Bulletin No. 161 - Methods of Winter Wheat Tillage

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METHODS OF WINTER WHEAT TILLAGE

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METHOD OF WINTER WHEAT TILLAGE*†
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INTRODUCTION

The purpose of this publication is to present the progress and results of the experiments with winter wheat at the Cheyenne Experiment Farm in order to answer more completely the practical questions regarding the production of winter wheat in this section than can be done by letter or conversation. Bulletin No. 151 of the Wyoming Experiment Station, published in February, 1927, is an introduction to this phase of work at this station. It gives certain details which space will not allow in this publication.

HISTORY

The Cheyenne Experiment Farm was established in 1912. The first spring crops were seeded during the spring of 1913. The first winter wheat crop was seeded during the fall of 1913. Since that time experiments with varieties and methods of tillage have been in progress. The average annual precipitation from 1913 to 1927, inclusive, is 14.73 inches. The elevation is 6,000 feet.

Results as contained in U. S. Department of Agriculture Bulletin No. 1315 show that to the time of its writing, 1923, winter wheat production at this station was a failure. The average reseeding of all or most plats was seven years out of ten. In rotation 118, during a ten-year period, where winter wheat was seeded on fallow there were two years with an average yield of 1.8 bushels per acre, three years with an average yield of 25.2 bushels per acre and five reseedings. The yields of winter wheat seeded in stubble land were equally unsatisfactory. A number of reseedings were made and the yields were low.

*Division of State Farms Bulletin No. 12.
State Farms—Archer, Laramie County; Eden, Sweetwater County; Gillette, Campbell County; Grover, Lincoln County; Lander, Fremont County; Lyman, Uinta County; Sheridan, Sheridan County; Torrington, Goshen County; Worland, Washakie County. (Cheyenne and Sheridan Farms cooperating with U. S. D. A.)
†This study was made at the Cheyenne Experiment Farm, Archer, Wyoming, by the Division of State Farms, in cooperation with the Office of Dry Land Agriculture, Bureau of Plant Industry, United States Department of Agriculture.
The possibility of producing profitable yields of winter wheat on fallow land, if soil blowing could be checked, encouraged further investigations in the production of this crop. Accordingly a number of preliminary methods had been tried before the furrow drill and duckfoot or “Field Cultivator” were brought into use.

EXPERIMENTS

The first winter wheat experiment definitely designed to overcome soil blowing was planned during the winter of 1922. Since then this experiment has been added to several times. In addition, after the first year’s trial, the rotations and varietal experiments were treated, where possible, in accordance with the new methods of tillage and seeding. In this way data from all winter wheat experiments are of direct value. But since space allotted to this publication is very limited only those data that have a direct bearing on the subject under discussion will be given.

Yields of winter wheat produced on fallow during 1927 were, in most cases, small. This was due to unusually severe damage by rabbits during the fall of 1926. Seeding on November first produced 24.1 bushels per acre. Emergence occurred after the rabbits had either been killed or had moved to other sections. The average yield of the November 1 seeding is about one-half that of the seedings made from August 15 to September 15. Allowing for considerable variation it is safe to say that the seedings on fallow, if they had not been damaged by rabbits, would have produced 30 bushels per acre, instead of about eight bushels per acre. Winter wheat seeded on stubble land was not injured by rabbits because emergence occurred after they had disappeared. This factor should be kept in mind in considering the data presented.

DRILLS AND TILLAGE

During the winter of 1922 an experiment was planned, with the object of proving the comparative value of the farrow drill with the common disk drill on three different methods of tillage. Accordingly 12 one-tenth acre plats were laid out side by side with five-foot alleys between the plats. One-half of these plats were producing a crop, while the other half were fallow. Eight of these
plats were tilled with the plow and four with the duckfoot or "Field Cultivator." This implement was not secured until 1923.

