practices for a period of years. With such information available, one can determine the extent of the changes in the physical condition of the soil as a result of different management practices and the means needed to improve this physical condition.

With greater use of fertilizers, improved crop varieties, and better management practices, soil moisture is becoming an increasingly more important factor which limits plant growth. Information is needed on the plant-available water storage capacities of the different soils, the seasons of the year when soil moisture reserves are increased or depleted, the depth utilization of the different crops, and the quantity of water used to produce a particular yield level. Investigations are now in progress to obtain this information. This information will also give the total quantity of water used to produce the particular crop. (Project 256. Leader: J. R. Runkles, Agronomy Dept.)

Traill, a New Barley

Traill, a new high yielding barley strain, released for 1956 planting, represents a potential improvement in yields that may help barley regain some of its former prominence in the state. It was developed in cooperation with the North Dakota Experiment Station. Breeding work in barley is concerned with the combination of suitable maturity level, heat resistance, smut and rust resistance with high yield. Feed barley development remains a very important phase of barley work in South Dakota.

Individual winter wheat lines have been developed which have shown field winter survivals in two seasons 50 percent superior to the recommended variety Minter. Should these lines have good quality and be satisfactory in agronomic qualities, it is quite likely that one or more may be increased, and may provide protection against winter killing in winter wheat in areas of the state where that is now a major hazard.

Pierre, Antelope, and Caribou, the three rye varieties recommended for this state, were the only ones making satisfactory winter survivals at all locations in South Dakota in the severe winter of 1955-56. Yield in rye has been closely associated with winter survival. (Project 25. Leader: D. D. Harpstead, Agronomy Dept.)

New Wheat and Oat Varieties

The release to South Dakota farmers of Yuma durum wheat for 1956 seeding
is the beginning of the comeback of northeast South Dakota as a producer of quality durum wheat. In 5 years, durum wheat acreage had slumped from 225,000 to 13,000 acres in the six major counties and production from 3,800,000 bushels to 135,000. Yuma has the disease resistance that will again make durum wheat a stable crop in this area.

Insurance against changes in stem rust races of bread wheat and oats before disaster strikes is provided by varieties like Conley spring wheat and Ransom oats, both released for 1956 planting. Conley is resistant to rust races that can attack Selkirk wheat and which are distinct threats to the future of Selkirk.

The oat variety, Ransom, is resistant to races 7, 7A, and 8 of oat stem rust and so is superior to varieties susceptible to one or more of these races. That makes it uniquely able to resist changes in diseases. Ransom also has earliness and excellent test weight. The oat variety Newton, also released in 1956, provides a Race 7 resistant Nemaha type plant for growers preferring that maturity level.

Yield trials of a large number of varieties in spring wheat, oats, and flax showed that the varieties recommended for planting in 1955 were superior or equal in performance to any other varieties that could be made. Thus, Selkirk, Lee, and Rushmore wheat were high, Mo-0-205 continued outstanding among oat varieties in South Dakota, and Marine and Sheyenne were best among flax varieties.

Research work which may be reflected in varieties of the future includes a breeding program to develop a variety of good quality, adaptation, and disease resistance with higher test weight than Selkirk and Conley. Selections are being made at both Brookings and Newell.

Heat resistance as well as disease resistance are major goals in oat breeding, while irradiation is being used to increase variability in flax in anticipation of the day when the present varieties may have to be replaced. (Project 181. Leader: V. A. Dirks, Agronomy Dept.)

### Grain and Forage Sorghum Testing and Breeding

Yield tests on 37 grain sorghum varieties and strains, 5 forage sorghum varieties, and 2 sudan grass varieties were conducted at 7 locations in 1955. The purpose of the work is to secure information on the relative performance ability of new promising strains as compared with standard varieties.

The grain yields (table 1) of the standard varieties tested show that Reliance and Norghum produced the highest average yields of grain. The other varieties were in most cases somewhat late in maturity. This is probably the main reason they produced less grain per acre.

Forty-eight strains and varieties of grain sorghum from six states tested in a Uniform Regional Sorghum Nursery

### Table 1. Yield in Bushels per Acre of Sorghum Varieties in 1955

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brookings</th>
<th>Highmore</th>
<th>Kennecott</th>
<th>Cottonwood</th>
<th>Newell Dry Land</th>
<th>Newell Irrigation</th>
<th>Eureka</th>
<th>Av Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliance</td>
<td>45.0</td>
<td>32.2</td>
<td>20.6</td>
<td>3.3</td>
<td>12.9</td>
<td>33.9</td>
<td>41.6</td>
<td>22.0</td>
</tr>
<tr>
<td>Norghum</td>
<td>48.9</td>
<td>27.6</td>
<td>34.3</td>
<td>3.0</td>
<td>20.9</td>
<td>41.7</td>
<td>55.3</td>
<td>33.1</td>
</tr>
<tr>
<td>Martin Milo</td>
<td>44.7</td>
<td>15.4</td>
<td>23.1</td>
<td>0</td>
<td>7.2</td>
<td>19.9</td>
<td>8.6</td>
<td>17.0</td>
</tr>
<tr>
<td>Redbine 60</td>
<td>39.9</td>
<td>16.6</td>
<td>23.0</td>
<td>0</td>
<td>4.0</td>
<td>21.9</td>
<td>14.5</td>
<td>17.1</td>
</tr>
<tr>
<td>Improved Coes</td>
<td>41.3</td>
<td>15.5</td>
<td>26.4</td>
<td>0</td>
<td>15.6</td>
<td>37.9</td>
<td>28.3</td>
<td>23.5</td>
</tr>
<tr>
<td>Early Kalo</td>
<td>55.7</td>
<td>16.6</td>
<td>24.9</td>
<td>0</td>
<td>8.7</td>
<td>26.4</td>
<td>20.3</td>
<td>21.8</td>
</tr>
<tr>
<td>Sooner Milo</td>
<td>54.7</td>
<td>7.0</td>
<td>32.2</td>
<td>0.2</td>
<td>4.9</td>
<td>19.0</td>
<td>28.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Hegari</td>
<td>8.1</td>
<td>8.0</td>
<td>1.0</td>
<td>0</td>
<td>7.3</td>
<td>26.2</td>
<td>0.5</td>
<td>7.3</td>
</tr>
</tbody>
</table>

123
at four of the locations. These strains were evaluated for adaptability, maturity, yield and other agronomic factors. Twelve hundred and eighty F3 to F8 colchicine-induced crossed variants of grain and forage sorghums were grown in the breeding nursery for observation and evaluation. Also 118 very promising colchicine-treated strains were selected and will be put into a variety test for further evaluation. (Project 61. Leader: C. J. Franzke, Agronomy Dept.)

Grant, A New Soybean, Increased

Because of new and adapted varieties resulting from this project, South Dakota farmers increased their soybean acreage from 43,000 acres (1944-53 average) to an estimated 272,000 acres in 1956, resulting in greater stability and higher income. These tests are in cooperation with the U. S. Northern Regional Soybean Laboratory of the North Central States.

Grant, a new release, was increased to about 500 bushels and distributed to the County Crop Improvement Association located in the northeastern part of the state. Grant has the same maturity as Ottawa Mandarin. The plant characters and seeding habits are very similar to those of Blackhawk. It has been a consistent high yielder in the early maturity zone of South Dakota.

Under field conditions, 193 F4 strains from 12 crosses which were not treated and treated with colchicine were evaluated for agronomic factors. The results showed that 42 untreated strains averaged 13 days later than Ottawa Mandarin. None of the strains were as early as the check. The 151 treated strains from the same crosses averaged 16 days later than the check. Thirty-one of these strains were of the same maturity up to 5 days earlier than the check. None of the untreated strains yielding ability were significantly higher than the check. Sixty-one strains from the 151 treated group yielded 3 to 13 bushels per acre more than their highest yielding strain within their respective untreated group. (Project 148. Leader: C. J. Franzke, Agronomy Dept.)

South Dakota Corn Hybrids Outstanding

Over five times as much certified seed of South Dakota-developed corn hybrids was used by farmers in 1955 as in 1946. It is estimated that this added to the income of farmers tremendously since station hybrids have consistently shown up well in competitive yield trials the last few years. In all but one of the tests a South Dakota hybrid was among the first five in performance and in over half of them they were among the top three hybrids.

The better inbred lines developed in the breeding nursery, along with good lines from other experiment stations, are combined into single crosses for yield testing to predict new double cross combinations. Last year six such tests were conducted. These covered material of three different maturities.

Yield tests are also conducted each year of promising double crosses. In 1955 seven such trials were carried on, again on different maturity material. The results from Codington County were typical and good evidence that better hybrids are on the way. In the trial on experimental double crosses, 13 experimental combinations performed better than the best of several commercial corns used as checks.

Two top cross tests involving material developed for root rot resistance by the Plant Pathology Department were conducted as cooperative work with that department in an effort to develop disease resistant hybrids. (Project 66. Leaders: D. B. Shank, D. E. Kratochvil, Agronomy Dept.)

Many Commercial Corn Hybrids Tested

Thirteen yield tests of corn hybrids being used extensively by South Dakota farmers were conducted in 1955. These were located throughout the state so that
each of the state's eight agricultural areas contained at least one trial. They were conducted near Newell, Vale, Cottonwood, Eureka, Highmore, Claremont, Brookings, Watertown, Chamberlain, Tripp, Dell Rapids, and Wakonda.

From 20 to 40 entries were included in each trial. They were the hybrids most widely used in the area represented by each test. Selections were made from recommendations made by the corn companies selling the hybrids and from surveys made by county agents as to the hybrids being sold in their counties.

Information obtained included yield and moisture content of the corn at harvest, the latter being indicative of relative maturity. Lodging was taken on plots when possible. Average performances were calculated for entries included more than one year. The results obtained have been published in South Dakota Agricultural Experiment Station circular 121.

Yields from all trials except those under irrigation and the test north of Watertown were below average. An early frost date plus drought and high temperatures throughout the season contributed to low yields and poor quality in most tests. (Project 151. Leaders: D. B. Shank and D. E. Kratochvil, Agronomy Dept.)

Grass Strains Improved

Strains superior to adaptability and usefulness are being selected in the main cultivated grasses used in South Dakota—smooth brome grass, intermediate wheatgrass, and crested wheatgrass. Progress in selection for leaf spot resistance is being made in smooth brome grass and a preliminary synthetic variety has been made. Testing of a synthetic variety of intermediate wheatgrass indicates a 50 percent increase in seed yield coupled with an increase in forage yield over Ree wheatgrass. High forage yield, root rot resistance, and desirable seed type are selected for in crested wheatgrass. A synthetic variety will be tested when seed becomes available from plantings made this year.

Advanced generations of crosses between wheat and wheatgrass are being selected for winter hardy types as well as high forage yield and large seeds. Artificial freezing tests are being used as a means of making selections. Cyto logical examinations of these selections to determine their probable fertility have been made. Successful selection of large seeded winter hardy types gives promise of ultimate success in production of a commercial variety but continued selection must be made for seed yield.

Breeding work is expedited by the use of disease tests for selections of resistant types in the greenhouse as well as the field. Selected clones are crossed in the greenhouse so that a new advanced generation can be transplanted into the field in the spring. New species and strains originating from this and other experiment stations are being tested at Brookings, Menno, Watertown, Highmore, Eureka, and Cottonwood. (Project 182. Leader: J. G. Ross, Agronomy Dept.)

Pasture Trials

The pasture trials started in 1953 were grazed the third season with Hereford yearlings. These include brome grass, alfalfa-brome, sweet clover-rye, and soybean-sudan pastures. Each was fertilized to maintain good soil productivity. The brome grass and alfalfa-brome pastures are divided in half so that the livestock can be rotated every 2 or 3 weeks for better utilization and management of the forage. The livestock on the sweet clover-rye and soybean-sudan pastures were not rotated.

The amount of forage consumed by the livestock was determined by clippings made from plots outside and inside of protected cages. Forage consumed per pound of gain in body weight varied from 14 to 16 pounds. Forage clippings representing an estimate of
amount consumed were as follows in 1955: brome 2,963 pounds, alfalfa-brome 3,714 pounds, sweet clover-rye 2,707 pounds, and soybeans-sudan 1,837 pounds per acre. Because of the hot dry season, the growth of the soybean-sudan pasture was small. The results obtained with livestock are reported under "Livestock Production." (Project 225. Leaders: W. W. Worzella, Agronomy Dept., L. E. DuBose, Animal Husbandry Dept.)

Physiology of Alfalfa

A project was started with the U. S. Department of Agriculture to study the physiology of the alfalfa plant in relation to environment, growth, habit, and genotype. Attention has been directed primarily toward establishing and equipping a physiological laboratory for study of chemical composition and metabolism of alfalfa. Experiments have been initiated on cold and drought hardiness and the relationship of maturity, stage of growth, and water stress to water content of various tissues of several alfalfas varying in resistance to drought and having different growth habits. (Project 295. Leader: C. R. Swanson, Agronomy Dept., in cooperation with USDA.)

Weed Research

Weed research has been devoted primarily to studies on the use of competitive crops, cultivation, and chemicals for the control of leafy spurge, Russian knapweed, Canada thistle, and perennial sow thistle; the testing of new chemicals for use on annual grassy weeds; and the study of the effects of chemicals on crops.

The perennial weed studies were conducted on a 30-acre leafy spurge farm in Deuel County, a 12-acre Russian knapweed farm in Spink County, and a 25-acre thistle farm in Hamlin County.

On the leafy spurge farm, 2,4-D was used in conjunction with brome grass, with winter rye, and other crops. Intensive cultivation was also combined with some of these treatments. The third series of 3-year experiments were finished in 1955. The outstanding treatments were (1) intensive cultivation followed by fall seeding of brome grass which was sprayed the next year, and (2) 2 years of rye, sprayed, followed by a crop of sudan grass.

The knowledge gained from these experiments was used to set up a new series of 4-year experiments in 1956, in an attempt to utilize better crop rotations. Likewise, a new set of 4-year experiments was initiated to see if soil building rotations will prevent reinfestation of land on which the weed has been eliminated.

Several of the new chemicals tested give promise of being useful for the control of leafy spurge. These include amino triazole, silvex, and new formulations of 2,4-D.

On Russian knapweed, a 3-year experiment utilizing perennial forage crops was terminated in 1956. As on leafy spurge, the best results were obtained when the crop was fall seeded after a season of intensive cultivation. Brome grass, crested wheatgrass, and alfalfa were equally effective when no spraying was done. However, spraying in the grasses with 2,4-D was helpful in eliminating the weed. Late summer spraying was more effective than earlier spraying; however, spring spraying prevented seed production.

No results have been obtained from the research on the thistle farm. Some greenhouse and laboratory studies indicate, however, that perennial sow thistle seeds are viable 6 days after the flowers open. Canada thistle requires insects for pollination and has viable seeds 1 week after the flowers start to turn brown.

Of all the chemicals tested, none were satisfactory for killing wild oats. TCA and Dalapon were the two best ones for foxtail. TCA can be used in flax and legumes but not in small grain.

Several new varieties or lines of small
grain were tested for the stage of growth that is most tolerant to 2,4-D. All varieties of a given crop gave the same response. Seven barley varieties or lines were more susceptible at the 3-leaf and boot stages of growth than at the 4-leaf, 5-leaf, 6-leaf, or heading stages of growth. Four wheat varieties were most susceptible at the 3-leaf stage and seven oat varieties were injured at the 3-leaf, 4-leaf, 5-leaf and boot stages.

In a single experiment, 2,4-D dust with minor elements added was compared with 2,4-D and MCP sprays for weed control in flax. All gave equally good annual weed control and flax yields were the same for all treatments.

More detailed information can be obtained from Experiment Station Circular 122 entitled, "Weed Control Research in South Dakota." (Project 32. Leader: Lyle A. Derscheid, Agronomy Dept.)

Also see: Some Factors that May Affect Bloat, page 128
Nutritive Value of Hay and Grasses of the Northern Great Plains, page 142
Irrigated Pastures in Western South Dakota, page 147

Dairy Production

Improve of Dairy Cattle Through Breeding

Two lines of Holstein cattle are being studied. All heifer calves in the South Dakota State College herd are weighed at birth and growth rate measurements are taken at various age intervals through maturity. This study will require several years before definite growth trends can be established for growing dairy heifers in the North Central area. (Project 153. Leader: Emery Bartle, Dairy Dept.)

Growth Studies of Calves and Heifers

The development of dairy heifers from birth until maturity is being developed by inbreeding to two sires. These lines are designated as B and R. Sire 1, Line B, has 35 daughters and has 13 inbred matings (F X = .25). Sire 1 of Line R has 27 matings and will be mated to half of his daughters. Inbred line crosses with reciprocal crosses are scheduled when inbreeding coefficients approximate 30 percent. An outbred control group maintained by artificial insemination as recommended by the NC-2 technical committee is provided in the plan.

Studies were conducted on the relationship of type classification ratings and butterfat production. The correlation between overall type ratings and butterfat production was -.28. The highest correlation found was that of dairy character classifications and butterfat production, which was -.58.

