Agricultural Research
IN SOUTH DAKOTA

SIXTY-EIGHTH
ANNUAL STATION REPORT
JULY 1, 1954 to JUNE 30, 1955

Agricultural Experiment Station
SOUTH DAKOTA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS
BROOKINGS, SOUTH DAKOTA
Letter of Transmittal

DR. EPHRIAM HIXSON, Chief
Division of Agriculture
South Dakota State College

Dear Dr. Hixson:

With the close of the fiscal year ending June 30, 1955, the Experiment Station presents its 68th Annual Report. The progress of research reported on the first 108 pages has previously appeared in the quarterly issues of the South Dakota Farm and Home Research publication.

During the year the Plant Pathology Department moved into its newly constructed building and laboratories. The research program on plant diseases has been greatly increased and two scientists in plant disease research with the U. S. Department of Agriculture have been assigned for work at the South Dakota Station.

Research in all of the other Station departments has also been increased, as active research is being conducted on 123 distinct problems in agriculture and home economics.

Field days were held at the State College Experiment Station, at all the Substations throughout the state, and at a few of the research fields. The increased attendance at these meetings was evidence of the interest being taken by farmers and ranchers in the Station's research activities.

With the increase in state appropriations for agricultural research two additional research acreages have been arranged for at the organized request of the farmers—one in the southeast part of the state in Hutchinson County and the other in the northeast part of the state in Codington County. Twenty acres of land were leased for a five-year period in each location. These two tracts are now being developed for effective research on soils, crops, and plant diseases.

On behalf of the Station staff may we express our appreciation to the college administration, the State Legislature, and the citizens of the state for the added support given to the Station's research activities.

Respectfully submitted,

Director, Experiment Station
Agricultural Research in South Dakota

Sixty-Eighth Annual Report
July 1, 1954 to June 30, 1955

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

South Dakota State College
of Agriculture and Mechanic Arts
Brookings, South Dakota
## Contents

### AGRICULTURAL BIOCHEMISTRY
- A New Aid in Diagnosing Selenium Poisoning ........................................ 12
- Cobalt in Our Grasses ........................................................................ 84
- Barley Proteins .................................................................................. 109
- Chemical Analysis of Grass Silage with Different Methods of Storage ... 109
- Nitrate Poisoning ................................................................................ 110

### CROP INSECTS
- Harvester Ants and Their Control ....................................................... 36
- Grasshopper Studies ........................................................................... 110
- European Corn Borer ........................................................................... 111
- Corn Rootworm in South Dakota ......................................................... 111
- Alfalfa Weevil ..................................................................................... 112
- The Ladybird Beetles or Coccinellidae of South Dakota ......................... 113
- The Tree Hoppers or Membracidae of South Dakota .............................. 113
- The Pine or Spruce Needle Scale .......................................................... 113

### CROPS AND SOILS

#### Grasses and Legumes
- Testing New Legume Developments ..................................................... 118
- Grass Breeding ..................................................................................... 119
- Pasture Trials Continued ..................................................................... 119

#### Management
- Fall or Spring Fertilizer Application in Western South Dakota .......... 62
- Soil Management Treatments Increase Crop Yields ................................. 114
- Crop Yields Increased Under Irrigation .................................................. 115
- Basic Soil Surveys Reported .................................................................. 116
- Soil Testing Increased ........................................................................... 116
- New Cultural Studies Started ................................................................. 119
- Weed Control Research ......................................................................... 120

#### Row Crops
- Colchicine, the Latest Tool for Plant Breeders ....................................... 18
- S. D. 604, A New Corn Hybrid for Southern South Dakota ................... 66
- High Yielding Soybeans Developed ......................................................... 117
- Over 150 Corn Hybrids and Varieties Tested ........................................ 117

#### Small Grains
- Winter Grains for South Dakota ............................................................. 41
- Barley and Flax Varieties Improved ......................................................... 116

### DAIRY PRODUCTION
- Alfalfa Silage for Milk Production .......................................................... 15
- Effects of Twinning on Dairy Cattle ........................................................ 107
- Milking Machine Sanitation .................................................................... 122
- Manufacturing Cottage Cheese ............................................................... 122
- A Study of the Recovery and Transplantation of Bovine Ova ................. 123
- Growth Studies of Calves and Growing Heifers ...................................... 123
- Improved Pastures for Dairy Cattle ........................................................ 123
- Bloat in Ruminants ............................................................................... 123
- Effect of Antibiotics on the Microflora of Chickens ................................. 124

### FARM ECONOMICS

#### Management
- Will Irrigation Pay in Central South Dakota? .......................................... 86
- Share Rents and Short-Term Leases ......................................................... 124
- Alternative Leasing Arrangements for Beginning Farmers ..................... 125
- Farm Management Practices .................................................................. 125
- Farm Credit ............................................................................................ 125
- The Farm Tax Burden ............................................................................ 126
Economic Trends Within South Dakota 127
Wheat Price and Income Policy 128
Sweet Clover Catch Crop Pays 128

Marketing
Developing Market News Service for Local Auctions 8
Grain Marketing Problems in South Dakota 30
Best Time to Market Livestock 128
Improving the Marketing of Farm Supplies 129
Marketing Dairy Products 129
Methods and Costs in Retail Distribution of Meat and Meat Products 130

FARM ENGINEERING
Irrigation for Potatoes 33
Field Picker-Sheller and Cold Air Drying 91
Application for New Materials and Design in Farm Buildings 130
Poultry House Ventilation 130
Trench Silos for Grass Silage Storage 131
Low Volume Fan Successful in Grain Storage Work 132

FRUITS, VEGETABLES, AND SHELTERBELTS
Wind Barriers Increase Vegetable Yields 25
Protect Strawberries from the Birds 77
Drought Resistance in Tomato Breeding 133
Vegetative Propagation of Hardy Ornamental Plants 133
Evaluation Studies Show Value of Foreign Fruit Plants 134
Tree Fruit Breeding in South Dakota 134
Small Fruit Breeding in South Dakota 134
Highmore Space Study Initiated 134
Elm Seed Storage 134

HOME ECONOMICS
Add Variety to Meals with Summer Squash 58
Hard Water, a Common Laundry Problem 81
Children's Clothing to be Studied 135
Shirt and Blouse Materials 135
Blended Fabrics for Suits 135
Protein Utilization 135

LIVESTOCK AND POULTRY DISEASES AND PARASITES
Mucosal Disease 27
Internal Medication, Can It Control Cattle Grubs? 92
The Fringed Tapeworm of Sheep in South Dakota 136
Screw-Worms and Secondary Maggots 137
External Parasites of Livestock 137
The Control of Fowl Cholera 137
Sporadic Bovine Encephalitis 138
The Control of Internal Parasites of Sheep 139

LIVESTOCK PRODUCTION
Beef Cattle
Vitamin A Supplementation of Range Cows 98
The Improvement of Beef Cattle Through Breeding 139
 Alfalfa Silage for Fattening Cattle 140
Manganese Requirements of Cattle 140
Nutritive Value of Prairie Hay 41
A Supervised Pasture System 142
Irrigated Pastures in Western South Dakota 143
Summer Grazing of Beef Cows for Calf Production 143
Reducing Farm-to-Market Losses in Livestock 151
A New Roughage Marketing Project 152

Sheep
Hay or Silage as the Only Roughage for Pregnant Ewes 50
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine</td>
<td>Rotation Crossing of Hogs Doesn't Run Out</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Creep Rations for Pigs</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Systems of Breeding Swine for More Efficient Productivity</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Swine Production for the Irrigated Area of Western South Dakota</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>Levels of Alfalfa in Growing-Fattening Swine Rations</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>Vitamin Supplementation of Swine Rations</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>Amino Acid Requirements of Pigs</td>
<td>146</td>
</tr>
<tr>
<td>PLANT DISEASES</td>
<td>Siouxland—A New Rust Resistant Cottonwood</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>The Control of Foliage Disease of the Tomato in South Dakota</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Potato Diseases and Their Control</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Corn Diseases and Their Control</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>Sorghum Seed Treatment</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>Folage Diseases of Small Grains and Their Control</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td>Root Rot Diseases of Cereals and Grasses and Their Control</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td>Investigations and Control of Alfalfa and Other Forage Legume Diseases</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td>The Biology and Control of Important Grass Diseases, Grass Seed Treatment</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>Diseases of Shelterbelt Trees and Their Control</td>
<td>157</td>
</tr>
<tr>
<td></td>
<td>The Quality of Grass and Alfalfa Silage as Affected by The Development of Specific Microorganisms</td>
<td>158</td>
</tr>
<tr>
<td>POULTRY PRODUCTION</td>
<td>Antibiotics and Egg Production</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Egg Marketing Problems</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Evaluation of Mating Combinations by Performance Testing</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td>Effects of Inbreeding and Use of Inbred Lines</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Control of Selenium Poisoning in Poultry</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Factors Affecting the Performance of Turkeys</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Forage Crops for Turkeys</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Mineral Requirements of Turkeys</td>
<td>160</td>
</tr>
<tr>
<td>RURAL SOCIOLOGY</td>
<td>Progress on the Belle Fourche Irrigation Project</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>The Socio-Economic Influences of the Communal Type Farm</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>on the Rural Community of South Dakota</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population Changes and Implications for the Development of Agriculture and Rural Life</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>Growth and Decline of South Dakota Trade Centers, 1901-51</td>
<td>161</td>
</tr>
<tr>
<td>SUBSTATION REPORTS</td>
<td>Antelope Range Field Station, Buffalo</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>Central Substation, Highmore</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>North Central Substation, Eureka</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>Range Field Station, Cottonwood</td>
<td>163</td>
</tr>
<tr>
<td></td>
<td>Reed Ranch, Preso</td>
<td>163</td>
</tr>
<tr>
<td></td>
<td>U. S. Newell Irrigation and Dry Land Field Station, Newell</td>
<td>163</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td>Publications</td>
<td>163</td>
</tr>
<tr>
<td></td>
<td>Journal Articles by Staff Members</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td>Experiment Station Staff</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>Financial Report</td>
<td>168</td>
</tr>
</tbody>
</table>
Compared to outbreeding, rotation crossing, either among inbred lines of different breeds or among inbred lines of the same breed, is an efficient mating system for the production of slaughter hogs. Contrary to the often-made observation, these crosses do not "run out."

The data reported here compare performance of pigs produced by (1) rotation crossing of four Poland China inbred lines, (2) rotation crossing of inbred lines of the Hampshire, Poland China, Duroc, and Landrace breeds, and (3) outbred Poland Chinas as the control. Poland China line-crosses were raised during the years 1945 through 1951, breed line-crosses during the years 1947 through 1953, and Poland outbred controls in the years 1945 through 1953. Seven generations for each rotation-cross allowed two complete cycles of crossing.

The crossing scheme can best be described by outlining the procedure for the four-breeding line-cross. Initially inbred Poland China boars were mated to inbred Hampshire gilts. Gilts from this cross were saved and mated with inbred Duroc boars. Again only gilts were saved and mated with inbred Landrace boars. The second cycle of crossing was completed by using inbred boars of the four breeds in the same order as described. Four different inbred Poland China lines were crossed in a similar manner.

It will be noted that inbred Hampshire gilts were the first females used in the crossing program. These were used because the Station had developed the line, so gilts were available without purchasing them especially for the program. This point is worth keeping in mind when beginning any crossing system. Use females at hand rather than buying
them, provided any are available. Then purchase a boar or boars for the first cross which best comple-
ments the females.

**How the Experiment Was Conducted**

All the pigs were spring farrowed at the Experiment Station, Brook-
ings. As soon as weather permitted after farrowing, sows and pigs were moved to brome-alfalfa pasture and self-fed shelled corn and protein supplement. Within a season, manage-
ment was as nearly uniform as possible for all pigs. Year to year changes in feeding and manage-
ment were made in keeping with the newer research results. Pigs were fed to weights of 200 to 225 pounds at which time all but gilts

to be used for breeding were marketed.

Performance by years of the two rotation crosses and the outbred con-
trols appears in Table 1. It will be seen from Table 1, that with few exceptions, rotation-cross pigs consis-
tently performed better than did the outbreds. In most cases the breed line-cross was the most effi-
cient breeding system. Especially marked is the greater number of pigs farrowed and weaned per litter. Litter size appears to have increased gradually over the years. Individual pig weights and litter weights of the breed line-cross were also consist-
ently heavier than for the other two groups. Litter weights represent both litter size and individual pig

weights. Litter weights at 5 months

<table>
<thead>
<tr>
<th>Year</th>
<th>Poland China Outbred</th>
<th>Poland China Line-cross</th>
<th>Four-breed Line-cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>6.5 2.9 28 15 129 559</td>
<td>6.8 3.0 27 156 26 214 1221</td>
<td></td>
</tr>
<tr>
<td>1946</td>
<td>6.5 3.1 32 141 17 164 633</td>
<td>8.8 3.0 27 152 20 164 833</td>
<td></td>
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<tr>
<td>1947</td>
<td>5.8 2.8 27 142 17 137 687</td>
<td>6.5 3.0 29 152 20 164 833</td>
<td></td>
</tr>
<tr>
<td>1948</td>
<td>6.5 3.1 27 147 17 141 675</td>
<td>6.8 3.1 27 147 17 141 675</td>
<td></td>
</tr>
<tr>
<td>1949</td>
<td>5.8 2.8 27 142 17 137 687</td>
<td>5.9 2.9 27 147 17 137 687</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>6.5 3.1 27 147 17 141 675</td>
<td>6.8 3.1 27 147 17 141 675</td>
<td></td>
</tr>
<tr>
<td>1951</td>
<td>8.4 2.7 33 150 22 169 620</td>
<td>7.6 2.8 32 153 21 161 719</td>
<td></td>
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<tr>
<td>1952</td>
<td>8.4 2.7 33 150 22 169 620</td>
<td>10.1 3.0 36 170 31 286 1276</td>
<td></td>
</tr>
<tr>
<td>1953</td>
<td>8.4 2.7 33 150 22 169 620</td>
<td>11.1 2.7 35 184 30 312 1622</td>
<td></td>
</tr>
</tbody>
</table>
are a good index of total production since pigs are sold by the pound. Breed line-crosses were much superior to either of the other groups in this character.

Mating System Differences

Mating system differences are most apparent in Table 2. Data for each system were averaged over all years. To the right of the averages for each of the rotation-crosses is a figure which is the percentage superiority or inferiority of the crosses over the controls. In only two cases did one of the crosses have less average performance than the outbreds. Poland China line-

Table 2. Average Performance Over All Years for the Rotation-crosses and Outbred Control

<table>
<thead>
<tr>
<th>Poland China</th>
<th>Poland China Line-cross</th>
<th>Four-Breed Line-cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbred Control</td>
<td>% above or below control</td>
<td>% above or below control</td>
</tr>
<tr>
<td>Number of litters</td>
<td>68</td>
<td>45</td>
</tr>
<tr>
<td>Average number farrowed per litter</td>
<td>7.0</td>
<td>7.4</td>
</tr>
<tr>
<td>Average number weaned per litter</td>
<td>4.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Average weight per pig farrowed</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Average weight per pig weaned</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Average weight per pig at 5 months</td>
<td>150</td>
<td>146</td>
</tr>
<tr>
<td>Average weight per litter farrowed</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Average weight per litter weaned</td>
<td>142</td>
<td>150</td>
</tr>
<tr>
<td>Average weight per litter at 5 months</td>
<td>658</td>
<td>743</td>
</tr>
</tbody>
</table>

The order in which boars of the different breeds were used in the experiments, and the approximate percentage representation of each breed by generations are shown. Little change in breed representation occurred after the fifth crossbred generation.
cross pigs were not as heavy individually as the controls at weaning and 5 months of age. However, litter weights at those ages were heavier for the line-crosses since there were more pigs per litter at the respective ages. Breed line-cross performance for all characters was greater than for either of the other mating systems. Most striking differences are those for litter weights at weaning and 5 months.

These mating systems represent three levels of genetic diversity. Least average diversity is among the outbreds, with greatest diversity in crossing inbred lines of different breeds. Performance in these data agrees with similar data from other experiment stations. It indicates that the wider the cross the better performance should be expected.

**Control of Breeding Program Is Important**

It should be pointed out that other systems of crossing may be equally as effective as those reported here. More practical for most slaughter-hog producers, than either line or breed line crossing, would be a system of straight breed crossing. Two, three, or four breeds may be used with good results. The important point is to use them in a systematic manner. Don't try to use so many breeds that control of the program is lost.

No mating system can cure the ills of a hog production program. Attention to the performance characters—litter size, thriftiness, growthiness, and good use of feed—must be followed. The hog man who is crossbreeding should be just as particular in the selection of good purebred boars as is the producer of purebreds.

Rather than rotation crossing "running out" on the hog man, it is more likely to be the other way around. (Project 124. Leaders: J. W. McCarty and C. P. Wilder, Animal Husbandry Dept.)

A lot of outbred Poland China gilts representative of control group used for this study.
Antibiotics
AND EGG PRODUCTION

By C. W. Carlson

Many workers still disagree about the value of antibiotics for mature hens, particularly as to the possibility of their causing an increase in egg production. A number of reports from various experiment stations have indicated no or very slight effects from penicillin, aureomycin, or terramycin additions to diets for laying hens. On the other hand, reports from the Texas Station and earlier reports from the Ohio Station, together with reports from the USDA Agricultural Research Service, and reports from this Station, have indicated marked improvements in performance of hens fed antibiotics.

Recently, the so-called “high levels” of antibiotics (levels at or above 50 grams of an antibiotic per ton of diet) have been reported to greatly increase egg production, particularly where certain types of diseases, including chronic respiratory disease, have been a problem. Recommendations have been made that the “high levels” be used continuously to forestall any possible drop in egg production by keeping the hens in top physical condition at all times.

A brief summation of most of the work done at this Station will be presented here. Although data on egg quality, hatchability, feed efficiency, mortality, and progeny growth were obtained, those figures will not be given in this report.

How the Experiments Were Set Up

For the most part, heavy type hens, including New Hampshires and White Plymouth Rocks, have been used in these experiments. One trial each has been conducted with Barred Plymouth Rocks, S. C. White Leghorns, and Experimental Heavy-type Hybrids. Sixty birds per group were used in most trials.

In Experiment I, a medium-energy mash and grain diet was used, whereas in Experiment II, various types of medium and high energy diets were used, and in Experiment III, high energy all-mash diets were used for the “low-level” trials and a medium-high energy mash and grain diet was used for the “high-level” trials. In all of the “low-level” trials, procaine penicillin was the antibiotic used at levels of from 2 to 12 grams per ton, whereas in the “high-level” trials, aureomycin, terramycin, or tetracycline were used at levels of from 50 to 100 grams per ton. In the first experiment, the trials where streptomycin was used at approximately 30 grams per ton
were placed in the "high-level" series.

During the course of the trials, numerous cases of various diseases were reported as the causes of mortality, including chronic respiratory disease, fowl cholera, infectious bronchitis, Newcastle disease, and various types of leucosis. The housing for most of the trials was in the north wing (30' x 120') of a laying house recently constructed, in which twelve (12' x 20') pens are serviced from a central alleyway. Subfreezing temperatures may exist inside the house during the colder winter months. Such disease and temperature conditions might not be conducive to maximum laying performance at all times. In most cases the trials were initiated in December, at which time the severe weather had usually begun. All trials were conducted for a 6 to 7 month period, and most, but not all, showed their greatest differences in the months of January, February, and March.

Egg Production of Birds

The egg production figures for work conducted since the fall of 1950 have been averaged and are summarized in Table 1. It will be noted that there was some improvement in performance of the control groups over the years, a portion of which may have been due to the improvement of the control diets. In addition however, continual selection for better performance should be given credit for some of the improvement.

In Experiment III, the layers had not reached their usual peak of 55-65 percent production before the trials were initiated. One reason for this is that a greater incidence of respiratory difficulties was encountered in Experiment III, and the pullets were much slower in coming into production. They might, therefore, be expected to lay at a greater rate during a later part of their productive cycle. It was in this experiment that the S. C. White Leghorns and Hybrids were used but only in the "high-level" series.

In all cases it will be noted that the hens receiving antibiotics performed at a better rate. Considering each experiment alone, and using the average percent production for each trial within the experiment in statistical analysis calculations, no single differences were great enough to be considered significant. However, considering all trials of all ex-

The 2 grams of penicillin in the vial cost 16 cents. When this amount of antibiotic was added to a ton of poultry feed it resulted in the production of 211 extra eggs.
Table 1. The Effect of Antibiotics Upon Egg Production

| Experiment | No. of Trials | Hen Day Production  
<table>
<thead>
<tr>
<th>Control</th>
<th>Low Level*</th>
<th>High Level†</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>4</td>
<td>37.9</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>41.7</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
<td>34.9</td>
</tr>
<tr>
<td>III</td>
<td>4</td>
<td>50.9</td>
</tr>
<tr>
<td>Average All Low Levels*</td>
<td>12</td>
<td>42.7</td>
</tr>
<tr>
<td>Average All High Levels†</td>
<td>9</td>
<td>43.6</td>
</tr>
</tbody>
</table>

*Levels of procaine penicillin per ton diet were (Exp. I) 2 to 12 grams, (Exp. II) 2 grams, and (Exp. III) 4 grams.
†Antibiotics and the approximate levels used per ton of diet were streptomycin (Exp. I) 30 grams, aureomycin (Exp. II and III) 50 to 100 grams, terramycin (Exp. III) 100 grams, and tetracycline (Exp. III) 100 grams.
Numbers in parentheses refer to the calculated increased value of eggs produced per 100 hens in a 200-day period over the costs of antibiotics, with eggs valued at 35 cents per dozen. Since tetracycline is not commonly used in animal feeds, its cost was considered equal to that of aureomycin.
§The increase over that of the control group was found to be highly significant.

Experiments, the averaged differences were found to be highly significant. That is an important consideration and should not be overlooked. Small differences may not appear to be real at first, but when considered with numerous other trials, they may establish true differences, as in this case.

Further consideration of the data shows that, although the responses with “low-level” antibiotic additions were highly significant, the beneficial effects were greater when the “high levels” were used. However, data for the individual trials would not support the conclusion that the “high levels” could be expected always to promote greater production than the “low levels.” The necessity for using “high levels” would appear to depend upon the state of health or degree and type of infection involved. In many cases, the “low levels” were just as effective as the “high levels.” However, direct comparisons are only available for Experiment I, and for that work, the “high levels” (approximately 30 grams of streptomycin) were most effective.

Effect of Antibiotics on Feed Efficiency

Feed efficiencies and the results on hatchability of fertile eggs were somewhat variable, in some cases marked beneficial effects were noted from the antibiotics. In no case was there any detrimental effect. Egg interior quality appeared not to be greatly affected. Except where disease effects were encountered that the antibiotics appeared to counteract, mortality was not affected consistently. The egg shells from antibiotic-fed hens seemed to be stronger, although the evidence on that point is only in the smaller numbers of cracked eggs noted in one trial. Progeny growth also varied. However, when the better starter diets were used no marked detrimental effects were observed.

The results of calculations on the increased value of the eggs produced by antibiotic-fed hens shown in parentheses in the table indicate Continued on page 17
Developing

MARKET NEWS SERVICE

By Ottar Nervik and Gerald Marousek

One of the notable changes in livestock marketing in the last 20 years is the growth of local livestock auctions. The livestock auctions have become especially important in the western range areas which are a considerable distance from terminal public markets. Auction sales of livestock in 12 western states had a value of one billion dollars in 1951. In South Dakota the value of livestock going through auctions yearly is somewhere between 100 to 150 million dollars.

This trend in marketing of livestock has led to some benefits to producers. On the other hand, this method of marketing has also certain disadvantages. One of the chief disadvantages is the lack of price quotations from auction markets. In most terminal public markets prices are reported by the United States Market News Service. This service provides unbiased, up to date market news reports from the terminal public markets. These reports are sent out by radio, newspapers, and mail. Today this service is considered essential by most livestock producers.

When direct marketing of hogs grew in importance during the 1920's and 1930's it was felt that there was a need to extend the market news reports to include interior packing plants. In Iowa such reporting was established through cooperation between the Federal Market News Service and the state Department of Agriculture. The reports from interior markets are now well established.

Market news reports tend to make markets more competitive by providing producers with price information at alternative market outlets. However, if a considerable portion of the livestock in an area is sold through auctions the lack of price information from auctions makes it difficult for producers to compare prices between the auctions and the terminal markets. In South Dakota producers of feeder cattle particularly are aware of this problem, since feeder cattle to a large extent are sold through auctions. In 1950 more than 40 percent of the feeder cattle were sold through auctions in all areas of the state except east central which is the area surrounding Sioux Falls.
Weakness of Present Market News Service

Several studies have pointed out that the major weakness of the present market news service is that it does not cover the auctions. Some states have reported auction markets on an experimental basis. Texas is presently reporting two auction markets and Oregon is reporting two markets. In both of these states trained reporters are used. Some of the eastern and southern states are also reporting prices at auction markets. These states obtain their price reports directly from personnel at the auction market. This method is probably less expensive than reports obtained through trained reporters employed by the market news service. On the other hand, it is questionable if personnel employed by the auction agencies have the impartial attitude which is essential for a good service.

After consultations with ranchers and farmers, auction agencies and others interested in livestock marketing, the state Department of Agriculture, the Experiment Station, and the Extension Service were requested to investigate the possibility of establishing a market news service for livestock in the state.

A joint project was prepared. The state Department of Agriculture would be responsible for the actual price reporting and dissemination of the reports. The Experiment Station would study various methods of making, preparing, and disseminating the reports and make an evaluation of the feasibility of maintaining such a service. The Extension Service would make information available to farmers, ranchers, and market agencies about the purpose and use of market news reports, and conduct an educational program to make producers familiar with the grades and methods used in market news reporting. Funds were made available through

In 1950 more than 40 percent of South Dakota's cattle were sold through auctions. Each year the value of livestock sold by auction is about 100 to 150 million dollars
Title II of the Research and Marketing Act.

Price Reporting from Auctions

The price reporting of livestock auctions was started early in October, 1953. The reporting was continued through March, 1954, when the seasonal feeder cattle run was over. The early reports were on an experimental basis and were not widely disseminated.

A weekly mimeographed report was made up each Friday evening and mailed from Pierre on Saturday morning. This report gave a tabular breakdown of prices by sex, age, and grade for feeder and stocker cattle and also a summary of price trends, weather conditions, buyer strength, and receipts.

By the end of the reporting season weekly reports were being mailed to several hundred South Dakota producers, feeders, and livestock dealers as well as to interested persons in 16 other states.

After conferring with representatives of the wire news services and several radio stations a summary of the trading at auction sales for the week was filed with the Associated Press and United Press Offices in Pierre on Saturday morning. This weekly summary was carried by almost all of the daily newspapers of the state and many of the radio stations.

About eight or nine of the larger feeder cattle auctions representing all sections of the state were included in the report. The reporting personnel and schedules were as follows: Clayton B. Kelsey, in charge of marketing with the South Dakota Department of Agriculture reported Rapid City (Tuesday), Sturgis (Wednesday), Belle Fourche or Philip (Thursday), and Winner or Ft. Pierre (Friday). Another South Dakota Department of Agriculture reporter covered sales at Kimball (Tuesday), Miller (Wednesday), Mobridge (Thursday), and Ft. Pierre (alone or in conjunction with Mr. Kelsey on Friday). By reporting the Ft. Pierre auction together these two reporters had an opportunity to compare their grading and thus keep the reports coordinated. In addition, Ed Dailey, Extension Livestock Marketing Specialist, covered the Watertown auction on Friday and phoned in the report that evening. Then workers made up the weekly report and got it in the mail and on the wire.

The reporting was confined to feeder and stocker classes because with limited funds and time in which to get the program underway it was thought best to concentrate on a small number of classes at first. Beef production is a major industry in the state with over half of all beef cattle and calves sold as stockers and feeders, and more than 40 percent of the stockers and feeders being sold through auctions.

Work of the Extension Service and Experiment Station

Soon after the reporting was started the Extension Service project leader contacted all county extension agents in the state, informing them of the report. All of the agents were placed on the mailing list for the report. Many agents subsequently sent in names of feeder cattle producers and cattle feeders in their respective counties who
were interested in receiving the report.

At the end of the reporting season a survey of farmers and ranchers was made by the Experiment Station concerning the report. The survey covered 250 operators picked at random from six geographical areas of the state. The operators were asked such questions as: what market news is being received at the present time? Is this news satisfactory? Are you acquainted with the state Department of Agriculture auction market reports? Would such reports be of value to you?

On the basis of the survey the reports would be useful to producers and feeders alike. While only 20 percent were acquainted with the reports in this first year of operation, 90 percent of those interviewed wished to see the reporting continued. Over 85 percent of those selling feeder cattle thought the report would be of value in comparing auctions with other marketing alternatives. Of those buying feeder cattle nearly 9 out of 10 thought the report would be helpful in comparing markets.

Several livestock buyers and dealers were also interviewed. Most of those dealers were favorable toward the report and wished to see it continued. Several emphasized that the reporting must be accurate and unbiased if it is to have the confidence of those using it.

Problems of Operating the Service

In the first year of operation several considerations involved in conducting an auction market news service became evident. One of these is the need of employing well-trained, unbiased market reporters. The reporter must be a man able to place live grades on cattle as they pass through the auction ring. He must understand the auction system of selling and have the respect of the auction operators. The reporter must be able to interpret the market as far as trends, future outlook, and demand are concerned and to record this information in a report. In addition he must be willing to travel several hundred miles and spend several nights per week away from home.

The necessity of employing only two or three reporters rather than a local man from each auction was pointed out by some of the livestock men interviewed. They said that only in this way can all markets be reported on the same basis, with comparable grading at all sales. Even then it would be necessary for the reporters to work together to coordinate their grading and reporting techniques.

Problems of time and distance are encountered in setting up a schedule to cover major auctions in a state as large as South Dakota. Several tentative schedules have been worked out in addition to the one used the past year.

Many farm and ranch operators would like to have more information on range conditions, weather conditions, and price trends. A large proportion of farmers and ranchers asked that outlook information and evaluation of future price prospects be included in the report. Other comments were that future receipts of cattle at the various auctions be estimated, that feeder lambs be re-

Continued on page 24
In the first place, the feed or pasture sample would only represent what the animal was eating when symptoms were first noticed, while the feed or forage the animal had eaten the previous months would be most important in causing symptoms.

In the second place, it is difficult to determine what plants on a particular range cattle have eaten the most of, and different kinds of plants take up widely varying amounts of selenium from soils. Finally, a single kind of plant will vary from almost none to many parts per million of selenium within a single pasture, and a very extensive sampling would be required to obtain a representative sample.

Since selenium accumulates in tissues while an animal is eating seleniferous feeds, the analysis of some part of the animal appeared to be the best solution to the problem. Blood samples are most often used for diagnostic purposes, so they were used in these studies. However, hair has long been known to accumulate selenium, and in view of the ease of its collection, preserv-
tion, and shipping it appeared to offer the greatest possibilities.

**Range Plants Vary in Selenium**

Before experiments on this problem were undertaken, the well-known fact that plants vary in selenium content with the season of the year had to be considered. With but few exceptions, plants are highest in selenium early in their growth and decrease in respect to their content of this element as maturity progresses. By fall, the selenium content of grasses is reduced many fold from what it was in June and remains so reduced until the next growing season. During the summer months, therefore, grazing animals take in the most selenium, and during late fall, winter, and spring the least. It was felt this variation might reflect itself in the selenium content of the hair so studies throughout most of the year were necessary.

**Results on Seleniferous Range**

In mid-April of 1953, 28 yearling calves were obtained for an experiment at Reed's Ranch, a location where selenium poisoning has long been a problem. Some of these calves had been raised on Reed's Ranch while some were from non-seleniferous areas. Part of the work with these calves dealt with the analysis of blood and hair samples. In early May the first samples were collected and analyzed for selenium, and at several other intervals throughout one year more analyses were made. During this period, four of the animals exhibited symptoms clearly typical of selenium poisoning. The figure shows the variations in the average values as well as the ranges in values for the hair.

The selenium content of the hair increased throughout the growing season, leveled off, and then decreased (probably as a result of shedding the old hair and growing new). The average value for the herd was, except for the first sampling, over 10 parts per million of selenium, and the individual values varied over a fairly wide range, especially for the last sampling (this probably reflects the wide variation in amount of shedding). In spite of
this variation, proper sampling procedures make the use of hair samples practical as a diagnostic aid.

The results of the blood analyses were similar to those for hair, as concerns annual variation, but the decrease during the winter occurred earlier and was no doubt the result of the rate of elimination exceeding the rate of intake on winter range. It appears that blood analysis is also a good diagnostic aid, but it does have obvious disadvantages for general use, such as difficulty of collection, preservation, and shipment.

Normal Values Also Studied

In addition to knowing the amount of selenium in the hair of cattle on seleniferous ranges, it was necessary to determine how much of the element could accumulate in the hair on ranges where “Alkali Disease” had never been observed to occur. Samples were collected from cattle from “non-seleniferous” areas, and the analysis of 28 of these gave values of from less than 1 to slightly over 4 parts per million of selenium. All of these samples had been collected during the fall. It appears from these results that, except for during the late winter and early spring months, an average selenium content of less than 5 parts per million indicates “Alkali Disease” symptoms should not occur in a herd.

Sampling Procedure

When it seems advisable to use hair analysis as a diagnostic aid for selenium poisoning, the following procedure should be used:

1. Select at least six cattle for sampling. This is necessary in order to arrive at a reasonable average figure in view of the variations in selenium content of hair as already discussed.
2. Clip the short hair from the side or back until a sample of

Continued on page 23

The selenium content of the hair of cows on seleniferous range varies during the year. The center line represents the average for 28 cattle, the broken portion a 5-month period during which no samples were taken. Other lines show high and low values.
Alfalfa silage is being made and fed rather extensively on many dairy farms in South Dakota. This has resulted in part from an attempt to avoid hay making difficulties due to rainy weather.

In an attempt to somewhat evaluate the feeding value of alfalfa silage as compared to alfalfa hay, milking cows in the South Dakota State College herd were fed varying rations. Three groups of cows were used for this purpose. Two Brown Swiss, two Holstein, and one Guernsey were used in each group making a total of 15 cows. One group was fed alfalfa silage free choice. A second group was fed alfalfa hay free choice while the third group was fed alfalfa hay free choice plus 1 pound of grain for each 5 pounds of milk. It would have been desirable to have fed a fourth group alfalfa silage plus grain, but the limited number of cows made this impossible.

Each group was fed each of the three different rations. The actual feeding period on each ration was 30 days with a 10-day preliminary period. For instance, when a group was fed alfalfa silage, it would be fed the silage for a 10-day period to get the group adjusted to it. At the end of this preliminary period the actual 30-day feeding trial would begin. At the end of this feeding trial, the group would be placed on
one of the other two rations. This was continued until each group was fed the three different rations.

Measurements of feed consumption, milk production, and body weight were obtained during the 30-day period for each group on each of the three different rations.

**Good Quality Hay and Silage Used**

The hay and silage that were fed were both of good quality made from first cutting alfalfa (Table 1).

**Table 1. Chemical Analysis of Feed**

<table>
<thead>
<tr>
<th></th>
<th>Alfalfa Hay</th>
<th>Alfalfa Silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>9.30</td>
<td>58.94</td>
</tr>
<tr>
<td>Ether extract (dry basis)</td>
<td>1.63</td>
<td>2.76</td>
</tr>
<tr>
<td>Crude fiber (dry basis)</td>
<td>28.76</td>
<td>25.62</td>
</tr>
<tr>
<td>Protein (dry basis)</td>
<td>18.30</td>
<td>19.01</td>
</tr>
<tr>
<td>Ash (dry basis)</td>
<td>9.58</td>
<td>9.43</td>
</tr>
<tr>
<td>Nitrogen free extract (dry basis)</td>
<td>41.73</td>
<td>43.18</td>
</tr>
<tr>
<td>Carotene mcg/gm (dry basis)</td>
<td>7.08</td>
<td>70.23</td>
</tr>
</tbody>
</table>

For the silage, the alfalfa was allowed to wilt slightly in the field, but no preservative was added.

All of the cows in the three groups were in the second half of their lactation at the start of these feeding trials. However, production was maintained at a reasonably good level until the end of the experiment at which time a number of the cows were immediately turned dry. It will be noted from Table 2 that the cows produced at the highest level when they were being fed hay and grain. When fed alfalfa hay alone they produced 87.6 percent as much milk as the alfalfa hay plus grain produced. The alfalfa silage when fed alone produced 82.2 percent of the maximum.

At this level of production the extra milk that resulted from feeding the grain barely paid the cost of the grain which was figured at 2 1/2 cents per pound. The milk was figured at $4.50 per one hundred pounds. It is quite likely that at a higher level of production the increased milk would pay a greater return for the grain fed.

**Rations Produce Increase in Body Weight**

All three of the rations produced an increase in body weight for the 30-day period that was used for each ration. The hay and the hay plus grain rations each produced 18 pounds of gain per cow in 30 days. The silage was less, being 12 pounds per cow in 30 days.

**Table 2. Consumption, Production, and Body Weight Gain**

<table>
<thead>
<tr>
<th></th>
<th>Daily Consumption</th>
<th>Daily Milk Production</th>
<th>30-day Body Weight Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry Matter</td>
<td>Dry Matter Percent of</td>
<td>Milk Percent of</td>
</tr>
<tr>
<td></td>
<td>Lbs.</td>
<td>Maximum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Hay plus Grain</td>
<td>32.3 hay</td>
<td>29.3 hay</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>4.2 grain</td>
<td>3.8 grain</td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>33.3</td>
<td>30.2</td>
<td>91</td>
</tr>
<tr>
<td>Silage</td>
<td>57.3</td>
<td>23.5</td>
<td>71</td>
</tr>
</tbody>
</table>
A result that does not show in either Table 1 or 2 is that the cows fed on alfalfa silage alone developed an intense craving or desire for dry feed. This desire was such that they made strong reaches for bedding or any type of dry feed that appeared to be within reach. As a result it made them a bit more unsetteled and somewhat harder to manage when milking, feeding, and handling.

In the case of higher producing cows grain would be fed on most dairy farms. This would supply some dry matter. However, it is not always customary to feed grain at as low a level of production as that encountered in this study. Thus, it would be necessary to feed hay to supply the desired dry matter. Even at higher levels of production, it will probably be necessary to feed some hay (perhaps 5 or 10 pounds per day per cow) in addition to their grain to supply the desired dry matter. It is also possible that the hay and silage will complement each other so that more total nutrients from the roughage will be consumed.

The cows when on alfalfa silage alone consumed only 71 percent as much dry matter as when they were eating hay and grain. But their milk production and body weight were both maintained at a higher level than this. More information is needed to determine the effect over the course of a longer feeding period. However, it does appear as though alfalfa silage can be used as a complete replacement for alfalfa hay for a short period of time with fairly satisfactory results. (Project 227. Leader: Chase Wilson, Dairy Dept.)

Antibiotics and Egg Production Continued from page 7

that the antibiotics were economical additions to the diets. In one instance in the “high level” studies of Experiment III, the advantage was much greater than indicated by the averages. In this instance calculations showed approximately a $50 advantage for 100 hens over the 200-day period. These birds were exposed to a respiratory infection.

To Sum it Up

The results of this work would indicate that antibiotics were valuable additions to laying diets under these conditions. If, however, the egg production rate had been above 70 percent, it would not be very likely that the antibiotics would have improved such performance. These results, together with other reports, indicate that the submaximal producers benefit most from antibiotic additions to the diet. Hens that were not producing at a profitable rate were caused to do so, and considering the costs involved, the antibiotic was an economical addition to the diet. Under normal conditions, antibiotic supplementation would appear to be a good “insurance protection” to have in a diet for mature birds. (Project 241. Leaders: C. W. Carlson, and R. A. Wilcox, Poultry Dept.; O. E. Olson, Station Biochemistry.)
Here in the United States, though the fact is seldom recognized, the richly stocked food basket of the Middle West has been made possible only through the plant breeders' efforts in introducing and perfecting new food crops. Some of these breeders have been unknown amateurs and will remain forever unsung. They brought with them seeds from the Old World homeland, which, through natural and controlled selection, have been adapted to the different environment of the New World.

Today, people depend upon plant breeders with formal training in the ways of plants and their heredity.
How Plant Breeders Develop New Varieties

Modern plant breeders have depended upon naturally occurring variation for the new characters desired in any crop. Plant explorers, such as the late Dr. N. E. Hansen of South Dakota State College, have traveled to the far reaches of the world in search of plants with characters of usefulness. These plants collected in other climes for some one or more desirable characteristic may also have characteristics which make them useless in their original form. Thus crosses are made involving such plants of local or exotic origin, with others adapted to special uses. Selection from the second and third generations of the resulting hybrids may give plants with all the characters desired. Following this, long years of selection for type and purification are necessary before a variety is ready for testing on experimental plots. Later, if it proves worthy, this variety is released for use by farmers.

Any method by which variation within an existing variety can be increased, so that selection for new characters may be made without making a world-wide search, would be of extreme value to the plant breeder. If at the same time it was possible to fix these new characters
immediately, there would not be a long delay between the time the cross was made and the time that the variety was in use. At South Dakota State College Experiment Station both of these objectives have been obtained by treatment of plant seedlings with a drug called colchicine.

What Colchicine Is

Colchicine is not a magic drug or a fertilizer or a growth regulator. Rather it goes to the heart of the inheritance by inducing genetic changes in plants—changes that nature might never bring about. Colchicine is a poisonous alkaloid extracted from the fall crocus. This drug has been used by the medical profession for many years. It has been known previously by research workers as an agent to induce polyploids in plants but the effects reported here have just recently been discovered at the State Experiment Station.

Startling things have happened. Results, that shouldn't occur but do, indicate unknown fundamental happenings in the cell which when thoroughly studied may have far reaching implications not only in the plant breeding field but perhaps even in the treatment of cancer.

An Experiment Using Colchicine

A recent experiment illustrates what takes place. In the greenhouse during the winter, 15 seedlings of the true breeding unnamed variety of sorghum called Experimental 3 were divided without selection into two groups. One group of eight was left untreated as a check, while the other group of seven was treated with this drug. As expected the eight untreated seedlings grew into plants uniform among themselves and true to the types of the parents. The treated plants behaved quite differently. Some of the treated plants had foliage of a different color, some had more tillers than others, their leaves were narrower, and their stems differed in thickness from the untreated plants.

Seed from these treated plants was obtained by covering the heads with a paper bag to keep out other pollen. Families from each of these plants were started in the
greenhouse and then transplanted into the field. The variation between and within these families was studied by taking measurements on the stems and leaves as well as the total plant and seed yields. In Table 1 are shown average height, number of tillers, width of leaves, and seed yield for the progenies of each of the 15 plants. You will note that there are significant differences between the measurements obtained on the treated plants but no significant differences between those from the untreated plants. This shows that treatment has caused variation giving the plant breeder an opportunity to select for new characteristics, some of which may never have been available previously.

At the same time it was shown that there was no significant difference in the variation within the families of the treated plants in comparison to those of the untreated plants. From this you see that not only were new characteristics obtained, but plants possessing these bred true immediately. This is illustrated in Fig. 1 by the uniformity within the family from treated plant 15 on the left, which is fully as true to type as the family of the untreated plant on the right.

Further Changes Are Possible

What happens when a new plant whose heredity has been changed so quickly and dramatically is crossed back onto its original untreated full sister? In Fig. 2 this is illustrated. On the left is the untreated plant whose full sister on the extreme right was changed by treatment. The plant in the center is the hybrid resulting from crossing these plants.

The extreme hybrid vigor shows again that a great many characteristics have been changed by treatment so that the new plant is entirely different from the original. Investigation with the microscope of the chromosomes which carry the factors for heredity within the cells of the new plants shows no startling differences in shape or size. The change then must be in the material of which the chromosome is made. More is being learned of this by studying the manner in which the segregation of the new characters occur. Studies of the changes in the cell are being made possible by a grant from the National Cancer Institute. This interest has grown out of a desire to learn more of the dramatic unknown happenings.

### Table 1. Average Plant Measurements of Each 28 Plant Families from Untreated and Treated Full Sister Plants from the True Breeding Experimental 3

<table>
<thead>
<tr>
<th></th>
<th>Height (inches)</th>
<th>No. of tillers</th>
<th>Width of leaves (cm)</th>
<th>Seed bu./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Families from untreated plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>34.6</td>
<td>2.8</td>
<td>6.3</td>
<td>53.8</td>
</tr>
<tr>
<td>2</td>
<td>36.2</td>
<td>2.9</td>
<td>6.0</td>
<td>66.0</td>
</tr>
<tr>
<td>3</td>
<td>35.5</td>
<td>2.8</td>
<td>5.9</td>
<td>60.1</td>
</tr>
<tr>
<td>4</td>
<td>35.8</td>
<td>2.6</td>
<td>5.0</td>
<td>62.0</td>
</tr>
<tr>
<td>5</td>
<td>33.9</td>
<td>2.9</td>
<td>5.8</td>
<td>61.2</td>
</tr>
<tr>
<td>6</td>
<td>36.2</td>
<td>2.8</td>
<td>5.8</td>
<td>67.4</td>
</tr>
<tr>
<td>7</td>
<td>33.8</td>
<td>2.8</td>
<td>6.2</td>
<td>57.5</td>
</tr>
<tr>
<td>8</td>
<td>35.1</td>
<td>2.5</td>
<td>6.0</td>
<td>61.8</td>
</tr>
<tr>
<td>LSD*</td>
<td>N.S.*</td>
<td>N.S.*</td>
<td>N.S.</td>
<td>N.S.</td>
</tr>
<tr>
<td>Families from treated plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>34.2</td>
<td>3.0</td>
<td>6.0</td>
<td>61.4</td>
</tr>
<tr>
<td>10</td>
<td>40.4</td>
<td>5.1</td>
<td>5.5</td>
<td>87.5</td>
</tr>
<tr>
<td>11</td>
<td>35.1</td>
<td>2.8</td>
<td>5.8</td>
<td>66.6</td>
</tr>
<tr>
<td>12</td>
<td>40.6</td>
<td>6.0</td>
<td>4.8</td>
<td>80.2</td>
</tr>
<tr>
<td>13</td>
<td>34.9</td>
<td>2.7</td>
<td>6.0</td>
<td>66.7</td>
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<tr>
<td>14</td>
<td>33.3</td>
<td>2.6</td>
<td>6.0</td>
<td>58.3</td>
</tr>
<tr>
<td>15</td>
<td>54.5</td>
<td>12.2</td>
<td>2.2</td>
<td>43.0</td>
</tr>
<tr>
<td>LSD*</td>
<td>1.8</td>
<td>1.0</td>
<td>0.4</td>
<td>7.3</td>
</tr>
</tbody>
</table>

*LSD* Least significant difference
*N.S.* No significance
Fig. 5. A photographic indication of Sorghum seed weight and size. (A) induced large ++ seeded cross variant obtained by treatment, crossing, and selection of B, C, and D, 4.07 grams. (B) male No. 11, 2.84 grams. (C) male No. 5, 2.89 grams. (D) female ob 31, 1.72 grams

within the cell which makes possible the changes in the plant after treatment with colchicine. It may give the answer to why cancer occurs!

In the meantime this new tool is being used in a very practical fashion in breeding sorghum and flax and is being tried with other crops as well. Many new combinations and variations have been found in plant types, yield, and disease resistance. One of these new characters namely seed size in sorghum is being combined into a new variety.

Value of Increased Seed Size

Increased seed size would have many advantages in sorghum such as increasing the yield of grain, ease in planting, and ability to secure more uniform stands. Larger seeds can be planted deeper because they produce stronger and more sturdy seedlings and are more readily distinguished from grass-like weeds.

