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Preparing Land for Wheat.

BY

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MANHATTAN, KAN.

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PREPARING LAND FOR WHEAT.

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WHEAT YIELDS VARYING FROM 9 $\frac{1}{3}$ BUSHELS TO 44 $\frac{2}{3}$ BUSHELS PER ACRE, DUE WHOLLY TO DIFFERENT METHODS OF PREPARING LAND BEFORE SEEDING, IS THE RESULT OF AN EXPERIMENT AT THIS STATION THIS YEAR. THIS IS THE THIRD YEAR IN SUCCESSION THAT SIMILAR AND EQUALLY STRIKING VARIATIONS HAVE OCCURRED.

Eleven methods of preparing land continuously cropped to wheat were compared, and the following are the results for this year:

1. Land disked at planting, but not plowed, produced 9 $\frac{1}{3}$ bushels of wheat per acre and returned \$5.51 after paying for the cost of preparing the ground.
2. Land plowed three inches deep September 15 (a common practice among farmers) and prepared for seeding at a cost of \$2.40 per acre, produced 16 $\frac{2}{3}$ bushels of wheat per acre, leaving \$10.71 after paying for cost of preparation.
3. Land plowed seven inches deep in September, at a cost of \$2.90 per acre to plow and prepare, made a yield of 17 $\frac{1}{2}$ bushels and a return of \$11.14 over cost of preparation.
4. Land double disked July 15 to kill weeds and stop evaporation of moisture and plowed three inches deep September 15—cost for preparation, \$3.60 per acre—produced 27 $\frac{1}{2}$ bushels of wheat per acre, valued at \$18.42 above cost of preparation.
5. Land plowed August 15, seven inches deep, worked thereafter sufficiently to kill weeds and maintain a soil mulch, yielded 32 $\frac{3}{4}$ bushels per acre—cost of preparation, \$3.55—leaving \$22.71 over cost of preparation.

6. Land plowed August 15, seven inches deep, not worked until September 15, produced $28\frac{3}{4}$ bushels of wheat per acre and gave a return of \$20.14 after deducting cost of preparation, which was \$2.90 per acre.

7. Land double disked July 15, plowed August 15, seven inches deep, cost \$4.75 per acre to prepare, produced $29\frac{3}{4}$ bushels of wheat and returned \$19.12 after paying for cost of preparation.

8. Land plowed July 15 (the right time), three inches deep (too shallow for best results) produced $21\frac{1}{2}$ bushels of wheat per acre, leaving \$12.90 above cost of preparation.

9. Land plowed July 15, seven inches deep, produced 35 bushels per acre, the highest yield of the continuously cropped plots, cost \$4.85 to prepare the land and returned \$23.11 above cost of preparation.

10. Land listed July 15, five inches deep, worked down level within the following month, to avoid loss of moisture and firm the seed bed, produced $27\frac{3}{4}$ bushels per acre—cost of preparation, \$3.35—leaving \$18.89 over expense of preparation.

11. Land listed July 15, five inches deep, ridges split August 15 (double listing), gave a yield of $29\frac{1}{2}$ bushels per acre, valued at \$19.82 above cost of preparation.

Five methods of preparing land for wheat, where wheat was grown after oats in rotation with corn and oats, were compared, and gave the following results:

1. Land plowed September 15, three inches deep, produced 25 1/2 bushels per acre, valued at \$18 above cost of preparation.

2. Land plowed August 15, seven inches deep, gave 41 bushels per acre, from which there was left \$29.37, after paying \$3.55 for cost of preparation.

3. Land plowed July 15, three inches deep, gave a yield of 44 bushels per acre, cost \$4.35 to prepare, leaving a net return of \$30.91.

4. Land plowed July 15, seven inches deep, produced 44 2/3 bushels of wheat per acre, the highest yield in the experiment, cost \$4.85 per acre for preparation and returned \$30.88 per acre over cost of production.