Factors which might influence breeding progress were examined. The most recent calving interval was 12.5 months, the second most recent, 13.6 months. Conception rates for the three sires were 74, 61 and 70 percent. Calf mortality was 7 percent, mostly from stillbirths.

Five cows with production records averaging 4,826 pounds of milk and 146 pounds of fat were culled. The herd average (305 2x M. E.) was 12,474 pounds of milk and 413 pounds of butterfat. (Project 184-R. Leaders: Howard H. Voelker and Emery Bartle, Dairy Dept.)
Recovery and Transplantation of Bovine Ova

Investigations this year dealt with the use of superovulating hormones, effects of relaxin upon the cow's cervix during estrus, and the use of progesterone for controlling the estrus period and its effect upon ovulation.

Injections of follicle-stimulating hormone preparation do not always initiate the liberation of ova. Administration of the lutinizing hormone injected after the follicle-stimulating hormone has been helpful but does not cause ovulation in every case. The administration of a luteotrophic hormone preparation has been tried in conjunction with the lutinizing hormone in an attempt to liberate additional ova. Results to date are inconclusive.

The effects of relaxin upon the cervix have been demonstrated, and inasmuch as the effects of relaxin are most beneficial when administered in conjunction with diethylstilbestrol, further experiments have been conducted to determine whether or not relaxin will greatly relax the cervix during the estrus period. Limited experiments this year suggest relaxin is not beneficial during this period.

The use of progesterone for controlling the estrus period is somewhat variable. Frequently ovulation is absent after an estrus period following progesterone treatment.

The isolation of ova by limited quantities of flushing materials has been continued. Attempts have been made to recover the ova 5 days post-estrus, but these seem to be no more beneficial than when the ova were recovered 7 days post-estrus. (Project 189. Leader: A. E. Dracy, Dairy Dept.)

Improved Pastures for Dairy Cattle

Pastures consisting of bromegrass and alfalfa have been established on the State College dairy farm to study pasture problems. Free-range, controlled or strip grazing, and cutting fresh forage for dry lot feeding are pasture management methods for dairy cows that are being studied. Carrying capacity, milk and butterfat production, and dollars income per acre are factors included in this study. (Project 234. Leader: Emery Bartle, Dairy Dept.)

Some Factors That May Affect Bloat

During the last year the following observations have been investigated that may be helpful in controlling bloat. Inasmuch as bloat is characterized by an accumulation of gas within the rumen any physiological disturbance that prevents the escape of gas from the rumen should produce bloat. A group of cattle after having grazed on alfalfa pasture for 3 hours were treated with 2.8 grains of atropine per animal. Although the atropine inhibited rumen motility, swallowing, and eructation, not enough gas accumulated to cause bloat.

Two groups of sheep were pastured together. The one group was Hampshire and Columbia; the other group was the No-tail breed developed at this station. Some of the Hampshires and Colombias bloated on alfalfa pasture, but none of the No-tails showed any signs of ruminal distress resulting from bloat.

A group of sheep was also drenched with 4000 ml. of fresh alfalfa juice. Inasmuch as fresh alfalfa usually produces the syndrome of bloat and since other workers have suggested that the juice will produce bloat, legume juice was administered to several animals on a preliminary basis. However, none showed severe signs of bloat.

There is evidence that saponins, chemical components of alfalfa, are involved in the production of bloat. Satisfactory methods for analyzing and differentiating between the various saponins have not been developed and this information is needed before the role these compounds play in the bloat problem can be determined. Extraction and partial purification techniques for obtaining the saponins from fresh alfalfa
have been developed, and a simple assay for determining crude saponin has been devised. Methods for separating the crude saponin into its various components are now being developed. An attempt will be made to correlate bloat production with the saponin content of alfalfa.

A study on the feed-lot bloat problem is being made with sheep. The rations fed are composed of 100, 60, and 20 percent chopped alfalfa hay and a corn-soybean meal mixture comprises the remainder of the latter two. No bloat or digestive disturbances have occurred on these rations in this experiment. Digestion trials and blood and urine analyses are in progress but results are not far enough advanced to report at this time. (Project 245-R. Leaders: A. E. Dracy, Dairy; L. B. Embry, Animal Husbandry; V. Wallace, Biochemistry; M. W. Adams, Agronomy Dept.)

Effects of Oral Administration of Diethylstilbestrol on Young Dairy Calves

Forty-eight calves (Holstein, Brown Swiss, Guernsey; 34 males, 14 females) were used in three experiments to determine the responses to feeding diethylstilbestrol (“Stilbosol,” Lilly Co.) from 4 to 88 and 116 days of age respectively. Females were continued to determine effects on estrus and reproduction.

Calves were individually fed concentrates free choice. Two milligrams (3 milligrams, Expt. 3) stilbestrol per 100 pounds of body weight were fed daily in milk to one-half of the calves; the others were controls. Males were slaughtered at 88 days in Experiment 1. In Experiments 2 and 3 they were castrated at 88 days and continued through 116 days.

Stilbestrol induced no significant effects on weight gains, body measurements, feed consumption, or utilization. Stilbestrol groups averaged 197 pounds, controls 208 pounds at 88 days. At 116 days hormone-treated calves averaged 249 pounds, controls 261 pounds. Dressing percentage in the stilbestrol group was 59.8 and 58.4 in the control group.

Testes weights averaged 9.8 grams in treated calves and 21.07 grams in controls. Testes, tunica albuginea, epididymus, vas deferens averaged 18.9 grams in stilbestrol calves and 38.1 grams in controls. Stilbestrol stimulated rudimentary teat development. Stilbestrol calves were not different from controls in growth of thymus, kidneys, liver, penis, or adrenals. (Project 274. Leader: Howard H. Voelker, Dairy Dept.)

Effect of Aureomycin on the Growth of Chickens in the Presence of Pleuro-Pneumonia-Like Organisms

The investigation of the effect of aureomycin on the growth rate of chickens has led to the consideration of subclinical infections produced by the pleuro-pneumonia-like organisms in the flock. Pleuro-pneumonia-like organisms were isolated and grown from turkeys having acute sinusitis. Chickens were inoculated with this organism and tested for the effect on weight gain with aureomycin.

Forty chickens at 1 month of age were inoculated intratrachially with an active culture of pleuro-pneumonia-like organisms. Thirty of the chickens received from 25 to 30 micrograms of aureomycin per pound of feed.

The birds fed aureomycin showed a weight gain of 87 grams per bird over the control group that received no aureomycin. None of the chickens showed clinical evidence of the chronic respiratory disease that is found in turkeys. Four weeks on the antibiotic was required to develop the maximum effect as shown by difference in weight. (Project 257. Leader: E. C. Berry, Dairy Husbandry-Bacteriology Dept.)

Silage for Dairy Calves? see page 48

Also see: Cream Versus Milk for Quality Dairy Products, page 130
Butter Consumption Study, page 130
Farm Economics

Cream Versus Milk for Quality Dairy Products

The South Dakota dairy industry has been trying to improve the quality of dairy products for many years so it may be in a better competitive position in the dairy products market. One way to do this is to convert dairy plants from cream procurement to whole milk procurement.

A survey of 22 cooperative creameries was made in 1955 to determine the feasibility of shifting from cream to whole milk. Eleven creameries have shifted to whole milk operations since the study was begun. Several reported they were able to utilize preliminary information furnished to them by the Experiment Station.

As the creameries shift from cream to whole milk procurement, a marked improvement in the quality of the dairy products produced in the area is anticipated. A manuscript giving the results of this study is now being written. (Project 201. Leaders: R. L. Kristjanson, Agricultural Economics Dept.; D. F. Breazeale, Dairy Dept.)

Butter Consumption Study

This study attempts to determine consumer's preferences regarding butter quality and flavor. Fifty families in Brookings and 343 in Sioux Falls were surveyed concerning their consumption of and preferences for butter, margarine, and other fats and oils. The data were tabulated and analyzed.

Four panels of 10 families each were used in a butter and margarine preference experiment. Paired samples of the spreads were given to each family for 10 weeks. Both husbands and wives were polled on their preferences. A manuscript covering two completed phases of the study was begun.

A study of cream handling in plastic bags was started. Data were collected concerning procurement costs and cream quality for plastic bags as compared to can handling. This new technique seems to hold great promise as a means of improving butter quality. (Project 272. Leaders: R. L. Kristjanson, Agricultural Economics Dept.; D. F. Breazeale, Dairy Dept.)

Best Time to Market Livestock

Producers of feeder cattle have to determine whether it is best to market their livestock as calves, yearlings, or later. This decision is reflected in the way the ranch is organized, such as a cow-calf operation. Once this decision is reached there remains the difficulty of selecting a time within the season. Whether it is economically feasible to market feeders from ranges more evenly through the year depends largely on the seasonal pattern of range production costs.

Cost studies of these problems are being made which consider seasonal differences in production costs, rates of gain, and other factors such as labor, capital requirements, and feed supplies that affect net returns under different livestock programs. (Project 226. Leader: Richard H. Kruse, Agricultural Economics Dept.)

Improving Methods for Marketing Poultry Products

To determine what effect management factors and marketing techniques have in the prices farmers receive for eggs, a questionnaire was prepared and mailed to 1,750 farmers having poultry enterprises. These questionnaires were sent out at 3-month intervals from May 1955 through February 1956. The data thus collected have been recorded on IBM cards and are being analyzed.

This study, when completed, will give an indication of the egg production and marketing methods which result in the
highest price returns to farmers in South Dakota. (Project 175. Leaders: Travis W. Manning and Gerald Marousek, Agricultural Economics Dept.; William Kohlmeyer and C. W. Carlson, Poultry Dept.)

How Egg Dealers Determine Prices Paid Farmers

A recently begun study is under way to determine the means used by egg dealers in South Dakota to arrive at the prices they pay farmers for eggs.

Since an estimated 80 percent of the state's egg production is shipped to markets outside the state it is important that egg quality be uniformly high in order to gain and hold these markets. One of the best means of achieving this is to pay the producer for the quality of eggs he produces. One objective of this study is to find to what extent prices paid to farmers do reflect consumers' preferences for various qualities of eggs. The use of terminal market price quotations and other factors considered by dealers in setting prices is also being studied.

To carry out this study, a questionnaire has been sent to all South Dakota egg dealers. This will be followed up by a detailed interview with each of the egg dealers in a local market area; several market areas in the state will be studied. (Project 271. Leaders: Travis W. Manning and Gerald Marousek, Agricultural Economics Dept.; William Kohlmeyer and C. W. Carlson, Poultry Dept.)

Land Value Trends and Mortgage Foreclosures

Data on farm land sales in the counties of Beadle, Brookings, Brown, Clay, Faulk, Haakon, Hand, and Spink have been secured for 1954 and 1955 from the offices of the Register of Deeds of each county. This will give us a continuous record of farm land sales in these eight counties for the 15-year period from January 1941 through December 1955. This study includes counties within the prospective irrigation area in central South Dakota as well as counties outside the prospective irrigation area. It will eventually give a record of farm land prices during the entire period of development of the irrigation project. Comparisons can be made between sales within the prospective irrigation area and those outside the irrigation area.

There is no indication, at present, of excessive speculation in farm land within the prospective irrigation area. Farm owners, renters, and sons of farmers have been the chief purchasers of farm land within the last 2 years. Estates and non-resident owners have sold some of the land they owned. Loan agencies have taken mortgages on additional land previously owned by farmers and in some cases have loaned more than the purchase price of the newly acquired land.

Data collected from every county in the state showed only 11 farm mortgage foreclosures were initiated in 1955 and 5 redemptions. The cause of the foreclosure action was sought from both creditors and debtors. Poor farm management, inefficiency, and even dishonesty were listed by creditors. Debtors listed size of farm, size of wheat allotment, bad weather, and family illness as causes. The farm mortgage foreclosure reports indicate that while farm income has fallen, distress is far from being as serious as in 1932 when 3,864 foreclosures were started.

A manuscript, "The Strength of South Dakota's agriculture as Measured by Farm Mortgage Foreclosures 1921-55," is being prepared for publication. (Project 157. Leaders: Ray F. Pengra, Gabriel Lundy, Agricultural Economics Dept.)

Irrigation Costs and Returns

Several farmers are keeping records of the cost of pump irrigation. It is believed that the analysis of these records may prove to be of help to farmers
planning to irrigate their crops in central South Dakota.

A manuscript is being prepared which discusses irrigation as a means of providing settlement opportunities for young farmers, food for an increasing population, and stabilization of farm incomes. "Farm Labor, Power and Machinery Performance for Selected Operations Under Dryland and Irrigated Conditions in Central South Dakota," (Agr. Econ. Pamphlet 43) has been slightly revised and printed as circular 131. (Project 198. Leader: Russell L. Berry, Agricultural Economics Dept.)

Grain Marketing Efficiency

Rapid changes have been occurring in modes of grain transportation. Trucks are hauling an increasing amount of grain. In some areas railroad spur lines to smaller elevators have been discontinued leaving these elevators with only truck transportation. One of the results of these changes has been to increase the volume of grain handled at some elevators and decrease volume at others.

To study the effect of these changes an over-all efficiency of grain marketing of South Dakota elevators was made. The work will provide basic information concerning elevator efficiency and grain transportation costs. (Project 224. Leader: Richard H. Kruse, Agricultural Economics Dept.)

Wheat Price and Income Policy

Wheat is a very important cash grain crop of farmers in South Dakota. As a result of variable weather conditions in the major wheat production areas, the supply of wheat fluctuates widely from year to year. On the other hand, the demand for wheat is relatively inelastic. These conditions result in widely fluctuating prices which cause considerable hardship for farmers and make for uncertainty as to wheat prices and adequacy of supply to meet domestic and foreign demands.

For the past 20 years the government has attempted to alleviate some of the hardships resulting from price uncertainty through various wheat price and production control programs. The nature and objectives of these wheat programs are being studied.

Analyses are being made of the effects that these programs have had on agriculture in South Dakota and other wheat states. Cost and results of various government policies are being studied. When complete these results will be made available to legislators, policy making and advisory groups, for their use in formulating future agricultural policies. (Project 263. Leaders: Max Myers and Richard H. Kruse, Agricultural Economics Dept.)

Corn-Oats-Legumes Catch Crop Rotation Most Profitable

A study of the estimated effects of various amounts of legumes on total production per 100 acres and net returns for the loess soil area on southeastern South Dakota is being printed as "Most Profitable Crop Rotations for the Corn Belt and Southeastern South Dakota," circular 129.

The principal conclusion is that sweet clover, seeded in small grain and plowed down for corn the following spring as a green manure catch crop, is the most profitable use of legumes where erosion is not a problem. Stand-over legumes for pasture or hay are second best. They are superior to a corn-oat rotation where no legumes, barnyard manure, or commercial nitrogen is being used. But a corn-oat-sweet clover catch crop rotation appears to be most profitable as the main rotation except where serious erosion can be prevented by legumes or on specialized livestock farms—especially dairy—where excellent pasture is needed. "Most Profitable Use of Fertilizer on Corn, Oats, and Wheat in South Dakota," Agricultural Economics pamphlet 69 (mimeograph) was prepared this spring. (Project 211. Leader: Russell L. Berry, Agricultural Economics Dept.)
Farm Business Management
Data and Practices

Seventy farmers and ranchers, representing the principal types of agriculture in the seven types-of-farming areas in South Dakota, have been secured as record-keepers for the project on farm business management data and practices. Each was visited by a representative of the Experiment Station and provided with the record books and information necessary for cooperating in the 1956 project. Records have been kept on crops, livestock, and feed, as well as receipts, expenses, and inventories.

Each cooperator will be visited by a station representative at least twice each year. Following the winter visit, his books will be summarized and an analysis provided, with a comparison made with similar farms whenever possible. Data from the records will be used as bases for farm planning and budgeting, as well as sources of information on the various aspects of farm and ranch operations in South Dakota. (Project 264. Leader: Charles H. Benrud, Agricultural Economics Dept.)

Opportunities of Beginning Farmers

This study will be directed toward the problem of beginning farmers bargaining for an opportunity to farm. It will attempt a qualitative as well as a quantitative approach. The quantitative approach is rather simple—either the beginning farmer does or does not obtain a quantity of land to farm. The qualitative measurement, however, must determine whether the farm purchased or rented, does in fact represent an opportunity; or is it, because of quality, size, tenure arrangement, or credit arrangement, just a hopeless situation that will consume the accumulated capital of the aspiring farmer before he can finally get himself out.

This study will attempt in the next year to evaluate the experience of a group of beginning farmers in Spink County, South Dakota, in order that other young farmers can profit by their experience. (Project 166. Leader: Loyd Glover, Agricultural Economics Dept.)

Improving the Farm Credit Situation

The work done in South Dakota this year has been of an exploratory nature. Bankers and other lenders have been contacted to determine the pressing credit problems from their standpoint. In our contacts with farmers there have been some reports of credit rationing. Bankers have reported an abundance of credit work is being done to clarify this discrepancy.