Tillage with the plow consisted of plowing two plats at the same time in the spring as the land was plowed for spring crops. The other tillage consisted of plowing two plats after corn planting or about the last of May and the forepart of June. After the plats were plowed they were left two or three days without further tillage. This gave a chance for the top soil to dry and form clods. The plats were then tilled with a view of bringing the clods to the surface and allowing the fine soil to fall beneath. The land was then left fallow during the summer. Only enough tillage was given to prevent plant growth and care was taken to preserve the clods. During 1922 the summer tillage was done with a spring-tooth harrow and since then with the duckfoot or "Field Cultivator."

After summer tillage one early-plowed plat and one late-plowed plat were seeded in the fall with the furrow drill. Similar seedings were made with the common drill.

### TABLE 1. YIELDS OF WINTER WHEAT PRODUCED IN A METHOD OF TILLAGE AND SEEDING EXPERIMENT AT THE CHEYENNE EXPERIMENT FARM FROM 1923 TO 1928, INCLUSIVE

<table>
<thead>
<tr>
<th>Kind of Drill</th>
<th>Kind of Tillage</th>
<th>Yield in Bushels Per Acre</th>
<th>5 yr. Aver.</th>
<th>6 yr. Aver.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>Early plowed</td>
<td>3.0</td>
<td>4.2</td>
<td>9.7</td>
</tr>
<tr>
<td>Common</td>
<td>Late plowed</td>
<td>8.8</td>
<td>17.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Common</td>
<td>Duckfooted (late)</td>
<td>14.5</td>
<td>8.0</td>
<td>6.2</td>
</tr>
<tr>
<td>Furrow</td>
<td>Early plowed</td>
<td>12.0</td>
<td>21.7</td>
<td>19.3</td>
</tr>
<tr>
<td>Furrow</td>
<td>Late plowed</td>
<td>17.3</td>
<td>22.3</td>
<td>16.5</td>
</tr>
<tr>
<td>Furrow</td>
<td>Duckfooted (late)</td>
<td>114.2</td>
<td>20.5</td>
<td>17.8</td>
</tr>
</tbody>
</table>

*Low yields caused by rabbit damage.
†In 1924 these plats were not seeded until October 8. The other plats were seeded August 28. In the date of seeding experiment on duckfoot fallow with furrow drill, August 17 seeding yielded 37.5 bushels, September 6 seeding yielded 28.0 bushels, September 17 seeding yielded 29.3 bushels and October 8 seeding yielded 15.9 bushels per acre. If the seeding of September 6 be taken as the basis to calculate the yield for the duckfoot fallow plats, the yield for the furrow drill would be 25.0 bushels per acre. This would make the 5-year average 18.9 bushels per acre. No comparable plats were seeded with the common drill, but no doubt the yield would have been larger if the plat had been seeded August 28.
The four plats used for the duckfoot fallow method were not plowed. Two of these plats were duckfooted, for the first time in the season, at the same time as the late plowed plats were first cultivated after being plowed. Thereafter the duckfooted plats were given the same cultivation as the late plowed plats. One plat was seeded with the furrow drill and one with the common drill. The other two plats were producing the crop.

The results of this experiment, as contained in Table I, show that seedings made with the furrow drill produced considerably better yields than seedings made with the common drill. Results from early plowing and late plowing, when the crop was seeded with the furrow drill, were about equal, but when seeded with the common drill the late plowing was better. This, no doubt, was due to the fact that the late plowed plat generally has considerably more and larger clods than the early plowed plat. These clods tend to prevent soil blowing and aid in protecting the grain not only from cold but also from rabbits.

The duckfoot fallow, which is a fallow where no plowing occurred, the duckfoot being the only tillage implement used, produced slightly smaller yields than did the plowed fallow when the furrow drill was used. The difference in yield was 0.3 of a bushel more per acre for late plowed fallow and 1.2 bushels more per acre for early plowed fallow. This difference hardly justifies plowing. The seeding with the common drill on duckfoot fallow produced 12.5 bushels per acre which is midway between the yields of early and late plowed fallow seeded with the common drill. It is very probable that if the duckfoot fallow plats had been seeded at the same time as the plowed plats for the 1924 crop the average yields produced by the duckfoot fallow plats would have been equal or slightly larger than the average yields produced by the plowed plats. (See note, Table I.)