In Fig. 3 are shown diagrammatically, the parents, treatment, and crossings which were made to obtain a very large seeded line. The solid circles next to the arrows denote colchicine treatment and F₁, F₂, and F₃ indicate the first, second, and third generations after the crosses were made. The numerals such as 3.08 and 3.0 denote the average seed weight in grams of four samples of 100 seeds each for the parent and cross. Treating Experimental No. 1 pure line (shown in Fig. 4) produced a variant which had slightly larger seeds and is somewhat earlier maturing than the untreated line. Retreating this variant the following winter (Fig. 3) an entirely different variant was produced than either of the parents. This variant is designated as ob 31. The seeds were of a color similar to the parent but they were much smaller in size, 1.72 grams. Seed weight of the treated parent was 3.11 grams. This was a 45 percent decrease in seed weight for ob 31.

Crossing ob 31 with male No. 5 produced a treated cross variant which had an average seed weight of 3.18 grams. This is a 35.3 percent increase in seed weight as compared with the average seed weight of the parents ob 31 and male No. 5. Using F₀ seed from the single cross (ob 31 x 5) X 11 with colchicine cross variants were induced which had large ++ seeded types. The largest
A New Aid Continued from page 14

about one packed cupful from each animal is obtained.

3. Place the samples in separate packages or sacks, labeling and dating each and including the name and address of the sender on each package.

4. Send to: Experiment Station Biochemistry, College Station, South Dakota.

5. Write a letter or postcard informing the laboratory as to why the samples are being sent.

At the laboratory the samples may be combined to allow for a single determination, since the selenium analysis is difficult and time consuming. If so, only an average value will be reported. Under no circumstances should such a combination be made at the time of collection unless facilities are available for accurately weighing the amount of hair from each animal.

Interpreting the Results

Based upon the work discussed here, and upon additional analyses not reported, Table 1 has been devised for use until more complete information is obtained. It should not be used unless a sampling procedure similar to that described has been followed.

Data on hogs obtained at this laboratory indicate that the table is applicable to these animals as well as to cattle. More analyses will be made to verify this in the near future. (Project 19. Leaders: O. E. Olson, Station Biochemistry; C. A. Dinkel, Animal Husbandry Dept.)

<table>
<thead>
<tr>
<th>Average selenium content of hair</th>
<th>Likelihood of selenium poisoning symptoms or damage in herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 parts per million</td>
<td>No symptoms or damage (improper weight gains) should be expected to occur, except possibly if samples were taken during late winter or early spring.</td>
</tr>
<tr>
<td>5-10 parts per million</td>
<td>In most cases, symptoms or damage would not be expected, but, especially at the higher levels, it is possible they would.</td>
</tr>
<tr>
<td>Over 10 parts per million</td>
<td>Symptoms and damage in some or all of the animals can be expected.</td>
</tr>
</tbody>
</table>

Table 1. Determining the Selenium Poisoning Symptoms According to Hair Analysis
ported during the fall, and that there be a more detailed breakdown of weights and prices within classes, especially in calves. Ranchers living near the North Dakota, Nebraska, and Wyoming borders expressed a desire to have nearby auctions in those states included in the report.

Estimated Cost of Operating the Service

The cost of operating the auction market news service has been estimated for various schedules. Assuming that the service is operated over a 35-week period with one or two reporters employed, and a mailing list of 5,000 to 10,000 names, the cost would range from approximately $15,000 to $20,000. This would involve reporting 10 to 15 auction sales weekly with main emphasis on feeder cattle and feeder lambs.

If the service is continued on the same basis as it was in 1953-54, half of the cost would be borne by the Federal Government and half by the state. The state funds could be obtained through an appropriation by the legislature. It has been suggested that a levy of 1 cent per head be made for all cattle sold through auctions to pay the cost of the service. Another suggestion is that a charge of $1 or $2 per year be made for the mailed report. Both of these latter methods may involve some practical difficulties.

Preliminary Conclusions from the Study

The experience of reporting the prices of feeder and stocker cattle sold through livestock auctions in South Dakota the past year shows that it is feasible to operate such a service on a permanent basis. The service as it was operated could not, of course, report all of the 50-odd auctions in the state. However, the major feeder markets representing all areas of the state can be reported regularly by about two full-time reporters.

The survey of farmers and ranchers as well as livestock dealers shows that the report has been favorably received, and would be of value to them in carrying out their marketing activities. The many letters received from buyers and feeders in other states indicate that there is a widespread interest in the auction report.

The opportunity exists to interest out-of-state buyers and feeders in South Dakota feeder cattle through the auction report. It can help promote one of South Dakota’s major industries in other states as well as be a service to our own producers and feeders.

Those engaged in reporting the auctions and disseminating the report found that they had the cooperation of auction operators, the press, and radio. Auction operators made available facilities for the reporter as well as records of receipts and scale tickets; the wire services and radio stations made helpful suggestions in the writing of press and radio reports. (Project 243. Leader: Ottar Nervik, Agricultural Economics Dept.)
Structures in which temperatures were recorded and compared at various locations.

R. L. Foskett

That level, open area which appears ideal for the garden site may be lacking one thing—wind protection.

Vegetable yields can be lowered considerably as a result of wind. Severe winds may kill newly transplanted tomato or pepper plants by breaking their main stems. A reduction in leaf surface as a direct result of wind and by windborne soil particles also affects yields. In addition these particles can mar the appearance of aboveground edible portions of plants.

Structures Boost Yields

Often it is desirable to protect small plants from wind after they are transplanted. In 1954 two specially built structures were placed over newly transplanted tomato plants at Brookings in an attempt to obtain earlier yields. The structures each covered an area 4 by 1½ feet—enough for 2 plants spaced 2 feet apart. These structures were 1 foot high. The sides were made of a transparent film and tapered in slightly toward the top for better sunlight entrance and to hold heat. Provisions were made for a glass top in case of freezing weather.

The plants were set out May 15, and the structures were placed around them for 1 month. The value of these structures was clearly shown by early yields. By August 17 the four plants that had been protected produced a total of 27 pounds while four unprotected plants, otherwise treated the same, produced only 8 pounds. Yields were 44 and 19 pounds respectively by August 23. Undoubtedly some of the gain in yields resulted from increased temperature, along with wind protection.

Various Types of Barriers Can Be Used

Wind barriers for the entire growing season may be of a number of types. The most common, of course, are tree and shrub windbreaks. A good ungrazed shelterbelt will do much to reduce wind damage, since ground winds are effectively blocked.
The Effect of a Snow Fence Wind Barrier on Butternut Squash Yields at the Redfield Plots in 1953. The Yields Are Expressed in Average Pounds of Squash per Hill.

Care must be taken not to plant a garden too close to trees and shrubs. A safe distance, beyond which tree root competition and shade are not harmful, must be determined locally. Generally a distance equal to at least the height of the trees is considered safe.

A raspberry planting at the horticulture farm at Brookings shows the results of wind protection. This planting is sheltered on the south by a dense shrub row approximately 15 feet high. The raspberry plot has four parallel rows running east and west. The closest row is 20 feet from the shrub row and the raspberry rows are 12 feet apart.

In number of canes per parent plant and average height per cane, the row closest to the shrubs exceeded all others and the row farthest away was lowest. Average heights of canes for the two extreme rows were 41.7 inches and 30.3 inches. Average number of canes per parent plant for the two rows was 2.2 and 1.7.

Ordinary snow fencing (corn cribbing) has been found to make an excellent wind barrier. Tests begun at Redfield in 1953 (see chart) have shown its value and more tests are planned to determine the best spacing and direction of placement. For commercial vegetable gardens it has the advantage over permanent wind barriers of being portable and thus doesn’t need to be in the field during planting and harvesting. This advantage may be offset under some conditions by labor costs of erecting and dismantling.

Protect From South or West

Some protection appears to be given by barriers located on any side of the garden. But since summer winds are usually from the south and west, protection from these sides should give the most benefit. Those running in an east-west direction have the advantage of not shading the garden as much in the early morning and late afternoon, and in the summer when the sun is high the shadow to the north is slight.

That modifying wind velocity may also increase the temperature was demonstrated. Snow fences 4 feet high were used as wind bar-

 Continued on page 49

Squash vines get smaller and more sparse as distance from snow fence becomes greater and they get less wind protection.
Nasal discharge and slobbering are two frequent symptoms of mucosal disease.

A disease of cattle characterized by diarrhea and inflammation of the mucous membranes of the digestive and respiratory systems has become increasingly prevalent in several midwestern states during the past 4 years. The name "mucosal disease" was first applied to this condition by veterinary investigators at Iowa State College because the disease seems to affect only mucous membranes.

The first diagnosis of mucosal disease in South Dakota was made early in 1952. Twelve outbreaks have come to the attention of the Veterinary Diagnostic Laboratory, but reports from veterinarians indicate that similarly affected herds have been seen in their practices. Seven of the laboratory diagnosed outbreaks occurred in February and March and one each in May, July, August, September, and November. Iowa workers have also reported a greater frequency in winter and early spring.

Young animals are more susceptible than mature cattle. Most of the cases submitted for diagnosis were 6 to 12 months of age, but a few mature animals have also died during the course of the outbreaks. Neither breed nor sex seems to influence susceptibility. In the affected groups, from 5 to 25 percent become sick but the death loss approaches 100 percent of those that show symptoms.

Most Common Symptom Is Diarrhea

The most constant symptom observed in affected animals is diarrhea. Straining is frequent and the feces contains a large quantity of
Hard palate of an animal with mucosal disease. Ulcers appear as dark blotches.

slimy mucus. Blood is present in the feces of some, but not all of the cases. The body temperature may be found elevated in very early stages, but returns to normal after 24 to 48 hours. The sick animals quit eating but will continue to drink. Within 2 or 3 days a nasal discharge is often noted which crusts around the nostrils and muzzle.

Some will also show watering of the eyes, with this discharge soiling and matting the hair over the side of the face. A few cases have shown cloudiness of the eyes. Slobbering is another frequent symptom. The sick animals lose weight rapidly, become progressively weaker, and die within 3 to 10 days.

The disease does not strike all animals at the same time. Generally one to three will sicken and a few days may pass before additional cases are noted.

Mucous Membranes Are Inflamed

On examination of the carcasses of animals which have died of mucosal disease, inflammation of the mucous membranes of the digestive and respiratory tracts is observed. In the mouth many shallow ulcers may be seen on the lips, gums, tongue, palate, and cheeks. These may appear as whitish patches, or the surface may be sloughed away leaving raw, reddened areas. Similar ulcers appear in the throat, esophagus, and glandular stomach (fourth compartment of stomach).

Throughout the length of the small and large intestine an inflammation of variable severity is found. The bowel contains a large amount of mucus and in some there is blood mixed in the contents. In a few cases a yellowish membrane has been found loosely attached to the inner surface of the small intestine and colon. No ulcers have been found in the respiratory tract but reddening and increased mucus may be seen in the nasal passages. The lungs are not affected.

Case Histories of Mucosal Disease

The history of three South Dakota outbreaks will better explain the behavior of mucosal disease in a herd.

Herd H.G. This Hereford herd consisted of 212 cows, 8 bulls, and 175 calves less than a year of age and averaging about 500 pounds. The calves were receiving oats and about 1 pound of pelleted soybean oil meal in addition to hay and pasture. At the time the disease was diagnosed (March 14) 5 calves had sickened and died. Additional cases continued to appear at short intervals through April and May when the death loss had reached 35 head. All sickness and deaths were con-
fined to the calves. Treatment of sick animals was ineffective.

Herd M.G. The group of animals on this farm in which mucosal disease occurred totaled 75 head of short yearling Hereford feeders of which 30 were heifers and 45 steers. The steers were obtained from a herd in the same area in December. The heifers were a mixed group purchased at livestock auction about the same time. The first sickness occurred in late January. In a 4-week period 11 head were lost. Sickness and loss was confined to the steers. In an adjoining lot with only a woven wire fence between were 40 head of 18-month old steers on feed. None were affected.

Herd A. W. This group of feeders was made up of 14 home raised steers and 16 purchased at livestock auction. These short yearlings mixed with older cattle on the farm but received their feed of whole oats, ground corn, alfalfa and prairie hay separately. Sickness first appeared about February 1, and 7 deaths occurred within a 5-week period. All animals which sickened and died were home raised steers.

**Cause Isn't Known**

The cause of mucosal disease has not yet been determined. While it has some of the characteristics of an infectious disease, attempts to transmit the disease to apparently normal calves using tissues and intestinal contents from field cases have so far failed. In many respects mucosal disease resembles a virus diarrhea of cattle described by New York investigators. Certain cases might be confused with coccidiosis, X-disease (hyperkeratosis), malignant catarrhal fever, or chemical poisoning and require laboratory tests to diagnose accurately.

There has been nothing consistent in feeding or management in the outbreaks to give cause to suspect those factors. Outbreaks have occurred during warm weather in cattle on pasture without supplemental feed as well as in colder months among animals on dry feed of varied combinations. Two of the outbreaks cited state that sickness was limited to a certain group in a mixed herd, suggesting the possibility that apparently normal carrier animals may be the infection source for susceptible young cattle.

The varied treatments which have been tried for sick animals have been without material value. A sound control program for mucosal disease cannot be developed until the cause is definitely determined. (Project 253. Leader: G. S. Harshfield, Veterinary Dept.)

In a diseased animal numerous shallow ulcers appear over the surface of the tongue and throat. These ulcers also appear on the animal's muzzle, lips, gums, and cheeks.
Lack of storage space is one of the problems of grain producers.

GRAIN MARKETING PROBLEMS
RICHARD R. NEWBERG

GRAIN MARKETING plays an important role in South Dakota agriculture. On the average, 40 percent of the total land area in the state is devoted to grain production. From 1948 through 1950, 59 percent of the grain produced in South Dakota was marketed as a cash crop. This accounted for 33 percent of the total cash farm income.

A survey was conducted in the state to determine the type and seriousness of grain marketing problems. Information was obtained from 140 farmers and 105 elevator managers as to the problems in their particular area.

Excess moisture in grain, variety mixtures or a mixture of grains, storage, and transportation are important problems.

Excess Moisture
Survey results indicate excess moisture in grain is the most widespread and one of the most serious problems which confront both farmers and elevator operators. It affects farmers from the standpoint of spoilage in stored grains and through price penalties for marketed grains. Grain elevator operators are inconvenienced by the extra handling operations and storage facilities required to keep high moisture grain from heating and spoiling in the bin.

Excessive moisture is responsible for heat damage, mustiness, mold, objectionable odors, and souring in stored grains. In unharvested grains it contributes to sprout damage, blight, and discoloration.
Heat damage in wheat is the largest single factor responsible for lower quality flour. As little as 1 percent heat-damaged kernels will darken the flour and cause a bitter taste. Since there is no way to separate heat-damaged kernels, the value of such grain is severely reduced. Musty, moldy, or sour wheat as well as that with objectionable odors is similarly lowered in value. Sprout damage in wheat reduces the gluten content of the kernel and results in poor quality flour.

In barley even small amounts of heat damage make it unsuitable for malting. Any trace of musty or moldy kernels or the presence of odors also disqualifies it. Malting barley cannot contain over 4 percent blighted and discolored kernels. A very small percentage of sprout damage makes barley unsuitable for malting since the germination process has already taken place.

The data indicate farmers are seldom as aware or as concerned about excessive moisture content in grains as are the elevator operators. If high moisture grain is delivered directly from the combine to the elevator, the farmer reluctantly accepts the discount, but his worries with respect to the grain are over. About half of the elevator men were concerned with spoilage compared to a tenth of the farmers.

Grain Variety Problems

Variety greatly influences acceptability for the majority of uses to which cash grains are put. Elevator operators were particularly troubled with a mixture of different varieties of barley intended for malting and with variety mixtures of wheat to be used in milling.

The combined effect of introducing new crop varieties and the reluctance of some farmers to give up old varieties has resulted in a hodgepodge of varieties. This situation is particularly true for oats and to a slightly lesser extent for barley and hard spring wheat. Twenty-one varieties of oats were raised in 1951 by the 140 farmers interviewed.

Farmers attributed mixed vari-

Grain becomes moldy and caked as a result of too much moisture when stored.
eties to three reasons: carelessness on the farm in grain handling, seeding, and harvesting; lack of adequate grain handling and storage facilities on farms to keep different varieties separated; and failure of elevators and seed selling concerns to maintain pure seed varieties.

Elevator operators blamed it on careless seed handling practices by farmers, too many varieties being produced on farms, and a few said it was due to volunteer grains.

On this basis the problem of mixed and undesired varieties can be lessened by following these simple principles: (1) know and use varieties which are adapted and recommended for the area, (2) produce only one or two varieties of a particular grain within any one year, (3) be certain that seed is a pure strain, and (4) use every precaution in seeding, harvesting, and handling of grains to minimize mixing of different varieties.

Mixed Grains

Since the majority of farmers do not have grain cleaning equipment, most grain is marketed containing varying amounts of other types of grain and foreign materials. The seriousness of this problem varies with the types of small grains involved and with the ultimate use to be made of the grain. Oats in barley and other grains in spring wheat were the most serious mixtures found in South Dakota grain.

Two major causes for mixed grains at the farm level were listed by the elevator operator as farmer carelessness in handling and cleaning seed grains and volunteer grains (this applied mainly to rye or winter wheat in spring wheat). Farmers placed most of the blame on volunteer grains and farmer carelessness in seeding, harvesting, handling, and storing.

Undoubtedly all of these factors contribute to the mixed grain problem. Many farmers either save seed from their own grain from year to year or purchase it from other farmers. In either case protection against mixed seeds depends upon the precautions exercised by the farmers. When seed grains are purchased from commercial concerns farmers should still be on the alert to be sure they are not contaminated.

The volunteer grain problem also must be remedied by the farmer. There are several possible methods of dealing with it. Land capable of a second year of small grain can be reseeded to the same variety.

Another alternative is to plant a row crop on the land. Or if livestock feed is needed the field can be spring sown to oats and the resulting crop, although somewhat mixed, can be used for feeding purposes. Summer fallowing the succeeding year is also effective in controlling volunteer growths. In some areas it is possible to spring seed grasses or legumes into the fall sown wheat or rye, and to use the land for hay or pasture the following year when the volunteer crop normally appears.

Grain Storage and Storage Facilities

One of the major problems in recent years, particularly under the price support program, has been lack of adequate storage facilities. Storage space in an area may be in-

Continued on page 45
Irrigation

FOR POTATOES

J. L. Wiersma

Potatoes need careful irrigation. Though they don't require as much water to produce a ton of dry matter as many other crops, the amount and time of application is much more exacting.

Potato plants should be kept in an active growing condition from the time they come up to near the time of harvest. If rapid growth stops for even short periods, reduced yields or lowered quality results. This makes it necessary to apply water before there is lack of moisture. Potatoes receive more than half of their required water from the top 12 inches of soil and over three-fourths from the top 24 inches. This shows the need for keeping the upper soil layers well supplied with moisture.

Sprinkler irrigation makes it possible to apply light applications of water without erosion and yet wet only the top soil layer. It may be that greater yields of high-quality potatoes can be obtained from the same amount of water by use of sprinkler irrigation than can be obtained by furrow irrigation.

Sprinkler and Furrow Irrigation

An experiment was set up at the Experiment Station at Brookings to obtain information on irrigation practices for these two general types of irrigation. Three potato plots, each with three replications, were set up. Five varieties with two plant spacings for each variety were used. Furrow irrigation was used on one of the plots, sprinkler irrigation on another, and the other was left as a dryland plot.

The ground on which the potatoes were planted was in alfalfa-brome the year before. Just prior to planting the potato plots, 200 pounds per acre of a 10-20-0 fertilizer were applied.

Rows were spaced 3 feet apart. Two plant spacings were used in each row—8 inches in part of the row and 12 inches for the remainder.

Water was applied to the irrigated plots when 50 percent of the available plant moisture was used. This practice was continued from planting until nearly harvesting.
Plant spacing affects potato size. These La Soda potatoes were the largest found in 3 hills. Those on the left are from 12-inch spacings; those on right from 8-inch spacings.

time. The plots were irrigated on July 9, July 26, and August 9. Each water application amounted to 3½ inches, making a total of 10½ inches of irrigation water.

A summary of the 1954 yields is given in the table. The figures are an average of the replications for each variety and plant spacing.

The potatoes were graded as No. 1 and 2, culls, and sun scalds. Sun scalds are cull potatoes, but it was believed many normally No. 1 and 2 potatoes in the sprinkled plots

<table>
<thead>
<tr>
<th>Plant</th>
<th>Spacing Within Rows (Inches)</th>
<th>Dryland</th>
<th>Surface</th>
<th>Sprinkled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Yield Bu.</td>
<td>No. 1 &amp; 2</td>
<td>Culls</td>
<td>Sun Scald</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobblers</td>
<td>8</td>
<td>317</td>
<td>229</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>266</td>
<td>176</td>
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<tr>
<td>Early Ohio</td>
<td>8</td>
<td>376</td>
<td>185</td>
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</tr>
<tr>
<td></td>
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<td>Kennbec</td>
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<td></td>
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<td>Pontiac</td>
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<td>405</td>
<td>310</td>
<td>62</td>
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<tr>
<td></td>
<td>12</td>
<td>295</td>
<td>240</td>
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</tr>
</tbody>
</table>
were sun scalds as a result of the top tubers being uncovered during the last irrigation. The data show this may be true to a degree.

**Yields Increase**

This 1-year trial shows a substantial yield increase through irrigation. There was little difference in yield or quality of potatoes that were sprinkler or furrow irrigated. All varieties and plant spacings showed significant differences, with those in the irrigated fields yielding best. There was also a greater difference in yield between the 8-inch and 12-inch spacings. The 8-inch spacing gave the greatest yields.

Spacing also had a marked effect on the size of the potatoes. In the irrigated fields, the number of potatoes per plant was nearly the same, but the 12-inch spacing had much larger potatoes. If this is a desirable characteristic, it could be regulated by plant spacings.

The trials indicate early Ohios may need more frequent irrigation than other varieties (note knobs in picture). This doesn't mean that more water will necessarily be required. Next year work of this kind will be carried out and the other trials will continue. Some variations that need investigation are time of irrigation and total amount of water needed. Other plant spacings could also be tried, especially with varieties having smaller tubers. (Project 192. Leader: J. L. Wiersma, Agricultural Engineering Dept.)
ONE USUALLY THINKS of the ant as that pesky little creature that pesters people at picnics or robs the pantry. But he has relatives that are even more destructive—they cause crop losses by gathering seeds and building large mounds in the fields. These are the harvester ants.

South Dakota has one harvester ant species (Pogonomyrmex occidentalis). It does the most damage in the western two-thirds of the state where it is most abundant.

Mounds Vary in Size

The presence of the ants is indicated by their mounds and the more or less bare area surrounding each mound. The largest mounds may measure up to 2 feet across and 1 foot high, but most of them are smaller. They are made of small pebbles and soil particles brought from beneath the ground surface. One or more openings are located within or at the edge of the mound and through these openings the ants make their way into and out of the galleries and chambers below ground.

Surrounding the mound is a more or less circular area that has been cleared and that will be kept clear of all vegetation. This area varies in size from 3 to 15 feet or more depending upon the size of the underground galleries and chambers and the number of ants occupying these. One or more runways lead away from the cleared area into the surrounding vegetation.

The nest of the ants is beneath the surface of the ground and consists of connecting tunnels and chambers. The tunnels are about \( \frac{3}{4} \) of an inch in diameter, while the chambers, which are usually flat bottomed and with dome-like ceilings, vary in size from \( \frac{3}{8} \) inch to 12 inches long and \( \frac{3}{4} \) inch to 10 inches wide. The tunnels and chambers may extend 6 to 8 feet or more beneath the surface of the ground.

The chambers may be used for storing the food of the colony or for nurseries in which the young are reared in the warmer months of the year. In the winter, the deeper chambers are used by the ants in which to pass the cold weather.
The ant nests may be found in cultivated as well as uncultivated areas. However, the ants do prefer and are more successful in establishing and maintaining their nests in soils that remain undisturbed. The number of ant nests in an acre of land varies considerably. In some fields the nests may be absent or very few in number while in another field there may be as many as 40 nests per acre. The crop loss in the latter case is considerable.

**Ants Eat Seeds**

The principal food of the harvester ant consists of seeds. The seeds are carried to the nests by worker ants and stored in the underground chambers. Almost any seed that is small enough to be carried is collected, stored, and used as food. Seeds of grain, legumes, or grasses are used. Apparently the seeds collected depends upon what is most available near the nests. At times grass heads bearing seed may be cut off and carried back to the nests for storage. They may also collect seed that is sown.

The ants occur as winged males, winged females or queens, wingless queens, and workers. Each of these individuals must pass through an egg, grub, and pupal stage before it matures. Eggs, larvae, and pupae may be seen by digging open a nursery chamber.

The workers are sterile females and are by far the most abundant individuals in a nest. Only one active egg-laying queen is usually found in a nest and she is wingless. During June, July, and August winged males and females leave the nest in large numbers and take to the air. They mate in the air and following this the males die and the females get ready to start a nest. Swarming has been observed in South Dakota in July and August, but it is likely that some swarming may take place earlier or later than the months listed.

**Females Build Nests**

After a winged female has mated, she pulls, cuts, or breaks off her wings and then seeks a place in which to begin her nest. She excavates a tunnel about 10 inches deep and following this, constructs from 1 to 4 small rearing chambers or

Continued on page 48

Types and life stages of the harvester ant.
A—Winged female, B—Queen, C—Male,
D—Larva, E—Pupa, F-H—Workers.
Siouxland is a new leaf rust resistant cottonwood that will be released this spring. This strain was developed by the Plant Pathology Department to meet the need for a rust resistant cottonwood that was better suited to South Dakota conditions. Siouxland should be more satisfactory for shelterbelts and farmstead plantings than the common cottonwood.

Compared to the common cottonwood, Siouxland is highly resistant to leaf rust. (This is a fungus disease closely related to the rust on flax, but it does not infect flax or any of the other small grains.) This tree is also resistant to some of the leaf spot diseases. It is not resistant to certain bark cankers, though efforts are being made to develop a resistant strain.

**Produces No Cotton**

There is no nuisance with cotton during the seed ripening period as with the common cottonwood tree. Siouxland produces only male flowers which do not develop cotton.

Siouxland is an attractive looking tree, the lower branches being arranged similar to those of the spruce. The branches do not prune off as with the common cottonwood, at least not until the tree has a trunk diameter of 10 inches or more. Groundwind protection is increased because of this.

The foliage is deeper green and somewhat larger than that of the common cottonwood. This strain grows rapidly. In field plots where leaf rust has developed in epidemic proportions on common cottonwood nearly every season since 1945, Siouxland is almost twice their size.

During the 9 years this tree has been in field experiment at Brookings, there has been no evidence of winter injury. Many other strains in the same trials had branches killed back as much as 4-5 feet. In other instances trees were killed following rust defoliation during several
Siouxland (left) shows no evidence of winter injury as does common cottonwood (right). This experimental planting is 7 years old.

consecutive seasons.

The common cottonwood, a native of South Dakota, has been planted extensively throughout the state. This has been especially true since the shelterbelt planting program was begun in 1935. Nearly 90,000 acres of shelterbelt and farmstead plantings have been made in the state. Cottonwoods are used in the center rows in shelterbelts because they grow rapidly and produce the needed height for maximum wind protection and soil erosion control.

Rust Damages Common Cottonwood

Extensive losses in cottonwood stands have occurred during the past years. It was first thought the losses were mainly due to the lack of winter-hardiness. But it was found that a leaf rust was infecting the cottonwood which caused them to lose their leaves. This disease appears to slowly starve the trees, making them susceptible to winter injury. The ends of the branches die first and eventually the entire tree. The growth of those that survive is slowed down.

Experiments demonstrated that trees sprayed for rust did not lose their leaves early and withstood the winter without injury. When the leaves are lost early they have not made enough reserve food to prevent winterkilling.

Siouxland will be available as certified stock, having been developed under certification standards applicable to tree stocks of this kind. This tree was increased under the supervision of the State College Foundation Seed Stocks Division. Two nurseries in the state (one at Colton and the other at Yankton) cooperate in carrying out the stock increase.

Available This Spring

Siouxland will be available in limited numbers this spring as rooted plants and as cuttings. In accordance with Experiment Station policy, the opportunity to obtain these trees is provided first to citizens of the state. After this demand has been met distribution may be made elsewhere.

The cuttings will consist of cut stems approximately 8 inches long and about ½-inch in diameter. They will have been treated with a fungicide. The results when either rooted stock or cuttings were planted have been excellent. Survival in plantings of about 40,000 in each of two locations was approximately 95 percent when treated cuttings and proper soil preparation were used.

Best results are obtained when

(Left) Seed pods of common cottonwood about to produce cotton. Siouxland has only male flowers, which do not produce cotton. (Right) Lesions from leaf rust fungus infections. When lesions become this numerous the leaf may be killed in 4-5 days and drop.
When planting the Siouxland cutting, place so only top bud is exposed above soil line. Pack soil firmly around cutting. Note depression left around the plant to collect rainfall.

the soil has been properly plowed (preferably the previous fall) and worked similar to the seedbed preparation recommended for field crops. The soil should be firmed to conserve moisture. Grass and weeds must be controlled, as young trees can not compete with them.

Use Care in Planting

It is very important when planting cuttings to place all of the stem below ground with the exception of the top bud. Be sure to pack the soil firmly around each plant, whether a cutting or a rooted plant. Leave a soil depression around each plant to catch rainfall.

Keep the rooted trees and the cuttings moist at all times before planting and avoid exposure to the sun. Plant when the ground is workable and danger of heavy frost is past. (Project 142. Leader: C. M. Nagel, Plant Pathology Dept.)

(Left) Common cottonwood defoliated by leaf rust during 1954. (Right) Siouxland showing no injury from leaf rust. Both rows planted with cuttings on May 20, 1954.
Rye and winter wheat are the two fall-sown grains grown in South Dakota. Varieties of rye hardy enough to survive South Dakota winters are available; as a result, rye can be grown successfully anywhere in the state. Winter wheat culture is confined to the southern and western areas because present varieties are not hardy enough to survive winter conditions regularly in the rest of the state.

Winter-Hardiness Is Important

Winter-hardiness is the most important criterion in choosing varieties of fall-sown grain. It is the basis of the current varietal recommendations in these crops, namely Pierre rye and Minter and Nebred winter wheats.

The main objective of the winter wheat breeding work at this Station is to produce winter wheats with more hardiness than that of the varieties now available. In rye, the problem is to produce varieties that combine the hardiness of Pierre with increased productivity and better agronomic characters.

Where winter wheat survives, it has a strong yield advantage over spring wheat. Minter winter wheat averaged 32.2 bushels per acre at Brookings during the last 7 years. Rushmore spring wheat averaged 23.4 bushels.

In South Dakota counties where both winter and spring wheat can be grown, the yield advantage of the winter type varies from 50 percent in Bennett and Haakon Counties to 10 percent in Hughes and
Cold chamber in which germination of grains at low temperatures is checked.

Hand (based on harvested acreages). Winter injury is the main cause of the yield variations.

Research on winter grains has been conducted at the South Dakota Station for many years. The selection from which Nebred was derived, Turkey 144, was developed at this Station and was widely grown in the state at one time. The Station also participated in the release of Minter winter wheat. Pierre has recently been developed as a hardy, high yielding rye for this area.

On the cultural side, agronomic research showed long ago that even the available winter wheat varieties could survive in the north central area (Eureka) if provided with a cover of straw. This might be feasible economically at present prices and with present equipment.

**Higher Yield and Stiffer Straw Wanted in Rye**

Rye breeding involves keeping present levels of hardiness and is aimed at getting varieties with

<table>
<thead>
<tr>
<th>Table 1. Frequency of Various Winter Conditions at Four South Dakota Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Station</strong></td>
</tr>
<tr>
<td>--------------</td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Huron</td>
</tr>
<tr>
<td>Highmore</td>
</tr>
<tr>
<td>Pierre</td>
</tr>
<tr>
<td>Kennebec</td>
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</tbody>
</table>

Classification based on data furnished from IBM punched card tabulations by R. F. Pengra, Agricultural Economics Department, South Dakota Agricultural Experiment Station, and U. S. Weather Bureau.

*Years of no thaw would be favorable to winter grain survival under snow cover. Short thaws reduce the cover and expose the grain. False springs are very harmful to survival of winter grain.

*Good cover—snow abundant and well distributed. Fair cover—snow total adequate but poor distribution. Poor cover—snow insufficient for continuous cover. No cover—open winter.*
Table 2. Average Annual Crop Statistics by 5-Year Periods of Winter Wheat, Rye, and Spring Wheat in South Dakota, 1926—1954

<table>
<thead>
<tr>
<th>Crop and Period</th>
<th>Acres Planted 000's</th>
<th>Acres Harvested 000's</th>
<th>Acres Abandoned %</th>
<th>Yield per Seeded Acre Bu.</th>
<th>Yield per Harv. Acre Bu.</th>
<th>Total Production 1,000 Bu.</th>
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</thead>
<tbody>
<tr>
<td>Winter Wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1926-30</td>
<td>112</td>
<td>90</td>
<td>19.8</td>
<td>11.3</td>
<td>14.1</td>
<td>1,262</td>
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<tr>
<td>1931-35</td>
<td>253</td>
<td>132</td>
<td>47.8</td>
<td>6.0</td>
<td>11.5</td>
<td>1,521</td>
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<tr>
<td>1936-40</td>
<td>195</td>
<td>104</td>
<td>46.8</td>
<td>5.7</td>
<td>10.7</td>
<td>1,110</td>
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<td>1941-45</td>
<td>248</td>
<td>193</td>
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<tr>
<td>1946-50</td>
<td>355</td>
<td>289</td>
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<td>12.0</td>
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<td>1951-54</td>
<td>455</td>
<td>372</td>
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<td>Rye</td>
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<td>214</td>
<td>22.2</td>
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<td>275</td>
<td>214</td>
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<td>662</td>
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<td>366</td>
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<tr>
<td>Hard Red Spring Wheat</td>
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<tr>
<td>1926-30</td>
<td>2,086</td>
<td>1,033</td>
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<td>9.8</td>
<td>10.5</td>
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<td>1936-40</td>
<td>2,613</td>
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<td>4.8</td>
<td>7.5</td>
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<td>12.7</td>
<td>13.3</td>
<td>32,520</td>
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<tr>
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<td>3.3</td>
<td>9.7</td>
<td>10.0</td>
<td>29,032</td>
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*Data from South Dakota Crop and Livestock Reporting Service

higher yield and stiffer straw. Since rye is an open-pollinated crop, the breeding methods used are similar to those in alfalfa. Because of the amount of seed needed per acre and the yield of rye that can be expected, the aim of the breeding program will be the production of synthetic varieties (a composite of several lines).

Breeding for winter-hardiness in wheat is especially hard because the commonly grown winter wheats in South Dakota represent the highest level of hardiness known. Consequently progress has been slow, and special breeding methods appear necessary to reach new levels of the desired character.

A special cold chamber in the agronomy greenhouse makes possible an accurate evaluation of the cold resistance of winter grain selections under controlled conditions. Survival in this "artificial winter" (temperatures can be set below those likely in the field) is closely related to the average survival in the field. Cold chamber tests indicate that it is possible to produce wheats harder than Minter.

Survival Counts Are Taken

The cold chamber can test numerous strains in the early stages of development. Field survival is the final measure of hardiness in winter grain. Survival notes and counts are taken on all plots grown at the Station.

Besides survival, the vigor of spring growth is important. Some strains are alive but so badly injured by the winter that their recovery is slow and their growth seriously delayed.
Winter survival in the field is a complex problem of which outright cold resistance is only the major factor. Field survival also depends on observation of proper planting dates and adequate fall growth to build up enough root reserves for the winter. Stands of winter grain are reduced or wiped out by smothering from ice cover; heaving of the soil which cuts off roots; drying out of the plants, especially on bare ground; and breaking of winter dormancy.

Dormancy break occurs when a warm period in winter stimulates the grain to begin growth, which is then cut off by sharp low temperatures. Midwinter thaws occur regularly in South Dakota (Table 1). Stands may also be reduced by soil blowing in spring, as occurred in April 1954.

**Winter Wheat Acreage Increases**

There has been a steady increase in the state's winter wheat acreage (Table 2). Some recent favorable years have been a factor in this expansion and present varieties are more winter-hardy. But much credit must be given to the widespread observation of proper planting dates, moisture and soil conservation practices, and improvements in soil fertility to get better fall growth. The use of the deep furrow drill with press wheels appears to result in better fall stands, more winter protection, and better survival. The maintenance of a cover by proper tillage methods is beneficial and with strip cropping reduces damage from blowing. Studies involving the use of fertilizers to increase survival of winter grains are underway.

Growers may take advantage of the yielding ability of winter grains and the spreading of risk and farm operations even with the varieties available today. They may choose rye anywhere in the state and win-
Winter wheat at least as far north as the central areas. They can take advantage of the techniques and farming methods used by the most successful operators in the state.

It may be profitable to seed winter wheat even where it only survives well 60 percent of the time. In years of poor survival the land can be used for spring grains, row crops, or emergency crops. The yield advantage and profit from winter wheat in the years it survives will more than pay for the seed and operations that are lost in the years of failure.

Winter Wheat Moves North

The limits of profitable winter wheat production have moved north 300 miles during the past 50 years. Developments in plant breeding and management are responsible. This northward movement is now proceeding through South Dakota. Research in plant breeding and management, adequately supported and vigorously pursued, may push the ultimate northern limits of winter wheat even further. This will be especially true if these advances are matched by progress at the farm level in soil and moisture conservation, proper equipment, and superior management. (Project 181. Leader: V. A. Dirks, Agronomy Dept.)

Grain Marketing Problems Continued from page 32

adequate because of lack of physical space to accommodate the grain to be held, because of poor quality and supervision of structures, or a combination of the two. The extent to which grains are stored on farms depends primarily upon the capacity and quality of farm storage facilities. The lack of adequate farm storage forces farmers to haul grain to the elevator at harvest time.

The total small grain storage capacity of South Dakota farms October 1, 1949, was slightly over 200 million bushels. Storage facilities were sufficient to store the entire 1944—1948 average small grain production in all except the northeast quarter of the state. With normal quantities being marketed at harvest time small grain storage facilities on farms were adequate in all production areas.

There is considerable variation between farms in the quantity of grain storage facilities. Some farms have excess storage facilities at all times, while others lack adequate storage even in years of below normal production. Thus area averages are not too meaningful in analyzing the adequacy of farm storage to accommodate annual grain production. For the 140 farms included in the sample, about 66 percent of the total small grain production was stored. This required 69 percent of the total small grain storage facilities.

Adequacy of grain storage facilities includes the quality aspect as well as capacity. If grain storage facilities are not structurally good enough to protect and maintain the quality of stored grains against the weather and to a reasonable extent from rodents and insects, the facilities cannot be considered adequate.

Based on the sample it is estimated that of the 206 million bushel to-
tal farm small grain storage capacity in the state, over 145 million bushel capacity would rate structurally adequate for storage of all grains. An additional 45 million bushel capacity would be satisfactory for feed grains. This 190 million bushel capacity is sufficient to accommodate 97 percent of the average 1944–1948 state small grain production.

Almost half of the farmers reported serious rodent damage to all grains in storage on their farms. Rodent damage results both from poor structures and from the lack of rodent control measures by farmers.

Insect damage was most common in farm stored wheat. Some insect damage to oats and barley was also reported. Insect infestation was attributed mainly to the weevil. However, a few farmers indicated that mites and aphids were serious in some years.

Condition of storage facilities is only partially responsible for insect infestation. Poor buildings encourage the hibernation and perpetuation of grain insects. Major cause of insect damage is usually the failure of farmers to handle and chemically treat stored grains properly.

Grain Storage in Elevator

Amount of grain stored on farms is influenced by the ability of elevators to handle the supply of grain which farmers wish to market at harvest time. Many South Dakota elevators become clogged for at least some portion of the harvest season because of the rush of grains from farms and the inability of transportation facilities to move the grains on to the terminal markets.

Information on clogged elevators was obtained from the 140 farmers. The number of times and the length of time they were clogged increased from east to west in the state. Possible explanations are: (1) rail facilities are more adequate in the eastern sections of South Dakota, (2) production and marketing fluctuate less from year to year in the eastern part of the state, (3) Grain is not harvested in as short a period of time in eastern South Dakota.

Fluctuations in annual grain production and the uneven flow of grains from farms to market throughout the year make it extremely difficult for elevator owners to determine how much grain storage capacity will be economical.

The elevator operators were questioned regarding the adequacy of their existing grain storage facilities. Fifty-nine of the 105 operators interviewed reported insufficient capacity. One-fourth of these planned to increase their capacity within 2 years.

Grain Transportation

The greater the distance of elevators from terminal markets, the greater the grain transportation problems are likely to be. All but 12 elevator operators reported box car shortages during harvest. These shortages usually extended over portions of at least 2 months.

Increased use of motortruck transportation offers a partial solution to this problem. The amount of grains moved by trucks is relatively small, but has gained considerably in importance in some areas during the past few years.
Between 10 and 20 percent of all grain marketed by elevator operators in the survey was sent out by truck. Percentages shipped by truck were considerably lower in the western portion of the state. A number of elevator managers in various areas expressed the intention of increasing truck transportation in the future, particularly during harvest season.

There are several disadvantages connected with trucking grains to terminal markets. One of the major handicaps is the lack of equipment to unload trucks at many of the terminal elevators. Another obstacle is inability to obtain the stop-in-transit privilege granted to rail shippers. Grains delivered by truck must be reloaded under a separate contract after sale and processing. Also Sunday truck laws in some major cities prohibit movement of semi-trailer type trucks on Sunday within a certain distance of the metropolitan area.

Quality Premiums

In most years premiums are paid for high protein content wheat and for high quality malting barley. In both grains eligibility for premium payments depends primarily on grain quality and on supplies of these high quality grains.

Handling of premium payments on grains presents a rather difficult problem for local elevators. Elevators rarely have the necessary equipment to determine protein content in wheat or adequately to test malting qualities of barley. Usually quality determinations must be made at the terminal elevators.

The most common procedure, particularly for protein in wheat, is for elevators to pay premiums on the basis of the station average. At the beginning of the harvest season grain samples from the locality are sent to the terminal elevator for analysis. Premiums, if warranted, are paid to all farmers in the area on the basis of these tests.

This system benefits farmers producing grain of below average protein content and penalizes those whose grain is above average. It is hard to eliminate this inequity unless it becomes possible for elevator operators to run tests on all grain delivered, even during the rush season. However, in the event a farmer has enough grain to fill a carload, most elevators will arrange for a separate shipment.

There is some misunderstanding regarding the eligibility of high protein wheat for premiums. No specific protein percentage content in wheat qualifies it for such payments. Uniform protein content is desired in flour for baking purposes. In years when the average protein content in wheats is below the desired level any wheat above the average may be eligible for a premium. In years when the average protein content is extremely high, premiums may be paid on low protein wheat in order to get enough of it to maintain desired flour uniformity. (Project 224. Leader: Richard R. Newberg, Agricultural Economics Dept.)
nurseries branching off from the tunnel. The tunnel is plugged with earth and then she lays a cluster of about 50 eggs in one of the nurseries.

The queen takes care of the eggs, feeds the grubs that hatch, and cares for the pupae until they develop into worker ants. Following this the queen remains in the nest, feeds, and lays eggs. The workers gather food; build additions to the nest; care for the eggs, grubs, and pupae; remove undesirable materials from the nests; and defend the colony. A nest may last many years. The same queen lives throughout this period, but the workers die off and are replaced and added to.

The worker ants defend the colony quite effectively. They are provided with an efficient sting and with a pair of strong jaws. When a nest is disturbed the workers rush from the nest and bite the disturbing enemy. They also attempt to sting.

Control by Several Methods

Harvester ants may be destroyed by several methods. One effective method involves the use of insecticides in dust form.

Effects of various insecticides were tried. These were dieldrin dust containing at least 2 percent of dieldrin, chlordane dust containing at least 5 percent of chlordane, and toxaphene dust containing at least 5 percent of toxaphene. Dieldrin remained effective longest as a killing agent.

The dust is applied as a continuous flat band 2 to 3 inches wide in the cleared area around the mound. All exit or entrance holes of the nest should be inside the ring of insecticide.

The ants must come in contact with the insecticide for it to be effective. If, after several weeks, it is found that all of the ants in a treated nest have not been killed, it will be necessary to repeat the application. The queen ant in a treated nest must be destroyed if the colony is to die out. If the queen ant is killed but some workers are not, the colony will die out.

Treatment of the ant nests as directed is effective and practical unless the nests are very abundant and the area to be treated is exceedingly large. Dieldrin, chlordane, and toxaphene dusts are poisonous and should be handled with all the precaution recommended by the manufacturer. Vegetation that is to be eaten by man, dairy animals, or cattle being finished for slaughter should not be dusted with these insecticides.

Another method that may be used to destroy harvester ants is use of a proper fumigant. Either carbon bisulphide or methyl bromide is ordinarily used for this purpose.

Precaution Is Needed

Carbon bisulphide should not be applied in the heat of the day. It should be handled like one handles gasoline for it is explosive. If it is stored it should be kept in a tight container that does not leak.

Small nests or those that have a clearing of 4 feet in diameter or less require about 4 fluid ounces of carbon bisulphide for a treatment.
Four holes, 6 to 8 inches deep, should be made in the mound with a sharpened broomstick or other implement. About 1 fluid ounce of the fumigant should be poured into each hole and following this the hole should be closed.

Larger nests require more preparation. Six inches of the top layer of soil should be removed from an area 3 to 6 feet in diameter around the exit and entrance holes. About a day or so later pour about 8 fluid ounces of carbon bisulphide into the entrance or exit holes of the nests, being careful to divide the fumigant equally among them. Close the holes and replace the soil that was removed.

If after 2 or 3 weeks it is necessary to treat a second time, enlarge the new entrance or exit holes in each nest as already explained and pour 4 fluid ounces of the fumigant into the holes and close. Repeat if necessary. Methyl bromide may be substituted for carbon bisulphide, but this material is more effective in moist rather than in dry or sandy soil. One to two fluid ounces of this fumigant should be released into the nest through the entrance or exit holes and then the holes should be plugged with soil. A special dispenser on the container of the bromide and fitted with a valve and several feet of rubber tubing tipped with a short metal tube is a handy device for releasing the fumigant into the nest.

Treatment with the bromide may have to be repeated. Methyl bromide should be handled carefully and should be stored in a room or building with good ventilation. A third possible method of control is use of a poisoned bait. This method is still in an experimental stage. If successful it will be the least expensive and laborious of any discussed.

(Leader: H. C. Severin, Entomology-Zoology Dept.)

Wind Barriers Continued from page 26

Barriers. Two parallel 50-foot lengths were placed approximately 60 feet apart in a field of onions. Temperatures were constantly recorded in a small structure away from the protection of the snow fences. Temperatures were also taken in another structure that was moved daily to different positions within the area in which the wind was modified by the snow fences.

The high and low temperatures were taken each day for a period during the summer and temperature differences between the two locations were compared. In 16 such observations there was no difference in the high for the day between the two locations.

On 3 days the maximum temperatures were 1 degree higher in the open field. However, there were 22 days in which the temperature was increased from 1 to 4 degrees in the protected area. Similar increases were also noted in the lows during the night. This seems surprising when one considers the distance between snow fences and that a snow fence doesn't afford complete wind stoppage. (Project 118. Leader: R. L. Foskett, Horticulture Dept.)
Lot of pregnant ewes being fed alfalfa silage as only roughage.