Cooperative work was done on a Great Plains bulletin “Credit, a Tool For Farm and Ranch Use.” This bulletin is presently being printed by the Nebraska Experiment Station and will be available through South Dakota county agents. Cooperative work was also done on, “The Frazier-Lemke Act: An Analysis of its impacts on Farmers and Lenders With Particular Emphasis on the Northern Great Plains.” This bulletin is presently being revised for publications as a Northern Great Plains Council Publication. (Project 240. Leader: Allen R. Clark, Agricultural Economics Dept.)

Improving Weather Information

An effort is being made to reduce South Dakota weather data to a more predictable form. Weather information for 60 South Dakota weather observation stations has been summarized by weeks from the earliest date from which reasonable continuous data are available for each individual station.

To develop methods to be used in a regional study of drought covering eight states in the North Central Region, the average precipitations at five stations within two different areas of South Dakota have been put on IBM cards.

The following mimeograph pamphlets have been prepared during the past year: Agricultural Economics Pamphlet 66, "Average Frequencies of Daily Oc-
Farm Engineering

Application of New Materials and Design in Farm Buildings

Work on expanded shale as a lightweight concrete aggregate was continued throughout the year. Contact and control was continued at various lightweight block manufacturing plants throughout the state concerning quality, yield, strength, and texture of the blocks. Designs on poured floors and decks made from lightweight aggregate was started.

Pentachlorophenol-treated fence posts are still in excellent condition after over 3 years of service.

Research on materials used in bunker type silo construction was continued during the past year. The exclusion of air in sidewall construction continues to be a problem with rather discouraging results when lining with paper. Tongue and grooved material or double wall utilizing an economical flooring material seems to be working satisfactorily after 2 years service. (Project 203. Leader: Dennis L. Moe, Agricultural Engineering Dept.)

Poultry Brooding Methods

An efficiency study was made of three types of electric brooders. Two of these types of brooders, the infra-red lamp and the conventional resistance type heating element and hover, are available commercially. The portable floor plate brooder with electric heating element was constructed for purposes of this study.

These three brooder units were tested in portable brooder houses which were of a wooden shed type. No insulation was used on the construction of any of these houses. The floor was uninsulated except for the litter that was used on the floor. Bales of straw were used to bank the outside perimeter. Inside temperatures of the brooder house was therefore subject to variation of the climatic temperature.

Under these conditions the primary purpose of this study was to compare the heat losses from radiation, conduction, and convection that were recorded in each of the three types of electric brooders. This meant an investigation of materials that will radiate or transfer heat by radiation. Cost differences of the three types of brooders were noted. (Project 280. Leader: Virgil H. Flesher, Agricultural Engineering Dept.)

Possible Toxic Effect on Plants of Iron Laden Water Transported Through Aluminum Pipe for Sprinkler Irrigation

Several irrigation wells in South Dakota, including one at South Dakota State College, have been found to contain iron laden water. This water, when used to irrigate through a sprinkler sys-
tern, forms a coat of rust upon the plants being irrigated.

A retarding effect has been noted on the plants. The cause has not yet been determined.

In the summer of 1955 a replicated experiment was set up using sprinkler irrigation with galvanized and aluminum pipe, surface irrigation, and also a nonirrigated check plot. The replications contained corn and a vine crop.

On the corn, the surface irrigation had a 20 percent higher yield than the dry check plot, the check plot had a 10 percent higher yield than the corn sprinkled by the use of galvanized pipe and the check plot had a 16 percent higher yield than the corn sprinkled with the use of aluminum pipe.

On the vine crops, the experiment indicated a high degree of burning on the vine leaves when sprinkled with galvanized and aluminum pipe. This slowed up the growth on the vines and reduced the yields below the dry check plot. Again the surface irrigated vines produced the highest yield and the dry check plots outyielded the plots sprinkled by the use of galvanized and aluminum pipe. (Project 281. Leaders: John L. Wiersma, Don Brosz, Agricultural Engineering Dept.)

Sprinkler Possibilities in South Dakota

Designing a sprinkler irrigation system to fit the farm is an engineering problem which involves the soil, the crops, and the equipment used to apply the water.

The past year a study of the irrigation management practices to be used on horticulture crops was initiated. Irrigation water and natural rainfall were measured and soil moisture levels were determined as plant growth progressed and irrigation was applied. This work was carried on in conjunction with variety studies and other work of the Horticulture Department. In this type of irrigated crop it is desired to not only obtain increased yields but also improved crop quality and earliness of maturity. Yield and quality studies indicate that irrigation costs are justified for a number of crops.

Timeliness of irrigation is as important as amount of water applied. The available water that a soil can hold for plant use and the amount of moisture a plant uses during various growth stages varies. If a simple method of determining when to irrigate could be devised, a savings in irrigation water could be accomplished and a better plant growth obtained. A correlation between evaporation from an evaporating pan and soil moisture used by different crops is being studied. Indications are that a correlation is possible. The best results were obtained from a partially buried pan. Correction factors for growth stage of plants is needed. If a correlation is possible it will be possible to tell when to irrigate by knowing the soil type and the amount of water that evaporates from a free surface.

New types of equipment are being made available to sprinkler irrigators. Increased interest has been indicated in the performance of the giant type sprinklers that discharge up to 600 gallons per minute and operate at pressures up to 125 pounds per square inch. A pattern and soil compaction study procedure for this work was determined but no definite results were obtained. (Project 192. Leader: John L. Wiersma, Agricultural Engineering Dept.)

Crop Drying and Conditioning

Forty bins of wheat (300-bushel capacity) at the Onida ASC bin site were carried through their third year or aeration tests. The final samples will be taken near September 1, and if possible the wheat will be shipped. During the first 2 years the cupola ventilators and the 50 c.f.m. fans have done the best job in preventing moisture migration to the top center of the bin. Thermostatic controls on all sizes of fans are doing a fair job in controlling moisture migra-
tion; but the humidistat controlled fans are doing an even better job.

Field shelling of corn, combined with cold air drying was successful in the fall of 1955. Early picking dates and good drying weather enabled picking to start on October 1 at 25 percent kernel moisture content, with corn being dried to 12 percent in October. All corn was down to 12 percent 2 weeks after the last field operation. The cost of running such a fan installation is approximately 4 cents per hour in electric power cost. Early picking again showed a saving in corn as compared with later picking. (Project 246. Leader: H. H. DeLong, Agricultural Engineering Dept.)

Poultry House Ventilation, see page 1
Pilot Silos, see page 40
Also see: Farm Water Problems, page 117

Fruits, Vegetables, and Shelterbelts

Growth and Yield of Strawberries as Influenced by Culture

While plant breeders have made much progress in developing varieties of strawberries and raspberries adapted to local climatic conditions, the value of cultural treatment cannot be ignored. Recent investigational work of this station proved that strawberry plants accumulate carbohydrates when exposed to cool weather. Such plants survive the low winter temperatures better. Plants covered with a mulch before they are "hardened" suffer greater loss than those not covered by a mulch. Rainfall during late summer of 1955 was very light and plants suffered from lack of moisture in September and October. By mid-November the leaves were dry and were not able to harden plants for winter conditions; as a result, loss was heavy. Plants receiving water in late summer survived the winter with little or no damage. (Project 145. Leader: S. A. McCrory, Horticulture-Forestry Dept.)

Small Fruit Breeding in South Dakota

High quality grape varieties were hybridized with early maturing native grapes and hardy hybrid grapes. Experiments were conducted in an effort to determine hardiness of young grape seedlings.

Additional wild raspberry plants were set in the field for evaluation as possible parents in our breeding program. Several varieties and selections of raspberries, grapes, currants, and gooseberries were planted for testing and for use in breeding. (Project 252. Leader: Ronald Peterson, Horticulture-Forestry Dept.)

Developing High Quality Tomatoes for South Dakota Climate

The summer of 1955 had both drought and high temperature. Such conditions were favorable for evaluating tomato lines as genetic material. Under such conditions many varieties drop their flowers without setting fruit. Yields were generally low and some plants were barely able to survive during July and August. Using this as a basis for selection, many lines were saved for future breeding work. During the winter many crosses were made and plants from these crosses will be observed in the field during the summer.

Much of the breeding work and some selection was done during the winter months. By growing plants under controlled temperature, light, and relative humidity, much of the field work can be eliminated. (Project 49. Leader: R. L. Nickeson, Horticulture-Forestry Dept.)

Tree Fruit Breeding in South Dakota

Several varieties of apples, pears, plums, cherries, and apricots were planted for determining their adaptive-
ness to South Dakota conditions and for breeding. New apple seedlings were transplanted from greenhouse ground beds to the field in an effort to develop high quality adapted varieties. Hybridizing was done on apples, pears, and apricots. (Project 1. Leader: Ronald Peterson, Horticulture-Forestry Dept.)

Preservation and Evaluation of Hardy Fruit Plants Having Genetic Value

At the time South Dakota was being settled there was great interest in fruit varieties. Most of those planted were not able to compete with climatic conditions. Those standing the test became the varieties most commonly planted. These varieties generally left much to be desired as to quality. This natural elimination has reduced our varieties to a few that are acceptable.

Earlier workers saw the need for a program of fruit breeding and started collecting plants from both foreign and domestic sources. More recently this material has been assembled in a foundation planting where it can be evaluated and used as genetic stock. In general this material has shown great winter hardiness. In some cases it has shown resistance to disease. It is now being used in a wide area of the country. (Project 174. Leader: S. A. McCrory, Horticulture-Forestry Dept.)

Effect of Spacing on Survival, Growth, and Effectiveness of Windbreaks and Shelterbelts

Most shelterbelts have been designed on a basis of opinions and judgement. The effectiveness of a particular design in controlling wind is not fully understood. Recent plantings having various arrangements and spacing distance have been made at Brookings and Highmore. Information from these may well serve as a basis for future arrangements. (Project 239. Leader: Paul Collins, Horticulture-Forestry Dept.)

Vegetative Propagation of Hardy Ornamental Plants

Vegetative propagation of the Lillian Gibson rose by means of hardwood stem cuttings proved unsatisfactory with all methods tried. However, propagation by root cuttings was fairly successful. Mature plants were dug in the fall and the roots were cut into sections 1 to 1½ inches in length. These root sections were buried in flats of moist peat and the flats were kept in a warm greenhouse.

The shoots which emerged from the peat were allowed to attain a height of 3 to 4 inches and were then cut off and rooted under mist in the propagating bench.

These cuttings rooted much more quickly and with much lower mortality than the hardwood cuttings started at the same time and derived from the tops of the same plants. (Project 258. Leader: Jesse Rawson, Horticulture-Forestry Dept.)

Chinkota Elm, see page 14
Better Vegetable Varieties, see page 22
Plastic Greenhouses, see page 86

Home Economics

Relation of Calories to Protein Utilization

The effects of changes in protein and calorie intake on nitrogen balance were investigated, one 66-year-old woman being observed for 26 five-day metabolic balance periods.

While on her own self-selected diet, her daily food supplied an average of 63 grams of protein and about 1,975 calories, estimated from tables of food composition. On these levels of intake, this woman was essentially in nitrogen equilibrium.
When her protein was decreased by 25 percent to an average of 47 grams and subsequently to 41 grams, with the caloric intake remaining the same, she was in definite negative nitrogen balance. Increasing her daily intake of calories to 2,100 did not compensate for the decrease in the amount of protein eaten. She was still losing nitrogen on an intake of 50 grams of protein and 2,100 calories. (Project 178. Leaders: Lida Burrell and Beth Alsup, Home Economics Dept., in cooperation with other stations in the North Central Region as a part of Project NC-5.)

Newer Fibers Compared to Cotton in Shirt and Blouse Materials

Blouse and shirt materials today are commonly made from cotton, Dacron, nylon, Orlon, rayon, or blends of these fibers. Several of these materials were purchased and physical properties studied in the laboratory.

A paper summarizing findings for some of the properties studied has been prepared.

Based on fabric breaking strength, dimensional stability, fabric structure, thickness, and weight per square yard, it appears that the cotton fabrics included in this study compare favorably with those containing the newer fibers. While these cotton fabrics have low permeability to air, they undoubtedly would be equally as comfortable as the other fabrics because of their ability to absorb moisture. (Project 254. Leaders: Lillian O. Lund, Home Economics Dept.; Mary Ann Morris, Minnesota Agricultural Experiment Station.)

Boys' Blue Jeans Studied

As a part of a North Central Regional study on boys' clothing, a study of blue jeans is in progress at this station. Garments of two weights were purchased and worn by 30 boys in the fourth or fifth grades. The three-year periods of 10, 20, and 30 days, were completed this year. Half of these were laundered in the homes and the other half in the laboratory. Visual observations and dimensional stability measurements were made throughout the wear periods. The garments are now being cut into samples for laboratory measurement of physical properties. (Project 259. Leader: Lillian O. Lund, Home Economics Dept., in cooperation with the Minnesota Agricultural Experiment Station as a part of NC-24.)

Blended Suitings, see page 10
South Dakota Plums, see page 91
Also see: Farm Water Problems, page 117
Minimizing Quality Losses of Poultry Meat in Market Channels, page 163

Livestock and Poultry

Control of Fowl Cholera

Fowl cholera is caused by an organism belonging to a group of bacteria known as *Pasteurella multocida*. The organisms of this group affect several different animal species.

In order that the nature of fowl cholera be more fully understood and better methods developed for controlling the disease, studies are being conducted to learn more about the cause by biochemical and antigenic tests.

Diseases and Parasites

During the past 5 years, 277 strains of *P. multocida* have been saved from those isolated in the diagnostic laboratory. Two hundred fifty-nine of these strains were isolated from poultry affected with fowl cholera; 18 strains were isolated from other farm animals, generally affected with respiratory conditions. A study is being made to determine the ability or inability of these strains to produce certain reactions in the test tube.
Previous tests have shown that the strains of *P. multocida* causing fowl cholera are of two main types. These were designated as type I or type II, according to their inability or ability to ferment xylose. The 277 strains, referred to above, were typed according to this method shortly after isolation and again this past year. The types remained the same on the second test. Of the 259 strains isolated from poultry, 87 percent were type I and 13 percent were type II; whereas, of the 18 strains isolated from other farm animals, 11 percent were type I and 89 percent were type II.

The type II *P. multocida* strains fermented arabinose and dulcitol in three more or less distinct patterns:

1. Arabinose and dulcitol negative
2. Arabinose positive and dulcitol negative
3. Arabinose positive and dulcitol positive.

A characteristic of note was the relative inability of strains isolated from poultry to ferment trehalose. None of the 225 type I strains fermented trehalose and only four of 34 type II strains gave positive fermentation reactions. In contrast, 13 out of 17 type II strains isolated from other farm animals fermented this carbohydrate.

A few strains of *P. multocida* fermented salicin, but no correlation as to type or species from which the strains was isolated could be established with this reaction.

All strains were checked for urease activity. A higher percentage of the older strains were urease positive, when compared with those that had been isolated more recently.

In addition to the biochemical studies, preliminary tests were made using a whole blood *P. multocida* antigen to check different strains as to type. An antigen prepared from a type I strain was agglutinated by blood from chickens experimentally infected with a type I strain, while an antigen prepared from a type II strain was not.

The study of the biochemical and antigenic nature of the cause of fowl cholera is being continued, attempting to determine whether or not there is an interrelationship between certain of these characteristics for different strains of *P. multocida*. (Project 141. Leader: T. A. Dorsey, Veterinary Dept.)

**Mucosal Disease of Cattle**

Mucosal disease is the name given to a disease condition in cattle in which the mucous membranes of the alimentary canal are principally affected. Surface erosions and ulcerations involving the muzzle, mouth, and tongue and a persistent diarrhea are the usual symptoms. On post mortem, any part of the digestive tract may show lesions. The mortality is nearly 100 percent of the animals which become sick regardless of the treatment used. The morbidity in affected herds has been 10 to 20 percent.

Mucosal disease has been recognized in South Dakota since 1952. Almost all cases have affected animals 6 to 12 months of age. Most of the outbreaks have occurred in the colder months of late winter and early spring.

In addition to studying the symptoms and pathological changes associated with mucosal disease, numerous attempts have been made to transmit it to calves of the same age group. Calves have been inoculated intravenously and subcutaneously with blood and tissue suspensions from field cases. Other calves have been given suspensions of intestinal contents and organ tissues by mouth.

Some of the experimental calves have shown no reaction. Others have shown a rise in body temperature as early as the third day and as late as the sixteenth day. The temperature reactions lasted 24 to 48 hours without the development of diarrhea. One calf which was given a suspension of intestinal mucosa and kidney tissue from a field case showed a temperature of 104.6 degrees on the fourth and fifth days. On the fifteenth
day there were mouth erosions and diarrhea. It became progressively weaker and was dead on the seventeenth day. The autopsy showed lesions throughout the alimentary canal which were typical of field cases of mucosal disease. The results of transmission trials thus far indicate that an infectious agent, probably a virus, is the cause of the disease. (Project 253. Leader: G. S. Harshfield, Veterinary Dept.)

**Leptospirosis of Farm Animals**

Leptospirosis is an infectious disease of importance in cattle and swine caused by the bacterium *Leptospira pomona*. In cattle it can cause death associated with anemia. In less acute infections it can cause abortion and reduction in lactation over a period of time. In swine it is a cause of abortion.