In 1926 this experiment was enlarged to include six other methods of tillage. Severe grazing by rabbits during the fall of 1926 practically killed the crop, causing low yields in 1927. This practically nullified the effects of tillage. However, the yields of 1928 add some light to the subject. Soil tillage treatments and yields per acre for 1928 were as follows:
Straw returned—Listed in fall—relisted late spring...28.2 bushels per acre
—Listed late spring ......................27.8 bushels per acre
Straw returned—Listed late spring ......................28.8 bushels per acre
Straw returned—Duckfooted early spring ......................29.7 bushels per acre
—Duckfooted early spring ......................32.2 bushels per acre
Subsoiled 12 inches deep, but not plowed ......................31.2 bushels per acre

The listing and subsoiling in the spring were done at the same time as the late spring plowing in Table 1. The subsoiler leaves the stubble and trash at the surface the same as the duckfoot. The lister stirs the soil more than the duckfoot, but does not bury the straw and stubble as does the plow. The ridges in the listed plats were worked down with the duckfoot when it was necessary for the further killing of weeds. The above yields were produced on plats separated by a 20-foot roadway from the plats which produced the results in Table 1.

The points of interest in these results are: (1) Other methods of tillage which are cheaper give promise of better yields than those commonly used, (2) in 1928 the early tillage with the duckfoot produced larger yields than when the duckfooting was delayed until late spring or early summer (late spring or early summer duckfoot tillage is shown in Table 1), and (3) straw, when left on the land, did not reduce the yields in 1928. These experiments should be of vital importance in the future.

In order that the reader may have an idea of the status of winter wheat production before the furrow drill and duckfoot were used at this station Table 2 has been included. This table shows that during the first 10 years a total of 29 reseeding and zero yields occurred out of a total of 49 plat years or about 60 per cent of the time no winter wheat crop was produced. Six of the remaining plat years produced less than six bushels per acre or about 71 per cent of the time the crop was a failure. During the last five years, since the furrow drill and duckfoot have been in use, only one plat failure occurred in 25 plat years or about four per cent. This is a large difference when compared with 71 per cent. It is possible that this four per cent would be decreased if the station were not surrounded by large tracts of pasture land from which rabbits gather in the fall and winter to feed on the green experimental plats.
### TABLE 2. YIELDS OF WINTER WHEAT PRODUCED ON FALLOW AND GREEN MANURE FOR 15 YEARS AT THE CHEYENNE EXPERIMENT FARM, SEEDED 10 YEARS, 1914 TO 1923, INCLUSIVE, WITH COMMON DRILL AND SEEDED 5 YEARS, 1924 TO 1928, INCLUSIVE, WITH FURROW DRILL

<table>
<thead>
<tr>
<th>Rot.</th>
<th>Treatment</th>
<th>COMMON DRILL</th>
<th>FURROW DRILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>Rye <em>G.M.</em></td>
<td>25.3</td>
<td>R.S.</td>
</tr>
<tr>
<td>117</td>
<td>Peas G.M.</td>
<td>29.7</td>
<td>R.S.</td>
</tr>
<tr>
<td>118</td>
<td>Fallow</td>
<td>27.5</td>
<td>R.S.</td>
</tr>
<tr>
<td>185</td>
<td>Fallow</td>
<td>21.3</td>
<td>R.S.</td>
</tr>
<tr>
<td>C. C.</td>
<td>Fallow</td>
<td>30.5</td>
<td>R.S.</td>
</tr>
</tbody>
</table>

*Green manure.
†Reseeded to spring wheat.
‡Low yield due to volunteer rye, which was pulled out.
§Nine year average.
It should be noted that the five-year average yield on rotation 85 is considerably less than on the other rotations. This, no doubt, was due to heavy grazing by rabbits. This rotation is on the outer portion of the rotation section and close to the course generally followed by rabbits when entering the field. The same is also true of the fallow plat in rotation 568. Grain seeded in stubble land is seldom injured by rabbits, because, if the fall is dry, it does not emerge until spring and if it does emerge in the early fall it produces but a slight growth and further, there is, in this event, plenty of good feed elsewhere for the rabbits. No doubt larger fields would not suffer to the same extent as did these plats.