R. M. Jordan

Alfalfa silage appears to be unsatisfactory as the only roughage for pregnant ewes. This conclusion is based on an experiment where alfalfa hay and alfalfa silage were compared as the only roughage for pregnant ewes during the winter of 1953-54.

Ewes fed alfalfa hay gained over twice as much weight during the gestation period as those fed only alfalfa silage. The hay-fed ewes had a 35 percent greater lamb crop and their fleeces averaged 2 pounds more. Besides this, their lambs were somewhat heavier at birth and gained a little more rapidly than lambs from the silage-fed ewes.

More Grass Silage Is Used

Frequent rains during haying often make it hard to put up a good quality roughage for winter feeding cattle and sheep in South Dakota. The extremely rainy season of 1951 did much to popularize the use of grass silages.

Since that time some people have advised the use of silage as the only roughage. This feeding test with pregnant ewes was conducted to see if they could be maintained economically and in a good state of productivity when alfalfa silage was
As the Only Roughage
for Pregnant Ewes

The only roughage.

The Experiment Is Set Up

By feeding one lot of pregnant ewes only hay and another lot only silage, alfalfa hay and alfalfa silage were compared as the only winter roughage. The 20 ewes in each lot had access to salt, a mixture of equal parts salt and bone meal, and fresh water.

The second-cutting alfalfa hay and silage used were harvested at the same time and from the same field. The hay received one rain but was of good quality and quite leafy. It was baled and stored in the barn. The silage was blown into a snow fence enclosure and piled about 16 feet high. No preservative was added.

This feeding trial lasted 126 days. A portion of the ewes had been bred when it began.

Approximately the same amount of dry matter was fed per head daily in each lot (3.9 pounds of alfalfa hay or 9.8 pounds alfalfa silage). During the last 30 days a half pound of shelled yellow corn was fed per head daily to both lots to prevent pregnancy disease.

The experiment was ended about a week before the ewes started to lamb. They were all placed on an alfalfa hay-corn ration. As a result some of the silage-fed ewes received alfalfa hay 2 to 4 weeks before they lambed.

Hay-Fed Ewes Produce Best

The hay-fed ewes produced better than the silage-fed ewes. During the experimental feeding period the hay-fed ewes gained 32.8 pounds compared to 14 pounds for the silage-fed group. Most of the gain for the silage-fed ewes was made during the last 30 days when the half pound of corn was fed daily.

Ten pounds of silage, which contained about 68 percent moisture or 3.2 pounds of dry matter, could hardly be expected to furnish ample nutrients for ewes weighing 170 pounds. On the other hand, the

This alfalfa hay and silage were harvested same day from same field. Pregnant ewes did better on alfalfa hay than on the silage when each was used as the only roughage.
Comparison of Alfalfa Hay and Alfalfa Silage for Pregnant Ewes

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<tr>
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<th>Lot 1 Alfalfa Hay</th>
<th>Lot 2 Alfalfa Silage</th>
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<td>Days fed</td>
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<td>170.9</td>
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<tr>
<td>Average gain per ewe, lbs.</td>
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<td>Death loss</td>
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<td>0</td>
</tr>
<tr>
<td>Average fleece weight, lbs.</td>
<td>11.45</td>
<td>9.57</td>
</tr>
<tr>
<td>Lambing percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ewes bred</td>
<td>165</td>
<td>130</td>
</tr>
<tr>
<td>Ewes lambing</td>
<td>174</td>
<td>173</td>
</tr>
<tr>
<td>Average birth weight, lbs.</td>
<td>11.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Single</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twins</td>
<td>9.6</td>
<td>8.6</td>
</tr>
<tr>
<td>Weaning percent</td>
<td>120</td>
<td>95</td>
</tr>
<tr>
<td>Average rate gain first 35 days, lbs.</td>
<td>.51</td>
<td>.45</td>
</tr>
<tr>
<td>Average daily feed consumed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain (last 30 days), lbs.</td>
<td>.5</td>
<td>.5</td>
</tr>
<tr>
<td>Roughage, lbs.</td>
<td>3.9</td>
<td>9.8</td>
</tr>
</tbody>
</table>

ewes would not eat more than the 10 pounds of silage and occasionally left some. Ewes that received the same amount of dry matter in the form of alfalfa hay ate their allowance and gained well.

It is possible that had the silage-fed ewes been given a small amount of alfalfa hay they would have made better use of the dry matter in the silage. These ewes ate most of the bedding in their pen, so it was apparent they craved dry roughage.

Fleeces of the ewes fed alfalfa hay averaged 11.45 pounds compared to 9.57 pounds for the ewes fed alfalfa silage. In addition, more of the fleeces from the ewes fed silage were tender and ewak, indicating inadequate food intake.

**Lambing Percentage Is Figured**

The lambing percentage was based on the number of ewes bred. Only one of the hay-fed ewes failed to lamb, and the lambing percentage was 165 percent.

Five of the silage-fed ewes didn’t lamb and their lambing percentage was 130 percent. Due to the greater lambing percentage, the hay-fed ewes weaned 120 percent compared to 95 percent for the other group.

Feed intake and the ability of the ewes to make use of the feed eaten is usually reflected on the birth weight of the lambs. This is one of the yardsticks used to determine the value of a ration. The lambs from the hay-fed ewes weighed about a half pound more each than those from the silage-fed ewes. Twin lambs averaged over a pound more per head from the hay-fed group.

**Vitamin A Deficiency Appears**

A nervous tendency showed up in the first 5 lambs born to the silage-fed ewes. These lambs stood with their heads drooped and continually backed up, trembled, and often rolled over in a nervous fit. This symptom suggests a vitamin A deficiency.

A chemical analysis of the alfalfa silage showed it contained virtually no vitamin A or carotene. Apparently alfalfa silage stored in an outside stack or pile, as was done in this instance, develops heat to the extent that vitamin A and carotene are destroyed. Failure of more lambs to exhibit this condition is probably because there was ample vitamin A in the hay fed after the experimental feeding.

The average daily gain of the lambs suckling hay-fed ewes during the first 35 days after birth was .51 pound per head. Those suckling silage-fed ewes gained .45 pound a day. (Project 237b. Leader: R. M. Jordan, Animal Husbandry Dept.)
Creep Rations for PIGS

Richard C. Wahlstrom

The value of creep-feeding nursing pigs is now quite widely recognized. Although earlier experiments did not always show an advantage from creep-feeding, recent studies with more palatable and nutritious creep rations have shown that they are of value.

Creep-feeding is necessary to supply additional nutrients for large litters, to supplement the sow's milk supply during the later stages of the lactation period, and to supplement the milk supply of poor milkers. The main objective of feeding a creep ration is to get the pig to eat more feed so it will be heavier and more vigorous at weaning time.

Any quantity of feed eaten is apparently used very efficiently, so these early gains are cheap gains. Therefore it is good economy and good management to use a high quality creep ration rather than one of poor quality which will not produce as rapid nor as efficient weight gains.

Two Trials Are Conducted

Two trials have been conducted during the past year to determine the value of a high quality creep ration compared to one of poorer quality and also to test the value of pelleting the high quality creep ration. During the spring of 1954 a trial was conducted in which 40 sows were placed (two sows and their litters in each lot) into five groups of eight sows each. The sows were distributed as uniformly as...
possible into the five experimental treatments according to breed, litter size, and age of sow.

Sows in Lots 1, 2, 3, and 4 were full-fed twice daily while the sows in Lot 5 were self-fed free choice. The ration given to all sows was as follows: ground yellow corn, 70 parts; ground oats, 8 parts; ground alfalfa, 5 parts; soybean oil meal, 8.5 parts; tankage, 7 parts; steamed bone meal, 0.5 part; ground limestone, 0.5 part; and trace mineralized salt, 0.5 part.

Creeps were placed in one end of the portable house and were equipped with small self-feeders. Creep rations were fed to the pigs in Lots 1, 2, and 3. Lot 1 received Creep Ration A in pelleted form while Lot 2 received this same creep ration in meal form. The composition of Creep Ration A is shown in Table 1. Lot 3 received Creep Ration B which was identical to the sows' ration with the exception that it contained 20 gm. of aureomycin per ton.

The second trial, conducted during the fall of 1954, was similar to the first one. However, in the second trial all sows were self-fed on rape pasture and there were only three experimental treatments. Lot 1 was fed Creep Ration A as pellets, Lot 2 received this ration in meal form, and Lot 3 did not receive a creep ration.

**Higher Quality Ration Proves Best**

The results of the first trial are given in Table 2 and those of the second trial in Table 3. It is apparent from Table 2 that the pigs receiving the higher quality creep ration (Creep Ration A) performed better than the other lots of pigs. There are marked differences in weaning weights and average daily gains in favor of the pigs in Lots 1 and 2. That this creep ration was more palatable than the creep ration offered Lot 3 is quite evident since the pigs in Lots 1 and 2 consumed much more creep feed daily. The feed required per hundred pounds of gain was also less for Lots 1 and 2 than for the other three lots.

The value of pelleting Creep Ration A was slight. A little more feed was eaten per day which resulted in slightly faster gains. However, the differences were small and the additional cost of the pelleting made the cost of the gains in Lot 1 about equal to those in Lot 2. The differences in costs per 100 pounds of gain between any of the five lots are probably not significant as they vary only slightly between lots. The highest and lowest costs of gains were in Lots 4 and 5. Neither received a creep ration.

In the second trial (Table 3) the pigs in all lots made less average daily gains than did the pigs in the corresponding lots in the first trial. The rather damp, cool weather dur-

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**Table 1. Composition of Creep Ration**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled oats</td>
<td>40.0</td>
</tr>
<tr>
<td>Ground yellow corn</td>
<td>25.0</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>17.5</td>
</tr>
<tr>
<td>Sugar</td>
<td>10.0</td>
</tr>
<tr>
<td>Fish meal</td>
<td>3.0</td>
</tr>
<tr>
<td>Meat scraps</td>
<td>3.0</td>
</tr>
<tr>
<td>Steamed bone meal</td>
<td>0.5</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>0.5</td>
</tr>
<tr>
<td>Trace mineralized salt</td>
<td>0.5</td>
</tr>
<tr>
<td>Vitamin, antibiotic mixture *</td>
<td></td>
</tr>
</tbody>
</table>

*Furnished 6 mg. niacin, 4 mg. pantothenic acid, 1 mg. riboflavin, 4 mg. vitamin B₂, 1000 U.S.P. units vitamin A, 125 U.S.P. units vitamin D₁, and 10 mg. aureomycin per pound of ration.
A pig's weight is recorded for comparison with pigs in other trials.

October may have had some bearing on these results as the creeps were located outside during this fall trial whereas they were located in the houses during the spring trial. Another possible explanation for a part of this difference is that the pigs were approximately 3 weeks old when started on the spring trial and averaged only 10 days of age in the fall.

A definite difference in weaning weights was again noted. The pigs receiving Creep Ration A in pelleted form averaged 5.7 pounds per pig heavier than those not receiving a creep ration, and the pigs receiving the ration in meal form averaged 2.8 pounds heavier at 56 days of age. Again, as in the first trial, the pigs receiving the pellets ate slightly more feed and gained a little faster than did those pigs receiving the same ration as meal.

**Weaning Weight Increases**

These trials indicate that a high quality creep ration either in pelleted or meal form will improve weaning weights of pigs from 3 to 5 pounds, thus enabling the pigs to reach market weight sooner. This gain is more efficient than when either no creep ration or a low

Continued on Page 80

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**Table 2. Average Sow and Litter Performance on Creep-Feeding Trial, Spring 1954**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1 Creep Ration A Pelleted</th>
<th>2 Creep Ration A Meal</th>
<th>3 Creep Ration B</th>
<th>4 None</th>
<th>5 Sows Self-Fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sows</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Average initial sow weight, lbs.</td>
<td>388</td>
<td>419</td>
<td>431</td>
<td>396</td>
<td>429</td>
</tr>
<tr>
<td>Average final sow weight, lbs.</td>
<td>411</td>
<td>434</td>
<td>454</td>
<td>410</td>
<td>441</td>
</tr>
<tr>
<td>Average gain per sow, lbs.</td>
<td>23</td>
<td>15</td>
<td>23</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Number pigs started</td>
<td>58</td>
<td>59</td>
<td>58</td>
<td>57</td>
<td>58</td>
</tr>
<tr>
<td>Number pigs finished</td>
<td>54</td>
<td>57</td>
<td>55</td>
<td>55</td>
<td>54</td>
</tr>
<tr>
<td>Number days on test</td>
<td>34</td>
<td>32</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Average initial pig weight, lbs.</td>
<td>11.0</td>
<td>11.0</td>
<td>10.0</td>
<td>10.1</td>
<td>11.5</td>
</tr>
<tr>
<td>Average final pig weight, lbs.</td>
<td>35.2</td>
<td>32.5</td>
<td>28.1</td>
<td>26.7</td>
<td>29.3</td>
</tr>
<tr>
<td>Average 56-day pig weight, lbs.</td>
<td>35.7</td>
<td>34.1</td>
<td>30.4</td>
<td>28.1</td>
<td>30.4</td>
</tr>
<tr>
<td>Average total gain/pig, lbs.</td>
<td>24.2</td>
<td>21.5</td>
<td>18.1</td>
<td>16.6</td>
<td>17.8</td>
</tr>
<tr>
<td>Average daily gain/pig, lbs.</td>
<td>0.72</td>
<td>0.67</td>
<td>0.55</td>
<td>0.51</td>
<td>0.55</td>
</tr>
<tr>
<td>Daily feed sow and litter, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sow ration</td>
<td>16.4</td>
<td>16.8</td>
<td>16.9</td>
<td>17.4</td>
<td>16.8</td>
</tr>
<tr>
<td>Creep ration</td>
<td>3.9</td>
<td>3.4</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily creep feed/pig, lbs.</td>
<td>0.57</td>
<td>0.47</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed/100 lbs. gain of sow and litter, lbs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sow ration</td>
<td>299.3</td>
<td>319.6</td>
<td>387.2</td>
<td>448.2</td>
<td>429.7</td>
</tr>
<tr>
<td>Creep ration</td>
<td>72.7</td>
<td>65.6</td>
<td>45.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total feed/100 lbs. gain</td>
<td>372.0</td>
<td>385.2</td>
<td>433.1</td>
<td>448.2</td>
<td>429.7</td>
</tr>
<tr>
<td>Feed cost/100 lbs. gain</td>
<td>$12.92</td>
<td>$12.97</td>
<td>$12.96</td>
<td>$13.36</td>
<td>$12.80</td>
</tr>
</tbody>
</table>
Marketing Practices

TRAVIS W. MANNING and WILLIAM KOHLMEYER

POULTRY AND EGGS contribute 30 to 40 million dollars to South Dakota's cash farm income every year. This is more than twice the state's income from sheep, lambs, and wool. Cash income from eggs, which makes up most of the poultry income, is usually about equal to cash income from milk and cream sales.

Egg income is spread out more evenly through the year than income for most other farm products. This permits many farm families to meet regular expenses, such as grocery bills, from their egg sales. The egg enterprise of a small but increasing number of South Dakota farmers has developed into a major source of their farm income.

Egg Production

South Dakota has the highest per capita production of eggs of any state in the nation. It produces about 1,950 eggs per person each year, based on a population of 660,000 and an annual production of over 1 billion eggs. United States per capita consumption is about 400 eggs per year. Assuming that per capita consumption in South Dakota is about the same, approximately four-fifths of the state's eggs are consumed outside of the state.

Commercial egg production is concentrated most heavily in the eastern part of South Dakota. The map shows that more eggs were sold per square mile in east-central and southeast South Dakota than in other areas of the state in 1949. The northeastern and east-central sections were the major surplus egg producing areas. However, all sec-

This study is based primarily upon a survey made by the South Dakota Agricultural Experiment Station in cooperation with other states in the North Central Region and the United States Department of Agriculture in 1951.
Production and Marketing of South Dakota Eggs by Crop Reporting Districts, 1951

<table>
<thead>
<tr>
<th>Crop Reporting District</th>
<th>1 North West</th>
<th>2 North Central</th>
<th>3 North East</th>
<th>4 West Central</th>
<th>5 Central</th>
<th>6 East Central</th>
<th>7 South West</th>
<th>8 South Central</th>
<th>9 South East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average size of laying flocks</td>
<td>77</td>
<td>140</td>
<td>158</td>
<td>95</td>
<td>159</td>
<td>193</td>
<td>78</td>
<td>120</td>
<td>181</td>
</tr>
<tr>
<td>Percentage of eggs sold as current receipts</td>
<td>83</td>
<td>87</td>
<td>39</td>
<td>93</td>
<td>96</td>
<td>28</td>
<td>*</td>
<td>100</td>
<td>56</td>
</tr>
<tr>
<td>Prices received by farmers (cents per dozen)†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current receipts</td>
<td>32</td>
<td>26</td>
<td>26</td>
<td>39</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>33</td>
</tr>
<tr>
<td>Grade A large</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†Prices received during the period January 14-19, 1952.

About three-fourths of the farmers in South Dakota sold eggs in 1949. Almost 90 percent of the eggs produced were sold. Farm flocks averaged less than 200 layers in all areas of the state in 1951 (see chart). The average size of laying flocks varied from 77 in the northwestern section to 193 in the east-central section. There was, of course, considerable variation in size of flocks within all sections.

Nearly one-half of the eggs sold in South Dakota were produced by farmers selling from 37 to 82 dozen eggs per week in 1951. One-third of the eggs were sold by farmers selling 83 dozen or more per week, and the remaining 18 percent by farmers selling less than 37 dozen per week. The large-scale producers

Continued on Page 78

Density of Egg Sales in South Dakota in 1949

SOURCE: U. S. Census of Agriculture, 1950. Figures in parentheses indicate dozens of eggs sold per square mile in each Crop Reporting District in 1949.
An easy way to provide variety in food flavor, color, and texture is to grow a few hills of summer squashes. Summer squashes add to the nutritive value of family meals too. When cooked soon after picking, they may be used as a summer vegetable. They also may be frozen and used in meals during the non-growing months.

During the summer of 1953, workers in the Foods and Nutrition Research Laboratories at the South Dakota Experiment Station analyzed several summer squash varieties for ascorbic acid content. In addition a variety of recipes was developed and standardized. Squash dishes from these recipes were taste-tested by a number of people. Persons who formerly had thought they did not like this rather bland vegetable found a pleasant surprise when it was combined with various seasonings.

Five Varieties Are Tested

The five summer squash varieties used for this study were grown by the Horticulture Department. They were Yankee Hybrid and Early Yellow Prolific, which are bright yellow, and Zucchini Hybrid, Cocozelle, and Cocozelle Hybrid which have mottled green skins and pale green flesh.

Summer squash seeds may be planted in hills or rows in the spring just as soon as danger of frost is past, about the same time cucumbers are planted. The bushy squash plants may grow to a height of 3 feet by harvest time.

Time required for them to begin
producing varies. The yellow varieties tend to produce in about 50 days which is a little earlier than the green ones. However, the slowest of the green ones requires only about 65 days. When the squashes are picked regularly, a plant will usually continue producing until frost, but due to the high water content of the plant, summer squashes freeze easily. Harvesting of the squashes for this study was begun in mid-August.

Very small summer squashes are especially high in water content and, even when cooked in a minimum amount of water, may prove more watery than desired. Therefore it is suggested that summer squashes should not be picked when shorter than about 4 to 5 inches. One 5- to 6-inch squash was found to be about right for an individual serving. Some of the green varieties will be tender at lengths up to 18 inches, but most varieties are more palatable when shorter.

Provides Vitamin C

Laboratory studies showed that summer squashes are a fairly good source of ascorbic acid (vitamin C). The ascorbic acid content of the freshly-picked raw vegetable was found to vary from 15 to 35 milligrams per 100 grams (100 grams = about 1/2 cup). Even though there is some loss of this vitamin in cooking, one-half cup of cooked squash will supply nearly one-sixth of the recommended daily allowance for an adult.

Ascorbic acid content apparently is not dependent on the size of the squash, but it does vary somewhat with variety. The yellow varieties were found to contain a little more of this vitamin than the green ones.

Summer squash should appeal to calorie-conscious individuals. A serving of summer squash contains no more calories than a serving of such vegetables as lettuce, celery, or tomatoes.

Prepare Soon After Harvesting

Summer squashes, like other succulent vegetables, are best when prepared as soon as possible after harvesting. When storing is necessary, clean the vegetable and keep in a cool place, preferably the vegetable drawer of the refrigerator.

A variety of cooking methods may be used to prepare fresh summer squash, but several general cooking hints should be kept in mind. Remember that squash is a vegetable of high water content and mild flavor. Therefore, cook it in very little water (only enough to prevent scorching) and season well before serving.

Squashes may be cooked whole, in halves, slices, or chunks depending upon the size. It is not neces-
sary to pare small- to medium-sized squashes. Their tender skins add both color and flavor as well as help prevent a mushy product.

Summer squash may be steamed, sauteed, broiled, fried, scalloped, or stuffed and baked. Perhaps the simplest and most familiar cooking methods are steaming and cooking in water. Butter, finely-chopped onion or onion salt, crumbled bacon, or grated cheese may be added to enhance the delicate flavor of the squash. Different combinations of these ingredients make it possible to serve tasty versions of "plain squash."

Fresh Summer Squash Recipes

Sauteed Summer Squash

Dip slices of squash (1/4 to 1/2 inch thick) in beaten egg, then in bread or cracker crumbs. Place in a shallow pan containing a small amount of hot fat and brown on both sides over medium heat. Serve immediately.

Scalloped Summer Squash

(Serves 6)

4 c. summer squash slices or chunks
1/2 to 1 tsp. salt,*
1/2 c. liquid (milk or tomato juice)
1/2 to 1 c. grated sharp cheese
1/4 c. bread crumbs
1 1/2 tsp. bacon drippings
2 Tbsp. grated onion or 1/2 tsp. onion salt*

Wash and cut squashes into pieces. Measure and place in greased baking dish. Add salt and liquid. Mix bread crumbs, bacon drippings, and cheese. Sprinkle over squash and bake at 375° F. for 1 to 1 1/2 hours.*

Variations:
1. Omit cheese.
2. Substitute 2 slices crisp crumbled bacon for the cheese.
3. Add 1 or 2 slices crisp crumbled bacon to the squash before the cheese and crumbs are added.

Summer Squash Casserole

(Serves 6)

2-3 medium (7-9") squashes sliced or 4 c. pieces
Flour seasoned with salt
3 Tbsp. bacon drippings
1 1/2 c. ground beef
1/2 c. diced ham or crisp bacon

Wash squashes and slice about 1/4 inch thick. Dip into seasoned flour and brown in bacon drippings. Remove and drain. Place ground beef and ham or bacon in the drippings to brown. Make cheese sauce.* Alternate in a greased baking dish layers of squash, meat, and cheese sauce. Top with crumbs and bake at 375° F. for 25 minutes.

*Cheese sauce:
3 Tbsp. melted butter
3 Tbsp. flour
1/4 tsp. salt
1/2 tsp. pepper
1/4 c. milk
1/2 c. grated sharp cheese
1/4 c. bread crumbs

Melt butter in small saucepan. Remove from heat and blend in flour, salt, and pepper. Add milk slowly. Return to heat and cook until thickened, stirring constantly. Add cheese.

French-Fried Summer Squash

Wash squash and cut into strips or slices. Dip in batter * and fry in deep fat at 375° F.

*Dipping batter: Combine the following ingredients and beat well before using for dipping.

1 c. flour
1/2 tsp. salt
1/2 tsp. sugar
1 egg
1 c. ice water
2 Tbsp. melted fat
Broiled Summer Squash
Dip squash slices (¼ to ½ inch thick) in beaten egg, then in bread or cracker crumbs, then in melted fat and place on the broiler pan. Broil about 4 inches from the heat source until brown, turn carefully and brown the other side. Serve immediately.

Stuffed Summer Squash
(Serves 8)
4 medium (7-9") squashes
3 c. soft bread crumbs
½ c. sharp cheese
1 small onion, grated
3 Tbsp. minced parsley
1 tsp. salt
¼ tsp. pepper
2 Tbsp. butter

Wash squashes and cut off ends. Don’t pare. Cook in boiling salted water 5 minutes. Halve lengthwise and remove pulp with spoon. Combine pulp with bread crumbs, cheese, onion, parsley, salt, pepper, and eggs. Fill shells and dot with butter. Sprinkle with additional cheese and bake 30 minutes at 350° F.

Freezing Summer Squash
Summer squash may be frozen successfully if a few simple rules are followed. As with other vegetables, the enzymes must be inactivated. This is best done by steaming. The steaming time depends on the size of the pieces. Various steaming times were used in experiments, with some whole squashes being scalded as long as 10 minutes. The following steaming schedule was found satisfactory:

<table>
<thead>
<tr>
<th>Whole (5-7 inch length)</th>
<th>5 to 8 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halves</td>
<td>4 to 6 minutes</td>
</tr>
<tr>
<td>Slices (¼ to ½ inch thick)</td>
<td>3 to 4 minutes</td>
</tr>
<tr>
<td>Chunks</td>
<td>2 to 3 minutes</td>
</tr>
</tbody>
</table>

After being steamed for the desired length of time the squashes were cooled completely by plunging immediately into ice water. Thorough draining before packaging helps to produce a product that will be less watery when defrosted and cooked.

The squash was then packaged for freezing. Danger of freezer burn will be lessened if laminated freezer papers are used for whole squash, halves, or slices since these papers do not tear easily. Slices will separate more easily if a piece of paper is laid between the layers of slices. Waxed cartons are suitable for the chunks.

The skin of some slices of the large green squashes tended to be less tender after freezing. This is not objectionable since scoring the slices with a knife or cooking them another few minutes will make the skin tender.

Cooking Frozen Summer Squash
Squash that has been frozen is not satisfactory for cooking in fat. Because of the added water in the form of ice crystals, it will splatter the cooking fat. Moreover, it is difficult to get a crust to stick to the slices or sticks.

However, frozen squash may be used successfully in the other recipes developed for fresh squash, but slight changes in procedure are necessary. After removing from the freezer, separate the pieces of squash without complete defrosting by placing them in a sieve and pouring a small amount of hot water over them. Then drain them thoroughly before adding any other ingredients. Decrease the baking time slightly because of the partial cooking prior to freezing. (Project 210. Leaders: Lida M. Burrill and Beth Alsup, Home Economics Dept.)
Fall or Spring FERTILIZER APPLICATION IN WESTERN SOUTH DAKOTA?

B. L. Brage

Fall fertilizer application has been gaining in popularity during the past few years. Farmer interest in this practice is natural because fall application of fertilizer means one less task to perform in the spring when the work load is heavier. The fertilizer manufacturer is also interested, for if more fertilizer is put on during the fall months, his manufacturing facilities will be utilized more uniformly throughout the year.

A number of experiments which compared fall applied with spring applied fertilizer were conducted in western South Dakota from 1951 to 1954. The experiments were made on the following crops: alfalfa, crested wheatgrass, winter and spring wheat, barley, and oats. Only results where significant yield increases were obtained from fertilizer, whether fall or spring applied, will be presented. Yield increases from fertilizer have not been as regular in western South Dakota as in eastern South Dakota because weather and soil management generally influence crop yields more than fertilizer.

Alfalfa

Application of phosphorus to alfalfa in western South Dakota has increased yields in only a few instances. In experiments conducted to the present, significant results from phosphate fertilizer have been obtained only on soils in the vicinity of the Black Hills and on the sandy soils in Tripp County. Generally the soils derived from the Pierre shale contain sufficient available phosphorus for alfalfa production.

An experiment which gave a good response to phosphate and can therefore be used to compare spring versus fall applied phosphate was located on a sandy loam soil in the southern part of Tripp County. The experiment was initiated in the fall of 1951. Part of the fertilizer was applied at that time (September 12), while the remainder was put on April 16, 1952.

Approximately 50 percent more hay was harvested when 60 pounds of phosphate were applied as com-
pared to the check (Table 1). The fall fertilizer plots produced on the average about 200 pounds more hay than those that were fertilized in the spring. The difference in yield was not statistically significant, but the trend in favor of fall applied phosphate should not be entirely disregarded.

Table 1. Effect of Phosphorus on Yield of First Crop Alfalfa, Tripp County, 1952

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield in Lbs./A. When Fertilizer Was Applied In</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
</tr>
<tr>
<td>0-0-0</td>
<td>2810</td>
</tr>
<tr>
<td>0-20-0</td>
<td>3577</td>
</tr>
<tr>
<td>0-60-0</td>
<td>4295</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>764</td>
</tr>
</tbody>
</table>

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

Crested Wheatgrass

It is known that tame grasses are among the more responsive crops to fertilizer—especially nitrogen fertilizer. However, not as much is known about the proper time for applying this fertilizer. An experiment was started in Lyman County on a heavy silty clay loam in the fall of 1950 to determine what effect the time of fertilization has on crop yields. The fall fertilizer treatments were applied on October 26, 1950, and the spring treatments were applied April 4, 1951. As can be noted from Table 2, there was a significant response to nitrogen fertilizer as well as a small but not significant response to phosphorus.

There were definite differences in yield with regard to when the fertilizer was applied. The seed yield was significantly higher for essentially all the treatments when the fertilizer was fall applied as compared to spring application. For instance, 120 pounds of nitrogen applied in the fall resulted in 340 pounds more seed than when the same amount of fertilizer was applied in the spring. On the other hand, there was no significant difference in yield of forage when fer-

Fertilizer increased the yield of winter wheat from 16 to 33 bushels an acre.
Table 2. Effect of Fertilizer and Time of Application on Crested Wheatgrass

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Fall—Lbs. Seed/A.</th>
<th>Spring—Lbs. Seed/A.</th>
<th>Fall—Lbs. Forage/A.</th>
<th>Spring—Lbs. Forage/A.</th>
<th>% Protein in Forage</th>
<th>% Protein in Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0-0</td>
<td>25</td>
<td>25</td>
<td>1480</td>
<td>1480</td>
<td>8.44</td>
<td>8.44</td>
</tr>
<tr>
<td>20-0-0</td>
<td>143</td>
<td>53</td>
<td>1940</td>
<td>2100</td>
<td>9.19</td>
<td>9.21</td>
</tr>
<tr>
<td>40-0-0</td>
<td>188</td>
<td>132</td>
<td>2440</td>
<td>2560</td>
<td>9.63</td>
<td>10.70</td>
</tr>
<tr>
<td>60-0-0</td>
<td>285</td>
<td>147</td>
<td>2760</td>
<td>2760</td>
<td>10.69</td>
<td>11.58</td>
</tr>
<tr>
<td>120-0-0</td>
<td>575</td>
<td>235</td>
<td>3240</td>
<td>3320</td>
<td>12.50</td>
<td>14.56</td>
</tr>
<tr>
<td>40-40-0</td>
<td>252</td>
<td>132</td>
<td>2480</td>
<td>2850</td>
<td>9.25</td>
<td>10.42</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>102</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*See footnote Table 1.

tilizer was applied in the fall as compared to that which was applied in the spring.

Nitrogen not only raised the yield of the grass, but it also improved the quality of the grass by increasing the protein content. There was a definite advantage in protein content when the fertilizer was applied in the spring. For instance, when 120 pounds of nitrogen were applied in the spring, the grass contained approximately 2 percent more protein than when nitrogen was applied the fall before.

Winter Wheat

A sizeable acreage of winter wheat is grown in western South Dakota. When winter wheat survives the winters it will usually outyield spring wheat because it generally matures before heat and rust do their greatest damage. To produce maximum yields the winter wheat crop must have adequate nitrogen. If the soil is unable to supply this needed nitrogen, it must be provided from other sources.

Nitrogen and phosphate fertilizer were applied at three test locations in Lyman County on September 11, 1951. All the phosphate was applied at that time, but nitrogen fertilizer was applied to only one-half of the plots. The remainder of the plots were fertilized with nitrogen on April 16, 1952. The soil in all three cases was a heavy silty clay loam over a clay shale. The previous crop in every case was small grain.

The data show there was a definite increase in yield from each additional increase of nitrogen fertilizer. When 20 pounds of nitrogen was used it made little difference

Table 3. Winter Wheat Response to Fertilizer Application in Lyman County, 1952

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Location I</th>
<th>Location II</th>
<th>Location III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall Bu./A.</td>
<td>Spring Bu./A.</td>
<td>Fall Bu./A.</td>
</tr>
<tr>
<td>0-0-0</td>
<td>10.9</td>
<td>10.9</td>
<td>11.2</td>
</tr>
<tr>
<td>20-0-0</td>
<td>18.8</td>
<td>17.8</td>
<td>17.8</td>
</tr>
<tr>
<td>20-40-0</td>
<td>20.0</td>
<td>17.4</td>
<td>20.1</td>
</tr>
<tr>
<td>40-40-0</td>
<td>27.3</td>
<td>21.3</td>
<td>24.6</td>
</tr>
<tr>
<td>60-40-0</td>
<td>32.2</td>
<td>22.0</td>
<td>28.1</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>3.1</td>
<td>4.0</td>
<td>4.6</td>
</tr>
</tbody>
</table>

*See footnote Table 1.
whether the fertilizer was applied in the fall or spring. However, significantly higher yields resulted when higher rates were put on at planting time in the fall in contrast to when the same rates were applied in the spring. On Location III, for instance, nearly 10 more bushels of wheat were produced when the 60 pounds of nitrogen were applied in the fall as compared to that which was top dressed in April.

Quality of wheat is also an important factor in wheat production since high protein wheat will usually bring a premium price at the terminal market. Wheat from Location III was analyzed for protein. The increase in protein percentage was greater when the nitrogen was spring applied as compared to a fall application; this was especially true at the higher rates of application. In this experiment the increase in percent protein of the wheat from applying fertilizer in the spring did not compensate for the increase in yield from fall applied nitrogen. For instance, when 60 pounds of nitrogen were applied in the spring, the protein in the grain was 1 percent above the grain on which nitrogen was applied the fall before. The yield, however, decreased about 10 bushels. On the average, the fall fertilized plots matured about one week earlier than the spring fertilized plots. This is an important factor in a low rainfall area.

A number of experiments also have been tried on winter wheat which followed fallow, but as a rule no response from fertilizer occurred whether the fertilizer was spring or fall applied. However, there were some small but significant differences obtained from fertilizer in a 1954 experiment on winter wheat that followed fallow.

The soil at this experiment was a Cheyenne Loam located in the

Continued on Page 74
A NEW CORN HYBRID FOR SOUTHERN SOUTH DAKOTA

D. B. SHANK

A new corn hybrid, later than any present South Dakota number, is being released this spring by the Experiment Station as South Dakota 604.

S. D. 604 is later than S. D. 400 (see Table 1), previously the latest maturing Experiment Station hybrid. It is adapted to an area of the state farther south than where previous South Dakota hybrids could perform satisfactorily. S. D. 604 should be well adapted to the eastern part of the state in the area between U. S. Highway 16 and State Highway 46. In addition, it should serve as an early hybrid in counties south of State Highway 46.

Performance Is Good

The performance records of S. D. 604 (formerly Experimental 8) are presented in Tables 1 and 2. Table 1 shows results of 5 years of testing in Clay County. In 1950 and 1951 the tests were conducted 6 miles north of Vermillion on silt loam soil, while in 1952 through 1954 they were located 4 miles east of Wakonda on silty clay loam soil. In both cases soil fertility was good.

Table 2 gives results obtained in Minnehaha County in 1954. S. D. 604 is too late for this area but was included in the 1954 tests to check its performance in the region. That it is too late in Minnehaha County is supported by its moisture percentage at the time of harvest when

S. D. 604 was produced by crossing (M14 x Os420) with (WF9 x Oh56A). Each of the four inbred plants comes from a different midwestern state.
Table 1. S. D. 604 Performance Compared with Other Hybrids, Clay County, 1950-54

<table>
<thead>
<tr>
<th></th>
<th>1950 Yield Bu./A.</th>
<th>Moisture Percent</th>
<th>1951 Yield Bu./A.</th>
<th>Moisture Percent</th>
<th>1952 Yield Bu./A.</th>
<th>Moisture Percent</th>
<th>1953 Yield Bu./A.</th>
<th>Moisture Percent</th>
<th>1954 Yield Bu./A.</th>
<th>Moisture Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.D. 604 (Exptl. 8)</td>
<td>67.7</td>
<td>29.5</td>
<td>66.1</td>
<td>34.3</td>
<td>72.3</td>
<td>24.5</td>
<td>104.3</td>
<td>15.3</td>
<td>50.9</td>
<td>16.6</td>
</tr>
<tr>
<td>S.D. 400</td>
<td>54.6</td>
<td>25.2</td>
<td>58.3</td>
<td>26.1</td>
<td>62.1</td>
<td>16.8</td>
<td>92.0</td>
<td>14.1</td>
<td>59.0</td>
<td>15.2</td>
</tr>
<tr>
<td>DeKalb 410</td>
<td>60.4</td>
<td>25.8</td>
<td>73.7</td>
<td>28.7</td>
<td>75.4</td>
<td>23.0</td>
<td>96.7</td>
<td>14.9</td>
<td>64.7</td>
<td>17.0</td>
</tr>
<tr>
<td>DeKalb 627</td>
<td>60.0</td>
<td>30.1</td>
<td>68.5</td>
<td>32.4</td>
<td>75.6</td>
<td>26.7</td>
<td>105.9</td>
<td>18.7</td>
<td>75.0</td>
<td>20.1</td>
</tr>
<tr>
<td>Pioneer 349</td>
<td>75.4</td>
<td>29.1</td>
<td>75.4</td>
<td>29.1</td>
<td>74.6</td>
<td>21.9</td>
<td>97.5</td>
<td>17.6</td>
<td>75.5</td>
<td>20.1</td>
</tr>
<tr>
<td>Pfister P.A.G. 299</td>
<td>49.7</td>
<td>32.5</td>
<td>65.1</td>
<td>34.0</td>
<td>78.4</td>
<td>24.1</td>
<td>102.8</td>
<td>16.2</td>
<td>61.2</td>
<td>18.4</td>
</tr>
</tbody>
</table>

Table 2. S. D. 604 Performance Compared with Other Hybrids, 1954, Minnehaha County

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Yield Bu./A.</th>
<th>Moisture Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.D. 604 (Exptl. 8)</td>
<td>82.1</td>
<td>32.3</td>
</tr>
<tr>
<td>S.D. 400</td>
<td>76.3</td>
<td>27.3</td>
</tr>
<tr>
<td>Funks G-6</td>
<td>77.5</td>
<td>27.8</td>
</tr>
<tr>
<td>Iowa 4417</td>
<td>78.7</td>
<td>25.3</td>
</tr>
<tr>
<td>Pioneer 377A</td>
<td>81.5</td>
<td>22.2</td>
</tr>
</tbody>
</table>

compared with that of several adapted hybrids. It contained 5 percent more moisture than S. D. 400 or Funks G-6. However, it did yield well in 1954, being the top hybrid of those in Table 2.

In Clay County, S. D. 604 is not only a later hybrid than S. D. 400, but in this area it also produces more corn. For a 5-year period it yielded 7.5 more bushels per acre and contained 4.4 percent more moisture at harvest time. It also performed well in comparison with commercial hybrids sold in the area.

The pedigree of S. D. 604 is (M14 x Os420) crossed with (WF9 x Oh56A). This hybrid is the result of interstate cooperative breeding work. WF9 is from Indiana, Oh56A from Ohio, M14 from Illinois, and Os420 from Iowa.

S. D. 604 Resists Lodging

No individual trait characterizes the S. D. 604 plant so that it may be easily identified in the field. The stalks grow 8 to 9 feet tall under average conditions, while the ears are from 3 to 4 feet from the ground. The plants display rather wide, dark green leaves. Good stalk lodging resistance is a characteristic of the hybrid.

The ears are cylindrical, long, and usually well-filled from butt to tip. Eighteen rows of kernels are the average number to be expected. The kernels are orange-yellow, deep, well-shaped, and display good luster.

This hybrid should fill the need for a good yielding, later South Dakota hybrid. (Project 66. Leaders: D. B. Shank and D. E. Kratochvil, Agronomy Dept.)
Prospects of a large-scale irrigation development in the James River Valley have stimulated interest in the advantages of irrigation farming for South Dakota. Farmers, businessmen, and other citizens are expressing a desire to learn about irrigation projects.

It is only natural to examine experiences on existing irrigation developments. Fortunately, one of the oldest Federal reclamation projects in the United States, the Belle Fourche Irrigation District, is located in western South Dakota. However, much information on this irrigation project has dealt with the early years when many troublesome problems retarded its development. As a result, state citizens are not generally aware of recent changes and improvements.

New Contract in 1949
A new contract between the Belle Fourche Irrigation District and the Bureau of Reclamation in 1949 was outstanding because of its far-reaching implications. Generally regarded as an improvement over former contracts, the significant features of the contract of 1949 are as follows:

(1) Greater power of self-government for the district. The district now hires and pays its own project manager and employees and is in charge of the operation and maintenance of the project. In addition, the district now has the right to modify land classifications and to provide for the correction of proved injustices to water users.

(2) A new land reclassification completed in 1948 eliminates 13,-
605 acres from the assessment roll. Charge-offs for construction and drainage previously assessed these and other lands resulted in a substantially reduced district indebtedness to the Federal government. Construction charges on assessable lands were adjusted to a more equitable basis, and total district construction charges fixed at $38,700 annually.

(3) The United States agrees to loan the district up to $400,000 to be spent for rehabilitation and betterment of the district's irrigation works.

(4) Project farmers are released from the “joint liability” feature of district repayment policy. Joint liability was intended to give security to the government’s investment, but it caused many creditors to be very cautious in making loans, since every farmer could be legally held liable for construction charge delinquencies of other farmers in the district.

Under the contract of 1949, it is possible for the district to take land in payment of construction charges just as the county can take land when taxes are delinquent. Hence it is no longer possible for individual farmers to be burdened by the construction delinquencies of other farmers, and for this reason credit is more readily available.

Additional Technical Aid for Project Farmers

Favorable features of the 1949 contract hastened and encouraged further development and acceptance of improved irrigation practices. An increase in the number and activities of agents and agencies on the project helped farmers solve their irrigation problems and contributed to the advancements from 1949 to 1953.

Better Irrigation Farming. The Utah and Idaho Sugar Company farm represents one such attempt at promoting better irrigation farming among project farmers. In 1948 this company bought 320 acres of land in the Arpan Flat area and started a demonstration farm to see what could be done with the heavy soil in that area. The farm was rundown, weedy, and had a record of low production. Experiments in new rotations, addition of organic matter, fertilizer, and different irrigation methods have made this farm a model unit.

Labor-saving machinery, such as mechanical beet thinners, are receiving increased acceptance among sugar beet farmers on the Belle Fourche Irrigation Project.
In addition to the demonstration farm program, the sugar company tests soil from project farms to help farmers build soil fertility. It also provides beet raisers with technical assistance, machinery, and labor to help in planting, thinning, and harvesting the crop. Besides increased sugar beet production on the project, efforts of the company are also reflected in better irrigation methods among beet farmers and in increased acceptance of labor-saving machinery, such as mechanical beet thinners.

Irrigation Specialist. An area irrigation specialist assisted with specialized irrigation farming problems on the project during 1950, 1951, and part of 1952. This man, employed jointly by the Bureau of Reclamation and the South Dakota Extension Service, was specifically assigned to assist individual farmers with their irrigation problems. He also contributed a number of articles on irrigation farming to local newspapers and participated in organizing group meetings on irrigation problems.

Land leveling under the Production and Marketing Administration is supervised by the Soil Conservation Service. Consequently, the expansion of the Soil Conservation District in 1951 to include the entire project marks the adoption of another measure designed to aid project farmers in improving irrigation practices. This has resulted in better planning, surveying, leveling, and farm ditch layouts than when farmers did most of the work.

Research. In the spring of 1950 the Newell Field Station at Newell initiated a new research and education program. At that time the crop research program was changed to more adequately meet the needs of all project farmers by locating experimental plots on portions of private farms representing major soil types in the project area. Prior to this change, most of the research work had been limited to the heavy clay soils characteristic of the Newell Experiment Station Farm. During the time this program has been in effect, project farmers have exhibited a definite increase in interest and acceptance of Experiment Station recommendations. The new program has also substantially aided in advancing the trend toward better irrigation farming.

New projects on livestock have also been added to the research program. Experimental work in animal husbandry has been keeping pace with current interest in irrigated pastures. Since 1950 research has been focused on determining the place of livestock in an irrigation economy by measuring beef and lamb production on irrigated grass-legume pastures.

The various new agencies and programs working on the project in recent years to assist in solving the problems of irrigation farming have resulted in a growing interest in improved irrigation methods. The increasing use of plastic tubes to prevent ditch erosion, sprinkler systems to irrigate and germinate sugar beets, and border systems of irrigation to conserve water and save labor reflect the services of these agencies.

Because of financial consideration, however, project farmers have
often had to accept such things as land leveling, border irrigation, and siphon hoses more in principle than in actual practice. Nevertheless, improved irrigation practices are being adopted by farmers. This, along with the acceptance of such practices as an ideal to strive toward, marks a significant and progressive change in the attitude of project farmers.

**Improved Water Services**

Attempts to improve the district's water supply and distribution system supplement the educational efforts of technical agencies. As mentioned previously, the provisions of the 1949 contract included a loan (by the United States) of $400,000 for rehabilitation and betterment of the district irrigation works. With these funds the district has undertaken a comprehensive program aimed at improving water service to project farmers.

Among the results of the rehabilitation and betterment program on the project are numerous structural improvements. Some of these are new outlet control works on the North and South Canals and the installation of devices to facilitate operation and maintenance work on the project, such as two-way radio units for project vehicles.

**Weed Control.** An enlarged weed and willow control program for the district's water distribution system is another instance of an attempt to improve water service to project farmers. Moist soil conditions in and along the banks of canals, laterals, and ditches support heavy growths of weeds and trees, especially willows. These growths, besides obstructing water passage through the distribution system and contributing to seepage through the ditch banks, drop large quantities of undesirable seeds into the irrigation water which eventually results in weed growth in the farmers' fields.

In addition to the use of weed and willow sprays to alleviate this condition, the district began cooperative spraying work in 1951 with the Butte County Weed Board aimed at eradicating leafy spurge and Russian knapweed on project lands. The Butte County Weed Board also carries out a separate program of weed control using district equipment to spray noxious weeds along county roads, railroad rights-of-way, and on farms badly infested with perennial peppergrass.

**Canal Linings.** Experimental asphalt and bentonite canal-lining programs conducted in the 1949-53 period represent another irrigation district program to improve water service to project farmers. Porous sections of canals and laterals on the project give rise to seepage which results in loss of valuable irrigation water and in many instances the "waterlogging" of nearby fields.

Canal lining experiments on the project are designed to find the most economical and efficient method of sealing irrigation ditches against such seepage. Tests using asphalt membrane and bentonite linings revealed that both types of lining are very helpful in retarding seepage, but durability and effectiveness tests extended over a period of time will be necessary to determine which lining process will
best serve the project’s needs. Bentonite is considerably lower in cost, partly because it is a local product.

**Keyhole Dam**

A significant step toward improving district water supply occurred in the 1949-53 period with the construction of the Keyhole Reservoir on the upper reaches of the Belle Fourche River near Moorcroft, Wyoming. The Keyhole Unit, authorized by the Flood Control Act of 1944, is designed to provide flood control, municipal water supply, pollution abatement, silt control, fish and wildlife conservation, and recreation in addition to providing supplemental water storage for the Belle Fourche Irrigation Project.

**Funds.** Initial funds for construction of the Keyhole Unit were appropriated in 1948. Work was started in 1950 and by July 29, 1952 it was about completed, allowing temporary arrangements to be made with the Bureau of Reclamation to buy Keyhole water for the Johnson Lateral and Inlet Canal.