Leptospirosis has been diagnosed in cattle and swine herds in South Dakota over a period of 5 or 6 years. It no doubt existed prior to that time. In the past year a survey of the incidence of the infection has been conducted, using an agglutination test of serum samples of cattle and swine which had been submitted to the diagnostic laboratory for brucellosis tests.

The leptospirosis test of 5,935 bovine samples from 1,258 herds resulted in 3.85 percent of the samples and 11.5 percent of the herds showing positive reactions. There were 883 swine samples from 275 herds tested with positive reactions in 1.6 percent of the samples and 3.63 percent of the herds.

It is not known at this time whether all positive reactions to this test indicate certain previous exposure to *L. pomona*. When the serum samples which were positive with the agglutination test were checked by the agglutination-lysis test, all gave titers of 1:100 or higher.

Leptospirosis was diagnosed in five swine herds in which abortions occurred in from 26 to 46 percent of the bred sows. All of the abortions occurred with-
spring, fecal samples were again obtained from each calf, and helminth egg counts are being made. Another set of fecal samples will be checked in the summer.

At the conclusion of the experiment, the helminth egg counts will be checked against the rate of gain for both the treated animals and the control animals in an attempt to determine the efficacy of the treatments. (Project 278. Leader: Ernest J. Huggins, Entomology-Zoology Dept. in cooperation with Projects 120 and 244.)

**Fringed Tapeworm of Sheep**

The fringed tapeworm, *Thysanosoma actinioides*, is responsible for the condemnation of a high percentage of livers from sheep raised on the range in western South Dakota. Moreover, it appears that a high percentage of lambs born on the western ranges have acquired the tapeworm infestation by the time they are moved to feed lots in the eastern part of the state. It is not known as yet how the infestation is acquired or how it is transferred from sheep to sheep, although workers in New Mexico have demonstrated that the transfer is not direct; i.e., some invertebrate vector must be involved. Furthermore, the vector probably is restricted to the western ranges, as sheep appear to acquire the infestation there only.

During the past year, several lots of sheep which were heavily infested with the fringed tapeworm have been traced to their home ranges. The home ranges have been searched for possible intermediate hosts (or vectors) of the tapeworm, and small mites which occur abundantly in sheep dung at some seasons have been brought under suspicion. These mites have been identified as comprising at least three different species, all of which are predaceous. Presumably, they feed upon insect larvae in the dung, and they might also devour any tapeworm segments or egg cases they chanced to encounter. The mites are abundant only in the large, moist stools which are produced by the sheep when green grass is available. In the winter the mites have been found hibernating beneath old, isolated deposits of cow manure. Efforts are being made to maintain these mites in the laboratory for infestation experiments.

Two rather interesting ecological factors have been investigated. One is that sheep raised in the Black Hills apparently are not infested with the fringed tapeworm, while sheep on the open range both north and east of the Black Hills show a high incidence of infestation. It seems that either the vector does not occur in the Black Hills habitat, or that if it does occur there, the lower temperatures and shorter warm season prevent the establishment of the tapeworm life cycle. (In the life cycle of a related tapeworm, it has been found that the larvae stage requires three to four months to mature in the intermediate host.)

The other ecological factor concerns the possible role of antelope as reservoir hosts for the tapeworm, since antelope run freely over much of the sheep range country. Several infested antelope have been found in New Mexico. Personnel of the South Dakota Big Game Survey cooperated by examining 36 antelope killed during the 1955 fall hunting season in Butte, Perkins, and Harding Counties. No fringed tapeworms were found. (Project 260. Leader: Ernest J. Huggins, Entomology-Zoology Dept.)

**Fish Parasites**

A total of 430 fish from 23 different bodies of water (largely lakes) in South Dakota have been examined for parasites. The fish were predominantly game fish, but many rough fish were included. For each fish there is a host record sheet with the following data: date taken, total length, sex, source, and number, kinds, and location of parasites found. Some stomach contents were saved for possible food analysis. Also,
in some cases scales (or vertebrae of bullheads) were saved for studies.

The parasites have been preserved, and many of them have been stained and mounted on permanent slides. They are in the process of being identified and tabulated. Fish from several lakes showed an extremely high incidence of parasitization, while fish from other lakes were relatively clean. (Project 277. Leader: Ernest J. Huggins, Entomology-Zoology Dept., in cooperation with S. D. Game, Fish and Parks Dept.)

**Sporadic Bovine Encephalomyelitis**, see page 106

Also see: Internal Medications for Cattle Grub Control, page 149

**Livestock Production**

**Improvement of Beef Cattle Through Breeding**

Two inbred lines have been culled on their performance and a satisfactory control line has been added. The control line will permit a more accurate comparison of selection alone versus selection combined with inbreeding.

Preliminary results from field tests where inbred bulls are compared with noninbred bulls in use in commercial herds in South Dakota, show some advantage to the inbred bulls in the performance test.

The South Dakota Station has been cooperating with the Iowa Station in the study of dwarfism by using available carrier cows. The bulls used on these cows have been predicted clean or carrier by the Iowa workers on the basis of various tests, such as x-ray.

Pilot studies utilizing drosophila and guinea pigs have been initiated in the study of breeding for resistance to selenium poisoning in beef cattle. The smaller animals will be used to gain information on the importance of heredity in resistance to selenium poisoning and also to study the effects of selenium on the reproductive systems. The cattle phase of the selenium poisoning problem will be continued and has been expanded to include a herd of grade Angus cows. These cows will be used to study breed differences and the effects of crossbreeding on resistance to selenium poisoning.

A publication covering the objectives and goals of the project, circular 130, was published during the year. (Project 167. Leaders: C. A. Dinkel, J. A. Minyard, Animal Husbandry Dept.; W. R. Trevillyan, Antelope Range Field Station; J. D. Rahn, Reed Ranch; Frank Whetzal, Cottonwood Range Field Station.)

**Nutritive Value of Hay and Grasses of the Northern Great Plains**

Three separate phases of this project were carried on during the past year. Winter feeding trials with high quality Angus steer calves were conducted at the North Central Substation, Eureka; the Central Substation, Highmore; and the Range Field Station, Cottonwood. One-half of the calves at Eureka and Highmore were drenched for a study of parasite control and this study is reported elsewhere. Digestion trials are also being conducted in conjunction with some of the feeding trials.

**Eureka Trials.** Feeding trials at Eureka compared the value of alfalfa hay and soybean meal pellets as protein supplements to an early-cut prairie hay. The design of the trial and the results are shown in table I.

The prairie hay contained about 6.8 percent protein and the alfalfa hay nearly 17 percent. The alfalfa hay and soybean pellets were fed in amounts in lots 1 and 2 to give rations with about 10 percent total protein. The results show
that alfalfa hay and soybean pellets, when used to supply equal amounts of protein, gave about the same rate of gain.

Calves fed alfalfa hay as the only feed scoured considerably during the first 2 weeks and lost some weight. The feces were rather soft throughout the trial. They made the largest gains of any lot. The amount of hay was limited to a maximum of 15 pounds per head daily.

**Highmore Trials.** The feeding trials at Highmore compared hay from land fertilized with ammonium nitrate at 150 pounds per acre, nonfertilized land, and land on which the hay had not been harvested the previous year. All the hay was harvested at an early stage of maturity from the same quarter section and had been stored as baled hay in open stacks for 1 year.

The design and results of this trial are presented in table 2. Each hay was supplemented with enough soybean meal

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**Table 1. Results of Winter Feeding Trials at Eureka (November 16, 1955 to April 19, 1956—155 Days)**

<table>
<thead>
<tr>
<th>Lot</th>
<th>Number of calves per lot</th>
<th>Av. initial weight, lbs.</th>
<th>Av. daily gain, lbs.</th>
<th>Av. daily ration, lbs.</th>
<th>Feed per 100 pounds gain, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prairie hay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Alfalfa hay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Soybean pellets</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>457</td>
<td>0.75</td>
<td>12.1</td>
<td>1.08</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>456</td>
<td>0.78</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>457</td>
<td>0.31</td>
<td>13.0</td>
<td>14.0</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>457</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. Results of Winter Feeding Trials at Highmore (November 22, 1955 to April 10, 1956—140 Days)**

<table>
<thead>
<tr>
<th></th>
<th>Fertilized 150 Lbs. Ammonium Nitrate per A.</th>
<th>Not Fertilized</th>
<th>Not Cut Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot</td>
<td>Number of calves per lot</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Av. initial weight, lbs.</td>
<td>414</td>
<td>417</td>
</tr>
<tr>
<td></td>
<td>Av. daily gain, lbs.</td>
<td>0.81</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Av. daily ration, lbs.</td>
<td>11.8</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>Hay</td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Soybean meal pellets</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feed per 100 pounds gain, lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hay</td>
<td>1465</td>
<td>1347</td>
</tr>
<tr>
<td></td>
<td>Soybean meal pellets</td>
<td>105.7</td>
<td>124.6</td>
</tr>
</tbody>
</table>
pellets to give about 10 percent protein in the total rations.

The fertilized land produced more hay and it contained more protein. This is the basis for the smaller amount of soybean meal pellets being fed in this lot. The hay also contained more weeds than the other two. The amount of refused feed for each lot was held to approximately the same by limiting the amount of hay fed. Since the weeds were not consumed by the calves in lot 1, their hay probably was restricted more than it should have been. This probably accounts for the lower rate of gain by this lot.

The hay from the land not harvested the previous year contained less protein than the other two. When enough soybean pellets were fed to give the same protein level in the rations fed to lot 2, the calves in this lot did slightly better. However, the small difference probably is not significant but does indicate that the hay from the land not harvested the previous year is a very satisfactory feed when the lower protein content is corrected by proper supplementation. Harvesting hay every other year is sometimes necessary to avoid depleting the land and to obtain yields high enough to justify the harvesting expense.

**Cottonwood Trials.** At Cottonwood, studies were continued on the value of prairie hay after various number of years of storage in the open. The results were quite similar to those of past years. Hay that has appeared to keep well, with little evidence of mold damage, has compared quite favorably with the current crop. Lower rates of gain were obtained with hay that showed evidence of considerable weather damage. Well made loose stacks appear to keep better over a period of several years than baled stacks. Studies are in progress to study the amount of loss under various storage conditions. (Project 120. Leaders: L. B. Embry, Animal Husbandry Dept.; O. E. Olson, Biochemistry Dept.; and J. G. Ross, Agronomy Dept.)

**Nutritional Studies with Beef Cows Wintered on the Range**

Fifty-four yearling Hereford heifers were permanently allotted to three levels of winter vitamin A supplementation with duplicate lots in the fall of 1952. They have been grazed on an excellent condition deferred winter range and fed 1 to 1 1/2 pounds per head daily of a 38 percent protein supplement containing added phosphorus and 0, 1,000, or 3,000 I. U. of vitamin A per 100 pounds of body weight. In 1955-56 they were fed the supplement from November 26, 1955 through April 19, 1956. Blood samples were taken at the beginning, about the middle, and near the end of the winter feeding period and analyzed for plasma, carotene, vitamin A, and phosphorus.

Vitamin A plasma levels during the winter are related to the amount of vitamin A contained in the supplement. No symptoms of vitamin A deficiency have been observed. However, cows from heavily grazed summer pastures have had much lower plasma vitamin A and carotene values than cows from lightly grazed pastures. Plasma vitamin A values of samples taken November 26, 1955 were 17.2 for heavy, 27.2 for moderate, and 46.1 mcg. percent for light summer grazing. The corresponding values for plasma carotene were 169.7, 272.4, and 491.8 mcg. percent.

This study is being continued with the same cows on the same treatments. (Project 217. Leaders: J. K. Lewis, Animal Husbandry Dept.; O. E. Olson, Biochemistry Dept.; and Frank Whetzal, Cottonwood Range Field Station.)

**Manganese Requirements of Growing and Fattening Cattle**

In a previous experiment, yearling steers fed a ration containing about 8 p.p.m. of manganese appeared normal and gained as well as a similar group fed the same basal ration with added manganese to give about 40 p.p.m. of manganese. The present experiment
was conducted to test the effects of this low-manganese ration with younger animals fed for a longer period.

Twelve heifer calves weighing about 380 pounds were individually fed a low manganese ration during a depletion period. After the depletion period, they were paired according to weight and rate of gain during the depletion period. One group continued to receive the basal ration and the other group the basal ration plus 30 p.p.m. of added manganese.

Considerable difficulty was encountered in getting a low-manganese ration that these young calves would eat. The best feed consumption was obtained on a ration composed of the following ingredients (percent): ground ear corn, 52.0; ground corn cobs, 25.0; dried whole blood, 4.0; dried brewers yeast, 3.0; dried buttermilk, 2.0; beet sugar, 5.0; animal feeding fat, 5.0; limestone, 2.0; salt (with iodine, cobalt, and copper) 1.0; bone meal, 0.5; and urea, 0.5. This ration was fortified with 2,000 U.S.P. units of vitamin A and 200 units of vitamin D per pound of ration. The ration contained about 8-9 p.p.m. of manganese and it was fed during the depletion and test periods. The large amount of limestone was used to give a high calcium to phosphorus ratio since a high Ca:P ratio is reported to influence the manganese requirement.

The results are shown in table 3. One heifer had to be removed from each group because of poor feed consumption. This resulted in some difference in initial weight and rate of gain from that used in the allotment.

The average daily gain for the control group was 1.37 pounds during the 112-day depletion period. In the 167-day test period, their average daily gain was 1.47 pounds. The manganese supplemented group gained 1.28 pounds during the depletion period and 1.68 pounds when supplemented with manganese (manganese sulfate, C.P. grade).

Feed requirement per 100 pounds of gain was nearly the same for the two groups, but the manganese supplement-

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depletion period—112 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>300</td>
<td>166</td>
<td>1.48</td>
</tr>
<tr>
<td>4</td>
<td>379</td>
<td>117</td>
<td>1.04</td>
</tr>
<tr>
<td>7</td>
<td>392</td>
<td>196</td>
<td>1.75</td>
</tr>
<tr>
<td>8</td>
<td>399</td>
<td>159</td>
<td>1.42</td>
</tr>
<tr>
<td>9</td>
<td>309</td>
<td>131</td>
<td>1.17</td>
</tr>
<tr>
<td>Av.</td>
<td>355.8</td>
<td>153.8</td>
<td>1.37</td>
</tr>
<tr>
<td>Experimental period—167 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>466</td>
<td>242</td>
<td>1.45</td>
</tr>
<tr>
<td>4</td>
<td>496</td>
<td>238</td>
<td>1.43</td>
</tr>
<tr>
<td>7</td>
<td>588</td>
<td>274</td>
<td>1.64</td>
</tr>
<tr>
<td>8</td>
<td>558</td>
<td>257</td>
<td>1.54</td>
</tr>
<tr>
<td>9</td>
<td>440</td>
<td>220</td>
<td>1.32</td>
</tr>
<tr>
<td>Av.</td>
<td>509.6</td>
<td>246.2</td>
<td>1.47</td>
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</tbody>
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<thead>
<tr>
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<tbody>
<tr>
<td>Manganese Supplemented Group*</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Initial Weight Lbs.</td>
<td>441</td>
<td>142</td>
<td>1.27</td>
</tr>
<tr>
<td>395</td>
<td>149</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>344</td>
<td>116</td>
<td>1.04</td>
<td></td>
</tr>
<tr>
<td>376</td>
<td>126</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td>425</td>
<td>181</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>Av.</td>
<td>396.2</td>
<td>142.8</td>
<td>1.28</td>
</tr>
<tr>
<td>Initial Weight Lbs.</td>
<td>583</td>
<td>257</td>
<td>1.54</td>
</tr>
<tr>
<td>544</td>
<td>278</td>
<td>1.66</td>
<td></td>
</tr>
<tr>
<td>460</td>
<td>261</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>502</td>
<td>307</td>
<td>1.84</td>
<td></td>
</tr>
<tr>
<td>606</td>
<td>298</td>
<td>1.78</td>
<td></td>
</tr>
<tr>
<td>Av.</td>
<td>539.0</td>
<td>280.2</td>
<td>1.68</td>
</tr>
</tbody>
</table>

*30 p.p.m. of manganese sulfate added to basal ration with about 8-9 p.p.m. of manganese during experimental period.
ed group consumed an average of 1.32 pounds more feed per animal. Any differences in body measurements appeared explainable on the basis of differences in weight and rate of gain. Chemical analyses are being made on certain carcass tissues of the heifers. Further work is planned to determine whether or not an actual response is being obtained from the manganese supplementation. (Project 218. Leaders: L. B. Embry, Animal Husbandry Dept.; and O. E. Olson, Biochemistry Dept.)

Alfalfa Silage for Fattening Cattle

This past season a third year’s experiment was conducted to evaluate different methods of storing alfalfa as silage or hay that was utilized as a beef cattle feed. Alfalfa was swathed and allowed to wilt; then a field chopper was used in cutting and blowing the alfalfa into trucks. Silage was made under three storage plans with approximately 62 tons being stored in each plan. No preservative was used in any of the silage.