The productive life of the soil is of great importance. Data secured from the production of winter wheat in itself is not definite on this subject. But when taken in connection with other data a fair idea may be gained for the period during which the land has been under cultivation. The land on which rotations 115, 117, 118, 85, and the plats in the continuous cropped series are located, was first seeded in the spring of 1913. Rotations 115 and 117 have each produced 16 crops. These are four-year rotations, consisting of corn on spring plowing, oats on disked corn ground, green manure crops on fall plowed oat land and green manure crops plowed under during the spring and summer and seeded to winter wheat in the fall. Rotation 118 is the same as 115 and 117, save that the green manure crop is not seeded but the plat is fallowed in the regular manner. Rotation 85 is a five-year rotation and the C.C. plat is cropped every other year to winter wheat and every other year is fallow.

With this explanation in mind the yields of winter wheat in 1915 may be compared with the yields of 1928. After making allowances for differences in weather conditions there appears to be no great difference in the productivity of the soil. Further, to date, green manure has not produced any increased yields. On the contrary the yields from the green-manured plats are less than from the fallow plat in rotation 118 and the C.C. fallow plat. This indicates that to the present time the conservation of moisture is the more important factor.
Attention should be given the fact that since the beginning of the experiment with the furrow drill and the common drill for seeding winter wheat, the data of which are contained in Table 1, there has not been a single year in which a crop has not been produced by seeding with the common drill. The method of tillage which preserves the clods and allows the finer particles of soil to drop beneath the surface must also have a marked effect in establishing a condition in the soil which will resist more effectively the action of the wind. Such favorable results were not secured prior to 1923.

Conditions which seem necessary for the successful production of winter wheat are moisture conservation and mechanical protection during the winter and spring months. Factors which contribute to the above are: (1) The establishment and maintenance of a clod mulch, (2) the establishment of ridges at seeding time, and (3) leaving stubble, straw or trash on or near the surface also appears to aid in moisture conservation and in checking soil blowing.

IMPLEMENTS AND SOIL

 Implements which will aid in establishing the above conditions aside from the plow, are the duckfoot or "Field Cultivator," lister and furrow drill. Other implements may be just as good or better, but the above have come under observation at this station. Implements which tend to destroy the above conditions are the disk harrow, the spike-tooth harrow and the common drill.

From the above discussion it is evidently clear that a sandy soil which will not form fairly firm clods is not suited for summer fallow for winter wheat production in this section.

The furrow drill is also adapted for the seeding of spring cereals. The four-year average results show that seedings made with the furrow drill produced 3.6 bushels more of spring wheat per acre than did seedings made with the common drill. Other spring crops appear to respond in a similar manner. Damage to spring cereals by soil blowing is quite marked in some localities. The furrow drill, no doubt, would be of value in such places.

Fields covered with heavy straw or trash present a difficulty in the use of the duckfoot and at times prevent its use in that the
straw or trash clogs the implement. Since the use of the combine
in harvesting is becoming more general the lister instead of the
duckfoot has been used with success. Some farmers report suc-
cess by the use of the one-way disk. In some cases the trash may
be cut up with the common disk and later the ground tilled with the
duckfoot.

CONTINUOUS CROPPING

Farmers have a tendency to “stubble-in” crops of winter wheat
and especially winter rye. It is a very easy method of seed bed
preparation. Some do not disk the stubble, others disk it, varying
from the time of harvest to late fall. The time of seeding is also
varied from shortly after harvest to late winter or early spring.
Plowing and deep tillage are often puzzling problems to the farmer.
To solve all these problems would require further experimental
work but considerable may be gained by considering Table 3. This
table contains data on 15 different plats dealing with the above
problems.

Plats A, B, C, D, E, and F have been seeded to winter wheat
for 15 years. Plats 568, 571, 572, and 573 have been seeded to
winter wheat, in this experiment, for five years. Plats in rotations
561 and 562 are in a three-year rotation of corn, oats and winter
wheat. In each case the land is plowed for the corn and oats and
the winter wheat is seeded on disked oat stubble land. In rotation
561 the plowing for corn and oats is done in the spring and in
rotation 562 it is done in the fall.

