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Methods of Spring Wheat Tillage

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INTRODUCTION

The purpose of this publication is to present in brief the results obtained by different methods of tillage in the experimental production of spring wheat at the Archer Field Station. This publication does not attempt to cover the effects of different rotations as such, but mainly the effects of the preceding crop and tillage on the yields of spring wheat when produced under dry-land conditions. It is probable that no crop lends itself to extensive production better than wheat. Therefore, any factor which may increase the yield of this crop is most important if it can be fitted into any extensive system of production. Any factor which increases the income per unit of labor and invested capital is of vital importance. In the application of these results, it is necessary for the individual to apply them to his own operations as best fits his chosen methods or procedure of farming.

HISTORY

The Archer Field Station was started in 1912. The first spring wheat crop was seeded in the spring of 1913. The data presented do not include the 1913 yields as all crops were seeded on similarly prepared soil. Owing to circumstances outside of station administration the seeding of the rotation and cultural plats in 1920 was not accomplished until June 12. This late seeding caused a very small average yield. On corn ground the average yield of spring wheat was four bushels per acre. Seedings of the same variety of spring wheat in the varietal plats, seeded May 21, produced 11.6 bushels per acre. This causes the 16-year average yields to be a little less than they otherwise would be.

PLATS AND TILLAGE

The plats used in these experiments are two by eight rods or one-tenth acre in size, with 5-foot alleys on the sides and 20-foot
roadways on the ends. Plowing, as designated in this publication, is seven inches deep. Subsoiling consists of plowing the land seven inches deep every fall and every other year running a subsoiler in the plow furrow to a further depth of seven to ten inches. This loosens the soil to a depth of 14 to 17 inches. Listing is done to a depth of about six inches. Disking consists of double disking with a tandem disk. Since 1924 the duckfoot or field cultivator has been used in place of the disk. Since that date the duckfoot cultivator has been used on plowed land in place of the spike-tooth or drag harrow. The duckfoot lifts the clods to the surface and the fine soil falls beneath. In this rough condition the land is seeded with the common drill. A few exceptions have occurred. On fall-plowed plats, that were plowed when the soil was very dry, a large number of dry clods were turned up. In the spring these clods were still dry and hard and it was necessary to use the disk harrow to cut them up so that they would not interfere with the seeding of the crop. On plats where the spring wheat is stubbled-in the land is first duck-footed in the spring at about the same time as spring plowing is done. Under these conditions the duckfoot stirs the soil to a depth of about three or four inches.

The fallow plats for the most part are plowed the last of May or the first of June. The soil is left a few days to dry, after which time it is cultivated with the duckfoot cultivator. This procedure causes the formation of clods which are lifted to the surface. The clods and ridges evidently help in preventing run-off during dashing rains and aid in preventing soil blowing during the winter.

The green manure plats are plowed when the crops have reached what appears to be their maximum growth. The winter rye is generally plowed under during the latter part of June, at which time it is full bloom. The peas are generally plowed under about the 15th to the 20th of July. The barnyard manure is applied at the rate of one 75-bushel load to the tenth-acre plat.

DISCUSSION OF DATA

Table 1 contains the yearly average, three-year average, six-year average, and 16-year average yields of spring wheat in bushels per acre. The three-year average is for the period 1927 to
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*One plat damage by hail.
†Average for 15 years.
1929, inclusive; the six-year average is for the period 1924 to 1929, inclusive; and the 16-year average is for the period 1914 to 1929, inclusive. The averages for the different periods were made in order that the work started in the beginning of each period would be comparable.

As stated above, the data, to be of practical value, must apply to extensive methods of spring wheat production. Some of the methods are not adapted to extensive production, but they serve the purpose of giving information on points which are vital, and may point the way to profitable methods of production.

CONTINUOUS CROPPING

Continuous cropping of spring wheat is a very common practice. The yields, regardless of the tillage, produced by this practice do not vary greatly except in the case of fall plowing, which produces smaller yields. It is shown in Table 1 that the 16-year average yield of spring wheat on spring-plowed small grain land is 9.4 bushels per acre and for fall plowing the yield is 8.6 bushels per acre. The average yield, 9.4 bushels per acre, is the average
of two plats, one on spring-plowed oat land and one on spring-
plowed spring wheat land. This last plat has been in spring wheat
continuously for 17 years. The 16-year average yield is 9.7 bush-
els of spring wheat per acre. Thus it makes no material difference
in the yield of spring wheat whether the wheat is produced after
oats in a rotation of corn, oats, and spring wheat on spring plow-
ing, or spring wheat seeded continuously on spring-plowed spring
wheat land.