Places of storage were an upright cement block silo, a pile on the ground, and a trench silo. The pile of silage was stacked by using cribbing to start the stack; then the center was topped to allow run-off from rains. No packing other than men working on the stack was used. The cribbing was removed after the stack was well set. To locate a trench silo with adequate drainage, it was necessary to store only part of the silage below ground level and the remainder was supported by planks constructed above ground. Silage was packed by driving a heavy truck over the silage after each load was dumped. This method of packing was not used in the first trial.

Another supply of feed was stored in the form of alfalfa hay baled from the same field as was the source of silage placed in the upright silo. An equal acreage was baled as hay as was made into silage. Weight records were kept on all the methods of storage so losses from time of initial storage through the feeding period could be measured.

Forty long-yearling Hereford steers divided into four lots of 10 each were started on feed in October. The intention was to produce enough gain on these steers that they could be sold at slaughter grades of Good or Choice. Each lot received the same amount of cracked shelled corn daily. They were started at the rate of 3 pounds per head daily and increased until all were getting 7 pounds a day. Salt, bonemeal, and limestone were offered free choice to all cattle.

At this time, not all lots have completed the utilization of the available alfalfa for the third feeding trial. The trends have been very similar for all three trials in that there has been excessive spoilage and loss in feed value from the alfalfa silage put up in piles and trenches. Silage from an upright silo has produced similar total beef gains as those fed baled hay. There has been very little difference in rate of gain but large differences in total gain, which is due to the variation in feed losses resulting in the different methods of storage. (Project 237. Leader: W. C. McCone, Animal Husbandry Dept.)

Effects of Sodium Metabisulfite on Feeding Value of Silage

Two round above-ground stacks of alfalfa silage were made to test the value of sodium metabisulfite in preserving above-ground stack silage and its effect on palatability and nutritive value of the silage. Sodium metabisulfite was added to the chopped forage of one stack at the rate of 10 pounds per ton of fresh forage. Both stacks were well packed but not covered.

Steer calves and wether lambs were used to determine the digestible nutrients and feeding value of the two kinds of silage. All forage was weighed into the stacks and the silage is being weighed out of the stack as fed. Chemical analyses are being made to deter-
mine amounts of various nutrients lost.

Six calves and eight lambs received one kind of silage and an equal number received the other. One-half in each group were also fed a small amount of corn. During a 92-day period, calves fed silage with 2 pounds of corn daily made an average gain of 44.0 pounds per calf while those fed silage alone gained only 1.0 pound per calf. The results with the lambs were an average gain of 2.6 pounds for those fed 200 grams of corn with the silage and an average loss of 14.5 pounds for those fed silage alone. There were no apparent differences in the two kinds of silage.

Consumption of the silage has been rather low but some better when the corn was fed. Other methods are now being tried to improve consumption of the silage.

The experiment is still in progress and results are not complete on the amount of loss of nutrients in the two stacks or the digestibility of the nutrients, but the amount of spoilage is rather high in both stacks. (Project 237b. Leader: L. B. Embry, Animal Husbandry Dept.)

**Summer Grazing of Beef Cows for Calf Production**

Six pastures at the Cottonwood Range Field Station have been grazed heavily, moderately, or lightly since 1942. Yearling Hereford heifers were permanent ly allotted to these pastures the fall of 1952 and dropped their second calf crop in the spring of 1955.

The results for the 1955 grazing season are shown in table 4. Cow and calf gains per acre were highest under moderate and lowest under heavy grazing. Cow and calf gains per animal unit were much higher under light grazing. This study is being continued with the same cows on the same treatments. (Project 216. Leaders: J. K. Lewis, Animal Husbandry Dept.; O. E. Olson, Biochemistry Dept.; and Frank Whetzal, Cottonwood Range Field Station.)

**Irrigated Pastures in Western South Dakota**

Cattle and sheep are being pastured on irrigated alfalfa-brome to determine the carrying capacity and the amount of beef and lamb that can be produced per acre. The pasture season for 1955 extended from May 8 to September 11 or 126 pasture days. The carrying capacity of the pasture was about 1.6 steers per acre and 7.4 mature sheep per acre. The steers gained on the average 189 pounds per head or 1.44 lbs. per head daily. Beef production per acre was approximately 295 pounds.

The sheep production per acre was 252 pounds, 212 pounds of this was produced by the lambs. The lambs gained an average of 0.3 pounds per day while on the irrigated pasture the ewes gained an average of about 1 pound per day during the 126-day pasture season.

The steers consumed about 3.7 pounds of dry roughage per head daily during the season. While the ewes ate only 0.3 pounds per head daily, a considerable portion of this dry roughage was consumed during a period of about 10 days when the pasture was very short. Due to the demand for water by farmers, the station was not able to irrigate at the proper time. Thus pasture was poor and hay was fed.


**Pasture Studies with Beef Cattle**

The value of brome grass, alfalfa-brome grass, sweet clover-rye, and soybean-sudan pastures are being tested at Brookings. Yearling Hereford steers were grazed during the 1955 pasture season at rates compatible with available forage in the various pastures. The alfalfa-brome and brome pastures were grazed from May 19 to September 23, the sweet clover-rye from May 19 to
July 9, and the soybean-sudan from July 28 to September 15. No bloat occurred in any of the pastures.

Pasture size, stocking rates, and animal production are shown in table 5. Stocking rates and gains per acre were very good for all pastures. The alfalfa-brome pasture was superior to brome alone in both carrying capacity and gain per acre. The sweet clover-rye and soybean-sudan pastures furnished grazing for much shorter periods than the alfalfa-brome and brome pastures, and thus less gains per acre were obtained with these short season pastures. Their stocking rates for the period actually grazed were superior to the alfalfa-brome and brome pastures. However, this is influenced by the steers being grazed on these short season pastures during the more favorable parts of the growing season.

The work is being continued to compare various pasture crops in forage and animal production under South Dakota conditions. Results from more years are needed to establish the over-all value of the short season pastures, sweet clover-rye, and soybean-sudan. Both seem to have a high rate of production for a short season and thus may fit in well as supplementary pastures. The results of forage production are reported under “Crops, Field.” (Project 225. Leaders: W. W. Worzella, Agronomy Dept.; L. E. DuBose, Animal Husbandry Dept.)

Roughage Marketing Project

This project was set up to survey

<table>
<thead>
<tr>
<th>Rate of Grazing</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>Amount of grazing furnished animal unit months†</td>
<td>95</td>
<td>100</td>
<td>103</td>
</tr>
<tr>
<td>Stocking rate, acres per animal unit month</td>
<td>1.68</td>
<td>2.66</td>
<td>3.55</td>
</tr>
<tr>
<td>Number of cows completing the season§</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Final weight, lbs.</td>
<td>792</td>
<td>887</td>
<td>996</td>
</tr>
<tr>
<td>Initial weight, lbs.</td>
<td>877</td>
<td>855</td>
<td>867</td>
</tr>
<tr>
<td>Gain, lbs. per head</td>
<td>-85</td>
<td>32</td>
<td>129</td>
</tr>
<tr>
<td>Calf crop weaned, percent</td>
<td>67</td>
<td>75</td>
<td>58</td>
</tr>
<tr>
<td>Weaning weight calves, corrected to 190 day age</td>
<td></td>
<td>329</td>
<td>404</td>
</tr>
<tr>
<td>Total cow and calf gains per animal unit, lbs.**</td>
<td>48</td>
<td>158</td>
<td>199</td>
</tr>
<tr>
<td>Total cow and calf gains per acre**</td>
<td>4.2</td>
<td>8.8</td>
<td>8.4</td>
</tr>
</tbody>
</table>

*Annual precipitation for 1955 was 13.95 inches and growing season precipitation (April 1-Sept. 30) was 11.32 inches compared with the longtime average of 14.72 and 11.77 inches, respectively. In 1955 3.89 inches were received in September.
†A 1,000 lb. cow is considered to be one animal unit. Animal units were calculated by a ratio of $\frac{W^{2.73}}{1000}$ where W is the average of 8 monthly weights taken during the growing season.
§18 animals were started on each treatment except that 17 were started on the heavily grazed pastures. Because of the very dry summer, all animals except the record animals were removed in midsummer.
||IWeaning weights were corrected to a standard 190-day age with correction factors developed at Cottonwood in previous years by Dinkel and Johnson.
**The total gain of cows and calves completing the season was used to calculate pasture production on the basis of the total number of animal unit months of grazing furnished.
methods and practices of marketing roughage in South Dakota and to correlate their market values and prices with their chemical composition, which is a measure of the nutritive content. At present the nutritive content is usually estimated from the appearance. However, roughages vary widely in feeding value, and a better method of evaluating the feed than by appearance alone is needed.

Samples of different types of roughages from various areas of the state are being collected. The samples will be analyzed for protein and moisture content as a measure of this nutritive value and will be classified according to botanical composition, color, leafiness, stage of maturity at harvest, area, and method of harvesting and storage. Price asked or paid for the hay that is sold is determined at the time the sample is taken. (Project 267. Leaders: L. E. DuBose, Animal Husbandry Dept.; Richard H. Kruse, Agricultural Economics Dept.)

**Table 5. Summary of Pasture Research for Season Starting May 19, 1955**

<table>
<thead>
<tr>
<th>Type of Pasture</th>
<th>Brome</th>
<th>Alfalfa-Brome</th>
<th>Sw., Clover-Rye</th>
<th>Soybeans Sudan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture no.</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Acres/pasture</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Max. no. animals/pasture</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Min. no. animals/pasture</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Av. no. animals/acre</td>
<td>0.98</td>
<td>0.87</td>
<td>1.16</td>
<td>1.16</td>
</tr>
<tr>
<td>Pasture days</td>
<td>126</td>
<td>126</td>
<td>126</td>
<td>126</td>
</tr>
<tr>
<td>Animal days/pasture</td>
<td>992</td>
<td>880</td>
<td>1166</td>
<td>1166</td>
</tr>
<tr>
<td>Total gain/pasture (lbs.)</td>
<td>2234</td>
<td>1807</td>
<td>2593</td>
<td>2836</td>
</tr>
<tr>
<td>Av. daily gain/animal (lbs.)</td>
<td>2.25</td>
<td>2.05</td>
<td>2.22</td>
<td>2.43</td>
</tr>
<tr>
<td>Total gain/acre (lbs.)</td>
<td>279</td>
<td>226</td>
<td>324</td>
<td>355</td>
</tr>
</tbody>
</table>

*All gains based on 15 hour shrunken weights.*

**Internal Medications for Cattle Grub Control**

During the past year in vivo experiments have been carried on in the Animal Husbandry Department to study the activity of five chemicals that had shown high promise to laboratory studies the previous year, and to study the effectiveness of phenothiazine and Hy-
polin* under field conditions in South Dakota.

In the late fall and winter of 1955-56, the chemicals that had shown promise in the \textit{in vitro} laboratory tests were tested \textit{in vivo} in calves for their toxicity to cattle grubs.

\textbf{Procedure.} Thirty calves from the Cottonwood Range Field Station were trucked into Brookings for use in the \textit{in vivo} testing. The calves were presumed to be infested with grubs and were divided into 10 lots of three animals each. They were randomly allotted by weight. The calves all received the same ration with the exception of the medication for grubs.

Two methods for the treatment of grubs were used. Four lots of three animals each were fed a low-level dosage of chemical (1 gram per day) in their ration for 84 days beginning December 22. Six lots of three animals each were drenched monthly with 5 grams of chemical per head (with the exception of chemical S.D. 119, only 2 grams per head per month dosage was used because of high toxicity). The drenched calves were treated at monthly intervals for 4 consecutive months beginning December 7. Three animals were used as controls and not treated.

The grubs were extracted from the backs of the calves at monthly intervals beginning February 3 before any of the grubs had emerged.

Four of the candidate chemicals were used both in the feeding and drench phases of the experiment. None of the treatments were effective controls for cattle grubs under the conditions of these tests.

\textbf{Field Tests of Phenothiazine and Hypol.} 120 head of Angus calves were purchased in the fall of 1955 for nutrition studies. Forty of these calves were sent to each of three substations—Highmore, Eureka, and Cottonwood. The calves were considered to be similar as far as grub infestations were concerned. All of the calves were purchased from the same county or general grub area.

The calves were fed to gain approximately \(\frac{3}{4}-1\) pound per head daily.** For the nutrition studies the calves were allotted into four uniform lots of 10 head each at each substation. The grub treatments were superimposed on the nutrition studies.

At the Eureka station 40 of the Angus calves were divided into four lots of 10 animals per lot for the nutrition studies. Five animals out of each of the four lots were drenched with 1\(\frac{1}{2}\) ounces of phenothiazine per head monthly beginning November 16 for 4 months. The remaining five calves of each lot were used as control animals and not treated. Monthly grub counts were made beginning February 5 to determine the effectiveness of the treatment, the counts beginning before any of the grubs had emerged.

At the Cottonwood station the calves were divided into four uniform lots for the nutrition studies. Five animals from each lot were drenched with 1\(\frac{1}{2}\) ounces of Hypol in each at monthly intervals beginning November 22 for 4 months. The remaining five animals in each lot were used as controls and not treated. Monthly grub counts were made.

At the Highmore station all lots were fed trace mineralized salt as their only source of mineral, with phenothiazine mixed in at the rate of 9 parts salt to 1 part phenothiazine. No control animals were left untreated at Highmore as it was necessary for the nutrition studies that all animals receive the same mineral supplement. Monthly grub counts were made before any emergence had occurred.

Internal parasites were also studied in these tests and that work will be reported at a later date.

*A proprietary compound obtained in England containing phenothiazine, di-n-butyl tin dilaurate, hexachlorethane, and nonfoaming dispersing agents.

**Their rations being prairie hay-protein supplement or alfalfa hay.
Table 6. Results of Field Tests With Phenothiazine and Hypolin

<table>
<thead>
<tr>
<th>Eureka Substation (Phenothiazine drench 1 1/2 ounce/head/month)</th>
<th>Lot I Drench Control</th>
<th>Lot II Drench Control</th>
<th>Lot III Drench Control</th>
<th>Lot IV Drench Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of animals</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total grubs</td>
<td>109</td>
<td>124</td>
<td>182</td>
<td>167</td>
</tr>
<tr>
<td>Av./no./grubs</td>
<td>21.8</td>
<td>24.8</td>
<td>36.4</td>
<td>33.4</td>
</tr>
<tr>
<td>Av. no. grubs per treated animal—all lots—30.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. no. grubs per control animal—all lots—22.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highmore Substation (Phenothiazine + Trace Mineralized Salt)</th>
<th>Lot I</th>
<th>Lot II</th>
<th>Lot III</th>
<th>Lot IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of animals</td>
<td>9*</td>
<td>9*</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total grubs</td>
<td>96</td>
<td>132</td>
<td>133</td>
<td>87</td>
</tr>
<tr>
<td>Av./no./grubs</td>
<td>10.67</td>
<td>14.67</td>
<td>13.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Consumption:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av./gms./phenothiazine/head/day</td>
<td>1.50</td>
<td>1.36</td>
<td>1.18</td>
<td>1.09</td>
</tr>
<tr>
<td>Av./gms./phenothiazine/calf/day/all lots—1.35 (for 144 days beginning 11-22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av./no./grubs/all lots—11.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cottonwood Substation (Hypolin drench 1 1/2 ounce/head/month)</th>
<th>Lot I Drench Control</th>
<th>Lot II Drench Control</th>
<th>Lot III Drench Control</th>
<th>Lot IV Drench Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of animals</td>
<td>5</td>
<td>5</td>
<td>4*</td>
<td>5</td>
</tr>
<tr>
<td>Total grubs</td>
<td>152</td>
<td>22</td>
<td>102</td>
<td>117</td>
</tr>
<tr>
<td>Av./no./grubs</td>
<td>30.4</td>
<td>4.4</td>
<td>25.5</td>
<td>23.2</td>
</tr>
<tr>
<td>Av. no. grubs per treated animal—all lots—23.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. no. grubs per control animal—all lots—12.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*One animal died not due to grub treatment.

There was considerable variation within treatments on the total number of grubs that were counted in each calf’s back.

Eureka—20 Treated animals, 3 to 70 grubs; 20 Control animals, 1 to 59 grubs.

Highmore—20 Treated animals, 0 to 36 grubs; (No control animals).

Cottonwood—20 Treated animals, 0 to 71 grubs; 20 Control animals, 0 to 43 grubs.

At the Eureka and Highmore substations there were more grubs in the treated lots than in the control lots. It is apparent that under the conditions of the experiment phenothiazine and Hypolin drenches were not effective in reducing the number of grubs that reached the backs of the calves. At the Highmore station the average number of grubs per animal was considerably less than at the other stations. A direct comparison can’t be made as they came out of a different herd than those involved in either of the other two trials. However, it is apparent that the treatment was not fully effective, if at all. (Project 244. Leader: Wm. M. Rogoff, Entomology-Zoology Dept.; and Paul H. Kohler, Animal Husbandry Dept.)