Lands along the Johnson Lateral and Inlet Canal depend directly on the flow of the Belle Fourche River for their water supply and have continually suffered from water shortages in dry seasons. It is expected that the Keyhole Unit will provide additional irrigation water for the whole project in years of water shortage as well as providing a more stable water supply for lands irrigated from the Inlet Canal and Johnson Lateral.

**Contracts.** Considerable controversy has surrounded the execution of a permanent contract for purchase of Keyhole water for use on the project. Through annual water service contracts with the Bureau

Keyhole Reservoir, near Moorcroft, Wyoming, was constructed in the 1949-53 period.
of Reclamation, water stored in Keyhole Reservoir has been received for use on the Johnson Lateral, Inlet Canal, and other lands pending agreement on a permanent contract.

In an election in October 1952, water users rejected a contract that called for an average charge of about 40 cents per acre for Keyhole water. Most of the land owners and farmers on the project are in favor of the additional water supply the Keyhole Reservoir will provide, but many feel it is not worth the 40 cents (average) an acre they have been asked to pay.

One reason for this is that farmers on the heavy soil often do not need their entire water allotment, while those on the lighter soils use all their allotment and need more. Consequently, the farmers on the heavier soils feel that they should not be required to pay for water they do not need and will not receive. On the other hand, farmers on the lighter soils do not feel that supplemental water will be of enough value to them to warrant paying all the costs of such water.

Any contract the district water users agree upon will undoubtedly reflect an attempt to compensate for such differences in the need and ability to pay for Keyhole water.

Increased Farm Ownership and Improved Living Conditions

The period 1949-53 revealed a more lively interest in the purchase of project farms. The elimination of "joint liability" under the contract of 1949 had the effect of stimulating renewed interest in project farms. In addition, land prices on the Belle Fourche project were comparatively lower than on other irrigation projects, and this served to attract a number of out-of-state irrigation farmers. The result was an increase in the proportion of owner-operated farms on the project in the 1949-53 period.

Farm Operators. From 1946 to 1948 an average of only 56 percent of the project farms were operated by their owners. However, increased land sales to former tenants and new settlers in the 1949-53 period boosted this average to 75 percent. The largest proportion of farms operated by their owners in the entire history of the project occurred in 1951 when 81 percent were in this category, and 19 percent were rented or leased. Only minor changes in this pattern have occurred since that date, and in 1953 over 78 percent of all farms on the project were operated by owners or their managers.

Growing interest in project farms, in addition to increasing the number of owner-operated farms on the project, affected farm population in the 1949-53 period. After having suffered heavy population losses during the war years (1942-45), renewed interest in project farms brought small but fairly steady increases in the population of irrigated farms after 1946. These increases continued from 1949 through 1952, and the loss of 134 of the project's farm population in 1953 is not necessarily indicative of a trend in population decline.

Farm Improvements. Throughout the 1949-53 period, growing interest was shown in farmstead and
land improvement on the project. This interest was due, in part, to the increase in the number of farms operated by owners. Moreover, several years of higher income gave project farmers the financial means to buy the material, services, and equipment necessary to manage their farms efficiently and furnish their homes with labor-saving devices.

This is reflected in the results of a sample survey of 45 project farms in August 1953. The survey showed that 95 percent of the farms had rural electrification and, largely as a result of this, 58 percent of the farms had running water, 98 percent had power washing machines, and all were using mechanical refrigerators and radios.

In addition, the survey revealed that 71 percent of the farms had telephones, 91 percent had autos (other than trucks), and 73 percent received daily newspapers. Assuming that the sample in the survey reported is representative of project farms as a whole, the high proportion of modern conveniences indicated points strongly to the conclusion that during the 1949-53 period project families enjoyed better living conditions than at any other time in the history of the project. (Project 64. Leaders: W. F. Kumlien and Marvin P. Riley, Rural Sociology Dept.)

Fertilizers Continued from Page 65

eastern part of Pennington County, northwest of Wall. The differences in yield were small as is shown in Table 4, but the yields were greater when the fertilizer was fall applied as compared to a spring application. For example, 40 pounds of nitrogen in combination with 40 pounds of phosphate produced 28 bushels of wheat when the fertilizer was applied in the fall as compared to 20.4 bushels when the fertilizer was applied in the spring. The data show that spring application of nitrogen alone, as well as nitrogen in combination with phosphate, depressed the yield when compared to the check plot. The decrease was not significant, however.

Spring Wheat

A fertilizer response on spring wheat was obtained at two test locations in Perkins County in 1953, even though spring wheat yields that year were generally not good because of the rust epidemic. At one location the wheat followed fallow, while at the other, it followed corn.

Yields indicate that the response to fertilizer was largely from nitrogen (Table 5). The data show that the yields were higher in every case were the fertilizer was applied in the spring than where it was applied the fall before.
Table 5. Yield Response of Spring Wheat to Fertilizer in Perkins County, 1953

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fall (Bu./A.)</th>
<th>Spring (Bu./A.)</th>
<th>Fall (Bu./A.)</th>
<th>Spring (Bu./A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0-0</td>
<td>9.0</td>
<td>9.0</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>40-0-0</td>
<td>12.7</td>
<td>15.1</td>
<td>12.7</td>
<td>15.1</td>
</tr>
<tr>
<td>40-40-0</td>
<td>10.7</td>
<td>14.4</td>
<td>10.7</td>
<td>14.4</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>2.6</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See footnote Table 1.

Oats

Oats did not respond significantly to fertilizer in any of the five experiments in western South Dakota in 1954. However, one experiment did respond in 1953. Results are shown in Table 6.

The increase in oats yield over the check was definitely due to nitrogen and not phosphate. Fertilizer applied in the spring increased the yield over the check by a larger amount than fertilizer applied the fall before. Differences due to time of application were not significant.

Barley

The acreage of barley in western South Dakota is small. One reason for this small acreage is that barley requires a fertile soil. The natural fertility of many western soils is too low. A farmer, however, need not depend on natural fertility entirely, because he can raise the nutrient content of the soil by legumes or fertilizer to the point where barley will produce well.

A highly significant response from fertilizer was obtained on barley in Perkins County in 1953 as well as in Dewey County in 1954 (Table 7). The data show that in

Table 6. Effect of Fertilizer Application on Oats Yields in Lyman County, 1953

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fall (Bu./A.)</th>
<th>Spring (Bu./A.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0-0</td>
<td>43.9</td>
<td>43.9</td>
</tr>
<tr>
<td>40-0-0</td>
<td>56.4</td>
<td>59.5</td>
</tr>
<tr>
<td>40-40-0</td>
<td>54.1</td>
<td>61.6</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>10.2</td>
<td></td>
</tr>
</tbody>
</table>

See footnote Table 1.

Oats on the left received 40 pounds of nitrogen and 20 pounds of phosphate.
Table 7. Effect of Fertilizer Application on Yield and Protein Content of Barley

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Perkins County, 1953 Fertilizer Applied</th>
<th>Dewes County, 1954 Fertilizer Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall Bu./A.</td>
<td>Spring Bu./A.</td>
</tr>
<tr>
<td>0-0-0</td>
<td>29.5</td>
<td>29.5</td>
</tr>
<tr>
<td>40-0-0</td>
<td>46.0</td>
<td>43.1</td>
</tr>
<tr>
<td>40-40-0</td>
<td>40.5</td>
<td>43.5</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level: 4.9 5.8

*See footnote Table 1.

Both counties the increase in yield was due to nitrogen and not phosphorus. The increase from 40 pounds of nitrogen over the check was approximately 50 percent in both counties. It seemed to make little difference in either experiment whether the nitrogen was spring or fall applied.

Barley from the experiments was analyzed for protein. When 40 pounds of nitrogen were used alone or in combination with phosphorus, the percent protein in barley increased by as much as 2.5 percent in Dewey County. The same relationship was true in Perkins County, but the increases were not as great.

Summary

Alfalfa can be fertilized either in the fall or spring in those sections of the state where phosphorus is needed. There appears to be a slight advantage in fall application.

Tame grasses should be fertilized with nitrogen in the fall if a seed crop is desired. Fertilizer should be applied in the spring if the farmer is essentially interested in a good yield of high protein hay.

If the soil is low in available nitrogen, winter wheat should be fertilized with commercial nitrogen at planting time in the fall. There might be a small increase in protein if the fertilizer is top dressed in the spring, but generally the yields are not as high as when the fertilizer is applied in the fall.

The comparative value of applying fertilizer either in the fall or spring for spring sown small grains has not been definitely established. In experiments which have been conducted on spring wheat and oats there has been a slight advantage to applying fertilizer in the spring in contrast to applying it in the fall. There was little or no difference due to time of application on the yield of barley.

There are a number of economic factors that will affect time of application. Money is invested in fertilizer for a longer time if it is fall applied. But fertilizer can sometimes be obtained more cheaply in the fall, and the grade desired might be more plentiful.

Time to apply fertilizer in the spring is limited; western South Dakota farmers realize the necessity of getting crops in on time so they mature before heat and rust are at their peak. It may, therefore, be advantageous in some cases to apply some of the fertilizer for small grain in the fall even though the maximum yield might be obtained with spring application. (Project 4. Leader: B. L. Brage, Agronomy Dept.)
“THE BIRDS get more of our strawberries than we do.” That is a complaint heard every year from strawberry growers. Small plantings are sometimes completely destroyed. In talking with growers about this problem numerous remedies have been suggested as a means of reducing the loss to birds.

The robin is responsible for most of the strawberry losses. Young robins leave the nest about the time strawberries are ripe and the strawberries are an easy source of food. Since this is the greatest problem connected with strawberry growing in this area, an attempt was made to determine the degree of protection these remedies would provide. Generally the fruit is only partially eaten so this appeared to be the best way of evaluating the repellent devices. Where quantitative results are given the information is based on damaged fruit.

Various Devices Are Tried

A carbide gas generator designed to explode periodically was placed in the strawberry planting. The explosion was much like that of a shotgun and was timed at 12-minute intervals. The entire area was in the same zone of protection so comparative losses were not measured. However, the young robins were not seriously disturbed by this noise and would not leave when the explosion occurred.

Strips of “spiral twirlers” stretched over the row gave limited protection. These aluminium strips suspended just above the plants were constantly in motion. Fruit in the rows directly under these moving tapes had half the damage of unprotected rows.

Since it was assumed that garden hose, which has been reported effective in protecting cherries, might resemble a snake it was decided to test the value of plastic toy snakes. The snakes were placed in exposed sites at close spacing between the rows. Counts were made of robins visiting the planting and compared with an “unprotected” area. From 10 a.m. until 5 p.m. of the first day the number of robins visiting the planting was at a ratio of 1 to 5 in favor of the protected area. Two days later there was no
difference in the number of robins visiting the two areas. Similar results were obtained with a stuffed owl. It appears that the fear robins have for such objects is temporary.

**Cat on Leash Helps**

A cat equipped with a collar and tied to a long leash which permitted it to roam over the planting was very effective in protecting strawberries. Little damage was done to fruit while the cat was kept in the planting. Those robins that did fly into the planting would frequently leave without damaging any fruit. As soon as the cat became accustomed to the leash it walked about the planting and provided good protection.

Bird netting to cover the planting was tried. This was effective in protecting the fruit but the shading lowered the quality. Some mechanical injury resulted from removing the net and placing it over the plants.

An electric fence provided about 25 percent protection. This was arranged by stretching two wires at one-half inch spacing over the top of posts around the planting. Two wires were used so a ground wire was not needed. Contact was made by touching both wires. The robin would usually light on a post or the wires before entering the planting. The electric shock would cause the bird to leave the area. It appears that if this method were used there would be some advantage in starting well in advance of the ripening date. Young birds cannot fly well and often hop to the planting, making this method ineffective.

**Wire Frame Gives Best Protection**

The only method found to give complete protection was a wire frame of small mesh poultry netting. The sides and top were made as units and could be easily taken down for storage and harvesting. Sections 10 feet long and 2 feet wide, made from 1" x 2" lumber to which the wire is tacked, are a convenient size. Small stakes driven in the ground will support the side sections, which in turn support the top. They can be joined for extending to any desired length or width. While the cost is a factor, these sections can be used for many years and will provide complete protection. (Project 145, Leader: S. A. McCrory, Horticulture Dept.)

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**Egg Marketing Problems Continued from Page 57**

were located primarily in the east-central and southeastern areas.

**Selling Practices of Farmers**

Three-fourths of the farmers reported that they sold eggs to only one type of buyer in 1951. More eggs were sold to local produce stations than to any other type of buyer. Following in importance were assembly plants that buy directly through truck routes and retail stores. Hatcheries and independent truckers bought considerable amounts also. Very few eggs were sold directly to consumers.

The relative importance of different types of buyers varied considerably among the different areas and was closely related to production patterns and practices. Retail stores bought most of the eggs sold in the least dense producing areas,
while local produce stations were most important in the denser production areas.

In only two areas, the northeast and east-central were more than one-half of the eggs sold on a graded basis in 1951. In other areas from 50 to 100 percent of the eggs were sold ungraded (as current receipts). Two-thirds of the farmers, selling 59 percent of the eggs, sold on an ungraded basis in the spring of 1951. A larger proportion of the eggs were sold on a graded basis in the fall. In the fall of 1951, 48 percent of the eggs were sold ungraded, 13 percent graded by size alone, and 39 percent graded by size and quality.

South Dakota farmers received an average of 5 cents more a dozen for Grade A large eggs than for current receipts during the period January 14-19, 1952. This difference tends to change by season and price level, being greater during the summer months and when the price level is higher.

Payment for eggs on a graded basis provides some incentive for quality improvement. Farmers who produce and sell high quality eggs generally profit from selling on a graded basis. However, there are some farmers selling only a small number of eggs who might gain little by selling on a graded basis.

In some of the sparser production areas current receipts eggs sold at higher prices than did Grade A large eggs in other areas. But in areas where a considerable proportion of the eggs were sold on a graded basis, Grade A large eggs commanded premiums of 5 to 6 cents per dozen.

Most eggs shipped to out-of-state markets are sold on a graded basis. The demand for higher quality eggs in the central markets accounts for the premiums on Grade A large eggs. Egg processors exert a strong influence on the market for lower grades. They can freeze or dry eggs which do not meet top grade requirements, such as small and medium eggs or eggs with shell defects.

Marketing Practices of Dealers

Dealers generally sell considerably more of their eggs on a graded basis than they buy on a graded basis. Dealers surveyed in 1951 reported no purchases of graded eggs in some areas, while in other areas as much as 46 percent of the eggs were bought on a graded basis. In contrast, dealers in the various areas sold from 12 to 75 percent of their eggs on a graded basis. Dealers in the major surplus producing areas of eastern South Dakota sold most of their shell eggs on a graded basis.

Conclusion

Quality improvement is needed if farmers are to receive better prices for their eggs. One of the best incentives for quality improvement is premiums for high quality. The higher prices which high quality eggs command on the market needs to be reflected back to the farmer. Buyers who purchase on a current receipts basis do not offer sufficient encouragement to farmers to bring about quality improvement. (Project 175. Leaders: William Kohlmeyer, Poultry Husbandry Dept., and Travis W. Manning, Agricultural Economics Dept.)
A high quality creep ration should be high in energy, low in fiber, adequate in protein (17 to 20 percent), vitamins, minerals, and an antibiotic (20 grams per ton). It is generally recommended that about 10 percent sugar be included in the ration as a source of energy and for palatability. Rolled oats has also been shown to be a good source of energy and a palatable ingredient.

This experiment has shown that a high quality creep ration produces good results with pigs nursing sows. However, in another trial this same ration (Creep Ration A) was fed as the only feed to pigs weaned at 3 weeks of age with only mediocre success. The weaning weights of the pigs were about 25 pounds and the cost of gains was higher than when the pigs were left with the sow. A great deal of variability was noted in that some pigs grew at an acceptable rate while others gained very poorly.

For weaning at the age of 3 weeks, a more nutritious or palatable ration may be needed until the pigs are accustomed to eating a dry ration. It should be emphasized too that for success in early weaning the best in management practices must be followed. (Project 212. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

Table 3. Results of Creep-Feeding Trials with Fall-Farrowed Pigs, 1954

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1 Creep Ration A, Pelleted</th>
<th>2 Creep Ration A, Meal</th>
<th>3 None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers of sows</td>
<td>8</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Average initial sow weight, lbs.</td>
<td>477</td>
<td>455</td>
<td>467</td>
</tr>
<tr>
<td>Average final sow weight, lbs.</td>
<td>481</td>
<td>470</td>
<td>499</td>
</tr>
<tr>
<td>Average gain per sow, lbs.</td>
<td>4</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Number pigs started</td>
<td>55</td>
<td>44</td>
<td>42</td>
</tr>
<tr>
<td>Number pigs finished</td>
<td>48</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Number days on test</td>
<td>44</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Average initial pig weight, lbs.</td>
<td>6.3</td>
<td>5.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Average final pig weight, lbs.</td>
<td>31.5</td>
<td>30.4</td>
<td>26.9</td>
</tr>
<tr>
<td>Average 56-day pig weight, lbs.</td>
<td>33.3</td>
<td>30.4</td>
<td>27.6</td>
</tr>
<tr>
<td>Average total gain/pig, lbs.</td>
<td>25.2</td>
<td>25.0</td>
<td>21.2</td>
</tr>
<tr>
<td>Average daily gain/pig, lbs.</td>
<td>0.57</td>
<td>0.54</td>
<td>0.46</td>
</tr>
<tr>
<td>Daily feed sow and litter, lbs. Sow ration</td>
<td>13.3</td>
<td>14.6</td>
<td>16.4</td>
</tr>
<tr>
<td>Creep ration</td>
<td>2.0</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Average daily creep feed/pig, lbs.</td>
<td>0.33</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Feed/100 lbs. gain of sow and litter, lbs. Sow ration</td>
<td>370.9</td>
<td>387.5</td>
<td>469.6</td>
</tr>
<tr>
<td>Creep ration</td>
<td>57.6</td>
<td>47.2</td>
<td></td>
</tr>
<tr>
<td>Total feed/100 lbs. gain</td>
<td>428.5</td>
<td>434.7</td>
<td>469.6</td>
</tr>
<tr>
<td>Feed cost/100 lbs. gain</td>
<td>$14.22</td>
<td>$14.03</td>
<td>$14.09</td>
</tr>
</tbody>
</table>

80
HARD WATER

...a common laundry problem

Lillian Lund

Homemakers in South Dakota struggle with hard water in daily living, but on washday it is especially troublesome. Despite using the best possible laundry procedures, the homemaker still may have clothes that are not as white and bright as she would like.

To help the homemakers with these problems, experimental work has been carried on. Numerous aspects have been studied and some of the findings may help answer a few of the questions often raised.

In working with hard water it is necessary to have some unit of measure or description for water hardness. Hardness can be expressed as calcium carbonate in either grains per gallon or parts per million (p.p.m.). Natural waters have been classified as is shown in Table 1. Most of the water in South Dakota is in the excessively hard group. It is not unusual to find water more than 100 grains per gallon in hardness.

Softening Hard Water

Hard water must be softened in some way to be used for cleansing purposes. The early method of adding lye to soften water is not recommended, as it may injure fabrics, cause fading, and not completely remove the hardness. It is dangerous as well as inconvenient.

A more modern method is to use an ion exchange tank where hard water flows through zeolite or other ion exchange resin. Such a process removes the minerals which cause the hardness. This method is not practical if water is so hard that it is necessary to regenerate the tank every few days.

In the absence of running water some other method must be used. Packaged softeners can be added to the water, but effective results are not always obtained since there can be no definite recommendation of the exact amount of softener.

Acknowledgement is given Alexandra Semeniuk for her assistance on this project.
needed, especially for our excessively hard waters. As water hardness may vary from day to day, the proportions of softener needed will vary.

Soaps, likewise, can be used to soften water. However, considerable soap must be added to remove the hardness, and an additional quantity of soap is needed for cleansing. This is expensive and not practical where water is very hard.

A more recent development is the synthetic detergent, sometimes referred to as a “syndet.” It dissolves

The launder-ometer is used to test soil removal of different methods of washing.

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### Table 1. Classification of Natural Water in Regard to Hardness

<table>
<thead>
<tr>
<th>Relative Hardness</th>
<th>Grains/Gal.</th>
<th>Parts/Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft water</td>
<td>0 to 3</td>
<td>0 to 55</td>
</tr>
<tr>
<td>Moderately soft</td>
<td>3 to 6</td>
<td>55 to 100</td>
</tr>
<tr>
<td>Moderately hard to hard</td>
<td>6 to 12</td>
<td>100 to 200</td>
</tr>
<tr>
<td>Hard to excessively hard</td>
<td>12 to 30 and above</td>
<td>200 to 500 and above</td>
</tr>
</tbody>
</table>

---

in hard water without forming a scum or curd.

**Methods Used**

It was not possible, nor was it the purpose of the study, to evaluate all types of packaged softeners, soaps, and synthetic detergents. Several products were used and those showing promising results were selected for further investigation. In the preliminary work a launder-ometer, in which many samples can be run at the same time, was used. A uniform method of laundry procedure was developed. Samples were washed for 15 minutes at 140°F, followed by three 2-minute rinses at 120, 100, and 80°F.

There are several types of specially soiled fabrics available. The one most suitable for this particular study was selected. Amount of soil in the sample was indicated in units using a light reflectance meter which showed differences too small to be detected by visual observation. The differences in the light reflectance readings of the fabric before and after laundering showed the amount of soil removed.

The change in the appearance of the sample was from a dark gray before washing to a lighter gray after washing. This indicates soil removed and does not necessarily give evidence to the degree lightly soiled or white fabrics would retain their original appearance if washed under these same conditions.
For effective soil removal, neither too much nor too little softener can be used.

Too Much Softener May Affect Results

Since there is no definite rule the homemaker can follow when using packaged softeners, one object of this investigation was to determine whether an excess of softener would affect washing results.

Several types of softeners were selected for use in the study. Each differed in the amounts needed to soften water. The amount required to produce zero hardness was determined for each type. Designating this amount as 1, proportional quantities of $\frac{1}{2}$, 1, 1$\frac{1}{2}$, and 2 were used in one experimental series. Results are shown graphically in the chart.

Water having a total hardness of 60 grains per gallon was used in this series. Only fair soil removal (12 units) was obtained when no soft-

*Continued on page 96*
COBALT in our grasses

George Gastler

The poor condition of cattle and sheep grazing certain areas in various parts of the world worried farmers and scientists for many years. When it was discovered that the lack of cobalt in the pastures and feeds of these areas was the cause, people interested in animal nutrition began to give it more attention.

Ruminant Requirement Is Small

Not much cobalt is required in the rations of cattle and sheep. Exact amounts are not known, but it appears that for sheep the ration should contain at least .07 parts per million of cobalt and for cattle at least .04 parts per million. When this amount is not present these animals gradually lose their appetites and fail to gain properly. In cases of severe and prolonged deficiency they become emaciated and finally anemic. Supplying a small amount of cobalt in their ration prevents or corrects the condition.

Cobalt deficiency disease was first explained in Australia and New Zealand. Then other parts of the world were also found to be cobalt deficient, including some areas of the United States.

Experiment Station bulletin 425 describes cobalt feeding experiments with lambs at Brookings in 1948-49 and at Newell from 1949 through 1951. At Brookings no response was obtained from feeding cobalt, while at the U. S. Newell Field Station, Newell, a response was indicated. This work suggested the need for cobalt analyses of our pasture and grazing lands. Investigations were begun to establish whether or not deficiencies in this element might be reducing the income from our grazing animals.
Some of the results are reported here.

**Plant Studies Are Made**

Reliable methods for determining the amount of available cobalt in soils have not been developed. Therefore it was decided that plants rather than soils should be analyzed.

Determination of the small amount of cobalt in plants is a lengthy procedure. It was immediately obvious that only a limited number of analyses could be made each year. To start with, therefore, samples have been collected from various substations. To allow for comparisons between the various areas and from 1 year to the next, western wheatgrass collected during July was used for the analyses.

Not all the samples collected have been analyzed as yet, but some of the results obtained are summarized in Table 1. These results, although preliminary, have two points of interest.

The largest number of samples analyzed was from the substations. A rather wide variation in the cobalt content of western wheatgrass was found in these samples. At least some of the samples from each location contained less than 0.04 parts per million of cobalt, while some contained more than 0.07 parts per million. The highest value obtained for this grass to date has been 0.32 parts per million, which is also higher than for any other type of plant thus far analyzed.

Average values indicate we may expect to find areas in the state where some pastures or ranges do not furnish the necessary cobalt, at least for sheep. However, before this can be said with certainty, more analyses will be needed and results for other plant species obtained also.

Some analyses on a number of other plant species have already been made. These plants were collected at a single location along with western wheatgrass. The results indicate there is probably a difference between species as to their ability to absorb cobalt from soils. However, they do not indicate western wheatgrass is normally any lower in cobalt content than other grasses or common edible range plants. These studies will be continued to clarify the picture.

**Trace Mineralized Salt Is Insurance**

Trace mineralized salt is being used more and more commonly for livestock. As a general rule, it is used whether trace mineral defi-

*Continued on page 97*
Will Irrigation Pay in Central South Dakota?

Rex D. Helfinstine

Irrigation for central South Dakota farmers appears to be nearer. The expected completion of Oahe Dam across the Missouri River north of Pierre brings irrigation closer to realization. Plans are being made to divert water from this reservoir to the James River Valley. But before these works are built, irrigation districts must be formed by favorable vote of the farmers and contracts made for operation and for repayment of the costs allocated to irrigation.

A cooperative study was made recently by the South Dakota Agricultural Experiment Station and the Production Economics Research Branch of the Agricultural Research Service to compare, in terms of profitability, improved dryland farming with potential irrigated farming for the years to come. This information should help farmers evaluate the future of irrigation in central South Dakota.

1950 Survey

Information about present dryland farming and typical farm situations was obtained in a survey by the Agricultural Economics Department in 1950. One hundred sixteen farmers were interviewed. Information on improved dryland farming practices and the possibilities of improved crop yields and livestock production was assembled from Experiment Station results and the experience of farmers. Estimates of practices and yields as well as costs and returns under irrigation were based on information from similar irrigation projects in
Nebraska, Montana, and North Dakota, but they were modified to fit expected conditions in central South Dakota. Crop yields obtained on irrigation development farms near Huron and Redfield in the last 5 years also were considered in these appraisals.

Preliminary information from surveys made by the Bureau of Reclamation indicated the distribution of arable soils in the area proposed for irrigation as shown in Table 1.

Drainability is an important factor so far as irrigability of land is concerned. Studies of this factor are continuing and the results may modify the proportion of land in each class as well as the total acreage considered irrigable. In connection with these studies, the Bureau of Reclamation recently engaged a board of specialists to review their findings on drainability. This review board concluded that the glacial till soils north of Miller were not sufficiently drainable for irrigation. Accordingly, the Bureau of Reclamation has decided to concentrate its investigations of irrigation upon the lake plain area near Redfield and Aberdeen.

### Crop Yield Estimate

Estimates of the average yields of crops to be expected under irrigation and under improved dryland farming are given in Table 2. Corn, alfalfa hay, and pasture are expected to show the greatest relative response to irrigation. These crops make more of their growth in July and August, the period when natural rainfall is most likely to be deficient. The small grains—wheat, oats, and barley—make more of their growth in spring and early summer.

Corn, wheat, barley, and alfalfa likely will continue to be prominent in the cropping system under irri-

### Table 1. Distribution of Arable Soils in the Area Proposed for Irrigation

<table>
<thead>
<tr>
<th>Land Class</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.6</td>
</tr>
<tr>
<td>2</td>
<td>21.0</td>
</tr>
<tr>
<td>3</td>
<td>26.1</td>
</tr>
<tr>
<td>4 (questionable arability)</td>
<td>7.0</td>
</tr>
<tr>
<td>5</td>
<td>4.2</td>
</tr>
<tr>
<td>6 (non-arable)</td>
<td>32.1</td>
</tr>
<tr>
<td>Total arable (classes 1, 2, 3, 5)</td>
<td>60.9</td>
</tr>
<tr>
<td>Total land, all classes</td>
<td>1,122,869 acres</td>
</tr>
</tbody>
</table>

### Table 2. Estimated Average Yields of Crops Under Irrigation and Under Improved Dryland Farming, Oahe Area*

<table>
<thead>
<tr>
<th>Crop</th>
<th>Under Irrigation†</th>
<th>Under Improved Dryland Farming§</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1 Land</td>
<td>Class 2T Land</td>
</tr>
<tr>
<td></td>
<td>54</td>
<td>51</td>
</tr>
<tr>
<td>Corn, grain (bu.)</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>Barley, grain (bu.)</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Oats, grain (bu.)</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>Alfalfa, hay (ton)</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Potatoes (bu.)</td>
<td>250</td>
<td>225</td>
</tr>
<tr>
<td>Sugar beets (ton)</td>
<td>13.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Pasture** (AUM)++</td>
<td>7.0</td>
<td>2.8</td>
</tr>
</tbody>
</table>

*Estimated by committee of agronomists at the Experiment Station.
†When grown in a rotation including ½ legumes and all crops fertilized with 100 pounds of 0-43-0 fertilizer annually.
‡Average weighted by proportion grown on each land class.
§When grown in a rotation including 1/10 legumes and fertilized with 100 pounds of 16-20-0 fertilizer annually.
*Land class considered not suitable for potatoes or sugar beets.
**Crops not generally grown commercially under dry farming.
***Not estimated separately by land class. In general would show same relationship as alfalfa hay.
#Animal-unit months, or the quantity of feed required for one mature cow or its equivalent for 1 month.
igation farming. Feed crops will be needed to supplement native range and irrigated pasture in growing and fattening livestock. Wheat will continue to be grown as a cash crop, at least to the extent necessary for rotation purposes. In addition to crops now grown in the area, sugar beets and potatoes are possibilities. Present estimates indicate satisfactory yields, but markets for these crops will have to be developed.

In working out probable incomes for these future farming systems a projected level of prices was assumed. These prices were estimated by the U.S. Department of Agriculture for use in river basin studies. In general, they approximate 1949 prices with a 1 to 1 ratio of prices to costs ($22.00 for choice yearling slaughter steers, $16.65 for hogs, $1.55 for wheat, $1.20 for corn, and $0.65 for oats).

Farm Sizes

Three sizes of farms were found to be typical of the area: 320 acres, 480 acres, and 800 acres. These sizes are likely to continue to be impor-
tant under irrigation. They were analyzed, in the study already mentioned, under dryland and irrigated conditions and with various organizations but for illustration in this article only the 480-acre cattle-hog farm will be used.

This 480-acre farm is assumed to have 330 acres of cropland and 145 acres of range pasture and hay. It also would have 288 acres of irrigable land—48 acres of class 1, 107 acres of class 2, and 133 acres of class 3. The cropping system for this farm under partial irrigation and under improved dryland farming would have the acreages of various crops shown in Table 3.

Table 3. Cropping Systems of 480-Acre Farm Under Partial Irrigation and Under Improved Dryland Farming

<table>
<thead>
<tr>
<th>Type of Farm</th>
<th>Acres</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland Farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Irrigated Farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>144</td>
<td>13</td>
</tr>
<tr>
<td>Wheat</td>
<td>48</td>
<td>25</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>96</td>
<td>4</td>
</tr>
</tbody>
</table>

The dryland farm would have a 7-cow beef breeding herd on the range pasture and 30 sows on alfalfa pasture. The partially irrigated farm would have either a 37-cow beef breeding herd or a 17-cow herd and 59 purchased feeders on the range pasture and irrigated pasture, as well as 30 sows on irrigated alfalfa pasture.

Average Investments
Total average investment would be $55,600 on the irrigated farm where all cattle were raised and $55,200 where the cattle were both raised and purchased (Table 4). In contrast, total average investment on the dryland farm would be $27,900. Labor requirements would be 408 man-days a year where all cattle are raised or 393 man-days where cattle are raised and purchased on the irrigated farm. On the dryland farm 180 man-days of labor would be required. Labor income (return to operator for his labor and management) would be $4,539 on the dryland farm and $6,755 on the irrigated farm where cattle are raised, or $9,310 where cattle are raised and purchased. Capital income (returns to operator for his investment expressed as percentage of investment) would be about 16 percent on the dryland farm and 12 percent (cattle raised) or 17 percent (cattle raised and purchased) on the irrigated farm.

As these comparisons indicate that approximately twice the investment would be required on the irrigated farms, a further comparison was made with a 1,060-acre dryland cattle-hog farm. This 1,060-acre dryland farm would require approximately the same total average investment as the 480-acre irrigated farm. Consequently, this comparison furnished an indication of returns from equal investment in a dryland farm and an irrigated farm. Labor income on such a partly irrigated cattle-hog farm (buying additional feeders) would be about $9,800 compared to $8,800 on the dryland cattle-hog farm (Table 5). Labor requirements would be 393 man-days on the partly irrigated farm and 295 on the dryland farm.
Stabilizing Effects

Another phase of the study involved a determination of the probable stabilizing effect of irrigation upon incomes and production in a period in which production fluctuated as it did from 1926 to 1952. Certain simplifying assumptions were made:

1. That prices would remain constant;
2. That yields for dryland crops would vary from year to year in much the same way that they did from 1926 to 1952 in Beadle County, as reported by the Crop Reporting Service;
3. That yields of irrigated crops, although at a different average level, would vary in much the same way from year to year as they did for the years 1926 to 1952 for the Belle Fourche Irrigation Project, as reported by the Bureau of Reclamation;
4. That cattle sales and costs would vary directly with the previous year's pasture production;
5. That hog and poultry sales and costs would remain constant at 30 litters of pigs and 100 hens;
6. That costs of tractor operation, machinery operation, and hired labor would remain constant.

Such a comparison of the 480-acre partly irrigated cattle-hog farm and the 1,060-acre dryland cattle-hog

Continued on page 104

Table 4. Comparison of a 480-Acre Cattle-Hog Farm Under Dry Farming and Under Partial Irrigation, Central South Dakota, Projected Price Level*

<table>
<thead>
<tr>
<th>Item</th>
<th>Dry Farm</th>
<th>Cattle Raised</th>
<th>Cattle Raised Plus Feeders Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry cropland (acres)</td>
<td>330</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Irrigated crops (acres)</td>
<td></td>
<td>225</td>
<td>232</td>
</tr>
<tr>
<td>Irrigated pasture (acres)</td>
<td></td>
<td>63</td>
<td>56</td>
</tr>
<tr>
<td>Native pasture &amp; hay (acres)</td>
<td>145</td>
<td>145</td>
<td>145</td>
</tr>
<tr>
<td>Other land (acres)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total (acres)</strong></td>
<td><strong>480</strong></td>
<td><strong>480</strong></td>
<td><strong>480</strong></td>
</tr>
<tr>
<td>Beef cows (number)</td>
<td>7</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>Feeders purchased (number)</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Poultry (number)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Labor used, oper. (man-days)</td>
<td>180</td>
<td>262</td>
<td>243</td>
</tr>
<tr>
<td>Labor used, hired (man-days)</td>
<td>146</td>
<td>146</td>
<td>150</td>
</tr>
<tr>
<td><strong>Total investment (dollars)</strong></td>
<td>27,899</td>
<td>55,616</td>
<td>55,231</td>
</tr>
<tr>
<td><strong>Total receipts (dollars)</strong></td>
<td>11,165</td>
<td>19,925</td>
<td>26,938</td>
</tr>
<tr>
<td><strong>Total expenses (dollars)</strong></td>
<td>5,276</td>
<td>10,445</td>
<td>14,026</td>
</tr>
<tr>
<td>Net cash income1 (dollars)</td>
<td>6,505</td>
<td>10,383</td>
<td>12,909</td>
</tr>
<tr>
<td>Interest on investment5</td>
<td>1,350</td>
<td>2,725</td>
<td>2,702</td>
</tr>
<tr>
<td>Depreciation (dollars)</td>
<td>616</td>
<td>903</td>
<td>897</td>
</tr>
<tr>
<td>Net farm income4 (dollars)</td>
<td>5,889</td>
<td>9,480</td>
<td>12,012</td>
</tr>
<tr>
<td>Labor and management income # (dollars)</td>
<td>4,539</td>
<td>6,755</td>
<td>9,310</td>
</tr>
<tr>
<td>Capital income** (percent)</td>
<td>15.6</td>
<td>12.5</td>
<td>17.0</td>
</tr>
</tbody>
</table>

*Hogs raised limited to 30 litters, cattle sold as slaughter cattle.
†Using Bureau of Reclamation estimate of $5 per acre of irrigable land for annual operation and maintenance charge; and $3 per acre for annual construction charge (deferred 10 years, then collected for 40 years).
$Defined as total receipts less total expenses, not including depreciation or interest on investment.
**At 4 percent on real estate and 6 percent on average investment in machinery and livestock.
#Defined as total receipts less total expenses, not including interest on investment.
**Defined as net farm income less charge for operator labor (at $4.70 a day) and management (at 7 percent of total receipts less feeds and feeders purchased), and expressed as percentage of total investment.
The field picker-sheller, combined with cold air drying, proved to be entirely workable for a season of good drying weather such as the fall of 1954. Field shelling of corn allows for a greater concentration of the grain, thus reducing bin space. Cobs are left in the field and the separate shelling operation is not needed.

However, there are some problems involved with this method. Usually the field shelled corn is too high in moisture content to store safely. Moisture must be reduced to 14 percent for good market grade or winter storage. For longer periods of storage it should be reduced to 12 percent moisture.

Two methods of drying are available—fast drying with heated air and slower drying with cold air. Although cold air drying takes longer, it requires less time on the part of the operator. In addition, each crib must be equipped with an air duct system.

**Field Picker-Sheller Efficiency**

A trial was conducted to determine the efficiency of a field picker-sheller in 1954. Three runs were made over a 133-foot distance. A summary of the test is shown in Table 1.

Picking started on October 18 when moisture was 23 percent and before the wind had caused many

### Table 1. Loss of Corn From Picker-Sheller Harvesting

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregleaned* ear corn on ground</td>
<td>1.71%</td>
</tr>
<tr>
<td>Postgleaned† ear corn on ground</td>
<td>3.02%</td>
</tr>
<tr>
<td>Sheller loss on ground</td>
<td>4.39%</td>
</tr>
<tr>
<td>Other shelled corn on ground</td>
<td>2.22%</td>
</tr>
<tr>
<td><strong>Total machine loss</strong></td>
<td><strong>9.43%</strong></td>
</tr>
<tr>
<td><strong>Total loss</strong></td>
<td><strong>11.14%</strong></td>
</tr>
<tr>
<td>Corn in the load</td>
<td>88.86%</td>
</tr>
<tr>
<td><strong>Total yield</strong></td>
<td><strong>69.8 bu/A</strong></td>
</tr>
<tr>
<td>Yield brought in</td>
<td>62.2 bu/A</td>
</tr>
</tbody>
</table>

*Before picking.  †After picking.

*Continued on page 105*
CATTLE GRUBS are among the most important insect pests of livestock in South Dakota. The damage they do involves losses to the meat and hide industries as well as to cattlemen.

The adults or heel flies cause cattle to run during the egg-laying season in the spring and early summer. They generally lay their eggs on the legs and the lower parts of the body. The eggs hatch and the larvae burrow through the skin and start their long, 8- or 9-month stay in the bodies of the cattle. They spend this time in the connective tissue, wandering in the walls of various internal organs before reaching the back. There they form a cyst under the hide.

The paths of the larvae through the body can be followed by the severe inflammation along the route taken. The grubs remain in the back for about a month and then drop to the ground to pupate and change into adults or flies.

Present Control Methods

Present methods of control involve attacking these parasites when they are in the back. Spraying with rotenone, or rotenone washes or dusts, gives a fairly high level of control if repeated two to four times. However, to be effective such treatment must be undertaken in cooperation with practically all cattlemen in the area. Where treatment is applied on only one or a few ranches, the result is merely a form of revenge against the grubs; they have already done their damage, and little reduction would be expected the following year.

Cooperative treatment by cattlemen over large areas, however, can reduce the number of flies produced. Previous research at the South Dakota Agricultural Experiment Station and elsewhere has shown that such large-scale cooperative treatment can greatly reduce the number of grubs at the center of such areas.
Present cattle grub control methods are time consuming and ineffective unless done in the whole area. If an internal medication can be found, you may be able to control cattle grubs with chemicals that are added to salt or feed. Limitations of this method include the considerable effort needed to get cooperation over large areas. Other difficulties involve the practical problems associated with applying several treatments to cattle during the worst part of the winter. Also the rotenone treatments are sometimes quite variable in their effectiveness. Thus it appears desirable to search for an improved procedure to control these insects.

New Research

Some entomological research centers are trying to kill the eggs or to kill the larvae before they have a chance to penetrate the skin. Encouraging results have been reported, and though many serious obstacles remain, a greatly improved procedure for the control of cattle grubs may result from this research. The ideal solution to this problem appears to be a grub-killing chemical that can be added to salt or feed and made available to cattle during the fall of the year. The chemical can then be absorbed by the cattle, distributed to where the grubs are, and kill the grubs before they have had a chance to do much damage. A chemical of this sort would have to be relatively non-toxic to the animal when used in concentrations that would kill the parasites. It could leave no toxic residues which would interfere with the marketing of meat or milk.

Internal Medication. Several research stations have experimented with internal medication as a method of controlling cattle grubs. The best known work of this type was done at the U. S. Department of Agriculture laboratory at Kerrville, Texas. The Kerrville entomologists developed procedures for screening large numbers of chemicals in the laboratory. They tested the more promising chemicals against grubs transplanted into mice, as well as against natural infestations in cat-
Many valuable leads have been developed as a result of their work.

Phenothiazine. Other research workers have investigated the possibilities of using phenothiazine for the control of cattle grubs. Phenothiazine is now widely recommended for the control of many helminth parasites in livestock. If it should prove useful against grubs as well it would be a discovery of great value to the stockman.

Professor A. N. Worden of Huntington, England, has published some encouraging results using a mixture of phenothiazine, hexachlorethane, and di-n-butyl tin dilaurate. Professor Worden has had some unaccountable failures, however, and it appears plain much work remains to be done.

Other encouraging work with phenothiazine has been reported from the U. S. Department of Agriculture laboratory at Auburn, Alabama. This work, while impressive, was based on so few animals that much additional data must be collected before definite conclusions may be drawn. Research reports from other sources are as yet inconclusive as regards the possible value of phenthiazine for grub control.

The Station Project

The South Dakota Experiment Station has undertaken a project to devise a method of controlling the young larvae before they reach the backs of cattle. The project consists of a search for new chemicals that will kill the grubs in the laboratory, and a program of field testing of the more promising chemicals in grub-infested cattle.

The laboratory phase of the project involves collecting the grubs, preparing the test media, and screening the candidate chemicals. The field phase requires the selection of presumably infested cattle, treatment of the animals, and evaluation of the results.

Collecting Grubs. One of the two species of cattle grubs found in South Dakota, the common grub (Hypoderma lineatum), can be found in considerable numbers in the connective tissue lining of the gullets of cattle. Infested gullets can be obtained at packing plants during the fall and early winter.

Routine procedure has been to visit the plant of John Morrell and Company in Sioux Falls the start of each week during the time larvae are found in the gullets. In Brookings the young larvae are dissected from the gullets and subjected to the effects of the various chemicals.

Testing Chemicals. Test chemicals are obtained mostly from insecticide and pharmaceutical companies, though some are obtained locally. They are added, at various concentration, to bovine serum in covered glass dishes. Five larvae are added to each dish, and the entire preparation is placed in an incubator for three days.

Grubs are examined at the end of 2 days and again at the end of 3 days. The number of dead larvae are recorded and the data obtained each time is compared to the mortality data in control dishes to which no test chemical was added.

Experiments conducted in the laboratory during the past 2 years
have uncovered 18 compounds that were toxic to all larvae tested when held for 72 hours at 100 p.p.m. (parts per million of the test chemical relative to serum). Of this number, seven were toxic at 25 p.p.m. or below, and three were toxic at 10 p.p.m. or below. A total of 120 compounds have been studied.

Phenothiazine was not toxic to all larvae tested at 400 p.p.m. A sample of “Hypolin” containing phenothiazine, hexachlorethane, and di-n-butyl tin dilaurate also failed at 400 p.p.m., though a sample of the tin compound was toxic to all larvae tested at 10 p.p.m.

Limitations. It should be realized that laboratory screening procedures such as this have great limitations. The obvious advantage is that a great many compounds can be studied in a short time and at much lower cost than corresponding tests run in cattle. The biggest disadvantage is that conditions in a glass dish are far different from conditions within a cow. The next step after the laboratory selection, therefore, is to test the more promising chemicals against natural infestations of grubs in cattle.

Toxicity Tests. Before unknown chemicals can be used in cattle, something must be known of the way they affect mammals. Tests of various formulations of each chemical are first made on rabbits and later on sheep before cattle are given the treatment. Then before a number of cattle are treated, individual calves are exposed to each test chemical.

Tests in Cattle. During the 1954-55 experimental season, a group of 28 calves was kept at the College. These animals were obtained in the fall from central and western South Dakota from areas that normally have heavy infestations of cattle grubs. These presumably infested calves were then shipped to Brookings for treatment and observation.

The 28 calves were then weighed and assembled into seven lots of four animals each. One lot was used as a control and one lot was drenched with “Hypolin,” the proprietary mixture of phenothiazine, hexachlorethane, and di-n-butyl tin dilaurate used by Worden in England. The other five lots were treated (either under the skin of the neck or by stomach tube) with the materials that looked best in the 1953-54 laboratory tests.

Efficiency of these tests was evaluated by four monthly extractions of grubs during January to April. The grubs were identified as to species to determine whether a chemical might be toxic to one species but not to the other.

Test Results. Results of this first year of field testing were negative. The calves in all seven lots were heavily infested with both species of grubs, and while some trends are apparent in the data, none of the treatments used can be regarded as successful. The “Hypolin” treatment was completely unsuccessful in these tests. Differences in susceptibility to the two species of grubs were not apparent.

An additional group of 12 presumably infested cattle were sub-

Continued on page 106
ener was used. As the amount of softener was increased to 1, soil removal was more effective. This also was the peak of efficiency.

Additional softener hindered soil removal as is shown by the downward slope of the lines in the chart. Apparently in excessively hard water it is necessary to use the proper amount of softener to get best results. Either more or less softener does not appear to be as effective.

More Detergent Needed in Hard Water

Synthetic detergents dissolve in hard water and produce good suds. Still, it is necessary to increase the amount used as the hardness of the water increases for more effective soil removal.

In water of zero grains hardness, 4 grams of synthetic detergent per liter did not remove more soil than did 2 grams per liter (Table 2). Four grams of synthetic detergent per liter effected more soil removal than did 2 grams in water of 30 grains hardness. This trend toward greater soil removal with increased amounts of synthetic detergent was even more pronounced at 60 and 120 grains of hardness.

A few of the soaps, softeners, and synthetic detergents tried in the launder-ometer were selected for use in a full-size washer. Soaps and softeners used in correct proportions and a synthetic detergent were about equal in removing soil in water at 35 grains and at 60 grains per gallon hardness (Table 3).

Since it was found that twice the amount of synthetic detergent was necessary for use in extremely hard water, the quantity of the synthetic detergent was doubled in water of 120 and 150 grains of hardness. The synthetic detergent removed more soil in this extremely hard water than the soap and softener. However, these results cannot be considered as conclusive evidence since it was not possible to collect more data at this time.

Homemaker and Laboratory Results Compared

A number of homemakers throughout the state have been interviewed on their particular laundry problems. In several of these homes soiled samples were laundered along with the regular family washing. These samples were read at the laboratory before and after washing to determine the amount of soil removed.

Methods, machines, and types and amounts of detergents varied somewhat. Still it was necessary in all cases for improved washing results to increase the amount of soap or synthetic detergent as water hardness increased. The results obtained in home washing corresponded closely to the findings in the launder-ometer studies.