The 16-year average yield, 8.6 bushels per acre, on fall plow-
ing, following small grain is the average of three plats. One plat
has been seeded continuously to spring wheat for 17 years. The
16-year average yield of this plat is 7.6 bushels per acre. Another
of these plats is in a rotation of corn, oats, and spring wheat on
fall plowing. The 16-year average yield of this plat is 9.8
bushels of spring wheat per acre. The other plat is in a rotation
of fallow, oats, and spring wheat on fall-plowed oat land. The
16-year average yield of this plat is 8.3 bushels of spring wheat
per acre. The average of the last two plats is 9.1 bushels per
acre. Thus it is evident that when land is continuously cropped
to spring wheat, spring plowing is to be preferred, but when in a
rotation and following a small grain crop, spring plowing and
fall plowing are about equal in the production of this crop. How-
ever, spring wheat seeded continuously on spring plowing produced
slightly better than when seeded after an oat crop. Spring wheat
grown continuously on subsoiled land produced 0.1 of a bushel
more per acre than the same method of cropping on spring plow-
ing. When compared with spring wheat continuously cropped on
fall plowing, there is 2.2 bushels per acre in favor of the subsoil-
ing. However, these increased yields by subsoiling are not suffici-
et to cover the apparent cost of the subsoiling operation.

The listed plat is listed in the fall and worked down in the
spring. The 16-year average yield of this plat is 8.2 bushels per
acre, which is 0.6 of a bushel more than the continuously cropped
fall-plowed plat. The three-year average yield for listing is only
0.2 of a bushel less than the three-year average for subsoiling.
It is probable that spring listing would produce yields about equal
to spring plowing. Spring wheat on spring-plowed flax land re-
sponded very similarly to the plats continuously cropped to spring wheat.

Two factors enter into the 16-year average yields produced on the continuously cropped plats, (1) there is a tendency for certain weeds to become established which at times seem to decrease the yields, and (2) spring plowing appears to control these weeds better than fall plowing.

The continuous cropping work in the 1923 rotations emphasizes the fact brought out in the discussion of the 1913 rotations, that there is little difference in the yields of spring wheat regardless of the tillage when spring wheat follows a small grain or a similar crop. As recorded in Table 1, spring wheat on spring-plowed spring wheat land produced a six-year average yield of 11.9 bushels per acre. For the same period, spring wheat after spring wheat, stubbled-in, produced 11.6 bushels per acre. When stubbled-in after millet, the average yield was 11.5 bushels per acre. The differences are so slight that practically no account should be taken of them.

A more detailed examination of the averages of the five plats stubbled-in on spring wheat land may add some information as to how frequently plowing should be done. Therefore the annual individual plat yields and the six-year average yields are presented in Table 2. Rotation No. 581 is one plat which is seeded to spring wheat every year but never plowed. It is duckfooted every year at about the time the spring plowing is done. Rotation No. 582 consists of two plats. One of these plats is plowed every year and the other is stubbled-in. Thus the land is plowed every other year. Rotation No. 583 consists of three plats. One of these plats is plowed and the other two are stubbled-in. In this group the land is plowed once in three years. The stubbled-in plats are treated the same as in Rotation No. 581. Rotation No. 569 consists of three plats, one is fallow, one is spring wheat on fallow, and the other is spring wheat stubbled-in. Rotation No. 423 consists of corn on spring-plowed wheat stubble, millet on duckfooted corn ground, and spring wheat stubbled-in on millet ground. Rotation No. 424 is the same as No. 423 except sunflowers take the place of corn.
It is quite clear from the results in Table 2 that the effect of plowing is a rather minor factor. So far, it appears that plowing has not produced yields materially larger than those produced by stubbling-in. Plowing every other year did not increase the yield of spring wheat over plowing every third year, and not plowing at all is probably the more economical under the continuous cropping system.

The factor of fallowing is of greater importance. In Rotation No. 569 it increased the yield about five bushels per acre over the average of the continuously cropped plats. The stubbled-in plat in this rotation produced an average yield of nearly two bushels more than the average yield of the continuously cropped plats. This is a total increase of about seven bushels per acre due, evidently, to fallow. If 11 bushels per acre be considered as the yield for stubbling-in the crop there is a loss of four bushels per acre during the fallow year. Some of the factors to consider in this loss are the cost of fallowing as compared with the cost of seeding and harvesting the crop which would have been produced during the fallow year.