Two fallow plats are contained in Table 3. The first is C and
D. One of these plats is fallow while the other is producing the
crop. Cropping system No. 568 consists of three plats; one fallow,
one with winter wheat on fallow, and one with winter wheat stub-
bled in. As previously stated the yields of the fallow plat 568 are
lower than they should be, due to continual rabbit damage. Plat
571 is seeded to winter wheat every year, but is never plowed.
Number 272 consists of two plats. These plats are plowed alter-
nate years. The one which is not plowed is disked and seeded. The
one which is plowed is worked down with the duckfoot and seeded.
Number 573 is the same as 572, save there are three plats. Here
the plats are plowed once in three years. The other two years they are stubbled in.

TABLE 3. YIELDS OF WINTER WHEAT PRODUCED ON 15 PLATS BY DIFFERENT METHODS OF TILLAGE AT THE CHEYENNE EXPERIMENT FARM FROM 1924 TO 1928, INCLUSIVE

<table>
<thead>
<tr>
<th>Plat</th>
<th>Method of Tillage</th>
<th>1924</th>
<th>1925</th>
<th>1926</th>
<th>1927</th>
<th>1928</th>
<th>Five Year Aver.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Late Fall Plowed</td>
<td>12.8</td>
<td>5.3</td>
<td>11.2</td>
<td>5.7</td>
<td>13.5</td>
<td>9.7</td>
</tr>
<tr>
<td>B</td>
<td>Early Fall Plowed</td>
<td>16.7</td>
<td>4.0</td>
<td>15.7</td>
<td>9.2</td>
<td>16.3</td>
<td>12.4</td>
</tr>
<tr>
<td>C &amp; D</td>
<td>Fallow (Plowed)</td>
<td>18.7</td>
<td>20.3</td>
<td>19.2</td>
<td>8.8</td>
<td>30.8</td>
<td>19.6</td>
</tr>
<tr>
<td>E</td>
<td>Subsoiled Winter Wheat</td>
<td>14.0</td>
<td>4.8</td>
<td>15.7</td>
<td>7.7</td>
<td>20.0</td>
<td>12.4</td>
</tr>
<tr>
<td>F</td>
<td>Listed Winter Wheat</td>
<td>16.0</td>
<td>4.0</td>
<td>14.5</td>
<td>10.0</td>
<td>17.5</td>
<td>12.4</td>
</tr>
<tr>
<td>571</td>
<td>Continuously Disked</td>
<td>15.3</td>
<td>3.7</td>
<td>10.7</td>
<td>6.3</td>
<td>12.7</td>
<td>9.7</td>
</tr>
<tr>
<td>572</td>
<td>Plowed Winter Wheat</td>
<td>12.8</td>
<td>2.8</td>
<td>8.7</td>
<td>5.0</td>
<td>11.8</td>
<td>8.2</td>
</tr>
<tr>
<td>572</td>
<td>Disked Winter Wheat</td>
<td>13.5</td>
<td>2.7</td>
<td>7.3</td>
<td>4.2</td>
<td>16.2</td>
<td>8.8</td>
</tr>
<tr>
<td>573</td>
<td>Plowed Winter Wheat</td>
<td>15.3</td>
<td>3.5</td>
<td>10.5</td>
<td>9.7</td>
<td>13.0</td>
<td>10.4</td>
</tr>
<tr>
<td>573</td>
<td>Disked Winter Wheat</td>
<td>17.0</td>
<td>3.2</td>
<td>9.3</td>
<td>3.8</td>
<td>13.0</td>
<td>9.3</td>
</tr>
<tr>
<td>573</td>
<td>Disked Winter Wheat</td>
<td>19.3</td>
<td>3.5</td>
<td>10.5</td>
<td>13.8</td>
<td>14.0</td>
<td>12.2</td>
</tr>
<tr>
<td>568</td>
<td>Fallow (Plowed)</td>
<td>25.8</td>
<td>13.5</td>
<td>12.8</td>
<td>12.0</td>
<td>19.0</td>
<td>16.6</td>
</tr>
<tr>
<td>568</td>
<td>Disked Winter Wheat</td>
<td>19.8</td>
<td>4.8</td>
<td>9.7</td>
<td>10.7</td>
<td>14.2</td>
<td>11.8</td>
</tr>
<tr>
<td>561</td>
<td>Disked Oat Stubble</td>
<td>12.3</td>
<td>5.3</td>
<td>14.3</td>
<td>9.8</td>
<td>5.3</td>
<td>9.4</td>
</tr>
<tr>
<td>562</td>
<td>Disked Oat Stubble</td>
<td>15.5</td>
<td>5.7</td>
<td>14.3</td>
<td>11.5</td>
<td>5.2</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Plat A is plowed seven inches deep and worked down at the same time as plats E and F are tilled. Plat E is plowed seven inches deep every year and subsoiled eight to ten inches deeper than the plowing every other year. Plat F is listed every fall. Plat B is plowed as soon after harvest as practicable. All of these plats are immediately worked down with the duckfoot, except plat F, which is disked after listing, and then duckfooted. The yields of plats E and F are larger than they normally should be, because, during recent years, one-half of these plats have received the beneficial effects of runoff water.