Further work will be necessary
before definite recommendations for the use of soap, softeners, and synthetic detergents can be made. (Project 193. Leaders: O. E. Olson and G. F. Gastler, Station Biochemistry Dept; Lillian Lund, Home Economics Dept; D. F. Breazeale, Dairy Dept.)

Table 3. Comparison of Results Obtained Using a Soap and Softener with Those of a Synthetic Detergent in a Home Size Conventional Type Washer and Water of Varying Degrees of Hardness

<table>
<thead>
<tr>
<th>Grains of Hardness</th>
<th>Soap and Softener</th>
<th>Synthetic Detergent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 Gm.* Soap/Liter</td>
<td>4 Gm.† Soap/Liter</td>
</tr>
<tr>
<td>35</td>
<td>15.7</td>
<td>16.7</td>
</tr>
<tr>
<td>60</td>
<td>9.7</td>
<td>11.1</td>
</tr>
<tr>
<td>120</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>7.0</td>
<td>19.8</td>
</tr>
</tbody>
</table>

*100 grams of soap or synthetic detergent measured approximately 1¼ cups. This quantity was used in 50 liters of water which approximates 13⅛ gallons.
†200 grams of soap or synthetic detergent were used in 50 liters of water or approximately 2⅓ cups in 13⅛ gallons of water.

Cobalt in Our Grasses  Continued from page 85

Table 1. Cobalt in Western Wheatgrass

<table>
<thead>
<tr>
<th>Where Collected</th>
<th>Number of Samples</th>
<th>Cobalt Content (parts per million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>North Central Substation, Eureka</td>
<td>3</td>
<td>0.042-0.057 0.050</td>
</tr>
<tr>
<td>Central Substation, Highmore</td>
<td>21</td>
<td>0.027-0.250 0.080</td>
</tr>
<tr>
<td>Reed Ranch, Presho</td>
<td>6</td>
<td>0.040-0.320 0.117</td>
</tr>
<tr>
<td>Range Field Station, Cottonwood</td>
<td>20</td>
<td>0.014-0.088 0.049</td>
</tr>
<tr>
<td>Antelope Range Field Station, Buf</td>
<td>17</td>
<td>0.020-0.176 0.062</td>
</tr>
</tbody>
</table>

The final step in measuring cobalt in grass.
VITAMIN A is an essential nutrient for all animals; however, it does not exist in the plant world. Carotene, which is present in forage, is converted to vitamin A by the animal.

Carotene values of our range grasses are quite high early in the growing season but decline to very low levels in the winter. When the carotene content of the feed is high, cattle store vitamin A, principally in the liver. This reserve supply is used up during periods of low carotene intake and may be large enough following a favorable growing season to prevent vitamin A deficiency symptoms during an average winter.

Several workers have reported vitamin A deficiency in range cattle while others have been unable to produce a deficiency under normal range conditions. The carotene intake during the growing season and winter stress conditions on the animal would affect the results. Since these factors may be quite variable in South Dakota, a study of the response of range cattle to vitamin A supplementation during the winter feeding period was started.

The Plan
A series of trials was begun in the winter of 1952-53 to compare the longtime production of beef cows wintered on range and supplemented daily with 0, 1,000, or 3,000 U.S.P. units of vitamin A for each 100 pounds of body weight. The first level of supplementation is the total daily amount recommended by the National Research Council to prevent gross clinical symptoms of vitamin A deficiency. The second level is the amount recommended to provide for reproductive needs and moderate storage.

Winter Phase. Fifty-four high grade yearling Hereford heifers were bought in 1952 and permanently assigned at random to three levels of winter vitamin A supplementation and to three rates of sum-
mer grazing. The winter and summer treatments were replicated and balanced.

Nine animals were placed in each of six groups which were winter-grazed on comparable range pastures. These pastures have been deferred each year for winter grazing and are in excellent condition. The cattle were rotated from pasture to pasture every 2 weeks to compensate for pasture differences.

They were fed daily a 38 percent protein supplement composed of 87 percent solvent process soybean oil meal, 5 percent cane molasses, 8 percent dicalcium phosphate. It contained a sufficient vitamin A supplement to add 0, 1,000, or 3,000 U.S.P. units of vitamin A for each 100 pounds of body weight.

During the winters of 1952-53 and 1953-54, this supplement was fed at the rate of 1 pound a head daily from about December 1 until about May 1, while in 1954-55 it was fed at the rate of 1½ pounds a day. Late-cut prairie hay was fed in amounts that the cattle would clean up readily when grazing was impractical during storms or because of snow cover. This hay was cut after frost so that it would be similar to the forage on the winter range.

Summer Phase. For the summer phase of the study, nine animals were allotted to each of six comparable summer pastures. The pastures had been grazed heavily, moderately, or lightly from about May 1 through December 1 each year since 1942 and correspondingly were in fair, good, or excellent condition.

Six of these animals were designated as record animals for measuring pasture production. The other three animals were designated as "put and take" cows. They were added to or removed from the pasture to secure a utilization of 35-55 percent under moderate grazing, less than 35 percent under light grazing, and more than 55 percent under heavy grazing.

It was planned that all of the record animals should complete the grazing season even though in dry years this might mean heavier use than desired. The cattle had access to well water, iodized salt, and a salt-dicalcium phosphate mineral mixture containing at least 10 percent phosphorus.

The cows were bred to calve as 3-year-olds. Two closely-related bulls were used and each served the cows in a heavily, a moderately, and a lightly grazed pasture. The calves were weighed at birth and at monthly intervals until they were weaned about November 1. The cows were weighed each month throughout the year. Blood samples were taken in December, January, and March of each year for vitamin A, carotene, and phosphorus determinations.

Results and Discussion

No symptoms of vitamin A deficiency have been observed in any of the cows or calves during the 3 years that this study has been conducted. No differences attributable to feeding different levels of vitamin A in the supplement were observed in the calf crop, birth weights, wean-

1In 1954-55, dicalcium phosphate composed 5.6 percent of the mixture and soybean oil meal 89.4 percent.
2NOPCAY Type III micronized vitamin A supplement containing 10,000 U.S.P. units of Vitamin A per gram was furnished by the NOPCO Chemical Co.
ing weights, or in the general well-being of the cows or calves.

**Blood Studies Show Differences.**
The only important differences have been found in the blood studies. Levels of vitamin A, carotene, and phosphorus in the blood plasma of these cows in October 1952 before they were placed on experiment are shown in Table 1. The levels of these three nutrients in the plasma near the end of each winter (March) are shown in Table 2 and the levels at the end of the summer grazing period (December) are presented in Table 3.

**Large Yearly Differences.** Yearly differences in the plasma vitamin A and carotene values were large. Climatic variations and the accompanying changes in the quality of the forage were largely responsible for this. The fall and early winter of 1952 were dry. Only 1.64 inches of

---

**Table 1. Pretreatment Levels of Vitamin A, Carotene, and Phosphorus in the Blood Plasma of Cows Which Were Later Summer-Grazed at Different Intensities and Supplemented with Different Levels of Vitamin A on Winter Range**

<table>
<thead>
<tr>
<th>Intensity of Summer Grazing</th>
<th>Level of Vitamin A Supplementation</th>
<th>Vitamin A</th>
<th>Carotene</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>meg %</td>
<td>meg %</td>
<td>mg %</td>
</tr>
<tr>
<td></td>
<td>Heavy</td>
<td>26.0</td>
<td>37.0</td>
<td>4.89</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>26.0</td>
<td>37.0</td>
<td>4.89</td>
</tr>
<tr>
<td></td>
<td>Light</td>
<td>26.0</td>
<td>37.0</td>
<td>4.89</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>26.0</td>
<td>37.0</td>
<td>4.89</td>
</tr>
</tbody>
</table>

---

**Table 2. March Levels of Vitamin A, Carotene, and Phosphorus in the Blood Plasma of Cows Summer-Grazed at Different Intensities and Supplemented with Different Levels of Vitamin A on Winter Range (35 Cows Each Year)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Level of Vitamin A Supplementation</th>
<th>Vitamin A</th>
<th>Carotene</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>meg %</td>
<td>meg %</td>
<td>mg %</td>
</tr>
<tr>
<td>1955</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>23.8</td>
<td>25.2</td>
<td>6.25</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>28.5</td>
<td>26.0</td>
<td>6.98</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>22.8</td>
<td>24.2</td>
<td>6.10</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>25.0</td>
<td>26.2</td>
<td>6.21</td>
<td></td>
</tr>
<tr>
<td>1954</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>21.0</td>
<td>25.2</td>
<td>6.09</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>20.2</td>
<td>24.5</td>
<td>6.97</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>21.8</td>
<td>29.0</td>
<td>6.73</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>21.0</td>
<td>26.2</td>
<td>7.26</td>
<td></td>
</tr>
<tr>
<td>1953</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>15.2</td>
<td>15.8</td>
<td>7.42</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>21.8</td>
<td>17.0</td>
<td>7.98</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>25.5</td>
<td>17.5</td>
<td>6.70</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>20.8</td>
<td>16.8</td>
<td>7.57</td>
<td></td>
</tr>
<tr>
<td>All years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>20.0</td>
<td>23.1</td>
<td>6.26</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>23.5</td>
<td>22.5</td>
<td>7.97</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>23.8</td>
<td>23.6</td>
<td>6.61</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>22.3</td>
<td>23.1</td>
<td>6.95</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. December Levels of Vitamin A, Carotene, and Phosphorus in the Blood Plasma of Cows Summer-Grazed at Different Intensities and Supplemented with Different Levels of Vitamin A on Winter Range

<table>
<thead>
<tr>
<th>Level of Vitamin A Supplementation</th>
<th>Intensity of Summer Grazing</th>
<th>Vitamin A mg %</th>
<th>Carotene mg %</th>
<th>Phosphorus mg %</th>
<th>Vitamin A mg %</th>
<th>Carotene mg %</th>
<th>Phosphorus mg %</th>
<th>Vitamin A mg %</th>
<th>Carotene mg %</th>
<th>Phosphorus mg %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1954</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>25.2</td>
<td>133.5</td>
<td>5.25</td>
<td>26.2</td>
<td>120.0</td>
<td>8.70</td>
<td>51.5</td>
<td>509.5</td>
<td>5.31</td>
<td>34.5</td>
</tr>
<tr>
<td>A1</td>
<td>23.5</td>
<td>104.0</td>
<td>8.26</td>
<td>26.2</td>
<td>148.8</td>
<td>6.52</td>
<td>52.8</td>
<td>518.0</td>
<td>6.07</td>
<td>34.2</td>
</tr>
<tr>
<td>A2</td>
<td>26.2</td>
<td>103.0</td>
<td>5.96</td>
<td>31.7</td>
<td>154.0</td>
<td>5.59</td>
<td>54.2</td>
<td>591.8</td>
<td>4.34</td>
<td>37.9</td>
</tr>
<tr>
<td>Mean</td>
<td>25.0</td>
<td>113.5</td>
<td>6.58</td>
<td>27.7</td>
<td>139.7</td>
<td>7.00</td>
<td>52.8</td>
<td>539.8</td>
<td>5.27</td>
<td>35.4</td>
</tr>
<tr>
<td>1953</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aa</td>
<td>18.8</td>
<td>59.5</td>
<td>5.45</td>
<td>18.2</td>
<td>59.8</td>
<td>6.63</td>
<td>25.2</td>
<td>137.5</td>
<td>5.72</td>
<td>20.8</td>
</tr>
<tr>
<td>A1</td>
<td>19.8</td>
<td>61.2</td>
<td>7.63</td>
<td>18.2</td>
<td>63.2</td>
<td>8.90</td>
<td>32.0</td>
<td>121.8</td>
<td>5.63</td>
<td>23.3</td>
</tr>
<tr>
<td>A2</td>
<td>21.3</td>
<td>65.5</td>
<td>6.85</td>
<td>20.0</td>
<td>64.0</td>
<td>7.35</td>
<td>26.8</td>
<td>149.8</td>
<td>5.39</td>
<td>23.0</td>
</tr>
<tr>
<td>Mean</td>
<td>20.0</td>
<td>62.1</td>
<td>6.64</td>
<td>18.7</td>
<td>62.2</td>
<td>7.65</td>
<td>28.0</td>
<td>156.3</td>
<td>5.58</td>
<td>22.3</td>
</tr>
</tbody>
</table>
| Precipitation received from August 1 to January 1, 1953. The dry fall was reflected in lower plasma carotene and vitamin A values of the unsupplemented cattle reported for March 1953 (Table 2). The falls of 1953 and 1954 were favorable for late growth of forage. The precipitation was 1.98 inches in October 1953 and 2.50 inches in October 1954. Favorable rains were followed by warm days in November in both years. This produced new growth of cool season grasses and germination of winter annuals, especially Japanese bromegrass. Plasma vitamin A and carotene values were high in December 1953, and were exceptionally high in 1954 in those cows that were grazed on the lightly-grazed pastures. The plasma vitamin A values for the different rates of grazing in December 1954 were 25.0, 27.7, and 52.8 micrograms per 100 milliliters, respectively, for heavy, moderate, and light rates of grazing. The corresponding values for plasma carotene were 113.5, 139.7, and 539.8 micrograms per 100 milliliters. Cool Season Grasses. Higher values for cattle on lightly-grazed pastures were probably due to the larger proportion of cool season grasses present in the pastures which were in excellent condition. These grasses make fall regrowth and extend the green feed season when moisture is plentiful. In both 1953 and 1954 conditions were favorable for the germination and growth of Japanese bromegrass. In late November of 1954, this invader was about 1 inch high. It was very abundant on the lightly-grazed pastures but was rather infrequent on the heavily and moderately grazed units. This difference in abundance was probably due to the fact that most of the plants were consumed the previous year on the more heavily-stocked units and, consequently, there was a limited seed supply.
Japanese bromegrass is an undesirable plant on the range, but it composed part of the diet of the cattle on the lightly-grazed units in the fall. It was undoubtedly responsible in part for the high plasma vitamin A and carotene values observed in December. Although differences in plasma vitamin A and carotene were large in December, the differential effect of the summer treatments was not apparent by the end of the winter. Likewise, there was no important effect of different levels of vitamin A supplementation during the winter on plasma levels of the vitamin the following December.

Winter Conditions. The winters of 1953-54 and 1954-55 were open and mild. Hay was fed only 3 days during 1953-54 and none was required in 1954-55. In both years plasma vitamin A levels remained high at the January sampling but showed lower values by March. However, during February and early March of 1953, the cattle were unable to graze 27 days because of snow cover. They were fed an average of 14.6 pounds a head daily of hay containing 6.20 micograms of carotene per pound. This was poor quality hay with low carotene content. However, when fed in this amount, it supplied more than enough carotene to meet the recommended allowance of the cattle in all lots.

The effects of the different levels of vitamin A supplementation were thus partially obscured. The carotene and vitamin A values at the midwinter sampling in January 1953 were lower than those reported for March in all lots. This was the only year in which the vitamin A levels in the plasma reached levels considered to be borderline for reproduction by some workers.

Vitamin A Supplement. The average plasma vitamin A values were higher each year in the lots which received a vitamin A supplement. This difference was statistically significant. Plasma carotene levels were not affected by the vitamin A supplementation.

Plasma carotene levels were high and were strongly correlated with plasma vitamin A at the December samplings \( (r=0.96) \). However, by the end of the winter the carotene values were considerably lower than the December sampling. They were not strongly correlated with vitamin A, even in those animals which received no supplementation of vitamin A \( (r=0.43) \).

These observations would suggest that the cattle receiving no vitamin supplement were mobilizing vitamin A reserves to maintain about normal plasma vitamin A levels. This was substantiated at the March sampling in 1954 by the use of an ethyl alcohol drench.

Other workers have reported that a large dose of alcohol will mobilize vitamin A reserves in the liver and thus increase plasma vitamin A values. Each cow was drenched with 95 cc. of 50 percent solution of ethyl alcohol for 100 pounds body weight. They were bled before and 4 to 6 hours after drenching. The increase in plasma vitamin A between the two bleedings was used as an indication of the liver reserves of the animal. This technique indicated

\[ r = 1.00 \] would mean that the two values were perfectly correlated while \( r=0.00 \) would mean the two values were not related.
that none of the animals were depleted, but the increases were slightly larger in the supplemented than in the unsupplemented lots.

**Phosphorus Levels.** The levels of phosphorus in the blood plasma did not show large differences in response to the experimental treatments. This was expected since a uniform level of phosphorus was added to the protein supplement in the winter and a phosphorus supplement was available from the salt box in the summer. However, the phosphorus levels in the blood plasma were inversely correlated with the plasma carotene at the December sampling, although the relationship was not strong \((r=-0.28)\). The plasma values of the nutrients were unrelated at the March sampling.

**Summary**

Grade Hereford cows have been winter-grazed on the range for three winters and supplemented with 0, 1,000, or 3,000 U.S.P. units of vitamin A for each 100 pounds body weight daily. It was fed in the protein supplement. They have been summer-grazed at heavy, moderate, or light intensities for 2 years on pastures averaging fair, good, or excellent condition, respectively. No differences due to the vitamin A intake were observed except that the blood plasma content of vitamin A at the end of the winter was generally higher in the lots which received supplemental vitamin A. The carotene and vitamin A content of the blood plasma at the beginning of the winter was higher in the cattle from the lightly-grazed summer pastures.

Animals are less likely to become deficient in vitamin A when grazed on ranges in excellent condition, especially when growing conditions in the fall are favorable for cool season range plants. A full feed of hay, even though it is of rather poor quality, may supply a significant amount of the animal's carotene, or vitamin A, requirement.

This study is being continued with the same animals on the same treatments. (Project 217. Leaders: J. K. Lewis, Animal Husbandry Dept.; O. E. Olson and Frances M. Moyer, Station Biochemistry Dept.)

Cows on winter range receive supplemental feed containing vitamin A.
Comparison of total investment for various organizations and sizes of farms under dryland and partial irrigation, central South Dakota, calculated on projected price level.

<table>
<thead>
<tr>
<th>Farm Size</th>
<th>Dryland</th>
<th>Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 ACRE</td>
<td>$300k</td>
<td>$400k</td>
</tr>
<tr>
<td>682 ACRE</td>
<td>$250k</td>
<td>$350k</td>
</tr>
<tr>
<td>480 ACRE</td>
<td>$200k</td>
<td>$300k</td>
</tr>
</tbody>
</table>

Information on the other sizes of farms and organizations considered in the cooperative study, as well as the problems likely to be encountered in changing from dryland to irrigation farming, is presented in South Dakota Agricultural Experiment Station bulletin 444. However, a farmer who is interested in comparing the profitability of his present dryland farming operations with irrigated farming on his farm needs to work out plans for his own situation. The results reported in this study represent averages for typical situations, and, in general, they will need to be modified to fit individual situations. (Project 198. Leader: Rex D. Helfinstine, Economist, USDA.)
Table 5. Comparison of a 1,060-Acre Dryland Cattle-Hog Farm and a 480-Acre Partly Irrigated Cattle-Hog Farm, Central South Dakota, Projected Price Level*

<table>
<thead>
<tr>
<th>Item</th>
<th>1,060-Acre Dryland Farm</th>
<th>480-Acre Partly Irrigated Farm†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry cropland (acres)</td>
<td>733</td>
<td>42</td>
</tr>
<tr>
<td>Irrigated crops (acres)</td>
<td></td>
<td>232</td>
</tr>
<tr>
<td>Irrigated pasture (acres)</td>
<td>56</td>
<td>36</td>
</tr>
<tr>
<td>Native pasture and hay (acres)</td>
<td>322</td>
<td>145</td>
</tr>
<tr>
<td>Other land (acres)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total (acres)</strong></td>
<td><strong>1,060</strong></td>
<td><strong>480</strong></td>
</tr>
<tr>
<td>Beef cows (number)</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Purchased feeders (number)</td>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>Sows (number)</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Poultry (number)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Labor used, oper. (man-days)</td>
<td>236</td>
<td>243</td>
</tr>
<tr>
<td>Labor used, hired (man-days)</td>
<td>59</td>
<td>150</td>
</tr>
<tr>
<td>Total investment (dollars)</td>
<td>55,148</td>
<td>55,231</td>
</tr>
<tr>
<td>Total receipts (dollars)</td>
<td>20,708</td>
<td>26,938</td>
</tr>
<tr>
<td>Total expenses (dollars)</td>
<td>12,341</td>
<td>12,909</td>
</tr>
<tr>
<td>Net cash income† (dollars)</td>
<td>9,318</td>
<td>14,926</td>
</tr>
<tr>
<td>Interest on investment§ (dollars)</td>
<td>2,591</td>
<td>2,702</td>
</tr>
<tr>
<td>Depreciation (dollars)</td>
<td>951</td>
<td>897</td>
</tr>
<tr>
<td>Net farm income® (dollars)</td>
<td>11,390</td>
<td>12,012</td>
</tr>
<tr>
<td>Labor and management income# (dollars)</td>
<td>8,790</td>
<td>9,310</td>
</tr>
<tr>
<td>Capital income** (percent)</td>
<td>16.2</td>
<td>17.0</td>
</tr>
</tbody>
</table>

*Hogs raised limited to 30 litters; cattle sold as slaughter cattle.
†Using Bureau of Reclamation estimate of $5 per acre of irrigable land for annual operation and maintenance charge and $3 per acre for annual construction charge (deferred first 10 years, charged next 40 years).
‡Defined as total receipts less total expenses, not including depreciation or interest on investment.
§At 4 percent on real estate and 6 percent on average investment in machinery and livestock.
||Defined as total receipts less total expenses, not including interest on investment.
#Defined as total receipts less total expenses and interest on investment.
**Defined as net farm income less charge for operator labor (at $4.70 a day) and management (at 7 percent of total receipts less feed and feeders purchased), and expressed as percentage of total investment.

Field Picker-Sheller  Continued from page 91

eyears to fall. The sheller had to be set to break the cobs into fine pieces because of the many small ears and the light yield over high ground. This caused some loss from the separator unit.

Cold Air Drying

On October 22, after enough corn was in the bin to cover the ventilator ducts, a cold air fan was started. It ran continuously until November 19 (28 days), at which time the corn tested 14 percent moisture.

The drying equipment consisted of metal ducts on the floor of a 1,000-bushel steel grain bin. The ducts provided an even air flow to all parts of the bin. A 3-horsepower electric motor and backward curved radial flow fan was used. This fan could have been used for two or three bins at the same time for cold air drying.

During the 28 days of running there was some cold weather but few rainy days. Drying conditions were favorable. Years when conditions are similar to 1954, field picker-sheller work with cold air drying seems to be an efficient way of harvesting corn. (Project 246. Leader: H. H. DeLong, Agricultural Engineering Dept.)
jected to further studies on phenothiazine. These animals were being used in a nutrition experiment, thus the phenothiazine tests were incidental. Phenothiazine was added to the feed of six animals; the other six were held as controls.

Unfortunately the calves were very irregular in their feeding. This was true of the controls as well, so phenothiazine is not incriminated. There was no significant difference in number of grubs between the treated and the untreated calves. No conclusions can be drawn from this phenothiazine experiment.

**Search Continues.** The search for an internal medication to control cattle grubs before they reach the backs of cattle will continue. Research in this field is still in its early stages. Great numbers of chemicals that prove successful under laboratory conditions may have to be abandoned. They may fail to kill the larvae within the animals, they may cause undesirable effects in cattle, or they may leave a residue that is unwelcome in human food. While the chances of failure are high, the value of success would be so great to the livestock producers, the packers, and the leather industry that continued work along these lines is justified. (Project 244. Leader: Wm. M. Rogoff, Entomology-Zoology Dept.)
effects of
TWINNING
in dairy cattle

BIRTHS OF TWINS in dairy cattle are not numerous, yet they occur often enough to cause some concern among dairymen. To determine the effects of twinning, an analysis was made of the dairy herd records at South Dakota State College. These records had been kept over a 50-year period.

During this period 70 cows gave birth to twin calves. The milk production records of these cows reveals some interesting information. All of these data have been converted to twice a day milking, 305-day lactation, and mature equivalent basis. The averages of these records are presented in Table 1.

Immediately following twinning the lactation averaged approximately 1,000 pounds of milk and 50 pounds of butterfat less than the records prior to and after twinning. Using a price of $4.44 a hundredweight for milk, this represents a loss of approximately $40 during the lactation following the birth of twins. In the case of purebred cattle the value of this extra calf may more than offset the reduction in milk income; however, in grade cattle, the extra calf may not pay for the loss in milk.

Effect on Cows. The comment is often heard among dairymen that after a cow has had twins, breeding difficulties and a lengthened interval between calvings are likely to occur. The records of these 70 cows were studied to obtain information on this point. It was found that after giving birth to a single calf these cows required 1.55 services for conception, but following the birth of twins 1.83 services were required. Thus, the length of time between calvings was increased, which usually means longer dry periods and less total milk produced.

Effect on Calves. A popular question about twins is whether or not they will be successful breeders. To answer this question it is necessary to consider the three types of births which may occur among twins, (1) both bulls, (2) both heifers, and (3) one heifer and one bull.

In general, when two bulls are born together they will be successful breeders. This is also true when two heifers are born together. However, when a bull and heifer are
twins, the heifer will be sterile or a nonbreeder in about 95 cases out of 100. These sterile heifers are known as freemartins.

**Fremartins.** About 95 percent of the heifers twinned with a bull are sterile because the heifer and her male twin are carried in the same fetal membranes in their dam. During embryonic life the male develops earlier than the female. This means the male starts secreting the male hormone (androgen) before the female secretes the female hormone (estrogen). Since both twins are in the same fetal membrane, they have a common blood supply. Therefore the male hormone is circulated through the blood stream of the female. As a result of the action of the androgen, development of the female organs is retarded. This prevents them from becoming fully developed and able to function in later life. Sometimes the whole reproductive tract appears to be developed, but it will not function normally. Regardless of the extent of underdevelopment of the reproductive organs, the freemartin cannot reproduce and will be of no value as a herd replacement.

<table>
<thead>
<tr>
<th>Description</th>
<th>Lbs. Milk</th>
<th>Percent Fat</th>
<th>Lbs. Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before carrying twins</td>
<td>10,963</td>
<td>3.66</td>
<td>401.7</td>
</tr>
<tr>
<td>While carrying twins</td>
<td>11,644</td>
<td>3.34</td>
<td>388.9</td>
</tr>
<tr>
<td>Following twinning</td>
<td>9,673</td>
<td>3.51</td>
<td>339.5</td>
</tr>
<tr>
<td>Subsequent records</td>
<td>10,324</td>
<td>3.74</td>
<td>386.5</td>
</tr>
</tbody>
</table>

Approximately 5 percent of the heifers twinned with a bull are carried in separate fetal membranes. In these cases, each has its own blood supply independent of the other. Therefore the male hormone does not inhibit the development of the reproductive organs in the heifers. Two afterbirths will be present in these cases. The heifers are not freemartins and can be expected to reproduce normally.

Since a large percentage of the dairy cattle in the United States are not purebreds, twin calves represent a loss to their owner more often than a gain. Losses due to lower milk production and lower breeding efficiency are usually greater than the value of the extra calf. (Project 184-R. Leader: Chase Wilson, former Dairy Husbandman, Dairy Husbandry-Bacteriology Dept.)

In 95 cases out of 100, a freemartin such as the one pictured below will be a nonbreeder.
Annual Report

supplementing the quarterly reports
of the
South Dakota Farm and Home Research
for the year ending
June 30, 1955

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.

Agricultural Biochemistry

Barley Proteins

When the same variety of barley is grown in different parts of the state its protein content varies considerably as the result of climatic and soil conditions. Certain fractions of the protein are more affected by changing protein content than are others. One of these, the hordein, increases most rapidly in amount with increasing protein content of the barley, so it was chosen for amino acid analysis in a study aimed at determining whether or not the nutritive value of high protein barleys differed from low.

The analytical results did indicate a small change in the percentage of some of the amino acids of hordein from barleys of increasing protein content. However, for most of the amino acids there was no consistent change. It appears, therefore, that there is no great advantage in studying the individual protein fractions further as to their amino acid content since factors other than changing protein content of the barley apparently cause variations. (Project 195; Leaders: A. W. Halverson, F. M. Moyer, Station Biochemistry Dept.)

Chemical Analysis of Grass Silage with Different Methods of Storage

The loss of nutrients from alfalfa stored in various ways has been investigated. The methods of storage used were as follows: (1) conventional or upright silo, (2) a trench type silo, (3) stack silo, and (4) baled hay.

Although this study is not complete as yet, it appears that losses in nutrients from the upright silo and the baled hay were about equal, those for the stack and trench type silo being considerably larger. Much of the loss is the result of fermentative processes, which in open type of silo (such as the stack) continues the year around.

In one stack of silage put up in June and stored over winter until the following August, 86 percent loss in dry matter was found largely as the result of
spoilage, fermentation, and leaching. Such a practice does not seem advisable.

To facilitate the study of several methods of preserving silage in stacks, several pilot type silos containing 1 ton of grass were put up. Results on these indicated that these may yield valuable information in future work.

In open types of silos such as the stack or pile, losses are kept at a minimum by feeding soon after ensiling. Using such silage during periods of pasture shortage in late summer may be advantageous. (Project 237-D. Leaders: O. E. Olson, A. W. Halverson, Station Biochemistry Dept.)

Nitrate Poisoning

Experimentation on the effect of herbicides on the accumulation of nitrates by plants has given variable results in the past. In some cases increased nitrate content has resulted from 2,4-D treatment while in other cases it has not. An explanation for these variable results may, it seems, be obtained from experiments carried on under carefully controlled conditions in a plant growing room.

Before plants will accumulate nitrates, their concentration in the soil must be high. The young plants absorb the nitrate rapidly and it accumulates in the tissues. Toward maturity which has accumulated is utilized and the amount present in tissues is greatly reduced. Spraying the young plant with 2,4-D, however, interferes with its utilization so that the high nitrate content of the plant tissues is not reduced. As an example, sugar beets containing about 5.7 percent of potassium nitrate when sprayed were found to contain 6.3 percent 10 days later, at which time unsprayed plants contained only 3.1 percent. Mustard gave similar results. Further experimentation of a similar nature is now under way. (Project 87. E. I. Whitehead, Station Biochemistry Dept.)

A New Aid in Diagnosing Selenium Poisoning, see page 12
Cobalt in Our Grasses, see page 84

Crop Insects

Grasshopper Studies

More than 125,000 specimens of South Dakota grasshoppers representing 104 species have been collected. These have been pinned, properly labeled, and identified. Collections were made in every county in the state. This collection of grasshoppers is stored in pest-proof cases in what is known as the Insect Collection Room in the Agricultural Hall of South Dakota State College.

Maps of South Dakota have been used on which is indicated the distribution of each species of grasshopper. On the reverse side of each map is recorded the following data: (1) life cycle of each species of grasshopper, (2) seasonal cycle of each species, (3) time when adults occur, (4) habitat preferred by the species, (5) economic importance of the species, (6) food plants preferred, (7) hatching dates. Additional data have been accumulated concerning the abundance of the most important economic species over a period of 40 years. All of this material is kept in systematic order in book form, the books being stored in steel filing cases. During the past year additional data were added to this wealth of information.

During the past 2 years, economic species of grasshoppers have been building up their populations in many areas in South Dakota. This was true of grasshoppers attacking croplands and grasshoppers infesting the range. Weather has been favorable for the survival of grasshoppers during the past 2 years in these areas and unfavorable for the multiplication and survival of the natural enemies.

Experimental control of grasshoppers through spraying with dieldrin was car-
ried on at Highmore and at Cottonwood. In succulent vegetation and when the temperatures were moderate or low, 2 ounces of dieldrin per acre gave excellent control of the pests, but when the plant growth began to dry out and the temperatures were high, it was necessary to increase the dosage rate to 4 ounces per acre to obtain a good kill. This was true when the spray was applied by plane or by ground sprayers. (Project 18. Leader: H. C. Severin, Entomology-Zoology Dept.)

**European Corn Borer**

The European corn borer cost the farmers of South Dakota an estimated $22,065,000 in 1954. These figures were based on the fall corn borer abundance survey made by the South Dakota State College Experiment Station and Extension Service, corn acreage figures provided by the Federal Crop Reporting Service and computations made by the Plant Pest Control Branch of the U.S. Agricultural Research Service.

This loss took place after the overwintering population had been reduced 20 percent by the various factors which influence what has been called “winter mortality.”

The 1954 fall survey indicated a general increase in corn borer numbers. The Experiment Station studies indicate that during the winter of 1954-55 the borer population was reduced by approximately 22 percent (78 percent survival).

The early spring of 1955 resulted in a somewhat earlier emergence of corn borer moths than South Dakota has experienced up to this year. The corn borers are ahead of the corn by from 2 to 3 weeks.

Studies have shown that corn which is not more than 20 to 25 inches high at the time the moths are laying, or have laid, their eggs is not favorable for borer development. Most of the corn planted in 1955 has not reached the critical height at this writing (June 10), while nearly half of the corn borer moths have emerged and many eggs have been laid.

The indications, then, are that in most of the corn fields the first brood corn borers will not likely be much of a problem. Eggs are being deposited on small grain and weeds. Small grain could suffer considerable damage from attack by the small borers.

If enough corn borer eggs are laid on weeds and other plants of large enough stalk size for the insect to complete its larval growth, then there could be a heavy second brood of borers in corn. (Project 187. Leader: Gerald B. Spawn, Entomology-Zoology Dept.)

**Corn Rootworm in South Dakota**

Corn rootworms are the larval stage of insects which are commonly known in the adult stage as cucumber beetles. There are at least three species of them in South Dakota.

Observations on adult populations in 1954 showed a slight predominance of northern corn rootworm (*Diabrotica longicornis*) over the southern form (*D. 12-punctata*). The western form (*D. soror*) was present in much smaller numbers.

During the fall of 1954 corn in Clay County averaged two to three adults per plant. Absence of strong winds during the critical season resulted in less lodged corn due to rootworm activity than is usually experienced.

Studies of corn strips treated with (1) aldrin, $\frac{1}{2}$ pound per acre, and (2) chlordane, $\frac{1}{2}$ pound per acre, with (3) a check strip of untreated corn between the treated strips indicated a noticeably better growth of roots on the treated plants.

Observations on adult populations appear to indicate that South Dakota farmers cannot depend entirely upon crop rotation practices to control the corn rootworms infesting their fields. Due to differences in life cycles and habits of the insects, the northern corn rootworm can be controlled in this manner.
but the southern form cannot. If the latter species is to be controlled in corn chemical control will be necessary. (Project 247. Leader, Gerald B. Spawn, Entomology-Zoology Dept.)

Alfalfa Weevil

The alfalfa weevil, *Hypera postica*, has been a serious pest to alfalfa in the Black Hills area for a number of years. The weevil was first discovered in South Dakota in Fall River County many years ago. Later it appeared in Custer, Pennington, Lawrence, Meade, and southern Butte County.

For many years the weevil caused little damage to alfalfa in the counties where it was found and during this time it extended its range but little. However, as the years passed, the weevil became more and more destructive, especially in the Spearfish and Sturgis districts and lately in the Belle Fourche and Newell areas. The damage done varied from year to year, being more severe in some years than in others.

In the past 2 years the weevil suddenly extended its range and in 1954 it was found throughout Butte and in Harding Counties to the north of the Black Hills and in Jackson County to the east. The farthest east the weevil has been found in South Dakota is at Cottonwood in Jackson County.

The weevil is destructive both in its adult stage and in its larval stages. However, most of the damage is done by the larval stages as they feed upon the expanded leaves, skeletonizing them. Some damage is also done by the larvae as they feed on the growing tips of the plants and on the leaves before they have fully expanded. While most of the damage is done to the first crop of alfalfa in June and early July, considerable damage may be done by the larvae after the first crop of hay has been cut because the larvae may devour the new plant growth for a time as fast as it appears.

It is essential that control measures for this pest be put in operation in areas where the weevil does considerable

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Diagonal lines indicate area infected up to 1952.
Cross-hatched lines show spread of weevil through 1954.
prepare a very worthwhile manuscript on the Coccinellidae of South Dakota. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

The Ladybird Beetles or Coccinellidae of South Dakota

This family of beetles is composed of between 50 and 60 species in South Dakota. All pass through four stages in completing their life cycles, namely egg, larval or grub stages, pupa, and adult or ladybird beetle. The feeding stages are the larvae or grubs and the adults or beetles.

All species of ladybird beetles with one exception are carnivorous in their larval and adult stages. They feed principally upon small insects that they can overpower, upon mites, and upon the eggs of insects and mites. The various species of carnivorous ladybird beetles are regarded as beneficial to mankind and their presence on plants of all kinds including grains, trees, bushes, and flowering annuals grown by man for his own use or for his pleasure are regarded as desirable. Common foods eaten by the carnivorous species of ladybird beetles and their larvae consist of aphids or plant lice, psyllids or jumping plant lice, scale insects in all of their stages, mites and their eggs, and eggs of many insects both large and small.

The only leaf eating species of Coccinellid that is found in South Dakota is the Mexican Bean Beetle, Epilachna varivestis Muls. This species is extremely destructive because it feeds upon the foliage of beans, soybeans, and cowpeas. For many years the Mexican Bean Beetle was limited in its distribution in South Dakota to the Black Hills and to a small area immediately east of the Hills. During the past few years this insect has moved eastward and at present it has been found as far east as Oglala in southern South Dakota.

Approximately 500 specimens of Coccinellidae were collected in South Dakota during the past year. These are now being identified and when this job has been completed it should be possible to prepare a very worthwhile manuscript on the Coccinellidae of South Dakota. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

The Tree Hoppers or Membracidae of South Dakota

An additional 400 specimens of tree hoppers were collected in South Dakota during the past year. The collections were made chiefly in Roberts, Marshall, Day, and Grant Counties in northeastern South Dakota and in Union, Clay, Yankton, and Bon Homme Counties in southeastern South Dakota. It was felt that our collections of tree hoppers made in past years in the counties listed were inadequate and consequently further collections of tree hoppers were made in these two areas during the past fiscal year.

These collections have been pinned and labelled and the material is now being identified into species and varieties. When this work has been completed, a manuscript which has been in preparation during the past year will be completed. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

The Pine or Spruce Needle Scale

The Pine or Spruce Needle Scale, Phenacaspis pinifoliae (Fitch), is a serious insect pest of pines and spruces in South Dakota. Only the needles of the trees become infested, while the trunk, larger limbs, and even the smallest branches remain free from the insect. Trees grown in shelterbelts and as ornamentals suffer most seriously from the attacks of this insect, while trees growing in forests are not heavily infested.

In the Brookings area in 1954 the eggs of the pine and spruce scale began hatching June 9, and by June 15 the bulk of the hatch had been completed. On July 3 a small percentage of the males had secreted the scale covering their bodies and by July 6 about 50 percent of the males had done so. On July 3 none of the females had secreted the thin waxy
film that will later cover their bodies, but by July 6 a small percentage of the females had done so. A week later or on July 13 practically all of the males had finished secreting their scale covering, while most of the females had finished secreting the thin waxy covering over their bodies.

Timely and thorough spraying with a malathion spray gives excellent control of the pine and spruce scale. If an emulsifiable malathion solution is used and it is a 50 percent material, then 4 pints of the solution should be added to 100 gallons of water to make up the spray. If 25 percent malathion wettable powder is to be used, add 8 pounds of this powder to 100 gallons of water to make up the spray.

The spray pumps should deliver sufficient pressure to reach the highest tips of the trees and to rather violently sway the branches so that the spray will cover the needles on all surfaces. It is highly desirable to apply the spray after the bulk of the eggs have hatched and before the young insects cover their bodies with a scale or waxy film. This, in 1954 in the Brookings area, extended from June 15 to July 3. A spray that was applied to infested trees during this time gave kills ranging from 90 to 97 percent, while sprays that were applied before or after these dates gave relatively poor kills, often less than 50 percent.

As an aid to determine when the eggs hatch, it is suggested that a small branch of an infested tree be broken off and placed in a bottle or jar. The container should then be closed with a cork, wad of cotton, or lid. The jar or bottle should then be placed on the ground in the shade of the trunk of the tree or it may be fastened in a shady spot to a limb of the infested tree by wire or string. When the eggs hatch, the crawlers may be seen as numerous specks moving over the wall of the container. Two to five days should be allowed to elapse and then the spray should be applied some time within the next two weeks. (Project 142. Leader: H. C. Severin, Entomology-Zoology Dept.)

Harvester Ants and Their Control, see page 36

Crops and Soils

Soil Management Treatments Increase Crop Yields

The effects of soil management practices on the yields of crops and soil fertility maintenance were studied on the agronomy farm and outlying field plots. These practices include tillage, rotations, crop residues, and fertilizer studies. The effects of soil treatments on the yields of corn and oats for 1954 are presented in Table 1.

It may be noted in this table that nitrogen and organic matter had a pronounced effect on crop yields in 1954, a dry year. On those plots where the seedbed was plowed, every soil treatment that included nitrogen in the form of fertilizer or crop residues increased the oat yield. On the subsurface tilled plots the application of residues and manure; residues and nitrogen; and residues, nitrogen, and phosphorus produced significant increases in oat yield. The yields of corn on the subsurfaced tilled plots were also increased by the same treatment.

The return of crop residues to the soil with plowing as the tillage practice has produced an upward trend in crop yields which is becoming more pronounced from year to year. The beneficial effect of crop residues on the yields of corn with plowing as the tillage practice was especially noticeable in 1954, a year of low summer rainfall. The yield of corn was increased approximately 9 bushels per acre by the return each year of all crop residues, including straws and stalks.
Table 1. Effect of Tillage, Residues, Manure, and Fertilizer on Crop Yields, Agronomy Farm, Brookings, South Dakota, 1954

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Corn (Bushels per Acre)</th>
<th>Oats (Bushels per Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plowing</td>
<td>50.6</td>
<td>34.2</td>
</tr>
<tr>
<td>Plowing with residue</td>
<td>59.3</td>
<td>42.4</td>
</tr>
<tr>
<td>Plowing + nitrogen</td>
<td>51.8</td>
<td>58.1</td>
</tr>
<tr>
<td>Plowing + nitrogen + Phosphorus</td>
<td>55.8</td>
<td>66.5</td>
</tr>
<tr>
<td>Subsurface</td>
<td>51.6</td>
<td>37.1</td>
</tr>
<tr>
<td>Subsurface with residue</td>
<td>53.0</td>
<td>36.6</td>
</tr>
<tr>
<td>Subsurface with residue and manure</td>
<td>61.1</td>
<td>59.9</td>
</tr>
<tr>
<td>Subsurface with residue and nitrogen</td>
<td>56.5</td>
<td>49.1</td>
</tr>
<tr>
<td>Subsurface with residue and phosphorus</td>
<td>55.4</td>
<td>38.2</td>
</tr>
<tr>
<td>Subsurface with residue, nitrogen, and phosphorus</td>
<td>58.6</td>
<td>52.7</td>
</tr>
</tbody>
</table>

*Nitrogen was applied at the rate of 20 pounds per acre as 60 pounds of ammonium nitrate; phosphorus at the rate of 20 pounds of phosphoric acid as 47 pounds of triple superphosphate.

Corn that had adequate nitrogen and where the soil organic matter was maintained with crop residues, manures, and legumes withstood the effects of the mid-summer drought and produced better yields.

Tillage and Residues Effect Soil Nitrogen. In Figure 1 the effects of tillage and soil treatments on soil nitrogen changes are shown. It may be noted that plowing caused larger losses of nitrogen than subsurface tillage. The return of all crop residues and the application of 10 tons of manure per acre every 3 years produced a gain in total soil nitrogen under subsurface tillage.

Fertilizer trials conducted in eastern South Dakota show that nitrogen or nitrogen and phosphorus fertilizers are needed on many soils for good oat yields.

New crop rotations have been established at the agronomy farm for determining the optimum amount of legumes needed for supplying the nitrogen required for maximum yields of corn and small grain. These rotations are compared with similar crop rotations that do not have legumes but have the nitrogen supplied with various levels of nitrogen fertilizer. (Project 46. Leaders: L. L. Puhr and W. W. Worzella, Agronomy Dept.)

Crop Yields Increased Under Irrigation

New rotation experiments installed in 1953 provided the opportunity for comparison of commercial nitrogen fertilizers with alfalfa in getting newly developed land into production under irrigation.

It was found that 1 year’s growth of alfalfa was about equivalent to 40 pounds of elemental nitrogen in increasing corn yields. Older rotation experiments continue to indicate that 2 years’ growth of alfalfa is equivalent to 60 to 80 pounds of nitrogen applied as commercial fertilizer. In addition to yield increases effected by alfalfa, the alfalfa had a considerable effect on the crude protein of corn grain. Corn following alfalfa had 11.21 percent protein, whereas corn following corn on similar land had 10.23 percent.

Barley lodged severely on land treated with 60 pounds of nitrogen, although yields of grain were increased from 38 to 47 bushels per acre in a rotation that does not include a legume. Protein content of this barley was increased from...
10.95 percent to 13.64 percent by the nitrogen application.

In the production of grains for feed usage these increases in protein content at a result of legumes in the rotation or use of commercial fertilizers should not be overlooked. The value of the protein produced, as well as the extra yields, should be taken into account when evaluating an improved soil management system.

In direct comparisons of crop yields, irrigation increased alfalfa hay yields from 3.5 to 5.5 tons per acre, corn from 65 to about 95 bushels per acre, spring wheat from 25 to 35 bushels in non-legume rotations, and from 31 to 44 bushels in an alfalfa-alfalfa-corn-wheat rotation. (Project 173. Leaders: L. O. Fine, H. M. Vance, and F. Wiersma, Agronomy Dept. and USDA cooperating.)

Basic Soil Surveys Reported

The following soil survey reports were prepared and published during fiscal 1955: (1) the Potter County Reconnaissance Soil Survey, and (2) the Spink County Soil Survey Series 1.

The Potter County publication consists of a county soils map on a controlled base of scale 1/2 inch = 1 mile, and a report of about 64 pages in which the individual soils and their management are described.

The Spink County Soils Survey Series is the first of its type published in South Dakota. It consists of a large scale air photo soils map of an individual farm, and about 6 pages of tables giving soil characteristics and qualities, yield predictions for specified management systems, and potential irrigability for individual soils.

Approximately 112 miles were mapped in Brookings County, 450 miles in Hand County, and 50 miles in Dewey County, all on progressive standard, soil surveys. (Project 183. Leaders: F. C. Westin, G. J. Buntley, F. E. Shubeck, and E. M. White, Agronomy Dept.)

Soil Testing Increased

The tests made on the soil samples received from farmers during the past 7 years were summarized. Part of this summary was made according to areas of similar soil and plant growth conditions. The summary when made in this way indicates more clearly the level of available plant food elements in an area and corresponds much better to our knowledge of crop response to fertilizer applications.

Cooperation has been started with the National Soil Test Work Group to evaluate current methods and develop better methods for determining the nitrogen-supplying ability of soils.

During the past year 3,300 soil samples have been tested. Approximately 90 percent of these samples were for South Dakota farmers.

In each case where the soil tests indicated a need for additional plant foods, a recommendation was made for those needed. A fertilizer that would supply these plant foods and the best method of application were suggested. (Project 172. Leaders: P. Carson and E. Williamson, Agronomy Dept.)

Barley and Flax Varieties Improved

The 1954 season provided an excellent measure of true yielding ability of barley in eastern South Dakota because the crop was not subjected to major fungus diseases nor other masking effects. Lines that were in the advanced state of testing maintained their superiority of yield when compared with all other barley varieties. Malting characteristics of these were found to be generally favorable. The central and western barley tests suffered from severe drying winds prior to ripening. Barleys with no drought and heat tolerance and experimental lines incorporating these characters were most successful in these tests.