If a farmer has more land than he can seed to spring wheat in the proper time, it is very probable that it would be more profitable either to fallow or to plant to row crops, that portion of his land that can not be seeded at the proper time. In 1925 the plats continuously cropped to spring wheat produced only 1 to 2.7 bushels of grain per acre. The fallow plats produced from 10 to 11.3 bushels of spring wheat per acre. The duckfooted corn plats produced yields of 7.3 to 9 bushels per acre. The

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</thead>
<tbody>
<tr>
<td>581</td>
<td>Stubbled in, never plowed</td>
<td>10.5</td>
<td>1.8</td>
<td>17.0</td>
<td>15.8</td>
<td>9.5</td>
<td>10.2</td>
<td>10.8</td>
</tr>
<tr>
<td>582</td>
<td>Spring plowed</td>
<td>10.5</td>
<td>2.2</td>
<td>18.2</td>
<td>14.7</td>
<td>10.2</td>
<td>12.7</td>
<td>11.4</td>
</tr>
<tr>
<td>583</td>
<td>Stubbled in</td>
<td>10.8</td>
<td>3.3</td>
<td>17.5</td>
<td>15.5</td>
<td>12.3</td>
<td>9.8</td>
<td>11.5</td>
</tr>
<tr>
<td>596</td>
<td>Spring plowed</td>
<td>10.8</td>
<td>3.2</td>
<td>17.3</td>
<td>16.3</td>
<td>16.2</td>
<td>10.5</td>
<td>12.4</td>
</tr>
<tr>
<td>583</td>
<td>Stubbled in</td>
<td>10.3</td>
<td>1.5</td>
<td>16.5</td>
<td>17.5</td>
<td>11.9</td>
<td>10.3</td>
<td>11.2</td>
</tr>
<tr>
<td>569</td>
<td>Fallow</td>
<td>12.7</td>
<td>10.5</td>
<td>20.5</td>
<td>23.3</td>
<td>16.7</td>
<td>13.5</td>
<td>16.2</td>
</tr>
<tr>
<td>423</td>
<td>Stubbled in</td>
<td>12.8</td>
<td>3.0</td>
<td>16.8</td>
<td>20.2</td>
<td>16.2</td>
<td>9.2</td>
<td>13.0</td>
</tr>
<tr>
<td>424</td>
<td>Stubbled in on millet land</td>
<td>11.2</td>
<td>5.8</td>
<td>15.3</td>
<td>23.3</td>
<td>12.3</td>
<td>7.0</td>
<td>12.1</td>
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</table>

The factor of fallowing is of greater importance. In Rotation No. 569 it increased the yield about five bushels per acre over the average of the continuously cropped plats. The stubbled-in plat in this rotation produced an average yield of nearly two bushels more than the average yield of the continuously cropped plats. This is a total increase of about seven bushels per acre due, evidently, to fallow. If 11 bushels per acre be considered as the yield for stubbling-in the crop there is a loss of four bushels per acre during the fallow year. Some of the factors to consider in this loss are the cost of fallowing as compared with the cost of seeding and harvesting the crop which would have been produced during the fallow year.

If a farmer has more land than he can seed to spring wheat in the proper time, it is very probable that it would be more profitable either to fallow or to plant to row crops, that portion of his land that can not be seeded at the proper time. In 1925 the plats continuously cropped to spring wheat produced only 1 to 2.7 bushels of grain per acre. The fallow plats produced from 10 to 11.3 bushels of spring wheat per acre. The duckfooted corn plats produced yields of 7.3 to 9 bushels per acre. The
duckfooted potato ground produced a yield of 13.7 bushels of spring wheat per acre. Where the potato land was manured the yield was 13.1 bushels per acre but the six-year average yield of these plats is 16.6 bushels per acre. The yields from duckfooted corn land, duckfooted potato land, and fallow are, on the average, about equal in the production of spring wheat. Where manure was applied to the potato land there was an increase in the yield of the spring wheat crop that followed.

It is apparent that plowing is of no practical importance either as to depth or frequency when the land is continuously cropped to spring wheat. The previous crop or fallow is of greater importance in producing larger acre yields of spring wheat. Further, the use of fallow and suitable row crops are important factors in securing fair yields of spring wheat during years of drought. This is vital to farmers on dry land.