With the above description of the tillage methods in mind it is interesting to note that there is no marked difference in the aver-
age yield per acre regardless of tillage, except in the case of fallow. This is brought more forcibly to mind if reference is made to Tables 1 and 2. Subsoiling, plowing, listing and diskig are all about equal in the production of winter wheat when the land is continuously cropped to winter wheat or when winter wheat is seeded in the stubble of other small grains. Further, the average yield of the four plowed winter wheat stubble plats was 10.2 bushels per acre and the average yield of the five unplowed winter wheat stubble plats was 10.4 bushels per acre. Table 3 shows that seeding in oat stubble has no advantage over seeding in winter wheat stubble.

In sections where falling is a general practice the seeding of winter wheat in unplowed winter wheat land is also practiced. This practice is not without good grounds. It is often profitable to disk and seed directly after the combine or disk and seed later. In this connection it should be noted that at this station there is but a short time between harvest and the best seeding date in which to accomplish tillage before seeding winter wheat. Yet it can be seen by comparing the yields of Plats A and B that there is an advantage in early tillage after harvest when the field is to be seeded to winter wheat the same year. However, as shown in the previous tables, the nature of the tillage makes but little, if any difference, so long as it prevents weed growth.

TABLE 4. YIELDS OF WINTER WHEAT SEEDED IN CORN ROWS AND SPRING WHEAT SEEDED IN DISKED CORN GROUND AT THE CHEYENNE EXPERIMENT FARM FROM 1924 TO 1928, INCLUSIVE

<table>
<thead>
<tr>
<th>Rot.</th>
<th>CROP</th>
<th>BUSHELS PER ACRE</th>
<th>Five Year Aver.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1924</td>
<td>1925</td>
</tr>
<tr>
<td>114</td>
<td>Winter Wheat</td>
<td>14.2</td>
<td>12.5</td>
</tr>
<tr>
<td>116</td>
<td>Winter Wheat</td>
<td>16.8</td>
<td>13.8</td>
</tr>
<tr>
<td>119</td>
<td>Winter Wheat</td>
<td>17.3</td>
<td>12.3</td>
</tr>
<tr>
<td>*425</td>
<td>Winter Wheat</td>
<td>17.5</td>
<td>11.8</td>
</tr>
<tr>
<td>19</td>
<td>Spring Wheat</td>
<td>11.8</td>
<td>7.5</td>
</tr>
</tbody>
</table>

*Corn stalks left standing.
In localities where the period between harvest and seeding is relatively long, precipitation relatively abundant and plant growth prevented, it is doubtful as to the profitableness of missing a year of production. However, at this station it is quite certain that the largest yields of winter wheat are produced by the fallow method.