Flax nurseries were severely damaged by a seedling blight tentatively identified as a form of Rhizoctonia. The nearly complete absence of rust decreased the
varietal expressions. Relatively high summer temperatures damaged late maturing varieties.

Tentative increases of high yielding experimental barley lines are being made. These lines are being continued in testing programs throughout the state and in the upper Mississippi Valley.

The recommendation of early, rapid maturing flax varieties for the southern flax areas was substantiated by the effects of high summer temperature on late varieties. (Project 25. Leader D. Harpstead, Agronomy Dept.)

High Yielding Soybeans Developed

Soybeans are an important cash crop in South Dakota. Therefore cooperative adaptation trials with the Northern Soybean Regional Laboratory are conducted on varieties and promising strains in three maturity zones in the state. Results are reported in the following three tables.

In 1954, 15 varieties and strains were planted in the adaptation trials and 8 strains in the preliminary test in group O; 8 varieties in the adaptation trials and 12 strains in the preliminary test in group I; and 16 varieties in group II adaptation test. These varieties and strains are being studied and evaluated for their good agronomic factors. These were 28 F2 crossed progenies grown in the breeding nursery.

Chippewa was increased by the Foundation Seed Stocks Division and about 200 bushels were distributed to the County Crop Improvement Associations in the areas where this variety is adapted. (Project 148. Leader: C. J. Franzke, Agronomy Dept.)

Over 150 Corn Hybrids and Varieties Tested

The proper choice of corn hybrids means a great deal to the welfare of South Dakota farmers since wide differences in yield and maturity exist among hybrid varieties offered for sale in the state. To aid farmers in selecting good hybrids, over 150 entries were included in various yield tests conducted throughout the state in 1954. The results have been made available in South Dakota Agricultural Experiment Station circular 112.

Trials were conducted near Newell, Vale, Cottonwood, Eureka, Highmore, Claremont, Watertown, Brookings, Dell Rapids, Chamberlain, Tripp, and Weldon. This places at least one trial in each of the eight agricultural areas into which the state has been divided.

Table 2. Three-Year Average (1952-54) Group O Early Maturity (Northern Part of South Dakota)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity*</th>
<th>Degree of Lodging</th>
<th>Height</th>
<th>Oil Bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>W6S-292</td>
<td>0</td>
<td>2.3</td>
<td>31</td>
<td>20.2</td>
</tr>
<tr>
<td>Chippewa</td>
<td>+3.0</td>
<td>1.8</td>
<td>33</td>
<td>20.2</td>
</tr>
<tr>
<td>Capital</td>
<td>+0.9</td>
<td>2.9</td>
<td>33</td>
<td>20.3</td>
</tr>
<tr>
<td>Mandarin* (Ott)</td>
<td>0</td>
<td>1.6</td>
<td>29</td>
<td>19.7</td>
</tr>
<tr>
<td>Norcheck</td>
<td>-3.9</td>
<td>1.8</td>
<td>29</td>
<td>20.2</td>
</tr>
</tbody>
</table>

Mandarin (Ott) used as a check. All other varieties taken either as a — earlier than check or a + later than check. Maturity of check 118 days.

Degree of lodging: 1 — nearly all plants erect, 2 — plants leaning and a few down, 3 — 25 to 50% plants down, 4 — 50 to 80% plants down, and 5 — 80% or more of plants down.

Table 3. Six-Year Average (1949-54) Group I Medium Early Maturity (East Central Part of South Dakota)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity*</th>
<th>Degree of Lodging</th>
<th>Height</th>
<th>Oil Bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chippewa</td>
<td>+3.1</td>
<td>1.5</td>
<td>33</td>
<td>20.4</td>
</tr>
<tr>
<td>Blackhawk</td>
<td>+8.6</td>
<td>1.9</td>
<td>35</td>
<td>20.5</td>
</tr>
<tr>
<td>Earlyanna</td>
<td>+10.2</td>
<td>3.0</td>
<td>38</td>
<td>19.7</td>
</tr>
<tr>
<td>Mandarin* (Ott)</td>
<td>0</td>
<td>1.3</td>
<td>28</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Check, Mandarin (Ott) maturity 110 days.

Table 4. Four-Year Average (1951-54) Group II Late Maturity (South Part of South Dakota)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity*</th>
<th>Degree of Lodging</th>
<th>Height</th>
<th>Oil Bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lincoln</td>
<td>+5.9</td>
<td>2.2</td>
<td>39</td>
<td>21.0</td>
</tr>
<tr>
<td>Adams</td>
<td>+2.9</td>
<td>2.1</td>
<td>39</td>
<td>21.2</td>
</tr>
<tr>
<td>Harsoy</td>
<td>-3.0</td>
<td>1.9</td>
<td>37</td>
<td>20.6</td>
</tr>
<tr>
<td>Hawkeye*</td>
<td>0</td>
<td>1.6</td>
<td>36</td>
<td>20.9</td>
</tr>
<tr>
<td>Blackhawk</td>
<td>-6.2</td>
<td>1.8</td>
<td>34</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Check, Hawkeye maturity 121 days.
From 15 to 42 entries were included in each of the tests. They were the most widely used hybrids in each area as determined by surveys of the representatives of corn companies producing and registering hybrids for sale and of county agents located in the areas where trials were conducted.

Information obtained included yield and moisture content of the corn at harvest, the latter indicating relative maturity. Lodging was taken in plots where it occurred. With entries included for more years than 1954, average performances were calculated.

The 1954 growing season was characterized by above average temperatures during July and early August while rainfall was below average for the same period. This resulted in somewhat lower corn yields than were obtained in 1953, but even so, good results were obtained from many plots. For example, the Brookings County plots averaged 76 bushels per acre and the Hutchinson County plots averaged 75 bushels per acre for all entries.

South Dakota-developed hybrids performed very well in the tests. In 10 out of the 15 trials harvested, station hybrids ranked first or second in performance rating. (Project 151. Leaders: D. B. Shank and D. E. Kratochvil, Agronomy Dept.)

Testing New Legume Developments

Since the 1954 report, agronomic and disease data have been obtained on several hundred plants in alfalfa progeny test nurseries at the Brookings and Cottonwood Stations, and in advanced observational nurseries at the Brookings Station.

Results obtained in 1954 indicate:

(1) In the Group III test (root prolificous type) there is little genotype and environment interaction; that is, the families that were most aggressively creeping at the Brookings Station were also most creeping at the Cottonwood Station. One variety of this type for the trait in question, should be satisfactory in most of South Dakota.

(2) Under conditions of intense selection for a highly heritable quantitative trait such as reaction to common leaf-spot in alfalfa, the additive genetic variance for that trait may be quickly exhausted. The 1954 results confirmed our experience on this point, first obtained from 1953 data from the Group I nursery.

Thirty-three selections of the creeping rooted type were made in the late fall in 1954 and intercrossed in groups in the greenhouse during the winter. Clonal material from these selections was established for foliage disease screening tests and wilt inoculations to be carried out in 1955.

Ninetynine selections of the wide-crowned type were also made in late fall of 1954 and these have also been subjected to further disease tests. On the basis of clonal and progeny performance in greenhouse and field for both agronomic and disease effects, 5 genotypes (parental clones) of the H2 group have been chosen as the basic clonal lines on which to base a new synthetic variety suitable for pasture in South Dakota. Preliminary vegetative increase has commenced for the launching of this strain.

Preliminary vegetative increase has commenced for the launching of this strain. The first seed will be used for area testing.

The work contributing to sub-project 2 (NC-11) has been with disease screening some 26 diploid lines and 14 tetraploid lines. Initial screenings were made using cultures of Ascochyta imperfecta and Cerospora zebrina. Neither organism fully duplicated field results, which had previously indicated marked differences in reaction to alfalfa blackstem disease. Self-pollinations have been made on all 40 entries in the test for the purpose of producing S1 families whose field reaction to blackstem will be sought in the summer of 1955 to confirm the parental reaction and to provide initial information on the genetics of reaction to the disease.
Pasture tests of several strains of alfalfa continue at three stations. A set of 14 strains of sweet clover was evaluated for total dry matter and total nitrogen produced in the seedling year. The biennials were found superior to the annuals in both respects, although the annual strain, Israel, is very promising as a green manure crop. In two experiments, one at Redfield and one at Brookings, we are studying the effect of differential soil moisture supply and phosphorus upon the development of rhizomes in two strains of alfalfa. (Project 74. Leader: M. W. Adams, Agronomy Dept.)

Grass Breeding

The immediate objectives in grass breeding are concerned with the improvement of existing species of grasses such as smooth brome grass, intermediate wheatgrass, and crested wheatgrass, which are well suited to South Dakota conditions. These may be made more acceptable by increasing their resistance to disease and increasing seed and forage production. These objectives are being achieved by selection and crossing and reselection combined with a degree in inbreeding.

There is, however, a more long-term and more challenging objective, the possibility of obtaining a grass totally different in its seed characteristics and consequently its ease of establishment and even the use of its seed for something more than just propagation. To achieve the long-term objective, crossing between different genera and selection within their progenies is being conducted. A program of selection for resistance to winter injury is being followed, using the artificial freezing chamber. The use of mutagenic agents combined with cytological studies are being used concurrently in this program. Evaluations of progenies of these plants are being made at Brookings and Cottonwood.

Screening tests for diseases are being conducted both in the greenhouse and the field. Seed from selected plants of intermediate wheatgrass and crested wheatgrass is being tested in comparison with the commercial varieties. Tests at Highmore, Cottonwood, Eureka, and Brookings continue to indicate the value of grass-legume mixtures and the superiority of Homesteader brome grass and Ree wheatgrass. (Project 182. Leader: J. Ross, Agronomy Dept.)

Pasture Trials Continued

Four types of pastures were grazed with Hereford yearlings. These were brome grass, alfalfa-brome, sweet clover-rye, and Sudan-soybeans. Because of sweet clover weevil and summer drought in 1953, the sweet clover was lost. The pastures were fertilized to maintain good soil productivity.

To estimate the amount of forage consumed each month by the livestock, several cages were placed in each paddock and clipped immediately after the cattle were moved to the alternate half of the pasture paddock. Each pasture was divided in half with a fence so the livestock could be rotated for better utilization and management.

The 1954 season was quite dry and the returns were smaller than those obtained in 1953. A new pasture of Sudan-soybeans was started with promising results. Summary from clippings trials from the pastures were as follows: brome 3760 pounds; alfalfa-brome 4470 pounds; rye 1599 pounds; and Sudan-soybeans 2256 pounds per acre. The results obtained with livestock are reported under "Livestock Production." (Project 225. Leaders: W. W. Worzella, Agronomy Dept., L. E. DuBose, Animal Husbandry Dept.)

New Cultural Studies Started

Three phases involving culture studies were undertaken during the year on this new project as follows: (1) methods of applying fertilizer, (2) Sudan-soybean combination, and (3) rates, dates, and corn maturity studies. On oats
in eastern South Dakota the method of drilling fertilizer gave the same yields as the broadcast method. In central South Dakota higher wheat yields were obtained by drilling the fertilizer with the seed. Drilling the fertilizer with the seed had no adverse effect on the stand. Using different row spacings on Sudan grass and soybeans, it was found that planting soybeans and Sudan grass in 6-inch rows proved best for forage yields. New pasture plots involving Sudan-soybeans were tested during the year.

A study was initiated to determine the total number of degree days required to mature varying maturity corn hybrids. Limited evidence indicates that this method may be more accurate for determining length of growing seasons for hybrids than the present practice of designating “number of days.”

On the basis of 1-year’s data, the data support the drilling of fertilizer with small grain seed over broadcasting, especially in central South Dakota. Sudan-soybean pasture should prove to be an excellent supplementary pasture in eastern South Dakota. Steers gained 2.5 pounds per day on this pasture. Alfalfa-brome pasture showed less gain per day than the soybean-Sudan. (Project 256. Leader: W. W. Worzella, Agronomy Dept.)

**Weed Control Research**

Although the easiest methods of weed control are preventative measures such as using good, clean seed, good crop rotations, fertilizer, and proper cultivation, the large infestations of weeds make it necessary to learn the cheapest and most effective methods of eliminating weeds now present.

Forty acres of leafy spurge have been divided into some 1200 plots to determine the most effective method of eliminating this weed. The leafy spurge research farm is located in northeastern Deuel County.

Soil sterilants such as chlorate, borax compounds, mixtures of chlorate and borax, amate, mixtures of borax and 2,4-D, and heavy applications of 2,4-D amine have proved to be effective for eliminating small patches. The borax compounds are the most effective and can be applied in July or September. The compounds containing chlorate or amate are not as effective in July as they are in September. However, all of these are too expensive to be used on anything but small patches. The borax compounds leave the soil unproductive for the longest period of time, followed in order by the borax-chlorate mixtures, chlorate, and amate.

Forty pounds (10 gallons) of 2,4-D amine is practical for elimination of patches up to, perhaps, 5 acres in size as the cost is less than for the soil sterilants. This treatment should not be applied until after October 1, however. The soil temperature will then be low enough to inactivate soil micro-organisms that decompose the 2,4-D applied when the soil is warmer.

Large infestations cannot economically be eliminated with chemicals alone. Proper cultivation and competitive crops used in conjunction with 2,4-D, however, will eliminate a high percentage of a heavy stand in 3 years. Spraying with 2,4-D in spring planted small grain is not adequate even though cultivation is used after harvest. The spurge gets ahead of the crop and the crop is not able to compete. Fall planted grains get an earlier start in the spring and offer more competition. However, Sudan grass seeded with a grain drill was the best annual crop tested. It was seeded after two crops of rye had been raised.

In the most successful treatment, fall planted rye was sprayed with one-half pound per acre of 2,4-D in an ester form before the rye headed out (about May 20). After harvest the stubble was sprayed with 1 pound per acre of 2,4-D in an ester form (about August 15).

A second crop of rye was seeded about September 10. It was not sprayed, but the stubble was sprayed with 1 pound of 2,4-D ester per acre (about August 15).
The area was plowed early in September and cultivated once with a duckfoot cultivator. During the spring of the third year the area was cultivated three times (May 15, June 1, and June 15) and the Sudan grass was seeded at a rate of 25 pounds per acre. It was cut for hay early in September and fall plowed.

When corn was planted the next year, over 95 percent of the spurge was gone. This plot is shown in Figure 2. A similar plot treated the same way for 2 years, but seeded to oats which was sprayed with one-half pound of 2,4-D ester the third year, is shown in Figure 3.

Perennial grasses and alfalfa are helpful in eliminating leafy spurge. A heavy stand (much better than the average stand) of alfalfa was needed to eliminate the weed. The leafy spurge was reduced considerably in a bromegrass stand by spraying with 1 pound of 2,4-D ester per acre twice a year (May 15 and September 1) for 3 years. However, this was not sufficient to eliminate all of the spurge.

Best results with bromegrass were obtained when the infestation of spurge was cultivated with a duckfoot cultivator every 2 weeks from May 15 to August 15. The bromegrass was seeded at the rate of 15 pounds per acre with 1 peck of oats as a companion crop.

Fig. 2. The best treatment controlled 95 percent of the leafy spurge in 3 years.

The next year the bromegrass was sprayed with 2,4-D ester. The amount of 2,4-D and the time of spraying were apparently unimportant. About 95 percent of the spurge was killed in all plots regardless of whether one-half pound or 1 pound of ester was used. One spraying was enough. Bromegrass seeded after cultivation yielded approximately 2 tons of hay per acre the next year; whereas, bromegrass seeded in the fall after small grain had been harvested did not yield a hay crop until the second year after seeding.

Russian Knapweed. Methods of controlling Russian knapweed are being studied on a 12-acre research farm in Spink County. It is too early to tell what the results will be, but at present it appears that they will be similar to those obtained with leafy spurge.

A 25-acre research farm was established this year in Hamlin County to study methods of controlling Canada thistle and perennial sow thistle. No results have been obtained.

Annual Grasses. Annual weedy grasses such as foxtail (pigeongrass) and especially wild oats are problems in much of the state. Each year for the past 5 years, numerous chemicals have been
tested for their effectiveness on these weeds. Nothing has been found that will kill wild oats. TCA is effective on foxtail. It can be used satisfactorily in flax if the weeds are not over 2 inches tall but cannot be used in small grain.

Aerial application of 2,4-D to wheat was compared with ground application during the summers of 1952, 1953, and 1954 in Perkins County and during the latter 2 years in Beadle County. All told, almost 100 acres of plots were devoted to this study. This study has been completed and the following conclusions were drawn:

1. There were no differences between aerial and ground applications of 2,4-D as far as yield of wheat or the kill of weeds was concerned.
2. Three ester formulations of 2,4-D had similar effects on yield and weed kill.
3. There were no differences between oil and water as carriers.
4. The volume of carrier per acre had little effect on yield and weed kill.
5. Comparison of rates of application of 2,4-D esters showed that up to half a pound acid equivalent had no effect on wheat yields when applied at the five-leaf stage to seven-leaf stage of growth. Higher rates sometimes reduced yield.
6. Wheat was more susceptible to 2,4-D when in the boot than when in the five- to seven-leaf stage of growth.

During the summer of 1954 several chemicals were tested for their effect on alfalfa seedlings when underseeded with oats and when underseeded with flax. Many of the chemicals were injurious to one companion crop or the other. However, the present stands of alfalfa indicate that several of them did not injure this crop. Final results have not been obtained.

Specific recommendations for the control of weeds are outlined in Experiment Station circular No. 102 entitled *Perennial and Annual Weed Control in South Dakota*. Summaries of this circular are given in Extension leaflets 154 and 155. Copies of these publications can be obtained from the County Extension Agents’ offices or from South Dakota State College. (Project 32. Leaders: Lyle A. Derscheid and R. Nash, Agronomy Dept. and State Weed Board cooperating.)

Colchicine, the Latest Tool for Plant Breeders, see page 18
Winter Grains for South Dakota, see page 41
Fall or Spring Fertilizer Application in Western South Dakota? see page 62
S. D. 604, A New Corn Hybrid for Southern South Dakota, see page 66

**Dairy Production**

**Milking Machine Sanitation**

The experimental work on this project has been completed. At present a manuscript is being prepared for publication. (Project 155. Leader: R. J. Baker, Dairy Husbandry-Bacteriology Dept.)

**Manufacturing Cottage Cheese**

Alterations of the standard manufacturing procedure for cottage cheese are being studied. The addition of dried milk-solids-not-fat to increase the total solids in the milk has been followed routinely. This has served two purposes, namely (1) to give a curd which is more firm and easier to handle during cooking, and (2) it is a means of increasing the yield of cheese if the vat capacity is limited.

The cottage cheese curd has been stored in a 2 percent sodium chloride brine solution, in the refrigerator, before being creamed. Brine storage is preferred to dry storage because there is no drying of the curd particles during long storage periods and the microbial spoil-
age is more easily controlled. (Project 169. Leader: R. J. Baker, Dairy Husbandry-Bacteriology Dept.)

A Study of the Recovery and Transplantation of Bovine Ova

The work this year has dealt with (1) the continued use of progesterone to regulate the estrus cycle of the cow, (2) the effects of relaxin upon a cow's cervix, and (3) a catheter for flushing the ova from the living animal.

The use of 50 milligrams of progesterone daily to control the estrus cycle is fairly well established. However, frequently, the estrus period following the use of progesterone is accompanied by a failure to liberate ova for fertilization. Further investigations are necessary to prove whether or not the ovaries are receiving the proper amount of progesterone in every case to induce ova liberation.

Repeated injections of 1500 guinea pig units of relaxin at 4-hour intervals, over a period of 96 hours, has not caused a relaxation in the cow's cervix so that it could be dilated more than 1.6 inches as has been done by a single injection. Apparently there is no accumulative effect on the cervix by repeatedly injecting relaxin.

Recovery of the ova by irrigating the uterus with a limited quantity of solution has been attempted. A catheter has been devised that can be placed in the upper horn of the uterus and that portion washed with a small quantity of physiological saline. Usually 50 milliliters has been the quantity used. The results from this have been rather disappointing in that the catheter is very hard to pass through the cervix and also extremely difficult to hold in place in the cow's uterus. The number of ova recovered by this device are similar to those recovered by other uterine flushing methods. (Project 189. Leader: Arthur E. Dracy, Dairy Husbandry-Bacteriology Dept.)

Growth Studies of Calves and Growing Heifers

The birth weight, height at withers, and chest circumference of dairy calves of the Holstein, Brown Swiss, Guernsey, and Jersey breeds are determined once weekly from birth to 1 month of age. Subsequently to maturity the measurements are taken monthly.

These data are valuable for establishing growth standards for the North Central States. The feasibility of breeding heifers for first pregnancy according to size and development rather than age may be a possible development from these studies. This is a long-time study. (Project 153. Leader: Emery Bartle, Dairy Husbandry-Bacteriology Dept.)

Improved Pastures for Dairy Cattle

The available acreage in the college dairy farm (approximately 90 acres) has been divided into 5 areas and a 4-year rotation has been established, consisting of corn for silage, oats for silage, seeded to alfalfa-bromegrass, followed by 2 years of alfalfa-bromegrass. One permanent bluegrass area serves as the control. This permits the testing and demonstration of rotation grazing as compared to continuous grazing. The comparative response to grazing at several stages of maturity of the alfalfa-bromegrass is tested. Other pasture management problems of practical application will also be studied. (Project 234. Leader: Howard Voelker, Dairy Husbandry-Bacteriology Dept.)

Bloat in Ruminants

During the summer of 1954 and the spring of 1955 no cases of natural bloat occurred among the experimental animals. Thus, all the work has dealt with some means to artificially induce bloat.

A series of experiments was conducted to determine the effect of atropine on rumen motility and the accumulation of gas in the rumen. When 5.6 grains of atropine was injected none of the animals showed signs of gas retention in the
rumen. These animals were unable to eructate, so as long as normal fermentation continued, the gas must have been lost from some other route.

To determine whether fresh alfalfa tops might cause an increase in blood sugar, reduce rumen motility, and cause bloat, some cows were kept on fresh cuttings several months. To further increase the sugar content of the ration, 4 pounds of corn sugar was given to the experimental subjects to possibly increase the blood sugar. None of the animals showed signs of elevated blood sugar nor signs of indigestion. None bloated and all had normal rumen motility. (Project 245. Leader, Arthur E. Dracy, Dairy Husbandry-Bacteriology Dept.)

Effect of Antibiotics on the Microflora of Chickens

A study of the intestinal contents of chickens has shown the normal bacterial flora to be as follows:

<table>
<thead>
<tr>
<th>Type of Bacteria</th>
<th>Range in Numbers per Gram of Feces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliforms</td>
<td>1x10^5 to 1x10^6</td>
</tr>
<tr>
<td>Streptococci</td>
<td>1x10^6 to 1x10^8</td>
</tr>
<tr>
<td>Lactic acid bacilli</td>
<td>1x10^5 to 1x10^6</td>
</tr>
</tbody>
</table>

No definite increase or decrease in the numbers of bacteria within the major groups of intestinal organisms has been shown to be due to the action of penicillin or aureomycin in the ration. It has been found during weekly sampling that variations in the coliform count were as great or greater between individual birds on the same ration than the variation from birds on different rations.

At the present time daily counts are being made on fecal samples from young chickens to attempt to eliminate these variations and to determine if there is any major shift in organism numbers during the first 2 weeks of a chick’s life. These chickens have been divided into five groups and are receiving the following ration supplements:

- Ration 1. Aureomycin
- Ration 2. Penicillin
- Ration 3. Penicillin plus growth factors
- Ration 4. Arsenical Compounds
- Ration 5. Control diet

The work to the present time has been on young chickens. It is hoped that the methods and techniques of the work on chicks may be applied to determine the effect of antibiotics on egg production of adult hens. (Project 257. Leader: E. C. Berry, Dairy Husbandry-Bacteriology Dept.)

Farm Economics

Share Rents and Short-Term Leases

Out of every ten farmers in South Dakota three rent all the land they operate. Another four rent part of the land they operate. Of these tenants, 83 percent have 1-year or year-to-year leases that can be terminated at the end of any lease year. Thus most tenants do not know whether they will be able to keep the land beyond the present crop year.

This insecure possession of the land has important effects on the way the tenants farm and live. This in turn affects the landlord and the community in which the tenants live. Insecure possession of tenure also affects the degree to which it has been possible to achieve national objectives of production adjustment and soil conservation. Tenants have little incentive to use their spare time in making lasting improvements on farms—to build terraces, dams, and fences or erect or remodel buildings—when they do not know how long they can keep the farm.

Longer-term leases are an obvious remedy to this problem. Two-thirds of the tenants say they would like lease
terms of 3 years or more.

*Share Rents and Short-Term Leases*, Station Circular 117, June 1955 presents the landlords' answers to this question and goes on to suggest possible solutions.

The most important reason appears to be associated with the use of share rent leases. Landlords say in effect that they have turned over to the tenant $10,000 to $30,000 worth of land and improvements at the beginning of the lease in exchange for a promise by the tenant to do "a good job of farming" and to give a share of the product. Under these circumstances they feel they need a short-term lease to make sure the tenant keeps his end of the bargain. What constitutes a "good job of farming" varies from year to year and at best is difficult to describe. The use of a more precise rental arrangement than the share appears desirable. Cash, standing rent, or flexible rent leases may meet this need. Copies of such lease forms are available from the Agricultural Economics Department.

At present a survey of tenants is being made to determine their willingness to accept these more objective rental arrangements as a means of getting longer term leases.

Tenant preference for cash and share renting will be studied in an area where cash leasing is a common practice. The effect of share compared with cash leasing on the tenant's feeling of security in the possession of the land will be studied.

*Farm Rental Arrangements*, a nine-page leaflet describing farm rental practices in each area of the state as reported by 1500 farm tenants is being published by the Extension Service. (Project 147 R. Leader: Russell L. Berry, Agricultural Economics Dept.)

**Alternative Leasing Arrangements for Beginning Farmers**

Many beginning farmers are caught between the alternatives of an insecure share rental system and farm ownership. While more secure, farm ownership may be undesirable in that it absorbs a large share of the farmers' working capital. As a result, entry into farming and the young farmer's level of living may be jeopardized.

This raises the question as to whether alternative rental arrangements, which provide greater security of tenure and freedom of operation at lower costs than does the crop-share lease, would be acceptable to tenants and landlords.

A field survey is now being made to determine under what conditions alternative tenure arrangements would be acceptable to tenants. (Project 166. Leader: Russell L. Berry, Agricultural Economics Dept.)

**Farm Management Practices**

The farm management practices project was started this fiscal year. It is an extension of work formerly carried on under project 146.

The project deals with earning capacity, management practices, and input-output relationships on different size farms and ranches in various parts of the state. A sample of farms and ranches representative of the various types and sizes found in each agricultural area of the state is being selected. The selection of the sample is being accomplished with the advice and assistance of county agents.

Cooperation of operators is being obtained in keeping detailed records of their financial transactions, operating techniques, and input-output relationships. The Experiment Station will provide assistance in keeping the records. In return for this assistance the information contained in the farm records will be available to the Experiment Station for analyses. Data thus obtained will provide insight into actual costs and operations on South Dakota farms and ranches. (Project 264. Leader: Allen R. Clark, Agricultural Economics Dept.)

**Farm Credit**

A study was conducted to record the experience of the thirties while records
and the memories of people concerned were still available. 

Objectives of this study were (1) to analyze the operation of general bankruptcy procedure as used by farmers, (2) to appraise the effectiveness of Section 75 of the United States Bankruptcy Act as a relief measure and of the Frazier Lemke Act in particular, and (3) to evaluate the bankruptcy experience of farmers in North and South Dakota from 1928-53 in regard to the development of effective farmer-debtor relief legislation.

The experience of farmers in North and South Dakota indicates that Section 75 of the U. S. Bankruptcy Act, particularly in its early years of operation, was not an adequate means of relieving financial distress among farmers. Several factors, separately or in combination, tended to reduce the effectiveness of this legislation.

Section 75, as originally enacted, provided only for voluntary conciliation. The credit policies of many lenders did not permit them to enter into any agreement which would reduce the contractual obligations of the debtor. A large number of cases in North and South Dakota were dismissed on constitutional grounds before the compulsory settlement provision of the Frazier Lemke Act was amended and held to be constitutional.

It appears desirable that permanent farmer-debtor relief legislation be enacted before economic crises occur. Experience under previous bankruptcy laws has shown that emergency legislation is often drafted with more emotion than deliberation.

It should not be assumed, however, that future legislation cannot be patterned after Section 75. Although the act was a hastily written and temporary piece of legislation, its provisions were considerably strengthened by court decisions and by actual practice. However, it is desirable that the weaknesses of the old legislation be eliminated by the addition of new and more farsighted measures designed to reduce economic hardship among farmers.

There is need for continued study of bankruptcy experiences of farmers in North and South Dakota. Farmers here and in other Great Plains states make more use of bankruptcy laws than in any other part of the country.

The findings of this study are published in Agricultural Economics pamphlet 61, available in mimeographed form. (Project 240. Leader: Allen R. Clark, Agricultural Economics Dept.)

The Farm Tax Burden

Our demands for tax supported services in South Dakota are ever increasing while the tax receipts used to finance these services are not increasing accordingly. South Dakota farmers have been and are being called upon to carry a large portion of the total tax burden in this state. As any successful tax system must eventually rely on the earnings of the taxpayer, it follows that the farmers' ability to bear the tax burden is related to the prosperity of that group.

The burden of taxation can increase as a result of improper adjustments in taxing procedures in relation to economic changes. As the percentage of total income decreases for agriculture and increases for other sectors of the economy, the incidence of tax payments should change accordingly.

For these reasons it is desirable to review and analyze our tax program from time to time so that alternatives may be suggested which can make the tax system in South Dakota more adequate and more equitable. Such an analysis was made and is compiled in a mimeographed pamphlet (No. 58) entitled, "Taxation in South Dakota." Included therein is a review of the major types of tax levies and expenditures in South Dakota with separate sections devoted to education, highway, and public welfare expenditures.

An analysis of overlapping taxes as
they apply in South Dakota is also considered.

Major emphasis was given to taxes that are most burdensome on farmers. Thus the property tax was treated in more detail with considerations given to the effect of the sales tax and the state income tax on agriculture.

Finally estimates were made of selected types of tax obligations of farmers in South Dakota, and alternatives were suggested for increasing our tax revenue. (Project 262. Leader: Max Myers, Agricultural Economics Dept.)

Economic Trends Within South Dakota

This project is directed toward collection of various data which affect or indicate trends in the state economy.

Data on farm mortgages and farm mortgage foreclosures provide excellent indications of the trend in economic well-being of agriculture within the state.

According to the USDA Agricultural Research Service the estimated farm mortgage indebtedness in South Dakota on January 1, 1954, was $112,224,000, and the preliminary estimate for 1954 was up to $117,304,000.

The collection of farm mortgage foreclosure data from South Dakota farmers was continued. Farm mortgage foreclosure reports are from the official records of the county Register of Deeds. During 1954 there were 18 such foreclosures involving 6,728 acres of farm land in South Dakota. Genuine redemptions numbered three and covered 1,473 acres. In addition one friend "redeemed" 1,861 acres and another friend "redeemed" 320 acres, each reportedly with the idea of returning the title to the original or former owner when the latter repays his "friend."

Mail Questionnaire. The farmer-debtors involved in foreclosures were asked by mail to give the basic cause or causes of delayed payment or non-payment which lead to foreclosure. Unfortunately relatively few replies were received. Others, including lenders and county agents, also were asked for information. In a few counties where Registers of Deeds failed to reply it was necessary to obtain the information from the county agents.

An inquiry into the economic consequences of farm mechanization provided statistics for South Dakota. It indicated the principal results of increased mechanization have been increased size of farms and increased effectiveness in use of land and labor in agricultural production.

A revised supplement to circular 17 is under way. It is entitled, Farm Mortgage Foreclosures Instituted in South Dakota, 1921-1954. The analysis of the data is broken down on a county basis grouped by agricultural areas.

Census data covering 50 years of South Dakota agriculture were assembled and published in Agricultural Economics pamphlet 56.

Weather Project. The work on the I.B.M. weather project has continued. Cards for the Rapid City station from 1889 have been punched and cards for Menno and Gann Valley have been completed. Most of the work this past year has been in preparing the cards to make weekly summaries of the data. Weekly summary cards have been made for 24 stations in the state and tabulations have been furnished the Agronomy, Horticulture, and Agricultural Engineering Departments.

Bulletin 441, Likelihood of Damaging Low Temperatures During the Growing Season, was completed and published. This bulletin shows the likelihood of low temperatures occurring at 12 locations within the state during the critical spring and fall months. This can be used by farmers to determine the length of the growing season for various crops as well as most suitable time for seeding and harvesting farm crops.

Considerable work has been done on
ern South Dakota are among the most productive and valuable soils in the state and among the ones most subject to soil erosion. During the past year a manuscript has been prepared for review showing the estimated effects of various amounts of legumes on crop yields and total production per 100 acres on three important soils in Moody, Minnehaha, Lincoln, Union, Clay, and Turner Counties.

Yield estimates prepared in cooperation with agronomists of the Experiment Station indicate that by seeding one-third to one-half of the cropland to sweet clover as a catch crop each year farmers in south-eastern South Dakota can increase their total grain production per farm by 25 to 30 percent. Net returns above cash expenses would jump $900 to $1100 per 100 acres of cropland. No additional investment in fences, buildings, or livestock would be needed to secure this return.

Farmers who are efficient producers of a forage consuming livestock—dairy, beef, or sheep—and who can get the necessary funds may find it more profitable to put one-fourth of their land in alfalfa-brome for hay. Such a change would gradually increase the total digestible nutrients from 67 tons per 100 acres to 92 tons without a lag as the legumes moved from field to field. Without the increased investment in livestock, putting one-fourth of the cropland in legumes would cause a drop of $300 to $500 in net cash income as compared to sweet clover catch crops. If these legumes prevent serious erosion, however, it may still be profitable for the farm owner to put 25 percent or more of his cropland in legumes. (Project 211. Leader: Russell L. Berry, Agricultural Economics Dept.)

Best Time to Market Livestock

One of the important problems facing producers of feeder cattle is the best time to market their cattle. They have to determine whether it is best to market
them as calves, yearlings, or later. They have to select a specific date to market their cattle and must weigh both the price and production factors in deciding this date.

There appears to be little difference in cost of feed-lot gains at different times of the year. There are decidedly larger supplies of finished cattle marketed at certain times of the year. This, of course, means lower prices at times of peak marketing of finished cattle. The seasonality of marketing of finished cattle may be traced to the seasonality in marketing of feeders. This seasonality in marketing of feeders also is reflected in a seasonal price pattern for feeders.

If the amount of seasonality in feeder marketing can be reduced this will result in a more even marketing of finished stock and more even supplies of beef over the year. This may be expected to benefit ranchers, feeders, and consumers. 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.

Past research work under this project has been directed primarily at providing detailed information on seasonal and cyclical price patterns for use by farmers and ranchers in planning their budgets and operations. This work is now being expanded to consider seasonal differences in production costs, rates of gain, condition of the livestock when offered for sale, and other factors such as labor, capital requirements, and feed supplies that affect net returns under different livestock programs. (Project 226. Leader: Richard R. Newberg, Agricultural Economics Dept.)

Marketing Dairy Products

Butter quality remains one of the foremost problems of the South Dakota dairy industry. A recent bulletin, Quality Aspects of Butter Marketing in South Dakota, analyzes some of the factors affecting the quality of butter. It was found that differences in butter quality among creameries were strongly associated with methods followed in procuring cream. The cream station and direct railroad shipment methods of procurement generally resulted in lower quality butter than did the truck route and door delivery methods. Frequency and regularity of cream procurement were found to be important factors affecting cream and butter quality.

In general, creameries that usually produced higher quality butter received more favorable prices for all of their butter, even for the lower grades. Butter consumption has declined drastically in recent years. Higher quality appears to be a means of increasing consumer acceptance of butter.

A means of improving butter quality currently being studied is whole milk procurement. This generally would involve daily pickup of milk, separation and churning at the receiving plant, and drying skim milk at a central plant. The over-all feasibility of such a shift is being considered for a small group of co-

Improving the Marketing of Farm Supplies

Many South Dakota farmers are finding themselves caught in a price-cost squeeze. The prices of the products they sell have been decreasing with little decrease in the price of supplies needed for production.

The most important item on the cost side is farm machinery. Much of this machinery is bought on credit. This study is being undertaken with the objective of investigating the role of credit and its availability to farmers who want to buy major items of farm machinery. Alternative methods of lowering credit costs will be examined.

This study is also designed to investigate marketing channels for other farm supplies with a view to lowering the cost of marketing these supplies. (Project 226. Leader: R. L. Kristjanson, Agricultural Economics Dept.)
operative creameries in the eastern part of the state. Results of this study will be applicable to many other areas where conditions are similar. (Project 201-R. Leaders: Travis W. Manning, Agricultural Economics Dept; Delbert F. Breazeale, Dairy Husbandry Dept.)

Methods and Costs in Retail Distribution of Meat and Meat Products

A detailed study was made of sample retail stores selling fresh meat in South Dakota and other states in the North Central Region. Data on prices of various cuts of meat, quantities and grades purchased and sold, costs of operation, and other facilities used were collected from each of the states over an 8-week period.

These data are being combined to provide information on methods, costs, and efficiency of operation of retail meat distributors. The data also will provide an index of the accuracy with which market prices received for livestock reflect consumer preferences.

In another phase of work under this project, data were collected on total receipts of all types of livestock received daily at central markets over the past 5 years.

Data on prices of different types of livestock at central markets are also being collected. These data are being subjected to statistical analysis to determine the principal factors that affect market prices and to determine why differentials between markets change. Factors affecting the efficiency of operation of central markets are also being analyzed with the objectives of increasing efficiency and improving the services offered by these markets. (Project 228. Leader: Richard R. Newberg, Agricultural Economics Dept.)

Developing Market News Service for Local Auctions, see page 8
Grain Marketing Problems in South Dakota, see page 30
Will Irrigation Pay in Central South Dakota? see page 86

Farm Engineering

Application for New Materials and Design in Farm Buildings

Research on materials and types of construction of above-ground trench silos has continued during the past year. A new trench silo utilizing tongue and groove, pressure Cresote treated, 2-inch material was erected. A 2-year old above-ground trench silo was lined with fir flooring running vertical to aid in the exclusion of air and prevent silage spoilage.

The 50 pine fence posts of 3- to 5-inch diameters that received a cold dip treatment of Pentachlorophenol are now entering their third year and are in excellent condition.

Research on expanded shale for use as lightweight concrete aggregate continued during the year. Additional samples were tested and manufacturing was increased during the year at the two plants now manufacturing this light aggregate material. Follow-up work was conducted at lightweight block manufacturing plants on quality, yield, strength, and texture of the units. (Project 203. Leader: Dennis L. Moe, Agricultural Engineering Dept.)

Poultry House Ventilation

A heat exchanger ventilation system was used in the poultry house at Highmore for the second winter. This unit consists of a number of parallel tubes through which exhaust air is forced. Incoming air passes through the spaces outside the tubes, where it is warmed, recovering about one-half the heat removed from the building by ventilation.

The flock of laying hens was smaller than the building was designed for. This
made it difficult to keep the building warm. In spite of this, when the heat exchanger was operating, freezing did not occur in the building until the outside temperature was at zero or below for several hours. In comparison, with the two-exhaust fan system, freezing occurred at temperatures as high as 9°F. Moisture removal was adequate, with the relative humidity never higher than 80 percent (considered the maximum desirable) while the heat exchanger was in use.

Power costs for the unit have averaged 45 cents a day (electricity at 2½ cents a kwh). This could be reduced by more careful design and streamlining of the air ducts and the use of more efficient fans.

Dust has presented a problem. It accumulates on the exhaust fan blades and reduces the fan efficiency. Inside the tubes it restricts air flow and interferes with heat exchange. Although the exchanger was designed to be cleaned, thorough cleaning is difficult, and it appears some type of filter should be used. The large amount of dust present clogs filters rapidly, requiring that the filters be changed or cleaned frequently. At present a plastic element filter (Goodyear Pliatron) is being investigated. This is a permanent filter which is easily cleaned with water.

Construction of an air-conditioner and dehumidifier for summer cooling as well as winter ventilation has been started. (Project 232. Leader: T. R. C. Rokeby, Agricultural Engineering Dept.)

Trench Silos for Grass Silage Storage

This is the third year of a project initiated in May 1953 to study the handling, storage, and feeding of grass silage. Several college departments (Agricultural Economics, Agricultural Engineering, Animal Husbandry, Dairy, and Station Chemistry) are cooperating on the various phases of the project.

Agricultural Engineering has been concerned chiefly with structural requirements, performance, and costs of trench silos as compared to other types of storage. Consequently, silage was stored in a trench silo, an above-ground trench silo (built in 1953), as well as in rectangular stacks, round piles, and conventional upright silos.

Trench Silo. The trench silo was made rather small to fit a beef feeding trial. It held 35 tons in 1953 but was expanded to hold 65 tons in 1954. An unsuitable location made it necessary to build only one-half of it below ground to get suitable drainage. The original excavation, materials, and labor cost of this silo was $138 or about $3.80 per ton of silage.

Above-Ground Trench Silo. The above-ground trench silo is 60 feet long, 8 feet high, and an average of 14 feet wide. A concrete floor was placed the second year. The walls are made of 2- by 6-inch lumber and they are supported by 6-inch by 12-foot treated posts. The total cost of this silo was $850, which includes labor, materials, two self-feeding gates, and support rails. This represents a cost of $4.08 per ton of storage capacity, and 208 tons were stored in it in 1954. Storage in an upright silo will range from $10 to $15 per ton.

The principal advantage of a trench silo over an upright in addition to original cost is the labor-saving, whether it is
self-fed or removed with a tractor scoop. In 1954, a labor record showed that it required 2.1 man-hours per ton to throw down feed silage from an upright, while the self-feeding from the above-ground trench required less than 1/10 of a man-hour per ton.

"Pilot Silos." During the second year (1954), "pilot silos" were constructed and used in the study to get a closer control on weight loss during the curing process. Nine 1-ton silos were used with different preservatives and degrees of packing. These pilot silos are being used again this year.

Extensive measurements of temperature in the various silos were accomplished by means of thermocouples. A total of 165 thermocouple points were placed in the six silos or stacks. Results showed lower temperatures in packed silage and higher temperatures in unpacked stacks or near exposed surfaces. All "spoilage" or dark material was in areas of high temperature. Plastic covers have been used and have reduced silage temperature by exclusion of air. But their high cost and relatively short life make their practicability doubtful.

This year a special type of above-ground trench silo is under construction, which will permit measurements on side-wall pressures. This information is necessary for structural design purposes. One wall of this silo is vertical and one is sloping. Hence, a comparison will also be made of the relative effectiveness of vertical and sloping walls in regard to side-wall packing and spoilage. (Project 237-A. Leader: G. C. Zoerb, Agricultural Engineering Dept.)

Low Volume Fan Successful in Grain Storage Work

The second year of grain conditioning work carried on at the bin site of Sully County ASC, Onida, South Dakota, has given similar results to the tests of a year ago.

Forty-six 3,000-bushel grain bins have been carried through their second storage season at the bin site and the grain itself has gone through its third storage season since it was harvested. Eight check bins have been observed for temperature and moisture and compared with eight bins with 50 CFM ventilator fans, eight with 100 CFM fans, eight...
with 200 CFM fans, and eight with cupolos or wind ventilators. All of these except the check bins have vertical aeration ducts down the center of the bin. In addition six new bins were added and have run during the 1954-55 storage season. These have horizontal ducts in the bottom of the bin and exhaust the air to the outside. Of the six, two have 50 CFM fans, two have 100 CFM, and two have 200 CFM.

The proper treatment is being discovered because it is found for the second year that the wind ventilator and the 50 CFM fan reduce moisture migration to the top layer of grain, but that the 100 CFM and the 200 CFM aggravate the condition rather than reduce it.

On the whole the grain grades are being maintained very well, insect damage has been held to a minimum, although slight damage from root leakage or the blowing in of snow is evident.

The experiment will be continued one more year and the 200 CFM fans will be discontinued. (Project 246. Leader. H. H. DeLong. Agricultural Engineering Dept.)

Irrigation for Potatoes, see page 33
Field Picker-Sheller and Cold Air Drying, see page 91

Fruits, Vegetables, and Shelterbelts

Drought Resistance in Tomato Breeding

Periods of high temperature and low moisture supply are not favorable for fruit setting in tomatoes. Under these conditions the flowers drop from the plants instead of forming fruits.

A study is being conducted to determine which lines and varieties are most likely to set fruit under adverse growing conditions. This genetic material can then be utilized in the breeding program to obtain more hardy varieties. Along with this study information is also being obtained to better understand how the physiological condition of the plant affects its reaction to high temperature. When plants have not been exposed to light for 2 days before the high temperature period, their ability to set fruit is greatly lessened.

Much of the tomato testing is being carried on during the winter. A controlled temperature and humidity chamber is used for subjecting the plants to high temperature. They are grown in pots in the greenhouse and transported to the chamber for the high temperature period. Use of the greenhouse also allows more than one generation to be grown each year. (Project 49. Leader: R. L. Foskett, Horticulture and Forestry Dept.)

Vegetative Propagation of Hardy Ornamental Plants

The Lillian Gibson rose is one of the most promising of the hardy varieties developed by Dr. N. E. Hansen for this area. Existing means of propagating it, however, are slow and unsatisfactory. With this in mind this project was set up to find, if possible, a better method of propagating this rose and other hardy ornamental plants.

Various techniques useful in rooting of cuttings were studied. This included a comparison of overhead misting versus the more conventional method of hose watering. The misting method proved superior with all hardy species tested. Several media were tried under the mist including sand, vermiculite, peat, perlite, and mixtures of these. In general, the mixtures were more satisfactory than the pure media, but no single media was superior for all species.

Hardy phlox, delphinium, and chrysanthemum rooted readily and rapidly under misting. Some of the Lillian Gib-
son rose cuttings rooted but the mortality rate proved too high with methods tested to date. The project is being continued to try cutting wood taken at different dates and also the effect of various hormones and nutrients. (Project 258. Leader: Jesse M. Rawson, Horticulture and Forestry Dept.)

Evaluation Studies Show Value of Foreign Fruit Plants
The Hansen Foundation Orchard has reached a bearing age. This material can now be more accurately evaluated for genetic purposes. An interesting observation is that all of this material has shown great winter-hardiness.

Also of interest is the great variation in resistance to disease. The Harbin pear has shown no injury to fireblight while others have been so badly damaged that their survival is doubtful. Resistance to scab has also shown great variation. Difference in growth and vigor has been quite noticeable. The blossom date, fruiting habit, and quality of fruit are showing greater variation. Characteristics such as these will enable plant breeders to make greater use of this material. (Project 174. Leader: S. A. McCrory, Horticulture and Forestry Dept.)

Tree Fruit Breeding in South Dakota
Apple and pear seedlings grown in ground beds last year were transplanted to the field. Additional apple seedlings from crosses of a year ago were started in sand flats and transplanted to ground beds in the greenhouse. Pear seedlings were also started in sand but later transplanted to paper cups. Later in the spring they were transplanted to their permanent field locations. It is hoped that this latter technique will give good growth the first year and reduce the cost and labor of handling young seedlings. (Project 1. Leader: Ronald M. Peterson, Horticulture and Forestry Dept.)

Small Fruit Breeding in South Dakota
Grape seedlings from crosses of native wild grapes and high quality eastern grape varieties were planted in the field. Several progenies of wild grapes grown from seed collected in various parts of the state were also planted in the field. From these wild grapes it is hoped that very early ripening wild grapes may be selected for crossing with high quality grapes to produce new varieties which are hardy, early ripening, and of high quality.