**PRECEDING CROPS AND FERTILIZATION**

In this locality corn is the most widely grown row crop and has a decided effect on the small grain crops that follow. The 16-year average yield of spring wheat on disked corn ground is 12.8 bushels per acre. The 16-year average of spring wheat on spring-
plowed small grain ground is 3.4 bushels less per acre. Assuming that the corn crop is profitable, which is indicated by its extensive production, it, in addition, causes a 36 per cent increase in the yield of spring wheat over the continuous cropping method. The plowing of corn land for wheat, either in the fall or the spring, produced smaller yields than disked or duckfooted corn land. The 16-year average yields of spring wheat on fallow are about equal to those produced on disked corn ground.

Green manure has not as yet proved to be of value to the spring wheat crop. The 16-year average yield of spring wheat on rye green manure and peas green manure is 12.8 bushels per acre. The average yield for rye green manure is 12.1 bushels per acre, and for peas green manure 13.4 bushels per acre. These yields do not indicate that green manure is of any special benefit. It is probable that it would be more profitable to pasture the green manure crops, and it is possible that the effects of the pastured crops on the following spring wheat crop would be fully as great as when plowed under. When plowed under it sometimes happens that the green manure crop has not decayed to any extent at seeding time the following spring and may even be a bright green after being covered in the soil for about nine months. In the spring of 1930 it was not fully decayed after being in the soil for one year and nine months.

Yields of spring wheat when seeded on duckfooted bean ground are markedly high. The average yields are for a period of only three years, but they are consistent and therefore have weight. In the 1926 group of rotations the average yield of spring wheat from corn land was 14.6 bushels per acre. Duckfooted potato land produced an average yield of 15.5 bushels per acre. Duckfooted bean ground produced an average yield of 18 bushels per acre. The tillage given the bean crop is well adapted to extensive methods of production.

The outstanding three-year average yield of spring wheat is 24.2 bushels per acre. This was produced on manured duckfooted bean ground. The land has not been plowed since 1919, and the rotation consists of corn, potatoes, beans and spring wheat. Each plat is manured and duckfooted every spring. The same rotation and manuring is followed on the manured spring-plowed
plat. In this rotation all plats are spring plowed. The three-year average yield of spring wheat produced by this treatment is 23 bushels per acre. This again shows that the costly operation of plowing is not necessary for the production of the largest yields of spring wheat on dry-land.

In order to measure the effect of manure on the spring wheat crop the Archer Field Station has another rotation the same as the two rotations mentioned above, that is, a rotation of corn, potatoes, beans, and spring wheat. In this rotation the land is plowed for the corn but is duckfooted for the other crops. No manure is applied to this rotation. The average yield of spring wheat from this rotation is 19 bushels per acre. Thus manure increased the yield of spring wheat 5.2 bushels per acre. Plowing decreased the yield 1.2 bushels per acre. Beans, in these rotations, increased the yield of spring wheat about five bushels per acre over the continuous cropping in the 1923 rotations and eight bushels per acre in the 1913 rotations. These comparisons are made from the three-year averages, the last being for spring wheat on spring-plowed small grain stubble.

It appears from these results that rotation, moisture conservation and fertility are probably the outstanding factors that determine possible increases in the acre yield of spring wheat.

CONCLUSIONS

1. Continuous cropping of spring wheat produces average yields of about 10 bushels per acre regardless of the method of tillage, except in the case of fall plowing with which the yield is decreased.

2. Duckfooted corn land, duckfooted potato land, and fallow were about equal in the production of spring wheat. These methods increased the acre yield over continuous cropping.

3. Green manure has proved of no practical value, but barnyard manure is of considerable value to the spring wheat crop.

4. Spring wheat on duckfooted bean ground produced the largest yields and is adapted to extensive production.

5. Plowing is a minor factor in the production of spring wheat. The major factors appear to be rotation, moisture conservation, and fertility.
July, 1930. Methods of Spring Wheat Tillage

The following bulletins of the Wyoming Experiment Station may be had upon request. (Revised list, January, 1930.)

No. STATE FARMS BULLETINS—
4. Some Results from Agricultural Stations over the State from 1923 Report.
7. The Service of the State Experiment Farms.

No. BULLETINS—
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.
162. Making Bread from Wyoming Flour.
163. Results with Tree Planting at the Sheridan Field Station.
166. Sterilization of Brood Combs Infected with American Foulbrood.
168. Soil Problems of Wheatland Project.
169. Artificial Incubation at High Altitudes.
170. Oat production and Varieties for Wyoming.
171. Varietal Tests with Wheat at the Sheridan Field Station.

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