Reducing Farm-to-Market Losses of Livestock

Research was initiated in 1954 to provide more information on the farm-to-market losses of livestock. Work is continuing in accordance with the following objectives: (1) to measure the physi-
cal losses in marketing due to bruising, crippling, death, and shrinkage (both tissue and excretory; (2) to determine the causes of marketing losses of livestock in transit; (3) to evaluate the economic significance of these losses and to determine the effect of shrinkage, bruising, and crippling on the value obtained for livestock and livestock products; and (4) to discover the means whereby these losses may be reduced and determine the relative net economic benefits to be obtained.

Annual, monthly, and daily records of dead and crippled livestock are being collected and tabulated from livestock marketing agencies in the state. These data are being related to such factors as species, method of transportation, point of origin, total receipts, and seasonal and climatological effects.

Observational data have been collected utilizing the livestock trucking operations of the Animal Husbandry Department in studying tissue and excretory shrinkage. Data were obtained on the effects of fasting and extent of in-transit shrinkage as related to the pattern of shrink recovery on 600-pound yearling steers.

Methods are being developed to determine the extent and magnitude of losses due to bruising and hidden damage and studies will be undertaken as the project continues. (Project 285. Leaders: R. M. Luther, Animal Husbandry Department, R. H. Kruse, Agricultural Economics Dept.)

Inbreeding, Linecrossing, and Selection Within the Hampshire, Duroc, and Yorkshire Breeds

A closed herd of Durocs having approximately 25 percent inbreeding receives major emphasis in selection for decreased backfat thickness. Live measurements taken at 154 days and at market weight are used to determine which animals have least backfat and will therefore go into the breeding herd. In spite of selection differentials of one-fourth inch for boars and one-sixth inch for gilts saved for breeding, pigs produced by these breeding animals averaged more backfat than the average of the fatter parent (gilts) by 0.15 inches and 0.27 inches. These results are probably due to small selection differentials and the fact that backfat thickness is a complex genetic character.

A Hampshire line is carrying approximately 45 percent inbreeding. With this level of inbreeding, pig production and growth rate have decreased to inefficient levels. To improve performance as well as body length, introductions of desirable outbred gilts are being made. They are mated to boars of the line, therefore allowing maintenance of identity of the line while making improvements.

Performance among six separate samples of the Yorkshire breed indicated that three of them were potentially useful as foundations for an inbred line. The three better performing samples were saved to be further tested.

One phase of this project is being pursued at the Eureka substation. Rotational crossing among the Duroc, Hampshire, and Yorkshire breeds, now in the ninth generation, shows this to be an efficient system for market hog production. Last season 9.5 pigs per litter were marketed at just over 5 months of age. Boars for this work are supplied from lines maintained at Brookings and constitute a partial test of crossing ability of the lines. (Project 124. Leaders: J. W. McCarty, Animal Husbandry Dept., and Albert Dittman, North Central Substation, Eureka.)

Swine Production for the Irrigated Area of Western South Dakota

The breeding phase of this project is receiving major emphasis at present. For that purpose a rotation crossing program utilizing inbred lines of the Hampshire, Duroc, and Yorkshire breeds is being maintained. This cross,
now in the ninth generation, continues
to demonstrate its value as an efficient
system for commercial hog production.
Pigs raised during the 1955 season were
sired by two inbred Duroc boars. Differ-
ences in average pig weights between
the sire groups were especially striking.
Weaning weights were 35 and 38
pounds while weights at 5 months of
respective groups were 161 and 185
pounds.

Carcasses of pigs in slaughter tests
averaged 29.6 inches in length, and had
an average of 1.8 inches of backfat. This
is more backfat than is desired in No. 1
hog carcasses. Primal cuts represented
46.2 percent of the slaughter weight.

This herd also serves as part of the
test for inbred lines being developed at
Brookings. Boars will continue to be
tested in this crossing program to meas-
ure combining ability of the Duroc,
Hampshire, and Yorkshire inbred lines.
(Project 132. Leaders: J. W. McCarty,
Animal Husbandry Dept., and Harry
E. Weakly, U. S. Newell Field Station.)

Comparisons of Weaning Pigs at 3 or 8
Weeks of Age

During the 1955 spring farrowing
season 50 pigs were weaned at 3 weeks
of age and divided into five lots of 10
pigs each. Each lot was fed a slightly
different creep ration. Comparisons
were made with five lots of six sows and
litters each that were fed the same creep
rations. There were 205 pigs weaned
from these five lots of sows. The sows
were hand fed at the rate of 11 to 12
pounds of ration per day.

Fifty-six day weights were approxi-
mately 4 pounds heavier when the pigs
were weaned at 8 weeks than at 3 weeks
of age. On a daily gain basis these pigs
gained 0.1 lb. per day faster than did
those weaned at 3 weeks. The lighter
56-day weights of the pigs weaned at
3 weeks of age appeared to be due to
very little, if any, gain by these pigs dur-
ing the first week after weaning.

The amount of feed required per
pound of gain was very much in favor
of the 3-week weaning age. These pigs
required only 2.3 pounds of feed per
pound of gain compared with 4.75
pounds for the pigs weaned at 8 weeks.
The reason for this difference was due
to an average 25 pound loss in sow
weight during this 5-week period. The
feed eaten by the sows is also charged
to the pigs in this case. In the previous
year's experiment when the sows were
self-fed they did not lose weight and the
amount of feed required per unit of
gain was not as large as in this trial.

Because of the difference in feed effi-
ciency, the feed cost per pound of gain
was 3 cents less for the pigs weaned at
3 weeks of age. (Project 212. Leader:
Richard C. Wahlstrom, Animal Hus-
bandry Dept.)

B-Vitamins and Unidentified Factors
for Growing Swine

A total of 72 weanling pigs were used
in two trials during the past year to
study the effect of supplementing a
practical swine ration with B-vitamins
and other growth factors. A 16 percent
protein basal ration was used in both
trials. The composition was as follows:
ground shelled yellow corn, 81.0; soy-
bean oil meal, 12.0; tankage, 6.0;
steamed bone meal, 0.5; trace-mineral-
ized salt, 0.5; and oxytetracycline, 10
gms. per ton.

In both trials an improvement in rate
of gain was observed when a B-vitamin
supplement consisting of riboflavin, nia-
cin, pantothenic acid, and vitamin B_{12}
was fed. Riboflavin alone gave a slight
growth response both when added to
the basal ration and when added to the
basal ration plus the other three B-vita-
mins. Pantothenic acid caused a growth
response in the presence but not in the
absence of the other three B-vitamins.

A fermentation product did not im-
prove the basal ration when it was
supplemented with B-vitamins. Tri-
methylalkylammonium stearate gave no
growth response above that of the basal
ration. In these trials the best growth rate and most efficient production occurred when the above basal ration was supplemented with riboflavin, pantothenic acid, niacin, and vitamin B₁₂.

(Project 238. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

Protein Supplements in Mixed Rations and for Free-Choice Feeding with Shelled Corn to Pigs

In previous experiments at this station, on the amino acid requirements of pigs, some difficulty has been encountered with a dermatitis in pigs fed an all-plant protein ration. This dermatitis is now called swine parakeratosis and appears to be aggravated by high levels of calcium in the ration.

A trial was conducted in which soybean meal was fed as the only supplemental protein to three lots of pigs fed mixed rations. The soybean meal was fed at a level of 17 percent of the ration. The fourth lot received a ration containing an equal amount of total protein but the ration used contained 10 percent of tankage and 3 percent of soybean meal. Two of the lots fed the soybean meal ration were supplemented with a mineral supplement to bring the calcium level to approximately 1.1 percent. One of these two lots also received 0.01 percent zinc carbonate. The third soybean meal ration contained approximately 0.7 percent calcium.

Three cases of parakeratosis were observed in the lot of pigs fed the high calcium ration without zinc and no symptoms were observed in the other lots. The daily gains of the pigs fed the soybean meal rations with zinc or a low level of calcium were considerably faster than the gains of the pigs fed the ration composed mainly of tankage as the protein supplement.

In a winter feeding trial, four different protein supplements were self-fed along with shelled yellow corn to four lots of 15 pigs each. The supplements fed to the four lots of pigs were as follows: Lot 1—soybean meal 48, tankage 48, trace mineral salt 2, steamed bone-meal 2; Lot 2—same as lot 1 except a B-vitamin supplement was added; Lot 3—Soybean meal 38, tankage 38, ground alfalfa 19, trace mineral salt 2, steamed bone-meal 3; Lot 4—Soybean meal 48, tankage 24, ground alfalfa 10, linseed meal 10, trace mineral salt 2, and steamed bone-meal 6. Chlortetracycline was added to all supplements at a level of 50 grams per ton.

The average daily gains and feed required per hundred pounds of gain for the four lots were: Lot 1—1.33 and 380; Lot 2—1.43 and 352; Lot 3—1.29 and 353; Lot 4—1.38 and 341. It was observed that the pigs in Lots 1 and 2 consumed excessive amounts of protein supplement, thus increasing their feed costs per unit of gain. The most economical gains, but also the slowest gains, were made by the pigs in Lot 3. (Project 251. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

Development of a Tailless Sheep

To further test the docking ability of No-Tail sheep, as well as their desirability in crosses with common breeds, half the 1955 lamb crop was sired by Hampshire, Southdown, Columbia, and Rambouillet rams.

At birth crossbred lambs weighed 10.1 pounds as compared to 9.7 for No-Tails. Crosshreds were heavier at weaning age of 120 days by 1.5 pounds (74.0 as compared to 72.5 pounds). Crossbred lambs showed more desirable mutton conformation, especially those sired by Hampshires and Southdowns. Use of the No-Tail appeared to reduce birth tail length by 2 to 3 inches. Crossbred ewes are being saved to test lamb and wool productivity.

All No-Tail ewe lambs were bred to lamb as yearlings in 1955. Eighty-three percent produced lambs—all singles. All lambs produced by yearling ewes were weaned. The effect on production of lambing ewes as yearlings will also
be studied. Since the No-Tails are managed under good farm flock conditions, it appears that the practice of lambing early can continue, thereby giving the ewes an average of 1 year longer productive life. (Project 9. Leader: J. W. McCarty, Animal Husbandry Dept.)

**Winter Feeding and Summer Grazing Studies with Range Ewes**

Results from this experiment indicate the following: Winter range forage is deficient in both protein and energy for maximum ewe production. If fed at the same level, a 40 percent protein supplement is superior to one of 20 percent for wintering bred ewes on the range.

Summer grazing management and level of winter supplementation are both important factors in ewe production. Level of winter supplementation is most critical when the ewes are poorly fed during the winter. Maximum ewe production is achieved with a high level of winter feeding and excellent condition summer range.

Maximum net returns may be achieved in some years by a high level of supplementation, in others with a lower level. This depends upon lamb, wool, and salvage ewe prices; feed costs; and climatic conditions. However, well-grown, vigorous, high-producing ewes may have better livability with possibilities of a longer productive life and a higher resale value. (Projects 159 and 177. Leaders: J. K. Lewis, G. T. King, and L. B. Embry, Animal Husbandry Dept., and William Trevillyan, Antelope Range Field Station.)

**Vitamin D Supplementation for Feeder Lambs**

An experiment was conducted to determine the effect of a subcutaneous injection of Vitamin D on growth rate, feed efficiency, and carcass quality. Two levels of Vitamin D were compared to determine the optimum level for feeder lambs. A comparison was also made between Vitamin D supplementation and feeding free-choice a mineral mixture consisting of 2 parts bone meal, 2 parts ground limestone, and 1 part salt.

Sixteen lots of 12 lambs each were used in the experiment. Each of the four treatments was replicated four times. The feed lot performance and carcass quality of the lambs were not significantly affected by the treatments. However, the lambs fed mineral made slightly more efficient gains and the carcass graded somewhat higher. The carcass yield for the controls was 1 percentage point lower than the treated lots. (Project 282. Leader: Leon F. Bush, Animal Husbandry Dept.)

**Protein Intake Regulator—Salt, see page 29**

**Free-Choice or Complete Mixed Rations, see page 66**

**Bentonite in Lamb Rations, see page 78**

Also see: Selenium Poisoning, page 118

**Pasture Trials, page 125**

**Some Factors That May Affect Bloat, page 128**

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**Plant Diseases**

**Corn Diseases and Their Control**

Approximately 400 inbred lines of corn were grown in field experiments in 1955. These corns consisted largely of lines being selected for resistance to root rot, rust, stalk rot, smut, and leaf blights. Foliage diseases were not as abundant as in previous seasons; however, root rot was of the same intensity.

In cooperation with the Agronomy Department, a limited number of the more promising root rot resistant lines were top-crossed to certain single crosses in 1954 and the seed planted in
a yield test involving other experimental hybrids. One of these three-way crosses out-yielded all other experimental combinations included in the test at Water-town in 1955.

Approximately 200 inbred lines of corn were tested in the greenhouse for resistance to root rot. Using a scoring system of 1-5, several lines were classified in category 1 indicating a rather marked degree of root rot resistance. (Project 185. Leader: C. M. Nagel, Plant Pathology Dept.)

The Nature and Control of Certain Soil-Borne Diseases of Sorghum

Sorghum seed treated with 12 fungicides was planted in early May, mid-May and early June at Brookings and Highmore. The greatest improvement in stand was in mid-season plantings made around May 20. As in previous years, Arasan, Carbon and Carbide 224, Ceresan and Orthocide 75 significantly increased stands at both locations. Experimental fungicide B-1484 significantly increased the stand of the early planting at Highmore. In no case did the final stand exceed 50 percent of the germination potential of the seed.

In certain seasons a large number of fungicides have significantly improved stands while in other years almost no fungicide increased stands. Seed treatment has never produced stands equal to the germination potential of the seed regardless of the season or time of planting.

The effect of environment on sorghum seed germination and seedling mortality has never been investigated. Experiments were initiated in the laboratory and designed to assess the influence of temperature, moisture and time of incubation on (1) germination, (2) mortality of ungerminated seed, (3) and the extent of fungus infection. In these experiments sorghum seed was planted in field soil of four moisture levels and held at 2, 10, 15, 30, and 35°C for 3, 7, and 14 days. At the end of the period all ungerminated seeds were surface disinfected and placed on nutrient agar plates to germinate. All germinated seeds were counted and molds growing from ungerminated seeds were isolated.

Germination was most rapid under a combination of high temperatures and high moisture, and within 3 days germination was almost complete. No germination occurred during the time the seeds were held at the lowest temperatures or moistures.

Mortality of the seeds was high when the temperature was high and the moisture low and again when the temperature was low and the moisture high. These results indicate that seed mortality is greatest under those conditions which restrict germination. It appears that the interaction between high moisture and high temperature gives rise to conditions most favorable for germination and on account of these conditions pathogenic activity is low.

The most frequently isolated fungus from the high temperature low moisture conditions was Aspergillus flavis, a seed-borne mold capable of killing seeds. Fusarium and Pythium species were most frequently isolated from the low temperature high moisture conditions. A seed protectant, then, to be effective should be toxic to a wide range of organisms.

Sorghum lines were tested for root rot resistance in the field and greenhouse. Two hundred sorghum selections were tested for resistance to a pathogenic isolate of Fusarium. Six percent were resistant, 13 percent moderately resistant, and the remainder were highly susceptible. (Project 110. Leader: C. J. Mankin, Plant Pathology Dept.)

Control of Root Rot Diseases of Barley and Winter and Spring Wheat

Surveys and isolations on the cause of cereal root rot showed three types of organisms: (1) facultative saprophytic fungi, (2) obligate parasitic mycorrhizal fungi, and (3) nematodes.
The facultative saprophytic fungi isolated from wheat and barley included *Helminthosporium sativum*, *Fusarium roseum* var *cerealis*, and *Pythium* (sp.)*). Pathogenic isolates were obtained of *Helminthosporium* and *Fusarium*, but no pathogenic isolates of *Pythium*. Inoculum concentration experiments for determining varietal tolerance and isolate virulence showed that *H. sativum* varied with concentrations but not *Fusarium*. This would indicate the rapid growth of *Fusarium* and the unsuitability of this type of investigation for determining tolerance to *Fusarium*. By mixing a pathogenic *H. sativum* isolate with a non-pathogenic *Helminthosporium* isolate the pathogenicity of the former isolate was decreased.

Phycomycetous mycorrhizal fungus, which is thought to be an obligate parasite heretofore unreported in South Dakota, was found in soil from southwest of Colome. Roots of barley seedlings growing in this soil had abundant infection by this fungus, but barley grown in soil from Brookings and Presho had none. The effect of this type of infection is not known. Infection with pure cultures were successful on barley roots, and arbuscules were present in cells of the root cortex.

Plant parasitic nematodes, heretofore not recognized in cereal root rot in South Dakota, were found in all soil samples examined. The genera found were *Pratylenchus*, *Tylenchorrhynchus*, *Tyl enchus*, *Psilenchus*, *Aphelenchus*, and *Aphelenchosoides*. In themselves the nematodes are not thought to be of sufficient numbers to cause much damage, but the possibility that wounds made by them in roots may be very important in allowing entry of otherwise weakly parasitic fungi. In the greenhouse, barley plants grown in field soil fumigated with dichloropropene and dichloropropane (a nematocide) had increased vigor over the control. The plants grown in soil fumigated with chloropicrin (a nematocide-fungicide) showed a greater response than those grown in soil treated with the nematocide. This indicates that nematodes are entering into the complex with fungi.