Seedlings of wild raspberries grown from seed collected on the plains of southwestern South Dakota and in the higher Black Hills were planted in the field. It is hoped that strains may be selected which are winter-hardy even during years in which winter temperatures fluctuate greatly. Such strains will be hybridized with large high quality raspberries in an effort to produce better and more hardy raspberries for South Dakota. (Project 252. Leader: Ronald M. Peterson, Horticulture and Forestry Dept.)

Highmore Space Study Initiated
A second windbreak spacing study planting was made at the Highmore Substation in 1955. The lack of suitable land made it necessary to modify the planting plan and weaken the over-all experimental design. Between row spacings of 10 and 20 feet were used and 8 foot spacing in the rows was used for all but the border rows. Species planted include Eastern red cedar, Ponderosa pine, green ash, Chinkota elm, and Tartarian honeysuckle. (Project 239. Leader: Paul E. Collins, Horticulture and Forestry Dept.)

Elm Seed Storage
Where only a single seed source is available for the current commercial production of seedlings, seed storage can help to insure production in years of seed crop failure. With the certification of Chinkota elm in 1952, no appreciable seed crop has matured in subsequent years. Seed of the 1952 crop was stored under conditions of low moisture con-
Children's Clothing to be Studied

This is a cooperative study with the South Dakota and Minnesota Agricultural Experiment Stations, both of which are contributing projects under the Regional Textiles and Clothing Project NC-24.

It is planned to use for this portion of the study, boys' jeans in two different weights of fabric. They are to be worn by boys 9 or 10 years of age. Differences in fabric and garment construction and performances as shown by differing qualities will be studied. Laboratory evaluations will be made of fabrics and garments. (Project 259. Leaders: Lillian O. Lund, Home Economics Dept.; Ethel L. Phelps, Minnesota Agricultural Experiment Station.)

Shirt and Blouse Materials

Chemically manufactured fibers are being used in increasing amounts for blouse and shirt fabrics. Sixteen fabrics, typical of those used for shirts and blouses, have been purchased. These include nylon, Dacron, Orlon, rayon, and cotton, which will serve as the control. Physical properties are to be studied, such as weight, thickness, fabric count, yarn number and twist, breaking strength, flexibility, and dimensional stability. Fabrics have been sampled and some of the measurements made. (Project 254. Leaders: Lillian O. Lund, Home Economics Dept.; Ethel L. Phelps, Minnesota Agricultural Experiment Station.)

Blended Fabrics for Suits

Traditionally most suitings have been made of all wool. With the coming of the numerous chemically manufactured fibers such as nylon, acetate, Dacron, Orlon, Vicara, and Acrilan a great number of blended suitings are being manufactured in which one or two of the above are combined with wool or rayon. As more and more of these blended suitings reach our markets the consumer is eager to have information as to the serviceability of these blends.

Data collected thus far indicate that the blending of new fibers with wool or rayon is not a simple problem, that fibers must be chosen to complement each other in nature and amount, and that in choosing a blended suiting the presence of nylon, Dacron, or Orlon is not in itself a guarantee of maximum satisfaction. Other characteristics also will influence the comfort and satisfaction to be derived from a garment made of these materials. South Dakota and Minnesota workers are continuing to study these fabrics and will measure such properties as resilience, wrinkling, resistance to abrasion, and air permeability. (Project 215. Leaders: Lillian O. Lund, Home Economics Dept.; Ethel L. Phelps, Minnesota Agricultural Experiment Station.)

Protein Utilization

Research in human nutrition at the South Dakota Experiment Station has been concerned with the utilization of protein by older women. Three healthy,
active women between 60 and 80 years of age have been studied for periods of 6 weeks each.

During the first 4 weeks each woman ate her own self-selected diet. She carefully weighed and recorded all food eaten. She also saved samples of each food for chemical analyses. The amount of nitrogen was used as a measure of the quantity of protein in the food. Body excretion of nitrogen was also determined and daily balances calculated by subtracting the amount excreted from that in the food. Balances may be either positive (storage) or negative (loss). Equilibrium or slightly positive nitrogen balances are associated with health; extended periods of negative nitrogen balances with ill-health.

During the last 2 weeks of the study each woman repeated diets eaten in the preceding period and in addition she had 100 grams of lean beef to increase her intake of high quality protein. Daily nitrogen balances were again used as a measure of protein utilization.

Two of the women showed similar pattern of utilization while that for the third one was quite different. The data for the three South Dakota women will be included with those from other stations in the region for further analyses and evaluation. (Project 178. Leaders: Lida M. Burrill and Beth Alsup, Home Economics Dept.; in cooperation with other stations in the North Central Region and the Human Nutrition Research Branch, USDA as part of Project NC-5, "The Nutritional Status and Dietary Needs of Population Groups in the North Central Region.")

Add Variety to Meals With Summer Squash, see page 58

Hard Water, a Common Laundry Problem, see page 81

**Livestock and Poultry**

**The Fringed Tapeworm of Sheep in South Dakota**

The fringed tapeworm, *Thysanosoma actinioides*, is known to occur only in sheep from the western ranges, the eastern limits being from West Texas and New Mexico to the Dakotas. In South Dakota, it is believed the tape worm is confined to the sheep ranges west of the Missouri River.

The tapeworm occurs primarily in the bile passages of the liver, although it may also be found in the small intestine occasionally. Infected livers are condemned by federal meat inspectors at the packing plants. This results in considerable economic loss due to the high incidence of infection. At the John Morrell Packing Plant in Sioux Falls, South Dakota, many sheep livers are condemned every day. Some lots of sheep show almost 100 percent infestation.

**Study Life Cycle.** Before adequate control measures can be worked out, the life cycle of the tapeworm must be discovered. Thus far, attempts by various investigators to work out the life cycle have been unsuccessful. The worm belongs in the family, Anoplocephalidae, and in the species of this family whose life cycles are known, oribatid mites (grass mites) appear to be the only intermediate hosts. However, grass mites have been virtually eliminated as suspects in studies on the fringed tapeworm. It has been shown that the worm cannot be transmitted directly from sheep to sheep, so some intermediate host is necessary.

In the present project, one of the first problems in studying the life cycle was the collection of tapeworm eggs to attempt experimental infection of insects and other small invertebrates. Entire tapeworms were collected from condemned sheep livers at Morell's Packing Plant, and countless proglottids (segments) from the posterior ends of the
worms were examined for eggs without success. Finally it was discovered that by the time the proglottids become gravid they have become detached from the worm and have passed down the bile duct to the intestine. Now the procedure is to go to the sheep killing floor at the packing plant, watch for infected livers, and take the intestines only. The caecum yields the largest number of detached, gravid proglottids, which are recovered by decanting and screening the feces.

Investigation last fall at the Antelope Range Field Station, where the fringed tapeworm is known to occur, showed that dung beetles, *Aphodius sexual*, commonly feed upon fecal pellets of sheep. Many dung beetles were collected and maintained for a long period in the laboratory, where they were exposed to tapeworm eggs on sheep pellets. Dissections showed no evidence of larval tapeworms, but these experiments will be continued, both on dung beetles and upon other small invertebrates from the western ranges.

**Egg Survival.** An experiment has been set up to try to determine how long the tapeworm eggs can survive at various conditions of relative humidity and temperature. Various saturated chemical solutions are being used in small sealed chambers to maintain relative humidities of 15, 44, 76, and 97 percent. Techniques have finally been worked out so that results should be available soon. The time of survival outside the body may give a clue as to the intermediate host which must ingest the eggs while they are still viable.

Attempts to trace the origin of heavily infected sheep have been discouraging thus far. Most of the heavily infected lots of sheep have come from feed-lots where animals have come from many sources and have been hopelessly mixed. However, the sheep from two ranges have been traced, and in the near future these ranges will be examined for evidence of small invertebrates which might possibly serve as intermediate hosts for the tapeworm. (Project 260. Leader: Ernest J. Huggins, Entomology - Zoology Dept.)

**Screw-Worms and Secondary Maggots**

The true screw-worm, *Callitroga hominovorax*, is not capable of enduring the cold weather of the winters in South Dakota. Consequently the insect dies out and disappears from the state with the approach of winter.

In the past year not a single specimen of the true screw-worm was sent us for identification from any locality in South Dakota. This is unusual, for in most years from a few to many samples of true screw-worms are sent us. It is not claimed, however, that no screw-worms made their way into South Dakota during the past year, but if they did occur in the state they could not have become a serious problem; otherwise we would have learned of their occurrence.

Many samples of secondary maggots (not screw-worms) were sent us for identification from many sections of the state. These came principally from maggot infested wounds of sheep and cattle and occasionally from hogs, poultry, cats, and dogs. Recommendations for the eradication of the secondary maggots in the wounds of infested animals were made in all cases brought to our attention. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

**External Parasites of Livestock**

Work during the summer of 1954 was concentrated on the control of flies in farm buildings. Bulletin 452, *Farm Fly Control*, is now available from the South Dakota State College Experiment Station. Any statement of results of experimentation given here would be a duplication of information contained in the bulletin. (Project 186. Leader: W. M. Rogoff, Entomology-Zoology Dept.)

**The Control of Fowl Cholera**

Experimental fowl cholera can be con-
trolled by using what is considered rather high levels of terramycin in the mash or drinking water. Field trials indicated that terramycin, at these high levels, might be effective in controlling naturally occurring outbreaks of the disease.

Different chemotherapeutic agents and antibiotic compounds have been tested to determine their effectiveness in controlling experimental fowl cholera. NF-180 (a furazolidone compound),isonicotinic acid hydrazide, and paraaminosaliclyc acid, when used in the mash were of no value. Chickens inoculated with a terramycin suspension in oil 1 week before they were exposed were afforded little protection by the antibiotic preparation. Terramycin animal formula used in the drinking water seemed to be as effective as terramycin poultry formula.

A comparison was made of two levels of terramycin used in the mash for protecting birds against experimental fowl cholera. When the antibiotic was used at the rate of 0.5 gram per kilogram of mash it was more than twice as effective as when used at the rate of 0.22 grams per kilogram of mash. Tetracycline used at the rate of 0.5 gram per kilogram of mash showed little benefit when compared with terramycin used at the same level. NF-67 (pure furazolidone) used in the drinking water appeared to retard the course of experimental infection but did not reduce the total mortality.

A flock of laying pullets in which an outbreak of fowl cholera was initiated was divided into two groups. One was given terramycin in the mash at the dosage level recommended by the manufacturer for control of other diseases. The other received no treatment. There was little difference in mortality during acute stages of the outbreak but over a 1-month period the total mortality was 50 percent lower in the treated group.

Most of the outbreaks of fowl cholera result from infection with Type I Pasteurella multocida. A small number of outbreaks result from Type II. Birds from two flocks infected with chronic fowl cholera gave positive agglutination reactions with an antigen prepared from a Type II strain but not with a Type I antigen. Type II strains of P. multocida were recovered on bacteriological examination of the birds. Antigens prepared from the two types of the fowl cholera organism may be useful in diagnosis of chronic fowl cholera. (Project 14 I. Leader: T. A. Dorsey, Veterinary Dept.)

Sporadic Bovine Encephalitis

Sporadic bovine encephalitis is a disease of cattle caused by a virus of the psittacosis group. The disease has been diagnosed in an occasional herd but there have been no reports of spread to neighboring farms. How infection reaches a herd and spreads from animal to animal within the herd has not been determined with certainty. The possibility of carrier animals which eliminate the virus in body excretions is being considered.

A psittacosis-like virus has been found in the feces of calves as long as 108 days following infection with SBE virus. Virus has also been demonstrated in feces of calves during stall exposure with infected calves and from calves without experimentally induced infection or exposure.

Four calves were inoculated with strains of virus recovered from feces of calves. There were no clinical symptoms resulting from these inoculations. Three of the calves which were later inoculated with known SBE virus resisted infection. On autopsy there were slight lesions in the body cavities dating from the first inoculation.

Further work will be necessary to determine whether the virus recovered from the feces of calves is SBE virus or a closely related virus of the psittacosis group. (Project 171. Leader: G. S. Harshfield, Veterinary Dept.)
The Control of Internal Parasites of Sheep

Observations of trends in the levels of parasite infestations in ewes and lambs on range at the Antelope Range Field Station were continued through the 1954 grazing season. Grazing levels in four pastures, as in three previous seasons, allowed for light, moderate, heavy, and rotation of grazing at a moderate level. The degree of infestation was determined at monthly intervals by examination of fecal samples from 10 percent of the animals in each pasture for parasite ova.

The ewes in each of the pastures showed a build-up in the spring, with the peak recorded at the June 3 sampling. The level of infestation was considerably higher in the group on heavy grazing than in the others. By July 6 a pronounced decline in the parasite levels had occurred in all four groups of ewes.

The lambs were showing a low level of infestations July 6 but by August 3 had reached the peak for the season, except in the heavily grazed pasture. In that group there was a continuing rise in parasite level through September 20.

The trends in the parasite levels in 1954 followed patterns in both ewes and lambs similar to those observed in previous seasons. The peak reached in lambs during 1954 was very close to that recorded in 1953 in each group.

Experimental work on parasitism in sheep under range conditions has been in progress since 1944. Bulletin 447 summarizing this work has been published during the year. (Project 139. Leader: G. S. Harshfield, Veterinary Dept.)

Livelock Production

The Improvement of Beef Cattle Through Breeding

The project has been modified to add the following objectives to the present project which involves the production of inbred lines and a comparison of inbreeding versus selection:

Field Testing of Beef Cattle. This work will deal with (1) performance testing on private ranches under the supervision of extension personnel and (2) the comparison of bulls produced in the inbred lines with bulls presently in use in commercial herds. The latter involves the placing of inbred bulls on ranches where the producer agrees to separate his cow herd and follow through by ear tagging calves from both the Station bull and his own bulls. Where possible weaning information and feed-lot performance will be obtained.

Identification of Beef Cattle Heterozygous for the Dwarf Gene. Work completed last year indicated normal adrenal function in the few dwarfs tested, as shown by the effect of ACTH on circulating eosinophils. The level of circulating eosinophils appeared to average higher for normal cattle than for dwarf cattle, but no difference was detected between "carrier" and "clean" animals. This phase of the work will not be continued. Any future work on this problem will be blood or measurement studies somewhat on the order of the eosinophil study.

Breeding for Resistance to Selenium Poisoning in Beef Cattle. This work will deal with (1) a study of the effects of crossbreeding on selenium resistance, and (2) a study of the large individual differences in resistance to selenium poisoning to determine the extent to...
which these differences are hereditary. (Project 167. Leaders: C. A. Dinkel, Animal Husbandry Dept; W. R. Trevilyan, Antelope Range Field Station; J. D. Rahn, Reed Ranch; Frank Whetzel, Cottonwood Range Field Station.)

Alfalfa Silage for Fattening Cattle

This past season a second year’s experiment was conducted to evaluate different methods of storing alfalfa as silage or hay that was utilized as a beef cattle feed. A first cutting crop of 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 different storage plans with approximately 62 tons being stored in each plan. In the previous year’s experiment approximately 35 tons were stored at each source. 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 the use of a heavy truck driving over the silage after each load was dumped. This method of packing was not used the previous year.

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 the time of initial storage through the feeding period could be measured.

Forty long-yearling Hereford steers divided into 4 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. Past work has shown that alfalfa hay or silage, supplemented with a limited amount of corn, produced desirable gains in fattening cattle. 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, bone meal, and limestone were offered free choice to all cattle.

Percentage of feed stored that was actually weighed out and consumed as good feed was 70 percent for the alfalfa silage in the upright silo, 45 for alfalfa silage in pile, 48 for alfalfa silage in the trench, and 77 for alfalfa hay in bales. Another year’s work is planned to evaluate different methods of storing alfalfa as a feed for beef cattle. (Project 237. Leader: W. C. McCone, Animal Husbandry Dept.)

Manganese Requirements of Cattle

No beneficial effect was obtained in a previous trial when manganese was added to a fattening ration which contained about 8 parts per million (p.p.m.) of manganese to yearling steers. Heifer calves are now being fed a ration of similar manganese content to determine the effects of long time feeding of a low manganese ration.

More trouble in obtaining satisfactory consumption of the type of ration used has been encountered with calves than with yearlings in the previous work. After several changes, a mixture composed of the following ingredients (percent) is being consumed quite satisfactorily: ground ear corn, 52.0; ground corn cobs, 25.0; beet sugar, 5.0; animal feeding fat, 5.0; dried whole blood, 4.0; dried buttermilk, 2.0; dried brewer’s yeast, 3.0; urea, 0.5; ground limestone, 2.0; bone meal, 0.5; and iodized salt with added cobalt and copper, 1.0. Vitamins A and D supplements have been added to furnish about 2000 units of vitamin.
A and 200 units of vitamin D per pound of feed.

The calcium phosphorus ratio has been reported to affect the manganese requirement of animals. The amount of ground limestone and bone meal used was selected to provide adequate phosphorus but a ratio of about four parts calcium to one part phosphorus. Such a ratio is not uncommon in many cattle rations in this area.

Twelve heifer calves were fed the low manganese ration for 98 days and then one-half of them were changed to the basal ration with 30 p.p.m. of added manganese. Two calves were removed because of poor feed consumption and the others were allotted to the two treatments on basis of feed consumption and gains during the preliminary period. The calves were individually fed and broken corn cobs (about 9 p.p.m. of manganese) were used for bedding.

The manganese supplement was added to the ration only recently and no results of its effect are available at present. (Project 218. Leaders: L. B. Emhry, Animal Husbandry Dept; O. E. Olson, Station Biochemistry Dept.)

**Nutritive Value of Prairie Hay**

Winter feeding trials with prairie hay that had been cut at an early stage of maturity and stored in the open for a number of years were conducted at the Cottonwood, Eureka, and Highmore substations.

Steer calves were fed hay supplemented with soybean meal pellets to give a total protein level in all rations of about 10 percent. One lot of calves at each substation was fed hay cut in 1954 to compare the hay from the storage stacks with the current crop. Water, trace-mineralized salt, and a mixture of trace-mineralized salt and bone meal were provided free access. The calves were fed hay and pellets once daily. Gains of about 0.75 to 1.0 pound daily were expected with the rate of feeding used. The results of the feeding trials are presented in Table 1.

**Cottonwood.** The gains at Cottonwood were quite satisfactory for all lots, with the 1953 hay giving the best performance. This hay contained nearly 10 percent protein, and only a small amount of protein supplement was fed at the beginning of the trial. The older hay appeared to have just as high feeding value as the new hay when supplemented in the manner used in this experiment. The hay at this substation appeared to be of good quality and did not show evidence of much weather damage. There was only a small amount of hay refused.

**Eureka.** The rates of gain at Eureka were low for all except the 1954 hay. The older hay had a rather large amount of weather damaged hay and the amount refused was high.

**Highmore.** Hay fed to the calves in lot 2 at Highmore contained many needles from needle-and-thread. The hay was cut before the needles fell. Hay consumption and rate of gain has been low in each trial in which this hay has been fed. The performance of the other three lots indicates a lower feeding value for the older hay when all are supplemented with a high protein supplement to equalize the total protein level of the ration at about 10 percent. Hay consumption was slightly better with the 1954 hay.

Results at the three substations indicate considerable variation in feeding value of hay stored for different number of years. The amount of damaged hay from exposure to weather appears to be an important factor. Further work is planned to measure the storage loss at various intervals with hay stored under different conditions.

Digestion trials were conducted with sheep fed hay cut in 1953, 1951, 1950, and 1948. This hay was fed to calves in winter feeding trials last year. In general, the older hay produced lower rates of gain and was less digestible. Other digestion and metabolism trials


<table>
<thead>
<tr>
<th>Table 1. Results of Storage Hay Feeding Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>COTTONWOOD TRIAL (November 18, 1954 to April 21, 1955—154 days)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Hay</th>
<th>1953</th>
<th>1990</th>
<th>1947</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1993</td>
<td>426.2</td>
<td>425.2</td>
<td>426.0</td>
<td>425.6</td>
</tr>
<tr>
<td>1950</td>
<td>0.80</td>
<td>0.94</td>
<td>0.78</td>
<td>0.84</td>
</tr>
<tr>
<td>Hay fed</td>
<td>12.7</td>
<td>12.7</td>
<td>12.7</td>
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<tr>
<td>Hay consumed</td>
<td>12.5</td>
<td>12.5</td>
<td>12.5</td>
<td>12.2</td>
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<tr>
<td>Soybean meal pellets</td>
<td>0.82</td>
<td>0.74</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>Feed per 100 pounds gain, lbs.</td>
<td>1577</td>
<td>1346</td>
<td>1635</td>
<td>1513</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>102.4</td>
<td>9.6</td>
<td>95.5</td>
<td>136.8</td>
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</table>

| EUREKA TRIAL (November 17, 1954 to April 20, 1955—154 days) |

<table>
<thead>
<tr>
<th>Year</th>
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<th>1947</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>10</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>1951</td>
<td>399.7</td>
<td>400.3</td>
<td>400.7</td>
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<tr>
<td>1949</td>
<td>0.72</td>
<td>0.51</td>
<td>0.43</td>
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<td>1947</td>
<td>11.5</td>
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<td>11.1</td>
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<tr>
<td>Hay fed</td>
<td>9.7</td>
<td>9.9</td>
<td>9.6</td>
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<tr>
<td>Soybean meal pellets</td>
<td>0.66</td>
<td>0.41</td>
<td>0.69</td>
</tr>
<tr>
<td>Feed per 100 pounds gain, lbs.</td>
<td>1574</td>
<td>2538</td>
<td>2845</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>92.4</td>
<td>80.2</td>
<td>162.1</td>
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</table>

| HIGHMORE TRIAL (November 19, 1954 to April 22, 1955—154 days) |

<table>
<thead>
<tr>
<th>Year</th>
<th>Hay</th>
<th>1950</th>
<th>1947</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1951</td>
<td>401.7</td>
<td>411.7</td>
<td>401.8</td>
</tr>
<tr>
<td>1950</td>
<td>1.17</td>
<td>0.38</td>
<td>0.89</td>
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<tr>
<td>1947</td>
<td>13.1</td>
<td>11.0</td>
<td>12.7</td>
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<tr>
<td>Hay fed</td>
<td>12.3</td>
<td>8.7</td>
<td>11.5</td>
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<tr>
<td>Soybean meal pellets</td>
<td>1.23</td>
<td>0.76</td>
<td>0.73</td>
</tr>
<tr>
<td>Feed per 100 pounds gain, lbs.</td>
<td>1122</td>
<td>2877</td>
<td>1418</td>
</tr>
<tr>
<td>Soybean meal pellets</td>
<td>104.9</td>
<td>197.7</td>
<td>81.8</td>
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A Supervised Pasture System

The plantings of brome grass, alfalfa-brome grass, and sweet clover-rye during the first part of the pasture season followed by soybeans-Sudan grass later are being tested as pasture crops at Brookings. Yearling Hereford steers were grazed during the 1954 pasture season at rates compatible with available forage in the various pastures. Pasture size, stocking rates, and animal production are shown in Table 2.

A dry summer was encountered and stocking rates and gains per acre were lower than during the previous season. The alfalfa-brome pasture was superior to brome alone in both carrying capacity and rate of gain. No bloat occurred in any of the pastures.

Because of weevil damage to sweet clover and dry weather, only rye was
present in the sweet clover-rye pasture. A short grazing season and a low gain per acre of pasture resulted. The cattle were taken off this pasture on July 2 and the soybeans-Sudan grass was not ready for grazing until August 3. The largest daily gains per steer were obtained on the soybeans-Sudan pasture and the average stocking rate was about the same as for brome or alfalfa-brome. The lack of pasture during the month of July was a major shortcoming of the sweet clover-rye and soybeans-Sudan combination in this trial.

The work is being continued to compare various pasture crops in forage production and gains of grazing animals under South Dakota conditions. The results of forage production are reported under "Crops and Soils." (Project 225. Leaders: W. W. Worzella, Agronomy Dept; L. E. DuBose, Animal Husbandry Dept.)

### 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 sheep that can be produced per acre. The pasture carried 2.4 steers per acre and 23.4 mature sheep per acre. The steers gained an average of 190 pounds during the pasture season in 1954 or an average daily gain of 1.5 pounds per steer. The amount of beef produced per acre was 455 pounds.

The sheep production per acre was 423 pounds, 323 pounds of this produced by the lambs. The lambs gained an average of 41.9 pounds per head during the pasture season or 0.33 pound per lamb per day. The ewes gained an average of 18 pounds each during the 127-day pasture season.

Consumption of hay by the steers while on pasture was 3.6 pounds per head per day. The ewes consumed only 0.41 pound per head daily.


### Summer Grazing of Beef Cows for Calf Production

Six pastures at the Cottonwood Range Field Station have been stocked heavily, moderately, or lightly from about May 1 to December 1 each year since 1942. Each of these pastures was stocked with six grade 3-year-old Hereford cows from May 14 through November 25, 1954. Other animals were put on or taken off of the pastures to control utilization.

The results are shown in Table 3. Cow and calf gains per acre were higher for the heavily-stocked pastures, whereas cow and calf gains per animal unit were higher for the more lightly-stocked pastures. This study is being continued with

### Table 2. Summary of Pasture Research for Season Starting May 29, 1954

<table>
<thead>
<tr>
<th>pasture number</th>
<th>type of pasture</th>
<th>Brome</th>
<th>Alfalfa-Brome</th>
<th>Sw. Clove-Rye</th>
<th>Soybeans-Sudan</th>
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<tbody>
<tr>
<td>acres/pasture</td>
<td></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>max. no. animals/pasture</td>
<td></td>
<td>15</td>
<td>13</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>min. no. animals/pasture</td>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>average no. animals/acre</td>
<td></td>
<td>1.2</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>pasture days</td>
<td></td>
<td>186</td>
<td>114</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>animal days/pasture</td>
<td></td>
<td>1308</td>
<td>1046</td>
<td>1180</td>
<td>1168</td>
</tr>
<tr>
<td>total gain pasture (lbs.)</td>
<td></td>
<td>1773</td>
<td>1538</td>
<td>1957</td>
<td>1989</td>
</tr>
<tr>
<td>av. daily gain/animal (lbs.)</td>
<td></td>
<td>1.36</td>
<td>1.47</td>
<td>1.66</td>
<td>1.70</td>
</tr>
<tr>
<td>total gain/acre (lbs.)</td>
<td></td>
<td>222</td>
<td>192</td>
<td>245</td>
<td>249</td>
</tr>
</tbody>
</table>

*Pasture 2 and 6 were grazed during the first 34 days of the season and 2A and 6A during the last 52 days.
*All steers were removed for 22 days in August due to drought.
*All gains based on 15-hour shrunk weights.
Table 3. Beef Production Under Heavy, Moderate, and Light Rates of Grazing in 1954*
(May 14 through November 25, 1954, 195 days)

| Rate          | Acres grazed | Amount of grazing furnished, animal unit months† | Stocking rate, animal unit months per acre | Utilization (visual estimate), percents | Range condition, percents | Number of cows completing the season || Average final weight, lbs. | Average initial weight, lbs. | Average gain, lbs. | Number of calves dropped by cows completing the season | Average weaning weight of calves, corrected to 190-day age, lbs.‡ | Total cow and calf gains per animal unit, lbs.** | Total cow and calf gains per acre** |
|---------------|--------------|-----------------------------------------------|-------------------------------------------|------------------------------------------|---------------------------|-----------------------------|---------------------------------|---------------------------------|------------------|----------------------------------------------------------|---------------------------------|---------------------------------|--------------------------|
| Heavy         | 160          | 160                                           | 2.03                                      | 70                                        | 32                         | 12                          | 756                             | 724                             | 32               | 9                                                          | 304                             | 232                             | 17.6                     |
| Moderate      | 266          | 266                                           | 3.19                                      | 48                                        | 61                         | 12                          | 812                             | 724                             | 88               | 9                                                          | 320                             | 284                             | 13.7                    |
| Light         | 366          | 366                                           | 4.33                                      | 25                                        | 76                         | 12                          | 841                             | 754                             | 87               | 12                                                         | 334                             | 354                             | 12.6                    |

*Annual precipitation for 1954 was 14.00 inches and growing season precipitation (April-September 30) was 7.63 inches compared with the longtime average of 14.72 and 11.77 inches, respectively.
†A 1000-lb. cow is considered to be one animal unit. Animal units were calculated by a ratio of 

\[ \frac{W}{1000} \]

where W is the average of 8 monthly weights taken during the grazing season.
‡200 pounds of prairie hay cut after frost in 1953 was fed to the animals on each treatment on October 26 and 27 because of snow cover.
§Utilization and range condition estimates were made by Leslie R. Albee, Range Conservationist, Soil Conservation Service.
∥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 mid-summer.
**The total gain of the 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.

Using litter weight at 5 months as a measure of productivity (since it represents both litter size and growth rate) the results were 738 pounds for inbred pigs, 1376 pounds for second topcross pigs, and 1425 pounds for first topcross pigs. These figures demonstrate, in part, the usefulness of inbred boars in improving performance when mated to unrelated purebred females and also to females that are part outbred and part inbred. A special attempt will be made to improve body length of the line by this system.

Special emphasis is being placed in the Duroc line on backfat thickness as measured on the live hog. Five boars that sired the 1954 pig crop averaged 1.26 inches and 24 gilts averaged 1.53 inches. Pigs of the 1954 crop averaged 1.49 inches of backfat. Boars had less backfat at market weight than either gilts or barrows. This indicates that when breeding for less backfat, a breeder must use boars with less backfat than the kind of market hogs he expects to produce. These selections will be continued.

the same animals on the same treatments. (Project 216. Leaders: J. K. Lewis, Animal Husbandry Dept; O. E. Olson, Station Biochemistry Dept; and Frank Whetzal, Cottonwood Range Field Station.)

Systems of Breeding Swine for More Efficient Productivity

Project objectives of developing lines of swine and selection procedures for improving productiveness in rate and economy of gain, mothering ability of sows, and carcass desirability are explored with herds maintained at Brookings and the North Central Substation, Eureka.

Hampshire and Duroc inbred pigs carrying approximately 40 and 25 percent of inbreeding, respectively, were raised at Brookings in 1954. The Hampshire line is closed, and inbred boars were also mated to outbred and first topcross Hampshire females to test this procedure for maintaining the line while making introductions from outbred stocks.

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Added to the project were six groups of littermate Yorkshires including a boar and three gilts each. Brother-sister matings were made to produce 1955 spring pigs. An attempt will be made to develop one or two high performing Yorkshire inbred lines to be crossed later with the station's Hampshire and Duroc lines.

The 1954 fall pigs were purebred Hampshires and Durocs and reciprocal crosses between those two breeds. Crossbred pigs surpassed both purebreds, reaching market weight a month sooner than the average of the purebreds. Crossbreds had carcasses with greater dressing percentage and greater carcass length. The carcasses were intermediate between the pure breeds in fatness and had more lean in the loin eye than the purebred average.

At Eureka a rotation crossbreeding program was continued in place of an inbred line formerly maintained. The rotation cross had been carried through two cycles with four breeds at Brookings. As at Brookings this crossing system demonstrated its value as an efficient program for the production of slaughter hogs. (Project 124. Leaders: J. W. McCarty, Animal Husbandry Dept; Albert Dittman, North Central Substation, Eureka.)

Swine Production for the Irrigated Area of Western South Dakota

A mating system using inbred lines of four breeds in a rotation cross has replaced the inbred Hampshire line formerly maintained at the Newell Station. Gilts farrowing spring 1954 represented two cycles of rotation crossing in which boars representing inbred lines of the Hampshire (Newell inbred), Poland China, Duroc, and Landrace breeds were included.

Performance was very good as shown by the following data: an average of 13 pigs per litter were farrowed of which 9.3 per litter reached 5 months of age and averaged 176 pounds at that age.

Carcass data were collected on 18 carcasses. Pigs slaughtered for carcass test weighed 205 pounds at 177 days of age. Dressing percent was 68. Carcasses averaged 29.8 inches long and had 1.6 inches average backfat. These met the requirements for Choice No. 1 grade. Primal or wholesale cuts represented 64.5 percent of cold carcass weight.

Pigs were farrowed in a central house after which sows and litters were moved to alfalfa pasture. After weaning, pigs were self fed shelled corn and a protein supplement of equal parts of soybean oil meal and tankage fortified with antibiotic, ground limestone, steamed bone-meal, and trace mineralized salt. Pigs were marketed at between 200 and 225 pounds.

This cross will be continued using boars from Yorkshire, Hampshire, and Duroc inbred lines maintained at Brookings. (Project 132. Leaders: J. W. McCarty, Animal Husbandry Dept; and Harry Weakly, U. S. Newell Field Station.)

Levels of Alfalfa in Growing-Fattening Swine Rations

Two trials were conducted during the past year to study the value of adding various levels of ground alfalfa hay to a growing-fattening swine ration. In the first trial all four lots fed received the same protein supplement free-choice. In addition Lot 1, the control lot, was fed shelled yellow corn while Lots 2, 3, and 4 received a pelleted mixture of corn and alfalfa containing 10, 30, and 50 percent of alfalfa, respectively.

The rate of gain decreased as the level of alfalfa in the ration increased. It also required more feed per unit of gain as the alfalfa level increased so that the most economical gains were produced on the low alfalfa rations. The carcasses decreased in yield and backfat and increased in leanness as the level of alfalfa in the ration increased.

In the second trial a complete mixed, ground ration was fed to four lots of
pigs. The alfalfa levels studied were 0, 5, 15, and 30 percent. The average daily gains were 1.75, 1.68, 1.60, and 1.18 pounds per day. The rate of gain again decreased with each increase in alfalfa content.

In this trial there was very little difference in the cost of the gains produced by the 0, 5, and 15 percent alfalfa rations. The 30 percent alfalfa ration was the least economical because it required an additional 100 pounds of feed per hundredweight of gain. Carcass measurements yielded information similar to trial 1. (Project 213. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

**Vitamin Supplementation of Swine Rations**

Previous work at this Station showed that a corn, soybean meal, tankage, and mineral ration could be improved by adding a B-vitamin supplement containing niacin, pantothenic acid, riboflavin, vitamin B₁₂, and choline.

A trial was conducted to determine if niacin was needed in this vitamin supplement. There was no benefit from adding niacin at any of the levels fed which ranged from 0 to 12 milligrams per pound of ration. Likewise there was no benefit derived, either in rate or efficiency of gain, when a fermentation product was added as a growth factor source. Additional tests are now under way to determine which of the above B-vitamins may be required in this basal ration. (Project 238. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

**Amino Acid Requirements of Pigs**

Three trials have been conducted with pigs from weaning to about 100 pounds which have shown that a 12 percent protein corn-soybean meal ration is deficient in lysine, tryptophan and/or methionine.

In trial I the basal ration was supplemented with lysine and methionine and levels of 0.02, 0.04, and 0.06 percent DL-tryptophan were added to the rations fed various lots. All levels of tryptophan supplementation increased the rate of gain over the pigs fed the basal ration. The 0.02 percent level was as efficient as the higher levels.

In the second trial each of the three amino acids were added singly or in all combinations. Although all amino acid supplements increased rate and efficiency of gain only the lysine supplement caused a statistically significant response. Best growth was obtained when all three amino acids were present.

The basal ration was supplemented with tryptophan and methionine in trial III. Levels of 0, 0.05, 0.10, and 0.20 percent L-lysine HCl were studied. A similar growth response was shown by the pigs receiving 0.05 or 0.10 percent lysine but no response was apparent in the group fed 0.20 percent lysine.

Lysine appears to be the most limiting amino acid in this ration. The requirements of the pig, expressed as a percent of the protein in the ration, appear to have been met by 4.5 percent lysine, 4.0 percent methionine plus cystine, and 1.0 percent tryptophan. (Project 251. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

**Development of a Tailless Breed of Sheep**

The tailless flock was continued closed using 6 rams and 57 ewes. Fifty-one of the ewes lambed 72 lambs and weaned 63. Lambs born and weaned as a percent of ewes bred were 126 and 110 respectively. Sixty pounds of lamb were produced per ewe bred up to a weaning age of 101 days. All rams used were tailless. They were mated to ewes averaging 1.9 inches of tail (based on birth measurement). All lambs averaged 1.25 inches tail at birth with a range of 0 to 5 inches. The distribution of tail lengths at birth were:

<table>
<thead>
<tr>
<th>Tail Length</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to .75</td>
<td>37</td>
<td>52%</td>
</tr>
<tr>
<td>1.00 to 1.75</td>
<td>14</td>
<td>20%</td>
</tr>
<tr>
<td>2.00 to 2.75</td>
<td>7</td>
<td>10%</td>
</tr>
</tbody>
</table>
3.00 to 3.75 6 (8%)  
4.00 to 4.75 5 (7%)  
5.00  2 (3%)  

Selections within the flock for production characters along with taillessness are being continued. (Project 9. Leader: J. W. McCarty, Animal Husbandry Dept.)

Effect of Bentonite in Feeder Lamb Rations

Two trials were conducted during the past year to determine the effect of adding bentonite to lamb fattening rations. Two grades of bentonite were fed at the rate of 0.1 pound per lamb per day. The addition of bentonite to the rations had little effect on rate of gain or feed efficiency made by the lambs. Also, little difference was noted in carcass grade and yield.

Feeding molasses to feeder lambs resulted in increased rate of gain. However, the molasses-fed lambs required more feed per pound of gain than did the controls. Feed costs per pound of gain was higher when molasses was fed and more than offset the advantage gained by the more rapid gain.

This work will be published in a 1955-56 quarterly article. (Project 233. Leaders: Leon F. Bush, Animal Husbandry Dept; Harry Weakly, U. S. Newell Field Station.)

Hormones in Fattening Lambs

A combination of 250 milligrams of progesterone and 10 milligrams of estradiol was implanted subcutaneously in fattening lambs. The treated lambs gained 25 percent faster and required 20 percent less feed per hundred pounds of gain than those not implanted. However, the carcass grade and yield were lower in the treated lots. Maturity of the lambs is hastened as indicated by 9 of the 32 lambs treated that failed to "break" and were sold as yearlings.

No unfavorable side reactions such as urinary calculi or prolapse of the vagina or rectum were noticed. However, most of the treated ewe lambs showed some increase in teat size and were in milk. Also the wethers showed some enlargement of the rudimentary teats. (Project 199. Leader: Leon F. Bush, Animal Husbandry Dept.)

Feeder Lamb Responses to Aureomycin and Pelleted Rations

Lambs full-fed long alfalfa hay and shelled corn were compared with those full-fed pelleted alfalfa hay and corn. The lambs fed the pelleted ration gained somewhat more rapidly and efficiently than those receiving long hay and shelled corn. However, the cost of pelleting the feeds more than offset the increased rate of gain and efficiency. The cost of feed per hundred pounds of gain was much more expensive in the lot fed the pelleted ration.

When 10 milligrams of aureomycin was added to each pound of a pelleted ration of equal parts of alfalfa hay and corn the rate of gain was depressed. The lambs receiving aureomycin gained 0.41 pound per head daily compared to 0.51 pound for those not fed the antibiotic. When aureomycin was included in a pelleted ration of 25 percent corn and 75 percent alfalfa hay, the rate of gain was increased slightly and less feed was required per hundred pounds of gain. The carcass grade and yield was lower for the lambs fed a ration of 75 percent hay and 25 percent corn. (Project 206. Leader: Leon F. Bush, Animal Husbandry Dept.)

Summer Grazing and Winter Supplementation Studies with Range Ewes at Antelope Range

In November 1951, 400 range ewes were permanently allotted at random into four lots for winter feeding and four lots for summer grazing considering age, weight, and fleece production. Winter and summer treatments are balanced and ages from 2 through 7 are balanced for each winter-summer combination.
These ewes are removed from the experiment only because of (1) age (7 years), (2) death, or (3) serious defect such as spoiled udder, rupture, blindness. These ewes are not culled on type or production because lamb and wool production are the measures of the experiment. Ewe lambs are saved from each winter-summer combination and are used for replacements in the lots from which they came.

**Winter Supplementation.** From November 6, 1953, through lambing, these ewes were grazed as a band on a winter-deferred range, cut four ways each day. They were also fed 0.2 pound 40 percent protein supplement, 0.2 pound 20 percent protein supplement or 0.4 pound 20 percent protein supplement per head daily. A fourth group was fed 0.2 pound 40 percent protein supplement for only the last 6 weeks of pregnancy. Prairie hay was fed at the rate of 2 1/2 pounds per head daily to all lots for 19 days because of snow cover.

Ewes were given free access to iodized salt and to a mineral mixture composed of equal parts of dicalcium phosphate and salt. Beginning in May they were given trace-mineralized salt. These ewes were bred as a band to rather uniform polled Rambouillet rams and were shed lambed in April. They received no special lambing ration but all lots were fed 0.2 pound 40 percent protein supplement until they were placed on summer pastures May 3.

Results are shown in the accompanying tables.

**Summer Grazing.** From May 3 through November 2, the ewes were grazed in fenced range pastures. The treatments were (1) season-long light grazing (.87 acres per ewe per month), (2) season-long moderate grazing (.68 acres per ewe per month), (3) season-long heavy grazing (.42 acres per ewe per month), and (4) moderate grazing rotated weekly in a four-pasture rotation (.68 acres per ewe per month).

The ewes had access to well water, trace-mineralized salt, and a dicalcium phosphate-salt mineral mixture. Lambs were weighed at birth and ewes and lambs were weighed at monthly intervals. Ewes were sheared in June and lambs were weaned September 20. Forage production and end-of-season utilization were estimated by species on a weight basis.

These ewes will be continued on the same pastures and on the same treatments to study cumulative effects. [Project 159 (Winter Supplementation) and

<table>
<thead>
<tr>
<th>Winter Treatments Nov. 6, 1953 Through Lambing</th>
<th>Summer Treatment May 3-Nov. 2, 1954</th>
<th>Average of All Summer Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items Measured</td>
<td>Light Grazing</td>
<td>Moderate Grazing</td>
</tr>
<tr>
<td>Number of ewes</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Number of ewes died</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ewe gain, Nov 6- March 31, lbs.</td>
<td>5.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Ewe gain, May 3- Sept. 20, lbs.</td>
<td>17.6</td>
<td>21.8</td>
</tr>
<tr>
<td>Fleece weight, lbs.</td>
<td>8.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Range grazing plus 0.2 lbs. 40 percent protein supplement winterlong</td>
<td>139.1</td>
<td>125.0</td>
</tr>
<tr>
<td>Lamb crop born, % of ewes completing trial</td>
<td>121.7</td>
<td>91.7</td>
</tr>
<tr>
<td>Cost of supplement, dollars per head*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Ewe Production—Summer Grazing and Winter Supplementation Studies with Sheep, 1953-54
Table 4. Ewe Production—Summer Grazing and Winter Supplementation Studies with Sheep, 1953-54 (Continued)

<table>
<thead>
<tr>
<th>Winter Treatments</th>
<th>Items Measured</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Average of All Summer Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 6, 1953 Through Lambing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Range grazing plus 0.2 lbs. 20 percent protein supplement winter long</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Number of ewes</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Number of ewes died</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, Nov 6- March 31, lbs.</td>
<td>0.6</td>
<td>-4.0</td>
<td>1.4</td>
<td>-2.0</td>
<td>-1.0</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, May 3- Sept. 20, lbs.</td>
<td>17.7</td>
<td>18.9</td>
<td>16.0</td>
<td>17.5</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Fleece weight, lbs.</td>
<td>8.9</td>
<td>9.4</td>
<td>8.9</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>Lamb crop born, % of ewes completing trial</td>
<td>121.7</td>
<td>125.0</td>
<td>133.3</td>
<td>116.7</td>
<td>124.2</td>
</tr>
<tr>
<td></td>
<td>Lamb crop weaned, % of ewes completing trial</td>
<td>100.0</td>
<td>101.7</td>
<td>104.2</td>
<td>75.0</td>
<td>92.7</td>
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<tr>
<td></td>
<td>Cost of supplement, dollars per head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.40</td>
</tr>
<tr>
<td>3</td>
<td>Range grazing plus 0.4 lbs. 20 percent protein supplement winter long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of ewes</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Number of ewes died</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, Nov 6- March 31, lbs.</td>
<td>8.3</td>
<td>5.7</td>
<td>8.2</td>
<td>5.6</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, May 3- Sept. 20, lbs.</td>
<td>15.7</td>
<td>19.5</td>
<td>10.3</td>
<td>14.6</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Fleece weight, lbs.</td>
<td>9.2</td>
<td>10.1</td>
<td>9.4</td>
<td>9.1</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>Lamb crop born, % of ewes completing trial</td>
<td>132.0</td>
<td>132.0</td>
<td>124.0</td>
<td>133.3</td>
<td>130.3</td>
</tr>
<tr>
<td></td>
<td>Lamb crop weaned, % of ewes completing trial</td>
<td>108.0</td>
<td>84.0</td>
<td>112.0</td>
<td>112.5</td>
<td>104.1</td>
</tr>
<tr>
<td></td>
<td>Cost of supplement, dollars per head*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.77</td>
</tr>
<tr>
<td>4</td>
<td>Range grazing plus 0.2 lbs. 40 percent protein supplement last 6 weeks of pregnancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of ewes</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Number of ewes died</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, Nov 6- March 31, lbs.</td>
<td>-0.8</td>
<td>-1.6</td>
<td>-0.4</td>
<td>-3.1</td>
<td>-1.5</td>
</tr>
<tr>
<td></td>
<td>Ewe gain, May 3- Sept. 20, lbs.</td>
<td>20.8</td>
<td>23.5</td>
<td>17.0</td>
<td>17.6</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td>Fleece weight, lbs.</td>
<td>9.2</td>
<td>9.0</td>
<td>8.4</td>
<td>8.1</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>Lamb crop born, % of ewes completing trial</td>
<td>133.3</td>
<td>116.0</td>
<td>100.0</td>
<td>116.0</td>
<td>116.3</td>
</tr>
<tr>
<td></td>
<td>Lamb crop weaned, % of ewes completing trial</td>
<td>91.7</td>
<td>84.0</td>
<td>91.3</td>
<td>84.0</td>
<td>87.8</td>
</tr>
<tr>
<td></td>
<td>Cost of supplement, dollars per head*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.46</td>
</tr>
</tbody>
</table>

Stocking rate, acres/ewe/month 0.87 0.68 0.42 0.68 ---
Number of ewes 100 100 100 100 100
Number of ewes died 4 3 5 4 16
Ewe gain, Nov 6- March 31, lbs. 3.3 0.5 3.2 0.8 2.0
Ewe gain, May 3- Sept. 20, lbs. 17.9 20.9 14.6 15.6 17.2
Fleece weight, lbs. 9.0 9.6 8.9 8.7 9.0
Lamb crop born, % of ewes completing trial 131.5 124.5 117.6 121.9 123.9
Lamb crop weaned, % of ewes completing trial 105.4 87.8 99.7 90.7 95.9

*The supplements cost 166.55, 94.66, 93.55, or 106.55 dollars per ton for winter 1, 2, 3, or 4, respectively. All ewes were also fed 2.5 lbs. native hay per day for 19 days because of snow cover.