**WINTER WHEAT IN CORN ROWS**

Winter wheat is sometimes seeded in corn rows. Table 4 contains the data secured during five years from four rotations in which one plat in each rotation was seeded to winter wheat in this manner. It also contains the yields of spring wheat from rotation 19 for the same period. In this rotation spring wheat is seeded on disked or duckfooted corn ground. From the average yields it is seen that spring wheat produced the largest average yield. Therefore the seeding of winter wheat in corn ground can be recommended only as a means of distributing labor. In the station dairy field good yields of winter wheat hay have been secured on corn ground when the corn crop was removed for silage before complete maturity and propitious rains followed. The success of winter wheat seeded on corn ground depends to a very large extent on favorable fall precipitation.

**RATES AND DATES OF SEEDING**

The rate of seeding varies, to some extent, with the condition of the soil and method of seeding. If the soil is in such shape as to be subject to blowing seedings of three to five pecks per acre may be advisable, but since the furrow drill has been used to seed the winter wheat in this experiment seedings of two pecks per acre have produced as large yields as heavier seedings. The best rate of seeding with the common drill was from three to four pecks per acre.

The largest yields have been produced by seeding about September 1 with August 15 and September 15 producing good yields. Seedings of October 1, October 15 and November 1 produced low yields. The later seedings mature later, hence are more subject to rust. Severe grazing or damage from soil blowing will result in later maturity and increase the susceptibility to rust with all seedings.
SUMMARY

1: The introduction and use of the furrow drill and duck-foot or "Field Cultivator" have changed the outlook in the production of winter wheat on fallow land at the Cheyenne Experiment Farm from failure to success.

2: Results from the winter wheat tillage experiment at the Cheyenne Experiment Farm show that shallow tillage, to the present time, is as effective for winter wheat production as deep tillage, it matters not whether the land is continuously cropped or fallowed.

3: Seedings of winter wheat made in corn rows with the corn row drill produced yields slightly less than spring wheat seeded on disked or duckfooted corn ground.

4: The productive power of the soil for winter wheat apparently has not decreased during a period of 16 years of cultivation.

The following publications of the Wyoming Experiment Station may be had upon request. (Revised list, January, 1929.)

ANNUAL REPORTS—
1909-10 to 1919-1920; 1921-1922; 1923-1924 to date.

No. CIRCULARS—
17. Feeding Yearling Steers.
18. Abortion Disease in Wyoming.

No. BULLETINS—
Index Bulletin D, July, 1907, Indexing Bulletins 54 to 75.*
110. Sweet Clover.
111. Alfalfa in Wyoming.
113. The Effect of Alkali upon Portland Cement.
116. Winter Grains.
117. Cattle Feeding:
    Oat and Pea Silage for Beef Cows.
    Oat and Pea Silage for Growing Cattle.
118. Oats in Wyoming.
119. Spring Wheats in Wyoming.
120. The Chemical Examination of Three Species of Larkspurs.
121. Swamp Fever in Horses.
123. Chemical and Pharmacological Examination of the Woody Aster.
129. Sunflowers, their Culture and Use.
130. Native Feeds for Fattening Lambs.
131. Effects of Alkali and Weathering upon the Wool of Range Sheep.
134. Wintering Range Calves.
135. Garbage for Fattening Pigs.
136. Avian Type of Tuberculosis in Cattle: Injection and Testing.
137. Wyoming Forage Plants and their Chemical Composition.
138. Experimental Transmission of Swamp Fever or Infectious Anemia by Means of Secretions.
139. Climatological Data for Wyoming.
143. Chemical Examination of Three Delphiniums.
144. Lupine Studies II—The Silvery Lupine.
145. Wyoming Hay for Milk Production.
146. Wyoming Forage Plants and Their Chemical Composition—Studies No. 7.
148. Wyoming Corn for Pork.
150. Fallow for Small Grains.
152. A Study of Potato Seed Treatment for Rhizoctonia Control.
153. Type in Beef Cattle.
155. Type in Two-Year Old Beef Steers.
157. Wyoming Forage Plants and Their Chemical Composition—Studies No. 8.
158. Use of Calcium Cyanide in the Apiary.
159. Surface Tension of Disinfecting Solutions for American Foulbrood.
160. Lessons from the University Dairy Herd.

Address requests: Bulletin Department, Experiment Station, Laramie, Wyoming.

*Very limited number.