Investigations of root rot of winter wheat are being conducted at Presho. These studies are to determine the effect of soil microorganisms on winter survival of winter wheat, to determine difference in susceptibility of winter wheat varieties to root rot, and to get indications of the importance of nematodes and fungi.

The planting of approximately 3,000 wheat and barley varieties on fumigated and nonfumigated soil for resistance studies in the field was not possible due to the cold spring of 1956. The varieties, however, were planted for seed increase and root rot readings in the field.

Preliminary control investigations using an antibiotic-producing organism, *Streptomycetes filipinensis* were unsuccessful because of the failure of disease development in the control. The antibiotic of this organism is quite specific against fungi, particularly against *Helminthosporium*. (Project 115. Leader: R. E. Ohms, Plant Pathology Dept.)

**Foliage Diseases of Small Grain and Their Control**

**Cereal Virus Investigations.** Investigations on wheat streak mosaic were begun by screening for resistance part of the 15,000 entries in the World Wheat Collection. Field inoculations on 1,000 durum and 500 spring wheat lines indicated that some tolerance to this virus disease does exist in some lines based on the severity of symptom development. From the 1,500 lines tested about 200 were selected for further tests in the greenhouse. Fifty-five of these were saved for further evaluations. From the results so far obtained it appears that complete immunity to this disease may not be found in the wheat collection, but certain degrees of tolerance appear to exist.
Some type of resistance to wheat streak mosaic will be the most satisfactory type of control. However, due to the time involved in developing a suitable variety possessing mosaic resistance, the immediate problem of control can probably be solved by finding the best cultural practices that will reduce disease severity. Previous limited experiments have shown that late planting of winter wheat reduces mosaic severity. Elimination of weed hosts has also been recommended. Further experiments concerning the benefits of these practices are being conducted.

Stripe Mosaic of Barley. In order to determine the prevalence of barley stripe mosaic, county agents in 21 counties were asked to collect three barley seed samples from their counties for stripe mosaic determinations. Stripe mosaic of barley is a virus disease which is becoming prevalent in South Dakota. The most striking symptoms of the disease are the dark brown streaks on the leaves of diseased plants. The foliage may turn light green in color. Dwarfing or stunting results in shrunken grain and empty heads. Experiments have shown that yields may be reduced 25 to 75 percent if infected seed is planted.

Rust Investigations. In cooperation with the U. S. Department of Agriculture, experiments were continued on factors influencing wheat stem rust development. These experiments are designed primarily to determine the effect of the initial number of rust infections produced from a known number of spores on the subsequent build-up of rust within a wheat field. Favorable weather conditions are the primary factors affecting rust development, so complete weather data are needed. The uniform stem and leaf rust nurseries of wheat and barley were grown and evaluated. A uniform bunt seed treatment nursery was grown and evaluated in cooperation with the Canadian Department of Agriculture.

A portion of the World Wheat Collection was grown and evaluated for reaction to stem rust. Sixty-four lines were selected as rust resistant to be used in further tests.

Smut Investigations. Loose smut of wheat caused an estimated 10 percent reduction in yield. This was probably the most economically important wheat disease for 1955. Twenty collections were made from both winter and spring wheat for race identification. (Project 204, Leader: J. F. Hennen, Plant Pathology Dept.)

Oats Diseases and Their Control

Field surveys made in the southeastern and south central counties indicate that root rot of oats is of widespread occurrence. In the 20 counties surveyed, only eight fields had less than 50 percent and no fields had less than 30 percent infection. The early spring drought may have influenced the high rate of root rot in these southern counties.

On the basis of this year's survey Fusarium, Rhizoctonia, and Pythium species are the most common fungi associated with oat root rot in South Dakota. Pythium and Rhizoctonia species are commonly isolated from diseased roots in the early stages of plant growth. After heading, Fusarium species are predominantly isolated. The etiology of the various species of fungi associated with root rot of oats is not clearly established and needs further clarification.

A collection of all fungus genera isolated from oat roots was maintained and these isolates were tested for pathogenicity in the greenhouse using pure cultures of a given isolate. All the isolates were tested on six oat varieties for pathogenicity. Under the conditions of these tests Missouri 205 was the most tolerant to the several fungus genera tested, and Gopher and Branch were the most susceptible. Cherokee, Nemaha, and Saut were intermediate.

Foliage diseases of oats were of moderate prevalence in the 1955 season.
Losses due to stem and leaf rusts were about 3 percent although certain local areas had up to 10 percent loss. Other diseases present but not particularly damaging were halo blight, red leaf (virus), loose and covered smut. (Project 283. Leader: L. S. Wood, Plant Pathology Dept.)

Flax Diseases and Their Control

The varieties of flax recommended for commercial production are susceptible to pasmo, a disease which attacks all above-ground parts of the plant and which reduces both the yield and quality of the crop. Sources of resistance are being sought from among the entries of the World Collection of Flax. Although 829 entries were inoculated with Mycosphaerella linum in an attempt to incite an epiphytotic of pasmo and thus be able to select resistant lines, no disease developed. These entries were tested in the seedling and mature stage in the greenhouse; pasmo in some lines was light, but moderate to heavy on most of the entries.

The Early Generation Flax Nursery and the Uniform Regional Flax Nursery, which comprise new varieties for possible release to growers, were grown for disease observation; likewise the Uniform Flax Rust Nursery was also observed but diseases were too light for determining differences in varietal response in 1955.

Nineteen different seed treating chemicals replicated four times were tested with one variety against seed rot. The effect of the seed treatment varied but none was as good as the standard control, Ceresan M. An experiment was made to determine the effectiveness of seed treatment in relation to yield with six fungicides—three liquid and three dust—with four standard varieties. Treatment included four dates of planting at 2 week intervals. Seed treatment did not affect yield of the varieties, but late varieties planted late did not yield well.

Greater emphasis will be placed on finding sources of resistance to pasmo. The number of entries to be tested has been increased to about 950. The lines will be grown at three different locations thus increasing the possibility of having a satisfactory test. (Project 276, Leader: M. E. Michaelson, Plant Pathology Dept.)

Biology and Control of Forage Grass Diseases

Twenty fungicides were used to treat crested wheatgrass, tall wheatgrass, Reewheatgrass, and brome grass seed at Brookings and Highmore. At Brookings Orthocide 75, B-1843, and Ethyl 856 significantly improved the stand of tall wheatgrass. No fungicide improved the stand of Reewheatgrass or brome grass.

Twenty-four selections of crested wheatgrass were tested for resistance to seedling blight caused by isolates of Pythium species. Eleven of the lines were highly resistant to pre-emergence blight, while only two of these lines were resistant to post-emergence blight. Post-emergence blight reduced the stands of seven of the eleven lines that were resistant to pre-emergence blight by 50 to 75 percent. The remaining lines were highly susceptible to both types of seedling blight.

Field readings for the prevalence and severity of Helminthosporium leaf blight and other foliage diseases of brome grass were made. Helminthosporium bromi was the most prevalent foliage disease of brome grass. Due to the dry season the severity was less than in past seasons. Selenophoma was rather severe early in the season in brome fields and pastures.

The progeny of various brome grass crosses was tested under greenhouse conditions for resistance to Helminthosporium leaf spot. With the exception of one line, all of the material tested was susceptible. These plants were planted in the fields in 1956 for further study.
Further attempts were made to determine the nature of the leaf blasting of Ree wheatgrass. Attempts to transmit the condition to various other grasses failed. In the greenhouse where regular fumigation was carried on, the plants did not develop symptoms, but where no fumigation was carried out symptoms developed. This is circumstantial evidence that the condition may be caused by some insect. Plants have been caged in the field to determine whether or not the symptoms appear in the field when the plants are protected from the larger insects. This procedure will not eliminate the possibility of this trouble being caused by mites which are often abundant on Ree wheatgrass. (Project 250. Leader: C. J. Mankin, Plant Pathology Dept.)

Investigations and Control of Alfalfa and Other Forage Legume Diseases

The crop year 1955 was quite dry and warm and unfavorable in the eastern part of the state for the normal development of such diseases as blackstem, common leaf spot (Pseudo pezizzua medicaginis), Cercospora leaf spot, and rust of alfalfa. It was favorable for abundant development of the leaf blotch disease (Pseudo-pezizzua jonesii), which normally has been abundant only in the extreme western part of the state. In cooperation with the Agronomy Department field disease readings were made as in previous years on clonal and intercross clonal alfalfa lines. Relative disease susceptibility of some of these lines to Corynebacterium insidiosum, Ascochyta imperfecta, and Cercospora zebrina were also determined in the greenhouse.

Considerable effort was devoted during the fall and winter months to a study of the relation of alfalfa seedling rot development in various South Dakota soils to the quantity of Pythium inoculum in these soils. The major results of this study have been incorporated in M.S. thesis which is on file in the South Dakota State College Library.

Alfalfa seedling rot powers or potentials of 167 samples of South Dakota soils varied from near zero to 98 percent. There was no over-all relationship between soil pH or current cover crop and these potentials. Dilution of 23 of these soils with steamed Brookings soil generally yielded lower amounts of seedling rot from the low and moderate seedling rot soils than from the high seedling rot soils, but there was no general reduction with dilution in the abundance of seedling rot. Dilution of 20 soils with a natural low seedling rot soil yield reductions that were related to the extent of dilutions and presumably to the amount of Pythium inoculum in these soils. The results supported the theory that the seedling rot powers or potentials of soils were related to the quantity of inoculum, presumably Pythium, they contained.

Plantings on agar media of diseased seedlings from a number of different soils yield Pythium ultimum as the sole pythiaceous species inducing the disease. Grown on a sterile 5 percent cornmeal-soil mixture, the fungus produced more abundant seedling rot as more of the colonized cornmeal-soil mixture, as inoculum, was added throughout several natural low seedling rot soils. In steamed soil the same inoculum amounts produced complete pre-emergence rot.

Grown on an agar medium, the fungus produced no seedling rot when pieces of the agar medium carrying it were added as inoculum in a layer one-fourth inch below the seed level to several natural low seedling rot soils and complete pre-emergence rot when the same or lower amounts of inoculum were added in a similar manner to steamed soil.

Placing cornmeal-soil inoculum of P. ultimum at the seed level in several natural soils or on top of the covering soil and watering from above produced more seedling rot than placing the
inoculum below the seed level or on the covering soil and watering from below.

In natural soils seedling rot inoculum appeared associated with fine soil particles capable of being moved about by water. It appeared to decrease in amount with repeated cropping of such soils to seedlings but increased when small amounts of these soils were added to low seedling rot soils. As infection of seed or young seedlings depends on contact between the pathogen and host, such contact could be obtained in steamed soil by an extensive growth of the pathogen and in nonsteamed soil on chance contact with inoculum particles as influenced by the abundance or concentration of inoculum, or on limited growth of the pathogen from nearby inoculum particles.

Biological interference in natural soils with *Pythium* infection of alfalfa seed or young seedlings appeared to be of a low order although an interference was evident in one of three low seedling rot soils. When equal amounts of pure culture inoculum of *P. ultimum* or of high seedling rot soils were added to each of three low seedling rot soils less seedling rot usually was obtained in one of these than in the others. Alfalfa seedling rot potentials of various soils thus depend not only on the amount or concentration of *Pythium* inoculum in the soil but presumably also on the nature of the biological population in such soil. (Project 230. Leader: George Semeniuk, Plant Pathology Dept.)

**Potato Disease Control Investigations**

Fifty-two experimental lines of potatoes were grown in the potato scab nursery including five commercial varieties. For undetermined reasons scab infection in the nursery was light in contrast to heavy infection for the past 6 years. Because of the light infection, it was not practical to select or eliminate lines in 1955; therefore, all lines were again planted in 1956 and where seed was adequate they were included in a yield test experiment.

A considerable amount of internal browning of tubers occurred in growers' fields in the Garden City area. Symptoms indicated it was due to a virus or to a wilt organism, however, a considerable amount of tuber indexing in the greenhouse did not clarify the cause. It is planned to make rather extensive field observations during the growing season and at harvest time in the main potato producing area in Clark, Codington, and Deuel counties in 1956. (Project 107. Leader: C. M. Nagel, Plant Pathology Dept.)

**Control of the Foliage Disease of the Tomato in South Dakota**

Because of the dry period during the latter half of the growing season in 1955, virtually no diseases developed on tomatoes. The few diseases which occurred were unusually light and insufficient to obtain data on disease resistance. (Project 146. Leader: C. M. Nagel, Plant Pathology Dept.)

**Control of Diseases Affecting Shelterbelt, Forest, and Shade Trees**

Leaf rust damage on cottonwoods was light in 1955. This was the first year in ten that the common strain of cottonwood did not defoliate at Brookings from leaf rust infection.

Ninety-five different strains of cottonwood were grown in field plots for observation. Leaf spot and a bark canker were damaging to several lines. Many strains appeared to possess resistance to these two diseases.

Siouxland, a rust resistant strain which was released in 1955, is being used to the limit of its availability. Production of the trees has been not as rapid as was anticipated due to hail damage and other weather conditions. Production is expected to reach a quarter million in 1957. Strain number
18773, which is equally resistant to leaf rust as Siouxland, also appears to possess considerable resistance to a very serious bark canker which girdles the limbs and trunk of the tree. (Project 292. Leader: C. M. Nagel, Plant Pathology Dept.)

Spoilage and Microorganisms, see page 61
Grass Diseases, see page 102

Poultry Production

Factors Affecting the Performance of Turkeys

Research on the relative merits of low energy (largely oats) and high energy (largely corn) diets for growing turkeys was continued. Pelleted rations of the type described promoted equal growth rates from 12 to 24 weeks of age but the high energy diet was the most economical. From 24 to 26 weeks of age the high energy diet with antibiotics was superior for growth promotion also. The antibiotic, chlortetracycline (at 10 gm. per ton, gave greater growth responses on the low energy diet.

Chlortetracycline (at 100 gm. per ton, had little effect on hatchability of apparently fertile eggs, but eggs from hens receiving the supplemented diets showed superior fertility. Progeny from the antibiotic-fed hens grew faster than control progeny on a riboflavin deficient diet but grew slightly slower on a diet adequate in known nutrients. Fish meal appeared to supply a factor required to a greater extent by the progeny of antibiotic supplemented hens but not by the hens themselves. (Project 242. Leaders: C. W. Carlson, Wm. Kohlmeyer, W. C. Morgan, A. W. Adams, Poultry Dept.; O. E. Olson, Biochemistry Dept.)

Comparative Values of Alfalfa, Rape, Sudan Grass, and Other Forage Crops for Growing and Finishing Turkeys

Turkeys were placed on pasture at about 11 weeks of age. The forage crops tested this past season were alternate drillings of oats and rape vs. an alternate two rows of corn and rape. Growth did not vary greatly with either type of range, but feed efficiency was markedly superior again on the corn and rape plot. Corn offers shade and wind protection, which may have been a factor in this work. (Project 79. Leaders: Wm. Kohlmeyer and C. W. Carlson, Poultry Dept.; Albert Dittman, North Central Substation.)

Maintenance and Uses for Inbred Lines

Three of the best performing inbred lines developed at this station have been used as parents for producing tester pullets. These lines consisted of purebred Rhode Island Red, White Plymouth Rocks, and Barred Plymouth Rocks. Although other lines are represented in the test groups, they are infrequent.

One inbred, White Plymouth Rock, SD-3, has been discontinued because of poor reproductivity. The new light-breed line, which has a White Leghorn as one foundation parent, is in its third generation. Several inbred White Leghorn lines from other stations are being used in an effort to evaluate relative performances.

The white plumage discovered in the Barred Plymouth Rock line was shown to be due to the recessive factor c.

Reproductivity of the inbred lines has continued at a low rate, but the mortality has been lower this past year. (Project 179R. Leaders: Walter Morgan, Wm. Kohlmeyer, Poultry Dept.)

Induced Sex Reversal

The left ovary was removed from pullet chicks which were less than 2 weeks old. As the birds matured, many of their characteristics were masculine. Large combs and wattles which were brilliant
red, glossy surface plumage, masculine appearing hackle and tail feathers and spurs were commonly observed. The heavy breeds and crosses from the heavies showed most complete transformation.

Inasmuch as the production of a potent cock is the objective of these studies, an effort was made to collect semen. None of the ovariectomized birds have yielded semen yet. (Project 289. Leader: Walter Morgan, Poultry Dept.)

**Supplementation of Cereal Grain for Chickens**

Studies were continued with chicks using diets composed largely of corn and soybean meal and well fortified with vitamins, minerals, and antibiotics. Chicks on this type of diet grew nearly as well to 4 weeks of age as those given supplements of various animal proteins. However, by 8 weeks of age, the supplemented groups had attained significantly greater weights. Dehydrated carp meal from South Dakota lakes was better than the sample of meat scraps tested and almost as good as the coastal products—menhaden fish meal blend or a blend of fish solubles on a soybean meal base—in supplying this factor or factors required for the most rapid growth.