†Some differential losses may have been suffered in the summer lots because of bad weather while handling the sheep on May 2.
<table>
<thead>
<tr>
<th>Winter Treatments Nov. 6, 1953 Through Lambing</th>
<th>Item Measured</th>
<th>Summer Treatment May 3-Nov. 2, 1954</th>
<th>Average of All Summer Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Number of ewes completing trial</td>
<td>23</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>Number of singles weaned</td>
<td>13</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Weaning wt. singles, lbs.</td>
<td>80.1</td>
<td>75.5</td>
<td>76.1</td>
</tr>
<tr>
<td>Weaning age singles, days</td>
<td>159.2</td>
<td>154.1</td>
<td>155.1</td>
</tr>
<tr>
<td>Number of twins weaned</td>
<td>12</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Weaning wt. twins, lbs.</td>
<td>63.5</td>
<td>67.5</td>
<td>58.5</td>
</tr>
<tr>
<td>Weaning age twins, days</td>
<td>155.0</td>
<td>152.0</td>
<td>155.0</td>
</tr>
<tr>
<td>Number of twins raised single</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Weaning wt. twins raised single, lbs.</td>
<td>74.7</td>
<td>68.6</td>
<td>71.7</td>
</tr>
<tr>
<td>Weaning age twins raised single, days</td>
<td>154.3</td>
<td>162.0</td>
<td>163.0</td>
</tr>
<tr>
<td>Lamb wt. weaned per ewe completing trial, lbs.</td>
<td>88.0</td>
<td>66.3</td>
<td>65.9</td>
</tr>
<tr>
<td>Number of ewes completing trial</td>
<td>23</td>
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<td>24</td>
</tr>
<tr>
<td>Number of singles weaned</td>
<td>14</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Weaning wt. singles, lbs.</td>
<td>76.1</td>
<td>79.8</td>
<td>72.6</td>
</tr>
<tr>
<td>Weaning age singles, days</td>
<td>156.9</td>
<td>160.4</td>
<td>157.2</td>
</tr>
<tr>
<td>Number of twins weaned</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Weaning wt. twins, lbs.</td>
<td>66.3</td>
<td>67.0</td>
<td>58.6</td>
</tr>
<tr>
<td>Weaning age twins, days</td>
<td>159.3</td>
<td>163.0</td>
<td>155.4</td>
</tr>
<tr>
<td>Number of twins raised single</td>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Weaning wt. twins raised single, lbs.</td>
<td>78.3</td>
<td>71.5</td>
<td>76.5</td>
</tr>
<tr>
<td>Weaning age twins raised single, days</td>
<td>162.3</td>
<td>155.5</td>
<td>155.5</td>
</tr>
<tr>
<td>Lamb wt. weaned per ewe completing trial, lbs.</td>
<td>74.2</td>
<td>69.0</td>
<td>70.1</td>
</tr>
<tr>
<td>Number of ewes completing trial</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Number of singles weaned</td>
<td>16</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Weaning wt. singles, lbs.</td>
<td>80.8</td>
<td>76.2</td>
<td>73.2</td>
</tr>
<tr>
<td>Weaning age singles, days</td>
<td>157.8</td>
<td>156.5</td>
<td>158.5</td>
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<tr>
<td>Number of twins weaned</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Weaning wt. twins, lbs.</td>
<td>73.7</td>
<td>60.8</td>
<td>62.6</td>
</tr>
<tr>
<td>Weaning age twins, days</td>
<td>162.7</td>
<td>161.0</td>
<td>161.2</td>
</tr>
<tr>
<td>Number of twins raised single</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Weaning wt. twins raised single, lbs.</td>
<td>74.6</td>
<td>95.0</td>
<td>73.0</td>
</tr>
<tr>
<td>Weaning age twins raised single, days</td>
<td>160.0</td>
<td>159.0</td>
<td>154.0</td>
</tr>
<tr>
<td>Lamb wt. weaned per ewe completing trial, lbs.</td>
<td>84.3</td>
<td>59.8</td>
<td>78.6</td>
</tr>
</tbody>
</table>

1 Range grazing plus 0.2 lb. 40 percent protein supplement winterlong

2 Range grazing plus 0.2 lb. 20 percent protein supplement winterlong

3 Range grazing plus 0.4 lb. 20 percent protein supplement winterlong
### Table 5. Lamb Production—Summer Grazing and Winter Supplementation Studies with Range Sheep, Progress Report 1953-54 (Continued)

<table>
<thead>
<tr>
<th>Winter Treatments</th>
<th>Summer Treatment</th>
<th>Average of All Summer Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Light Grazing</td>
<td>2) Moderate Grazing</td>
<td>3) Heavy Grazing</td>
</tr>
<tr>
<td><strong>Items Measured</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Number of ewes completing trial</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Number of singles weaned</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Weaning wt. singles, lbs.</td>
<td>82.5</td>
<td>77.7</td>
</tr>
<tr>
<td>Weaning age singles, days</td>
<td>157.2</td>
<td>155.2</td>
</tr>
<tr>
<td>Number of twins weaned</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Weaning wt. twins, lbs.</td>
<td>64.0</td>
<td>55.0</td>
</tr>
<tr>
<td>Weaning age twins, days</td>
<td>156.0</td>
<td>159.0</td>
</tr>
<tr>
<td>Number of twins raised single</td>
<td>67.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Weaning wt. twins raised single, lbs.</td>
<td>67.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Weaning age twins raised single, days</td>
<td>159.3</td>
<td>161.4</td>
</tr>
<tr>
<td>Lamb wt. weaned per ewe completing trial, lbs.</td>
<td>70.2</td>
<td>60.8</td>
</tr>
<tr>
<td>Average of all winter lots</td>
<td>95</td>
<td>98</td>
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<tr>
<td>Number of ewes completing trial</td>
<td>57</td>
<td>51</td>
</tr>
<tr>
<td>Number of singles weaned</td>
<td>79.9</td>
<td>77.3</td>
</tr>
<tr>
<td>Weaning wt. singles, lbs.</td>
<td>157.8</td>
<td>156.6</td>
</tr>
<tr>
<td>Weaning age singles, days</td>
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<td>18</td>
</tr>
<tr>
<td>Number of twins weaned</td>
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<td>62.6</td>
</tr>
<tr>
<td>Weaning wt. twins weaned</td>
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<td>Weaning age twins weaned</td>
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<td>17</td>
</tr>
<tr>
<td>Number of twins raised single</td>
<td>73.7</td>
<td>77.2</td>
</tr>
<tr>
<td>Weaning wt. twins raised single, lbs.</td>
<td>73.7</td>
<td>77.2</td>
</tr>
<tr>
<td>Weaning age twins raised single, days</td>
<td>159.0</td>
<td>159.5</td>
</tr>
<tr>
<td>Lamb wt. weaned per ewe completing trial, lbs.</td>
<td>79.2</td>
<td>64.0</td>
</tr>
</tbody>
</table>

*This is an average of averages in which one lamb in summer 2, winter 5 represents that lot.


**Reducing Farm-to-Market Losses of Livestock**

The marketing of livestock and livestock products is the largest source of cash farm income in South Dakota. In 1953, approximately 67 percent of the cash income to South Dakota farmers was from this source, of which 53 percent was contributed by meat animals alone.

The producer bears much of the physical loss occurring to livestock in transit from farm to market. The extent, magnitude, and economic significance of the annual livestock loss by South Dakota producers is being studied. Particular emphasis is being given to bruising, crippling, death, and shrinkage losses.

Bruising losses are serious but techniques for determining the causes and ages of bruises are being developed and the bruise studies will be initiated as the project continues. Daily records of dead and crippled animals, together with the point of origin and total daily receipts are being collected and tabulated from...
marketing agencies in the state.

Preliminary observational data on excretory shrinkage losses are being collected utilizing the trucking operations of the Animal Husbandry Department. (Project 285. Leaders: R. M. Luther, Animal Husbandry Dept; W. K. Ullman, Agricultural Economics Dept.)

A New Roughage Marketing Project
A project concerned with marketing value of roughages has been initiated recently. The objectives of this project are: (1) to survey methods and practices of marketing important roughages in South Dakota, and (2) to correlate the market values and prices of important roughages with their chemical composition. Large quantities of roughages are produced in the state each year and a considerable amount is sold for feed both within and without the state.

Roughages can and do vary widely in feeding value and buyers, sellers, and feeders of roughages need a better method of evaluating the feed than by appearance alone. Work is now in progress on this problem. (Project 267. Leaders: L. E. DuBose, Animal Husbandry Dept; W. K. Ullman, Agricultural Economics Dept.)

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Rotational Crossing of Hogs Doesn't Run Out, see page 1
Hay or Silage as the Only Roughage for Pregnant Ewes, see page 50
Creep Rations for Pigs, see page 53
Vitamin A Supplementation of Range Cows, see page 98

Plant Diseases

The Control of Foliage Disease of the Tomato in South Dakota
Approximately 100 tomato plots were grown in field experiments resulting from crosses involving non-commercial strains carrying resistance to septoria leaf spot. Septoria leaf spot is one of the most important diseases of tomatoes in South Dakota.

The performance of these lines varied widely in resistance or susceptibility to leaf spot. The resistance possessed by any one did not appear adequate without further back-crossing to obtain greater resistance. Many of the so-called "wild" non-commercial types have been inoculated in the search for sources of greater resistance. No strain obtained has been classified as highly resistant.

It does appear that it will be possible to obtain a variety possessing commercial quality and at the same time possessing considerable protection against septoria leaf spot. (Project 146. Leader: C. M. Nagel, Plant Pathology Dept.)

Potato Diseases and Their Control
To determine the influence of irrigation on disease development in potatoes, 15 varieties were grown on irrigated and non-irrigated land at the Redfield station in 1954.

A randomized block design with five replications was used in these experiments. It was planned so as to obtain yield data, but the poor germination and stands which resulted made this impossible. Data were obtained on scab and rhyzoctonia when these varieties were grown under the two soil environments. (See Table 1.)

Several standard varieties were included in the experiments while the majority were varieties which have been named and released during recent years. A number of them carried resistance to scab.

The intensity of scab was rather low in the soil and there appeared to be no definite trend in scab development under irrigation as compared to non-irrigation. However, there was evidence that rhyzoctonia was more prevalent and severe under irrigated conditions. Also, rhyzoctonia is a low temperature disease and undoubtedly, therefore, may have been slowed down in its activity dur-
Table 1. Disease Reactions of 15 Varieties of Potatoes Grown at the Redfield Station Under Irrigated and Non-Irrigated Conditions in 1954

<table>
<thead>
<tr>
<th>Variety &amp; Number</th>
<th>Scab (type)*</th>
<th>Scab (%)</th>
<th>“Rhyzoc” (%)</th>
<th>Scab (type)</th>
<th>Scab (%)</th>
<th>“Rhyzoc” (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bl Tr (Bliss Triumph)</td>
<td>1, 2, 3</td>
<td>40</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
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<tr>
<td>2 Canus</td>
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<td>30</td>
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<td>40</td>
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<tr>
<td>3 Cherokee</td>
<td>1, 2, 3</td>
<td>40</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>40</td>
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<tr>
<td>4 Chippewa</td>
<td>1, 2, 3, 4</td>
<td>20</td>
<td>1, 2, 3, 4</td>
<td>40</td>
<td>2, 3</td>
<td>40</td>
</tr>
<tr>
<td>5 Gobblers</td>
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<td>2, 3</td>
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<td>2, 3</td>
<td>40</td>
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<tr>
<td>6 Pringo</td>
<td>1, 2, 3</td>
<td>60</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>40</td>
</tr>
<tr>
<td>7 Col Rus (Columbia Russet)</td>
<td>1, 2</td>
<td>70</td>
<td>1, 2</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
</tr>
<tr>
<td>8 Early Ohio</td>
<td>1, 2, 3</td>
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<td>2, 3</td>
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<tr>
<td>9 Kathadin</td>
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<tr>
<td>10 Kennebec</td>
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<tr>
<td>11 La Soda</td>
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<td>30</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
</tr>
<tr>
<td>12 Red Pontiac</td>
<td>1, 2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
</tr>
<tr>
<td>13 Sebago</td>
<td>1, 2, 3</td>
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<tr>
<td>14 Yampa</td>
<td>1, 2, 3</td>
<td>30</td>
<td>2, 3</td>
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<td>2, 3</td>
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<tr>
<td>15 Starks Red</td>
<td>1, 2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
<td>2, 3</td>
<td>30</td>
</tr>
</tbody>
</table>

*Type 1—shallow lesions or russety condition, least severe. Type 4—deep or crater-like lesions, most severe type.

It is anticipated that the disease situation will increase with frequent cropping with potatoes. The scab organism lives in the soil more or less indefinitely and with frequent cropping with potatoes the disease population will be expected to increase.

Virus and other foliage diseases did not develop in significant amounts in 1954 at Redfield.

Sixty-two experimental lines of potatoes were grown in the scab nursery for further evaluation in the search for a scab resistant variety with desirable commercial qualities. (Project 107. Leader: C. M. Nagel, Plant Pathology Dept.)

**Corn Diseases and Their Control**

Three hundred nine strains of corn selected for resistance to root rot and other corn diseases were grown again in field experiments at Brookings. These strains have been inbred seven generations and continued selection for resistance have been made with each season’s program. Considerable uniformity now exists with respect to both vegetative characters and disease reaction.

Root diggings at the end of the 1954 season for root rot tolerance were carried out with all lines. On the basis of these records, a wide range of disease tolerance appears to exist within this germ plasm. Plans are to verify these results at the end of the 1955 season through similar root excavations and to correlate these results with those obtained in 1954.

In cooperation with the Agronomy Department, about 40 inbred root rot resistant selections were top-crossed onto two single cross tester lines. Yields will be obtained from these inbred root rot resistant lines at harvest time. It is hoped from this performance test that an estimate will be possible as to the performance of these inbred lines. (Project 185. Leader: C. M. Nagel, Plant Pathology Dept.)

**Sorghum Seed Treatment**

Twenty fungicides were used as sorghum seed treatments on three dates of planting at Brookings and Highmore, South Dakota. Stand counts and yield data were taken. The dry season at Highmore resulted in non-significant results from seed treatment. No fungicide at any given date of planting improved stand or yield.

At Brookings the results of seed treatment were, in part, inconsistent with previous years’ results. In 1954 no in-
crease in stand or yield was obtained for
the earliest date of planting. The results
from the second and third date of plant-
ing are in general agreement with pre-
vious years.

One reason for the failure of seed treat-
ment to produce significant increases in
stand at the earliest date of planting ap-
pears to be associated with unfavorable
soil temperatures for the germination of
sorghum seed. Three weeks were re-
quired for germination and during that
time the soil temperature ranged from
52° to 60° F. Such a prolonged period of
unfavorable temperature for germina-
tion might permit seed decay in spite of
seed treatment.

The results cast some doubt on the
advisability of attempting to plant sor-
ghum before soil temperatures favor-
able for germination have been reached.
Under prolonged unfavorable conditions
the protective value of the fungicides
seems to be dissipated before germina-
tion occurs.

Certain fungicides have performed in
a satisfactory manner year after year
while others, such as the mercurials per-
formed poorly. Arasan and Orthocide
75 are two readily available fungicides
which have produced good results over
a period of years and can be recom-

mended as generally reliable seed treat-
ments for sorghum.

From 210 breeding lines of sorghum
grown in 1953, twenty-two were selected
and planted in 1954 for further evalu-
ation as to their resistance to root rot.

The lines under test were planted in
six replications, three of which were
planted on soil that had been treated
with soil fumigant, Crag 974. This
material was ineffective in controlling
or reducing root rot.

Each sorghum line was rated accord-
ing to the amount of root rot present
just prior to maturity and at maturity.
Root damage due to root rot ranged
from light to heavy with little change
relative to the time of rating. The re-

cussions made in 1953. This marked and seem-
ingly constant difference in root rot
development between lines appears to
have genetic significance. If this proves
to be true, then root rot resistant or
tolerant varieties might be developed
through further breeding.

Foliage diseases of sorghum were at a
minimum during the 1954 season. Bacterial spot was the most prevalent
disease, but infection ranged from a
trace to moderate. (Project 110. Leader:
C. J. Mankin, Plant Pathology Dept.)

Foliage Diseases of Small Grains
and Their Control

The following diseases are listed in
order of their importance and were
found on small grain in South Dakota
in 1954: wheat—stem rust 15B, yellow-
streak mosaic, basal stem rot, septoria
leaf spot, scab, loose smut, leaf rust,
bacterial stripe, and black chaff; oats—
stem rust, crown rust, halo blight, sep-
toria leaf spot, red leaf, and loose and
covered smut; barley—stripe-mosaic,
bacterial stripe, scab, loose smut, spot
blotch, septoria leaf spot, and scald.

An epidemic of yellow-streak mosaic
of wheat resulted in an estimated 10 per-
cent loss to the winter wheat areas of the
state. Stem rust resulted in the following
percentage losses in 1954: durum wheat
45, spring wheat 17, winter wheat 6, oats
5, and barley 1.

In cooperation with the U. S. Depart-
ment of Agriculture, wheat, oats, and
barley uniform rust nurseries were
grown at Brookings and evaluated for
their rust reactions. The uniform oat
smut nursery was grown but only light
infection occurred, thereby making it
difficult to obtain clear differentiation be-
tween resistant and susceptible varieties.
Likewise, in cooperation with Canadian
workers, uniform seed treatment exper-
iments were grown at Brookings for the
control of smuts on wheat and barley.
Due to light infection no significant ad-
"
ment were obtained in 1954. Oat seed treatment trials for smut control resulted in good control of these diseases.

New Lines Tested. A large number of new and promising lines of wheat were grown for resistance to strain 15B of stem rust and other diseases at Brookings in cooperation with the United States Department of Agriculture. These lines were evaluated for their reactions to rust and other important diseases.

Sixty-two varieties of wheat were tested for resistance to the yellow-streak mosaic virus under greenhouse conditions in the new plant pathology greenhouses. One variety, Rio Negro, appeared to be quite resistant when inoculated by mechanical methods. This strain of wheat was obtained from Brazil, South America. It is being tested further under field conditions along with 1000 durums and 550 spring from the World Collection of wheat supplied by the U. S. Department of Agriculture. It is hoped that resistance may be found in some of these varieties. Such resistant strains when found will be used in cooperation with the Agronomy Department in a breeding program that will utilize this resistance in developing commercially acceptable varieties.

Try Chemicals for Rust Control. Fifty-five chemicals were applied on Mida and Marquis wheat and Brunker oats in the field during June for the control of rust. Calcium sulfamate was the only chemical to suppress rust. A spray machine was developed for applying chemicals at different rates. Greenhouse tests of 30 antibiotics and nearly 60 other chemicals failed to show rust control. Five organophosphorus insecticides and one organic compound controlled rust to a slight extent. These will be tested further in the field. (Project 204. Leaders: J. F. Hennen and George Semeniuk, Plant Pathology Dept.)

Root Rot Diseases of Cereals and Grasses and Their Control

Eighteen different fungicides were used in a seed treatment experiment to determine their effects on stand and yield of cereals and flax. The greatest benefit was associated with poor quality seed and unfavorable conditions for plant growth such as frequently occurs with early field plantings of these crops by farmers.

A zinc-copper-chromium oxide dust (Carbide and Carbon exp. cpd. 640) at the rate of 2 ounces per bushel was the most effective chemical used on wheat, while a zinc-mercury-chromium oxide dust (Carbide and Carbon exp. cpd. 224) at the rate of 4 ounces per bushel and spergon at the rate of 6 ounces per bushel were most effective with flax. The zinc-copper-chromium oxide dust seed treatment on wheat gave a 43 percent increase in stand and a two bushel per acre increase in yield over the non-treated seed. The zinc-mercury-chromium oxide dust and spergon seed treatments on flax gave a 78 and 73 percent increase in stand, respectively, following a period of wet, cold weather, the weather conditions which favor seed rotting disease organisms which live in the soil.

Additional seasons' results are needed before definite recommendations can be made as to the use of these chemicals for seed treatments in South Dakota. (Project 115. Leader: J. F. Hennen, Plant Pathology Dept.)

Investigations and Control of Alfalfa And Other Forage Legume Diseases

In continuing cooperation with the Agronomy Department, select clonal lines and intercross clonal progenies were further evaluated for disease resistance in the field and/or greenhouse at Brookings, South Dakota, to Ascochyta imperfecta, Cercospora zebrina, Pseudopezizzia medicaginis, Corynebacterium insidiosum, and Uromyces striatus.

Rust, caused by Uromyces striatus, and summer blackstem, caused by Cercospora zebrina, were unusually abundant in the field during the dry summer and fall of 1954. Spring blackstem,
caused by *Ascochyta imperfecta*, appeared as three distinct types of leafspots on different alfalfa clones, and tentatively differentiated as (1) typical, with small spots scattered over the surface of a leaflet; (2) blotch, with rapid progressive, light-brown necrosis from the edge of a leaflet, and (3) curl, with slow progressive, dark-brown necrosis at the tip, accompanied by twisting of the leaflet. Isolates from these appeared different culturally but their pathogenicities have not been compared.

*Ascochyta imperfecta* produced natural type pycnidia in a beef-peptone agar medium. *Cercospora zebrina* on dead leaves sporulated at relative humidities as low as 96 percent at 20°C. It sporulated abundantly on malt agar. The perfect stage of *Pseudopeziza ponesii* was found only in early spring on dead leaves on the ground. So far, no sporulating cultures of this pathogen have been obtained.

Alfalfa productivity on about one-half of 20 South Dakota soils in the greenhouse suffered from severe damping-off and from poor post-seedling growth. Poor post-seedling growth occurred on these same soils sterilized, indicating that nutritional or soil physical factors were responsible agents. Damping-off was caused by pythiaceous fungi that were more abundant in some soils than in others as revealed from tests in mixed soils. (Project 230. Leader: George Semeniuk, Plant Pathology Dept.)

**The Biology and Control of Important Grass Diseases, Grass Seed Treatment**

The difficulties sometimes encountered in obtaining satisfactory stands of certain forage grasses prompted a study of the effects of seed treatment on grass stands. Six grass species were treated with twenty fungicides in order to evaluate their effectiveness in increasing grass stands.

Fungicides tested included the commonly used mercurials and organics as well as the newer untested materials. The response of the various grass species was inconsistent.

**Treatment Results.** Bromegrass appeared to be the most sensitive to fungicide injury since 11 of the 20 fungicides significantly reduced the stand. It bromegrass is to be benefited by seed treatment further experimentation with dosages is required.

Although no improvement in stand was obtained with seed treatments, fescue and bluegrass did not appear to be as sensitive to fungicide injury as bromegrass.

The wheat grasses responded best to seed treatment and significant increases in the stand of crested and slender wheat grass was obtained. The stand of Reewheat grass tended to be better with seed treatment, but such increases failed to be statistically significant.

The organic fungicides as a group were superior to the mercurials and inorganics as grass seed treatments. The organic fungicides, Orthocide 75 and Thiram, ranked first and second in improving grass stands.

Proper dosage appears to be an important factor in seed treatment of grasses. Many of the materials used tended to produce better stands than the untreated check, but the increase in stand failed to be statistically significant.

Two fungicides, Orthocide 75 and Crag 794, a sulfur containing organic chemical, were added to the soil at the rate of 100 pounds per acre in an attempt to increase grass stands through the control of soil-borne organisms. An analysis of the results showed no increase in stands due to soil treatment of this type.

**Progeny Resistance Tests.** In cooperation with the Agronomy Department, the progenies from crosses in all combinations of fine bromegrass parents, selected for field resistance to Helminthosporium leaf spot, were inoculated with *Helminthosporium bromi* in the greenhouse. When the results of two separate inoculations were evaluated, on the basis of lesion size, a marked differ-
ence in resistance among the progeny was evident. No single progeny remained free of the disease, but the lesions on some failed to develop extensively. All plants tested in the greenhouse will be transplanted to the field and given a disease rating under field conditions. A correlation will be made of the greenhouse and field results.

Attempts were made to establish the virus nature of a late season foliage blast of Reec wheat grass. Mechanical inoculations and the transfer of eriophyidae mites from diseased to healthy plants failed to produce typical symptoms. Since no positive transmissions of a virus have been made and no causal organism has been found, the nature of this disorder remains unknown. (Project 250. Leader: C. J. Mankin, Plant Pathology Dept.)

Diseases of Shelterbelt Trees and Their Control

A search for the cause of the high mortality of cottonwood trees (*Populus deltoides*) in shelterbelt and farmstead plantings throughout South Dakota was investigated. One of the principal causes was found to be a destructive leaf-rust disease. This fungous disease is very similar in appearance to the leaf-rust disease on wheat, although it does not attack the cereal crops.

Rust Damage. This disease appears annually about mid-July and brings about 10 to 14 days. Defoliation interferes with the normal development of the plants. It stops the growth of the tree and, most important, prevents the production of carbohydrates for continued growth during the season or the storage of food reserves in the plant cells which are necessary for the new growth which takes place the following spring. The high food reserves in the plant tissues are an important factor in preventing winter injury.

This reduction in the stored food supply permits winter killing which is one of the typical symptoms in the death of cottonwoods. Previously, the losses had been ascribed to winter killing; however, this was found to be a secondary phase of the trouble and that leaf-rust defoliation appeared to be the major cause, which predisposed the weakened trees to winter injury.

Various methods of control were embarking upon at the outset of the project; however, through inoculation experiments, it was soon found that various degrees of leaf-rust resistance were to be found among the native strains of cottonwood.

Siouxland Developed. A number of such strains, ranging from susceptible to near immunity to leaf-rust, have been discovered. One of these strains has been selected, increased, and released to growers in the spring of 1955 following 8 years of field testing and observations. It has been named Siouxland, and grown under certified regulations and released as certified stock through the College Seed Stocks Foundation. Approximately 100,000 trees were distributed through commercial nurseries in 1955, and in 1956, approximately 500,000 plants are being grown for distribution.

Siouxland, in addition to having a high degree of resistance to leaf-rust, is winter hardy and does not produce “cotton” (which has been an objectional feature of the common cottonwood).

The cottonwood is one of the important permanent species used in shelterbelt plantings. It is planted in the central rows of the shelterbelt because it grows rapidly and attains a maximum height in a given period of time and is long-lived. These features make its use in shelterbelt plantings highly desirable in accomplishing the principal goals of shelterbelts, namely to provide wind protection and prevent soil erosion.

There are about 100,000 acres of shelterbelt and farmstead plantings in South Dakota. (Project 142. Leader: C. M. Nagel, Plant Pathology Dept.)
The Quality of Grass and Alfalfa Silage 
As Affected by the Development of Specific Microorganisms

"Spoilage" microorganisms developing in the outer regions of open stack silage are principally thermophilic actinomycetes and fungi difficult to isolate in pure culture. The most common one is a white filamentous actinomycete that develops in about a 1-foot broad band around the periphery of the stacks, about 6 inches beneath the surface. This microorganism grows at 45° and 55°C, but there are several more to be isolated. More filamentous microorganisms grow at 45°C than at 55°C. Silage samples from the inner parts of the stacks do not show or support mold growth at 20, 45, or 55°C as readily at the outer parts of stacks.

Cut, green alfalfa incubated under aerobic and anaerobic conditions at 30, 45, 55, and 65°C supported a much smaller bacterial development under anaerobic than under aerobic conditions and a much smaller bacterial development at 65°C than at lower temperatures. Bacterial development started earlier and was most abundant at 45°C. Mold and streptomycete development occurred only under aerobic conditions, the former at 30 and 45°C, the latter at 55 and 65°C. (Project 237C. Leader: George Semeniuk, Plant Pathology Dept.)

Siouxland—A New Rust Resistant Cottonwood, see page 38

Poultry Production

Evaluation of Mating Combinations by Performance Testing

As in past years, the birds in the comparisons described below were brooded and reared at the Experiment Station at Brookings with as nearly similar environmental conditions as could be provided. In September the pullets were taken to the Cottonwood, Eureka, and Highmore substations. The following comments are concerned with the first 8 months of performance at each of these substations.

Cottonwood. Two pens of single cross topcrosses were superior in egg production to an experimental hybrid and to a crossbred which served as a control. One of the reasons for lowered egg production in the experimental hybrid, which was a cross involving four different inbred lines, was a high incidence of broodiness. The crossbred hens (White Plymouth Rock X White Leghorn) laid the largest eggs, but not sufficiently larger to compensate for their lowered production. The group of hens sired by single-cross males (inbred New Hampshire X inbred Rhode Island Red) and from outbred White Plymouth Rock dams, had by far the lowest mortality.

Eureka. This test included two experimental hybrids, a commercial hybrid, and a crossbred. The hybrids laid at an earlier age than did the crossbreds; they also laid at a higher rate. Adult mortality was high for the commercial hybrid and for one of the experimental hybrids. The crossbreds laid larger eggs than any of the groups of hybrids. Broodiness was excessive in the two experimental hybrids, but was very low in the commercial hybrid and crossbred lots.

Highmore. A White Plymouth Rock X New Hampshire crossbred served as the control group at this test. The commercial hybrids at this substation had the highest production on a hen-day basis; they also had the highest adult mortality. An experimental hybrid was relatively late in attaining sexual maturity but ultimately performed as well as the controls. A topcross (inbred White Plymouth Rock sire X outbred New Hampshire dam) had few cases of broodiness and had low adult mortality. Again, the crossbreds had the largest eggs.
Two sets of like groups at different stations provided data for comparing environmental influences. Two of the substations have much lower adult mortality than does the other. At one test the pullets reach sexual maturity at a much later age than they do at the others. These observations have not been reported before, but previous years’ records show that a similar pattern has been apparent.

Five groups of single-cross pullets (some of which were used for the production of experimental hybrids) have produced very well for a 6-month test period at the Brookings Experiment Station. (Project 194. Leaders: Walter Morgan and Wm. Kohlmeyer, Poultry Dept.)

**Effects of Inbreeding and Use of Inbred Lines**

Four of the nine inbred lines developed at this station have been difficult to maintain this year. These four White Plymouth Rock lines are the most highly inbred. It has been necessary to maintain three of these lines by artificial insemination. As a generalization, the hatchability for all of the lines has been much better than the fertility. Adult mortality was variable, reaching higher than 50 percent in three lines.

Many birds in the Barred Plymouth Rock line were carriers of the gene for non-barred plumage, so that there were a number of white chicks produced in that line. There were a number of birds with crossbeaks and crooked toes.

Most of the lines are being used in combination with other inbred lines in an effort to identify superior combinations.

Single-crosses, single-cross top crosses, and experimental hybrids were sent to the Regional Poultry Breeding Project headquarters at Lafayette, Indiana, for testing. (Project 179. Leaders: Walter Morgan and Wm. Kohlmeyer, Poultry Dept; D. C. Warren APHRB, cooperating.)

**Control of Selenium Poisoning in Poultry**

Further work on this project has shown that 5 percent linseed meal, though slightly toxic in itself, will counteract, in part, the toxic effects of selenium upon young chicks. Glycocyamine, likewise toxic in itself, in the presence of an excess of D-1 methionine, also partially counteracted this toxicity. Linseed meal and glycocyamine did not supplement one another. (Project 28. Leaders: C. W. Carlson and Wm. Kohlmeyer, Poultry Dept; E. O. Olson, Station Biochemistry Dept.)

**Factors Affecting the Performance of Turkeys**

A growth response from a level of 10 grams of chlortetracycline per ton of diet was obtained with turkeys from 12-28 weeks of age on diets containing 70 percent oats (low energy) but not on diets containing 58 percent corn (high energy). Feed efficiency was not affected by the antibiotic, but nearly 25 percent less high energy feed was required per pound of gain. The birds on the high energy diets grew at a significantly faster rate than those on the low energy diets.

Vitamin E was shown to be necessary for good hatchability for Beltsville Small White breeder hens, but under similar conditions, was not so demonstrated for Broad Breasted Bronze breeder hens. At the low level of 10 grams per ton, chlortetracycline had no consistent effect upon egg production or hatchability of fertile eggs. A slight reduction in progeny growth apparently caused by the antibiotic was in evidence when a starter diet deficient in riboflavin was fed. This was not evident on a normal diet. (Project 242. Leaders: C. W. Carlson, W. C. Morgan, and Wm. Kohlmeyer, Poultry Dept; O. E. Olson, Station Biochemistry Dept.)

**Forage Crops for Turkeys**

Alternate strip planting of corn and rape in rows or oats and rape drilled alternately provided equally satisfactory
range for growing turkeys. The turkeys were placed on the range at an early enough date so that the forage growth did not get too far ahead of the consumption rate. As a result, forage production did not appear abundant but provided ample green food at a stocking rate of 150 birds per acre during a rather dry season. (Project 79. Leaders: Wm. Kohlmeyer and C. W. Carlson, Poultry Dept; Albert Dittman, N. C. Substation, Eureka.)

Mineral Requirements of Turkeys

Studies on the availability of phosphorus in commercially available phosphate supplements added to a practical type turkey starter diet have shown a possible correlation between known processing methods and phosphorus availability. This clue is being investigated further.

Under the conditions of this work, the availability of the supplements tested for turkey pouls is indicated in Table 1. Each supplement supplied 0.15 percent phosphorous to the ration and was compared to the dibasic calcium phosphate USP XIV which was arbitrarily set equal to 100. Body weights at 4 weeks of age and percentages of bone ash were the basis of comparison, and the figures are averages of the two indices. (Project 221. Leaders: R. A. Wilcox, C. W. Carlson, and Wm. Kohlmeyer, Poultry Dept; G. F. Gastler, Station Biochemistry Dept.)

Minimizing Quality Losses in Poultry Meat in Market Channels

Turkeys of acceptable carcass appearance were produced on low or high energy diets with or without antibiotics.

Table 1. Rating of Phosphorus Supplements When Supplying 0.15 Percent Phosphorus to a Practical Type Diet*

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*The averaged response of Dibasic Calcium Phosphate U.S.P. XIV in 4-week body weights and percent of bone ash was arbitrarily set equal to 100 and the other supplements compared to this.

Although the turkeys which had received the high energy feeds were larger, no great differences in carcass chemical composition, palatability preference, or cooking losses were noted. There was only slightly less fat in the muscular and skin tissues of birds fed low energy diets. It would not appear that there need be any great concern over the dietary energy level or the commonly used dietary antibiotics as affecting consumer value and acceptability of turkey meat. (Project 261. Leaders: C. W. Carlson and Wm. Kohlmeyer, Poultry Dept; Lida Burrill, Home Economics Dept; O. E. Olson, Station Biochemistry Dept.)

Antibiotics and Egg Production, see page 5

Egg Marketing Problems, see page 56

Rural Sociology

The Socio-Economic Influences of the Communal Type Farm on the Rural Community of South Dakota

The communal type farm has been in existence in South Dakota since the state's territorial days. Laws concerned with the organization of communals are to be found on the Statute books of South Dakota. In recent years the number of communal type farms has been
increasing in South Dakota; at present there are eighteen. In addition, available information suggests that these farms are increasing in size as well as number. Farmers, businessmen, legislators, and other citizens in the state have become interested in the social and economic implications of this type of farm for the rural community.

The main objectives of this research are to determine the present social and economic organization of the communal type farm in South Dakota and the socio-economic influences of this type of farm on the rural community. (Project 255. Leader: Marvin P. Riley, Rural Sociology Dept.)

Population Changes and Implications for the Development of Agriculture and Rural Life

This research project is a state project with data being contributed to the North Central Regional Project 18. A manuscript, "Population Change and Net Migration in the North Central States, 1940-50," based upon the Regional data has been published by Iowa State College, Ames, Iowa. South Dakota Agricultural Experiment Station bulletin 440, Population Trends in Relation to Resources Development in South Dakota, was published during the fiscal year.

Based upon the population changes between 1940 and 1950, areas of declining population and areas of increasing population are being delineated. These areas will then be sampled for intensive study to establish the effects of extensive outmigration and immigration upon the social organization within these areas. (Project 222. Leader: Robert M. Dimit, Rural Sociology Dept.)

Growth and Decline of South Dakota Trade Centers, 1901-51

Changes in agricultural mechanization, transportation, and merchandising are among some of the factors that have influenced a decline in the rural-farm population as well as the growth and decline of trade centers in South Dakota between 1901 and 1951. As the rural-farm population declined there was a corresponding decrease in the total number of trade centers according to the Dun and Bradstreet reference books. Within this decreasing number of trade centers there was an increase in the number and the population of cities.

Much of the urban growth has been at the expense of population losses in the rural-farm trade and service areas of towns and cities. The rural-farm population decreased 35 percent between 1930 and 1950. The rural-nonfarm population including trade centers under 2500 has represented approximately the same proportion of the total population since 1920.

The largest number of trade centers in South Dakota (759) existed in 1911 during the time of early settlement. By 1951 the number had decreased to 545, a loss of 28 percent. The largest decrease was in the hamlet class, trade centers with less than 50 inhabitants. The number of cities, trade centers with 2500 or more inhabitants, increased from 9 in 1901 to 25 in 1951. Within these total changes, some trade centers came into existence while others disappeared.

The more recent change has been for trade centers under 500 inhabitants to decrease in size, and for trade centers with more than 1000 inhabitants to gain population. The greater the size over 1000 the greater the increase. The increase alone in the population of the six cities with 10,000 or more people between 1940 and 1950 represented more people than the actual population of 191 trade centers in South Dakota ranging in size from 50 to 249 people for the same decade. During the same decade there was a large increase in the number of inhabitants not living in trade centers in the rural-nonfarm segment of the population. Most of this increase was in the unincorporated suburbs of the larger cities.
One of the greatest changes during the 50-year period has been in the functions of trade centers as they make adjustments to accommodate the changing life habits of people. This has been reflected in merchandising changes as well as changes in social institutions. Specialization in agriculture has resulted in specialization among trade centers. For this reason there will be a minimum of small trade centers and growth in the larger cities where specialized goods and services are available. High schools, churches, and various associations have become town-centered with the declining rural-farm population and the discontinuance of these institutions and associations in rural-farm areas.

This study is reported in Experiment Station bulletin 448, Growth and Decline of South Dakota Trade Centers, 1901-51. (Project 219. Leader: Douglas Chittick, Rural Sociology Dept.)

Progress on the Belle Fourche Irrigation Project, see page 68

Substation Report

Antelope Range Field Station, Buffalo
William B. Trevillyan, Superintendent

Animal Husbandry
Improvements of Beef Cattle Through Breeding. Project 167. See page 139.
Summer Grazing and Winter Supplementation Studies with Range Ewes. Projects 159 and 177. See page 147.

Veterinary
Control of Internal Parasites of Sheep. Project 139. See page 139.

Central Substation, Highmore
Wade R. Pringle, Superintendent

Agricultural Engineering

Agronomy
Crop Varieties and Strains Tested. Projects 25 and 181. See pages 116 and 41.
Corn Hybrids and Varieties Tested. Project 151. See page 117.

Animal Husbandry
Nutritive Value of Prairie Hay. Project 120. See page 141.

Entomology-Zoology

Horticulture
Highmore Space Study Initiated. Project 239. See page 134.

Poultry
Evaluation of Mating Combinations by Performance Testing. Project 194. See page 158.

North Central Substation, Eureka
Albert Dittman, Superintendent

Animal Husbandry
Nutritive Value of Prairie Hay. Project 120. See page 141.

Agronomy
Corn Hybrids and Varieties Tested. Project 151. See page 117.
Crop Varieties and Strains Tested. Projects 25 and 181. See pages 116 and 41.

Poultry
Evaluation of Mating Combinations by Performance Testing. Project 194. See page 158.
Forage Crops for Turkeys. Project 79. See page 159.
Range Field Station, Cottonwood

F. W. Whetzel, Superintendent

Agronomy
Testing New Legume Developments. Project 74. See page 118.
Soil Experiments — Moisture conditions were such the past year that very poor stands of small grain were obtained where small grains followed sorghum in the rotation. Fair stands and yields resulted, however, where small grain followed fallow. The yield of wheat following sorghum was 1.8 bushels while that following fallow was 15.3 bushels. Yields of small grain were not affected in any way by the use of fertilizer.

Both crested wheat and native grass yields were increased by using nitrogen fertilizer in 1954. The increases, percentage-wise, were large, but the actual increases were not of enough magnitude to make the application a paying proposition. It was found in addition in the native grass experiment, that 80 pounds of nitrogen will carry over in the soil for as much as 2 years. (Project 4. Leader: B. L. Brage, Agronomy Dept.)

Animal Husbandry
Improvements of Beef Cattle Through Breeding. Project 167. See page 139.
Summer Grazing of Beef Cows for Calf Production. Project 216. See page 144.

U. S. Newell
Irrigation and Dry Land Field Station, Newell

Harry E. Weakly, Superintendent

Animal Husbandry
Irrigated Pastures in Western South Dakota. Project 229. See page 143.
Swine Production for the Irrigated Areas of Western South Dakota. Project 132. See page 145.
Effect of Bentonite in Feeder Lamb Rations. Project 233. See page 147.

Publications

Bulletins


Circulars


Effects of Irrigation on an Adjoining Ranch Economy. Circular 115, by W. D. Schutz.

Agricultural Research at the Range Field Station—A Progress Report. Circular 116, by the Experiment Station Staff.

Share Rents and Short-Term Farm Leases. Circular 117, by R. L. Berry.

Technical Bulletins


Effect of Wind Variation on Water Distribution from Rotating Sprinklers. TB-16, by John L. Wiersma.

Journal Articles by Staff Members

Agronomy


164
Animal Husbandry

Dairy

Home Economics

Poultry

Station Biochemistry

Experiment Station Staff

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<td>JOHN W. HEADLEY, Ed. D., President</td>
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<tr>
<td>EPHRIM HIXSON, Ph. D., Chief, Div. of Agriculture</td>
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Agricultural Engineering

H. H. DeLong, M.S. Assistant Agr. Engineer
D. L. Moh, M.S. Associate
J. L. Wiersma, M.S. Associate
T. R. C. Rokeby, M.S. Assistant
G. C. Zoerbe, M.S. Assistant
Niel Dimick, M.S. Irriga. Engineer

Agronomy

W. W. Worzella, Ph. D. Agronomist
M. W. Adams, Ph.D. Agronomist
M. W. Adams, Ph.D. Agronomist
L. O. Fine, Ph.D. Agronomist
C. J. Franzeke, B.S. Agronomist
A. N. Humf, Ph.D. Agronomist Emeritus
L. F. Uhrl, Ph.D. Agriculturist
D. B. Shank, Ph.D. Agronomist
L. A. Derscheid, Ph.D. Associate Agronomist
J. G. Ross, Ph.D. Associate Agronomist
F. E. Shubeck, Ph.D. Associate Agronomist
F. C. Westin, Ph.D. Agronomist
B. L. Brage, Ph.D. Agronomist
G. C. Zorbe, M.S. Agriculturist
R. L. Carson, M.S. Agronomist
V. A. Diirs, M.S. Agronomist
D. D. Harpstead, M.S. Assistant Agronomist
D. E. Kratchovil, M.S. Assistant Agronomist
H. M. Vance, B.S. Agronomist
E. M. White, Ph.D. Assistant Agronomist
Frank Wiersma, M.S. Assistant Agronomist

Animal Husbandry

A. L. Musson, Ph. D. Animal Husbandman
L. L. Embry, Ph.D. Animal Husbandman
Turner Wright, M.S. Assoc. Prof. Emeritus
L. F. Bosh, Ph.D. Associate
C. A. Dinkel, Ph.D. Associate
J. W. McCarty, M.S. Associate
R. C. Wahlsbrone, Ph.D. Associate
L. E. DuRose, M.S. Assistant
G. T. King, M.S. Assistant
J. K. Lewis, M.S. Assistant
R. M. Luther, B.S. Assistant
W. C. Mccone, M.S. Assistant
Ellis A. Pierce, M.S. Assistant
C. P. Wilder, M.S. Assistant

Dairy

D. F. Breafeal, Ph. D. Dairy Husbandman
C. C. Wilson, Ph.D. Dairy Husbandman
E. C. Berry, Ph.D. Dairy Husbandman
Roscoe J. Baker, Ph.D. Associate Bacteriologist
Author F. Dracy, Ph.D. Associate
H. H. Voelker, Ph.D. Associate
E. B. Bartle, M.S. Assistant

Entomology-Zoology

G. B. Spawn, Ph.D. Entomologist
H. C. Severin, M.A. Entomologist, Emeritus
W. M. Rogoff, Ph.D. Entomologist
E. J. Huggins, Ph.D. Entomologist, Emeritus

Home Economics

Alice M. Rosenberger, M.S. Home Economist
Lida M. Burrill, Ph.D. Home Economist
Lillian O. Lund, M.S. Associate
E. Beth Alsup, M.S. Res. Assistant

Horticulture

S. A. McCrory, M.A. Horticulturist
P. E. Collins, M.S. Assistant
R. L. Foskett, Ph.D. Assistant
R. M. Peterson, Ph.D. Assistant
Jesse M. Rawson, Ph.D. Assistant

Poultry

Wm. Kohlmeier, M.S. Poultry Husbandman
C. W. Carlson, Ph.D. Associate
W. C. Morgan, Ph.D. Associate
R. A. Wilcox, M.S. Assistant

Publications

E. W. Metcalf, M.S. Station Editor

Rural Sociology

H. A. Sauer, M.A. Acting Sociologist
Douglas Chittick, M.S. Associate
R. H. Dimy, Ph.D. Assistant
V. D. Millan, Ph.D. Assistant
M. P. Riley, M.A. Assistant

Station Biochemistry

O. E. Olson, Ph.D. Station Chemist
C. W. Bonhoffer, Ph.D. Assoc. Chemist
A. W. Halverson, Ph.D. Assoc. Biochemist
E. L. Whitehead, M.S. Assoc. Chemist
G. O. Gistem, M.S. Asst. Chemist
Catharine M. Hendrick, B.S. Asst. Biochemist
L. D. Kamstra, M.S. Asst. Chemist
D. Kohlin, M.S. Asst. Chemist
Frances Moyer, M.S. Asst. Chemist

Station Plant Pathology

C. M. Nagel, Ph.D. Plant Pathologist
J. F. Hennen, Ph.D. Assistant
C. J. Mankin, Ph.D. Assistant
Richard E. Ohms, Ph.D. Assistant
M. E. Michaelson, Ph.D. Pathologist
J. W. Wood, M.S. Pathologist

Veterinary

G. S. Harshfield, D. V. M., M.S. Veterinarian
T. A. Dorsey, D. V. M. Associate
J. B. Taylor, D. V. M. Associate
Elaine J. Kerner, B. S. Technician

SUBSTATIONS

Frank W. Whetzal, Superintendent
Range Field Station, Cottonwood
Albert Dittman, Superintendent
North Central Substation, Eureka
RESIGNATIONS

Dairy
CHASE C. WILSON, Dairy Husbandman Oct. 12, 1954

Station Biochemistry
CATHARINE M. HENDREICH, Assistant Biochemist June 30, 1955
L. D. KAMSTRA, Assistant Chemist Dec. 31, 1954
D. KOEHN, Assistant Chemist June 30, 1955
FRANCES MOYER, Assistant Chemist Feb. 28, 1955

Veterinary
ELAINE KERNER, Laboratory Technician June 30, 1955

APPOINTMENTS

Administration
EVERTT W. METCALF, Station Editor Sept. 1, 1954

Agricultural Economics
JOHN E. THOMPSON, Assistant Economist Jan. 1, 1955
WINSTON K. ULMAN, Assistant Economist Oct. 1, 1954

Animal Husbandry
L. F. BUSH, Associate Animal Husbandman Aug 1, 1954
L. E. DUBOSE, Assistant Animal Husbandman July 1, 1954
RICHARD LUTHER, Assistant Animal Husbandman Dec. 1, 1954

Dairy Husbandry
HOWARD H. VOELKER, Assistant Dairyman Nov. 15, 1954

Entomology-Zoology
E. F. HUGHINS, Associate Zoologist July 1, 1954

Poultry Husbandry
WALTER C. MORGAN, Associate Poultyman Sept. 1, 1954

Station Biochemistry
D. KOEHN, Assistant Chemist Jan. 1, 1955

Station Plant Pathology
J. F. HENNEN, Assistant Pathologist July 1, 1954
RICHARD E. OHMS, Assistant Pathologist April 4, 1955

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FEDERAL RESEARCH FUNDS: Hatch, Adams, Purnell; Bankhead-Jones, Sec. 5, Sec. 9h 1 & 2.

STATE RESEARCH FUNDS: Experiment Station, Experiment & Substation.