Studies with antibiotics for egg production have continued to show their effectiveness in that regard. The improvements this year have been of lesser magnitude, probably due to the better performance of the controls, with respect to egg production, feed efficiency, and hatchability. Progeny from antibiotic-fed hens grew more rapidly than control progeny on a riboflavin deficient diet. With adequate diets there were small differences in growth rates. (Project 241. Leaders: C. W. Carlson, R. A. Wilcox, A. W. Adams, Poultry Dept.; O. E. Olson, Biochemistry Dept.)

**Control of Selenium Poisoning in Poultry**

Earlier work has shown that glycocystaminine and methionine combinations would counteract the growth-retarding effects of selenium in diets for young chicks. Subsequent work revealed that this effect was not always obtained and so studies were inaugurated to determine why.

More acute toxicities encountered for some unknown reason or obtained by using higher levels of selenium prevented the expression of the counteractive effect of glycocystamine and methionine. Methionine alone was not demonstrated to have any beneficial effect in counteracting the selenium toxicity. Chicks from dams fed diets containing arsanic acid appeared to have greater resistance to selenium poisoning. (Project 28. Leaders: C. W. Carlson, H. R. Woerpel, and Wm. Kohlmeier, Poultry Dept.; O. E. Olson, Biochemistry Dept.)

**Minimizing Quality Losses of Poultry Meat in Market Channels**

Market turkeys produced on relatively high energy diets showed a greater ratio of fat to water in the breast skin and to a certain extent in the coccygeus muscle than similar turkeys produced on low energy diets. This difference had no consistent effect either initially with the first half turkey or after 6 months of 0°C storage with the second half (polyethylene bagged) upon organoleptic tests on breast and thigh muscles for flavor, tenderness, and juiciness when cooked to an internal temperature of 92°C.

Toms with the greater skin fat:water ratio showed more drippings cooking loss with much less volatile loss. These toms also showed higher fat peroxide values after 6 months of storage. On the other hand, hens with a smaller skin fat:water ratio showed the highest fat peroxide values.

Differences between hens and toms were of interest in that the hens showed no consistent change in organoleptic scores whereas the toms showed a rela-
tive improvement with storage in scores for flavor, tenderness, and juiciness. After storage, the hens showed an increase in volatile cooking loss, whereas this loss was less for the toms. The hens also showed somewhat higher fat peroxide values, which indicates that the over-all organoleptic scores after storage were probably scaled high. (Project 261. Leaders: C. W. Carlson, A. W. Adams, Poultry Dept.; Beth E. Alsup, Lida M. Burrill, Home Economics Dept.; O. E. Olson, Biochemistry Dept.)

Poultry Breeding Methods, see page 31
Phosphates for Turkeys, see page 109
Also see: Improved Methods for Marketing Poultry Products, page 130
How Egg Dealers Determine Prices Paid Farmers, page 131

Rural Sociology

The Socio-Economic Influences of the Communal Type Farm on the Rural Community of South Dakota

Research on the history, settlement, and location of communal type farms in South Dakota has continued. Two communal type farms of approximately 4,500 acres in size located in southeastern South Dakota have been selected for study in the first phase of the field work.

The general features of the organization and operation of these two farms are being studied by the participant-observer technique. In addition, farmers living in the immediate vicinity of these two farms are being interviewed regarding their contact with communal type farming and their attitude toward the communal farm operators. (Project 255. Leader: Marvin P. Riley, Rural Sociology Dept.)

Retirement and Health Problems of Rural Families in South Dakota

This is a new project approved by the Office of the Experiment Stations August 10, 1955. The work Dr. Dimit, the project leader, had done on this study before his resignation February 1, 1956, had been limited to reviewing the literature as a basis for developing the hypotheses for the study and the questions for the questionnaire.

We are planning on Dr. Dimit’s replacement to continue this project next fall, when he arrives to assume his duties at South Dakota State College. (Project 279. Leader: Howard Sauer, Rural Sociology Dept.)

Tuberculosis Among South Dakota Indians, see page 112
The Houses We Live In, see page 36

Publications and Journal Articles

Bulletins

Date and Rate of Planting Corn. Bulletin 455, by A. N. Hume, V. A. Dirks, and D. B. Shank.


Circulars


Fertilization and Spacing of Irrigated Corn on the Belle Fourche Irrigation Project. Circular 120, by Bruce L. Baird and Joseph J. Bonnemann.


Agricultural Research at the Central Substation: A Progress Report. Circular 124, by Experiment Station Departments.


Technical Bulletins


Soil Survey Series


Journal Articles

Agricultural Engineering


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Agronomy


Animal Husbandry


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Poultry


Station Biochemistry


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**EXPENDITURES**

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<td>Land (Non-structural improvement)</td>
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<td>Total</td>
<td>$261,799.22</td>
<td>$54,262.94</td>
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<td>Unexpended Balance, 7/1/1956</td>
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<td>Grand Total</td>
<td>$261,799.22</td>
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# Staff Resignations and Appointments

## RESIGNATIONS

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<tr>
<th>Field</th>
<th>Employee Name</th>
<th>Date</th>
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<tbody>
<tr>
<td>Agricultural Economics</td>
<td>T. W. Manning, Associate Economist</td>
<td>June 30, 1956</td>
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<tr>
<td></td>
<td>R. R. Newberg, Associate Economist</td>
<td>Feb. 15, 1956</td>
</tr>
<tr>
<td>Agricultural Engineering</td>
<td>T. R. C. Rokeby, Assistant Agricultural Engineer</td>
<td>Sept. 9, 1955</td>
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<tr>
<td>Agronomy</td>
<td>E. J. Williamson, Assistant Agronomist</td>
<td>Sept. 30, 1955</td>
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<tr>
<td>Horticulture</td>
<td>R. L. Fossett, Assistant Horticulturist</td>
<td>Jan. 1, 1956</td>
</tr>
<tr>
<td>Rural Sociology</td>
<td>R. M. Dimit, Associate Sociologist</td>
<td>Feb. 19, 1956</td>
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## APPOINTMENTS

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<tr>
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<tr>
<td>Agricultural Economics</td>
<td>Chas. H. Benrud, Assistant Economist</td>
<td>Aug. 1, 1955</td>
</tr>
<tr>
<td></td>
<td>Loyd Glover, Assistant Economist</td>
<td>July 1, 1955</td>
</tr>
<tr>
<td></td>
<td>G. E. Marousek, Assistant Economist</td>
<td>Jan. 1, 1956</td>
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<tr>
<td>Agricultural Engineering</td>
<td>H. G. Young, Assistant Agricultural Engineer</td>
<td>Sept. 15, 1955</td>
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<tr>
<td>Agronomy</td>
<td>Q. S. Kingsley, Assistant Agronomist</td>
<td>Mar. 15, 1956</td>
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<tr>
<td></td>
<td>J. R. Runkles, Assistant Agronomist</td>
<td>Dec. 15, 1955</td>
</tr>
<tr>
<td></td>
<td>Mary E. Sanders, Research Associate</td>
<td>Nov. 1, 1955</td>
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<tr>
<td></td>
<td>E. J. Williamson, Assistant Agronomist</td>
<td>July 1, 1955</td>
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<tr>
<td>Animal Husbandry</td>
<td>L. D. Kamstra, Associate Animal Husbandman</td>
<td>Jan. 1, 1956</td>
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<td></td>
<td>Paul H. Kohler, Assistant Animal Husbandman</td>
<td>July 1, 1955</td>
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<tr>
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<td>J. A. Minyard, Assistant Animal Husbandman</td>
<td>Nov. 1, 1955</td>
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<tr>
<td>Entomology-Zoology</td>
<td>R. J. Walstrom, Assistant Entomologist</td>
<td>Sept. 12, 1955</td>
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<tr>
<td>Poultry</td>
<td>A. W. Adams, Assistant Poultryman</td>
<td>Aug. 15, 1955</td>
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<td>Station Biochemistry</td>
<td>K. C. Schneider, Research Assistant</td>
<td>Sept. 1, 1955</td>
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<tr>
<td></td>
<td>Volney Wallace, Assistant Biochemist</td>
<td>Aug. 18, 1955</td>
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Experiment Station Staff

(continued from back cover)

Lida M. Burrill, Ph.D.  Home Economist  V. D. Malan, Ph.D.  Assistant
Lillian O. Lund, M.S.  Associate  M. P. Riley, M.S.  Associate

Horticulture

S. A. McCrory, M.S.  Horticulturist
P. E. Collins, M.S.  Assistant
R. L. Forskett, Ph.D.  Assistant
R. M. Peterson, Ph.D.  Assistant
J. M. Rawson, Ph.D.  Assistant

Plant Pathology

C. M. Nagel, Ph.D.  Plant Pathologist
J. F. Hennen, Ph.D.  Assistant
C. J. Mankin, Ph.D.  Assistant
Merle Michaelson, Ph.D.  Assistant
R. E. Ohms, Ph.D.  Assistant
Geo. Semeniuk, Ph.D.  Pathologist
L. W. Wood, M.S.  (Pl. Path. USDA) Assistant

Poultry

Wm. Kohlmeyer, M.S.  Poultry Husbandman
A. W. Adams, M.S.  Assistant
C. W. Carlson, Ph.D.  Associate
W. C. Morean, Ph.D.  Associate
R. A. Wilson, M.S.  Assistant
H. R. WorrpEL, B.S.  Res. Assistant

Publications

E. W. Metcalf, M.S.  Station Editor

Rural Sociology

H. M. Sauer, M.A.  Acting Sociologist
R. M. Dimit, Ph.D.  Associate

Station Biochemistry

O. E. Olson, Ph.D.  Station Chemist
C. W. Bonhorst, Ph.D.  Assistant Chemist
Geo. F. Gastler, M.S.  Assistant Chemist
A. W. Halverson, Ph.D.  Associate Biochemist
Kenneth G. Schneider, B.S.  Res. Assistant
Volney Wallace, Ph.D.  Assistant Biochemist
E. I. Whittel, M.S.  Associate Chemist

Veterinary

G. S. Harshfield, D.V.M., M.S.  Veterinarian
T. A. Dorsey, D.V.M.  Associate
John McAdaragh, B.S.  Assistant
J. B. Taylor, V.M.D.  Associate

Substations

Frank W. Whetzel, Superintendent
Range Field Station, Cottonwood
Albert Dittman, Superintendent
North Central Substation, Eureka
Wade R. Pringle, Superintendent
Central Substation, Highmore
Harry F. Weak, Superintendent
U. S. Newell Irrigation and Dry Land Field
Station, Newell
W. H. Trevillan, Superintendent
Antelope Range Field Station, Buffalo
James D. Rahn, Superintendent
Reed Ranch, Presho
### Experiment Station Staff

**Regents of Education**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td>Honorable Mrs. Harry T. Dory</td>
<td></td>
<td>Watertown</td>
</tr>
<tr>
<td>Honorable Harry J. Eggen</td>
<td></td>
<td>De Smet</td>
</tr>
<tr>
<td>Honorable Frank Gellerman</td>
<td></td>
<td>Webster</td>
</tr>
<tr>
<td>Honorable Eric Heidepriem</td>
<td></td>
<td>Custer</td>
</tr>
<tr>
<td>Honorable Lem Overpeck</td>
<td></td>
<td>Elk Point</td>
</tr>
<tr>
<td>Honorable Laurence W. Robinson</td>
<td></td>
<td>Belle Fourche</td>
</tr>
<tr>
<td>Honorable A. E. Mead (Executive Director)</td>
<td></td>
<td>Mitchell</td>
</tr>
</tbody>
</table>

**Executive**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Agency</th>
</tr>
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<tbody>
<tr>
<td>John W. Headley, Ed.D.</td>
<td>President</td>
<td></td>
</tr>
<tr>
<td>Ephriam Hixson, Ph.D.</td>
<td>Chief, Div. of Agriculture</td>
<td></td>
</tr>
<tr>
<td>A. M. Eberle, M.S.</td>
<td>Dean of Agriculture</td>
<td></td>
</tr>
<tr>
<td>I. B. Johnson, M.Agri.</td>
<td>Director</td>
<td></td>
</tr>
<tr>
<td>J. P. Doods, Ph.D.</td>
<td>Comptroller</td>
<td></td>
</tr>
<tr>
<td>Elya O. Feuerhelm</td>
<td></td>
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**Agricultural Economics**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
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<tbody>
<tr>
<td>Max Myers, Ph.D.</td>
<td>Agr. Economist</td>
<td></td>
</tr>
<tr>
<td>Russell L. Berry, M.S.</td>
<td>Associate</td>
<td></td>
</tr>
<tr>
<td>Chas. H. Benrud, M.S.</td>
<td>Assistant</td>
<td></td>
</tr>
<tr>
<td>Allen R. Clark, M.S.</td>
<td>Assistant</td>
<td></td>
</tr>
<tr>
<td>Loyd Glover, Ph.D.</td>
<td>Assistant</td>
<td></td>
</tr>
<tr>
<td>R. Helperstine, M.S.</td>
<td>(Agent USDA)</td>
<td>Economist</td>
</tr>
<tr>
<td>R. L. Kristjanson, Ph.D.</td>
<td>Assistant</td>
<td></td>
</tr>
<tr>
<td>R. H. Kruse, B.S.</td>
<td>Assistant</td>
<td></td>
</tr>
<tr>
<td>G. Lundy, M.S.</td>
<td>Economist</td>
<td></td>
</tr>
<tr>
<td>T. W. Manning, Ph.D.</td>
<td>Associate</td>
<td></td>
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<tr>
<td>G. E. Marousek, M.S.</td>
<td>Assistant</td>
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<tr>
<td>Ottar Nervik, Ph.D.</td>
<td>Associate</td>
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<tr>
<td>R. R. Newberg, Ph.D.</td>
<td>Associate</td>
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<tr>
<td>R. F. Pengra, M.S.</td>
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<tr>
<td>John E. Thompson, M.S.</td>
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<tr>
<td>W. K. Ullman, M.S.</td>
<td>Assistant</td>
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**Agricultural Engineering**

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>H. H. DeLong, M.S.</td>
<td>Agr. Engineer</td>
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<tr>
<td>Donald Brosz, B.S.</td>
<td>Assistant</td>
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<tr>
<td>V. R. Flesher, B.S.</td>
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<tr>
<td>D. L. Moe, M.S.</td>
<td>Associate</td>
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<tr>
<td>T. R. C. Rokley, M.S.A.</td>
<td>Assistant</td>
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<td>J. I. Wiersma, M.S.</td>
<td>Associate</td>
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<tr>
<td>H. E. Young, B.S.</td>
<td>Res. Assistant</td>
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<tr>
<td>G. C. Zoerb, M.S.</td>
<td>Assistant</td>
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**Agronomy**

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<tr>
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<tbody>
<tr>
<td>W. W. Worrilla, Ph.D.</td>
<td>Agronomist</td>
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<tr>
<td>M. W. Adams, Ph.D.</td>
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<tr>
<td>Joseph J. Bonnemann, B.S.</td>
<td>(Agent USDA) Agronomist</td>
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<tr>
<td>L. A. Derscheid, Ph.D.</td>
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**Animal Husbandry**

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<tr>
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<tr>
<td>A. L. Musson, Ph.D.</td>
<td>Animal Husbandman</td>
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<td>L. F. Bush, Ph.D.</td>
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<td>C. A. Dinkel, Ph.D.</td>
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<tr>
<td>E. B. Dubose, M.S.</td>
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<tr>
<td>L. B. Emery, Ph.D.</td>
<td>Animal Husbandman</td>
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<tr>
<td>L. D. Kamstra, Ph.D.</td>
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<td>Paul H. Kohler, M.S.</td>
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<td>J. K. Lewis, M.S.</td>
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<td>C. P. Wilder, M.S.</td>
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<tr>
<td>Turner Wright, B.S.</td>
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**Dairy**

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<td>D. F. Breaule, Ph.D.</td>
<td>Dairy Husbandman</td>
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<td>R. J. Baker, Ph.D.</td>
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<tr>
<td>Emery Bartle, M.S.</td>
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<tr>
<td>E. C. Berry, Ph.D.</td>
<td>Bacteriologist</td>
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<tr>
<td>A. E. Dracy, Ph.D.</td>
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<tr>
<td>S. W. Seas, B.S.</td>
<td>Res. Assistant</td>
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<tr>
<td>H. H. Volker, Ph.D.</td>
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**Entomology-Zoology**

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<tr>
<td>G. B. Spawn, Ph.D.</td>
<td>Entomologist</td>
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<td>David Billman, B.S.</td>
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<tr>
<td>E. J. Huggins, Ph.D.</td>
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<tr>
<td>Wm. M. Rogoff, Ph.D.</td>
<td>Entomologist</td>
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<td>H. C. Severin, M.A.</td>
<td>Emeritus Entomologist</td>
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<td>R. J. Wallstrom, Ph.D.</td>
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**Home Economics**

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<tr>
<td>Frances M. Hettrick, Ph.D.</td>
<td>Home Economist</td>
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<tr>
<td>E. Beth Alsup, M.S.</td>
<td>Res. Assistant Nutrition</td>
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