5. Land plowed July 15, twelve inches deep, with the Spalding deep tillage implement, cost \$8.10 per acre for preparation, and produced 44 bushels of wheat per acre. The crop when sold returned \$27.10 per acre above the cost of preparation.

PREPARING LAND FOR WHEAT.

The preparation of the seed bed is the most important factor in growing a crop of wheat. An ideal seed bed for wheat is a firm, well-compacted soil, supplied with ample moisture and available plant food. To prepare a firm seed bed, to store moisture and to liberate plant food requires time. It is not accomplished in a day, a week or a month; it is the result of many days of settling, some good packing rains and frequent cultivation of the soil. It is, therefore, only possible to prepare an ideal seed bed when the preparation of the ground is started early in the summer.

Experiments were started at the Kansas Experiment Station several years ago to determine the value of different methods of preparing land for wheat. This work has been conducted during the last three years upon upland soil very low in fertility, land that had been previously cropped for many years to small grain, corn and sorghums, without the addition of manure or green manuring crops. The field was in wheat in 1910. A portion of this field was divided into plots in 1911, each plot receiving different seed-bed treatment. Eleven methods, in all, were used. In 1912 and 1913 the same methods of treatment were repeated upon each of the eleven plots. Another portion of the field was planted to corn in 1911, to oats in 1912, and to wheat in 1913. Five different methods of preparing the seed bed were used upon this area for the 1913 wheat crop. The wheat was seeded upon all plots October 2. Bearded Fife wheat was sown with a disk drill, at the rate of one and one-fourth bushels per acre. The following table shows the results of the various methods of treatment for the season of 1913 and an average of the three seasons, 1911 to 1913.

The plot disked and not plowed was double disked twice just before seeding. The other plots were treated as indicated in the table. An effort was made to prepare the best seed bed possible with each method employed. Thus: All plots were harrowed immediately after they were plowed, except where otherwise indicated, and were worked thereafter as was neces-

METHODS OF PREPARING LAND FOR WHEAT.

CROPPED TO WHEAT CONTINUOUSLY.

Preparing Land for Wheat.

July 1913.]

METHOD OF PREPARATION	Season of 1913.				Average 3 years, 1911-1913.		
	Yield per acre.	Cost per acre for preparation.	Value of crop at 80 cents per bushel.	Value of crop less cost of preparation.	Yield per acre.	Cost per acre for preparation.	Value of crop less cost of preparation.
Disked, not plowed.....	<i>bushels.</i> 9.39	\$2 00	\$7.51	\$5 51	<i>bushels.</i> 6.63	\$2.07	\$3.64
Plowed September 15, 3 inches deep.....	16.39	2.40	13.11	10.71	13.24	2.83	8.35
Plowed September 15, 7 inches deep.....	17.55	2.90	14.04	11.14	14.15	3.33	8.60
Plowed August 15, 7 inches deep.....	32.83	3.55	26.26	22.71	22.19	4.00	16.34
Plowed August 15, 7 inches deep..... } Not worked until September 15..... }	28.80	2.90	23.04	20.14	20.48	3.33	13.65
Plowed July 15, 3 inches deep.....	21.57	4.35	17.25	12.90	20.77	4.85	12.25
Plowed July 15, 7 inches deep.....	34.95	4.85	27.96	23.11	27.11	5.35	16.87
Double disked July 15..... } Plowed September 15..... }	27.53	3.60	22.02	18.42	19.71	3.93	12.37
Double disked July 15..... } Plowed August 15, 7 inches deep..... }	29.84	4.75	23.87	19.12	23.40	4.93	14.30
Listed July 15, 5 inches deep..... } Ridges split August 15..... }	29.40	3.70	23.52	19.82	22.90	3.92	14.73
Listed July 15, 5 inches deep..... } Worked down..... }	27.81	3.35	22.24	18.89	22.77	4.05	14.53
WHEAT AFTER OATS IN ROTATION WITH CORN AND OATS.							
Plowed July 15, 3 inches deep.....	44.08	\$4.35	\$35.26	\$30.91			
Plowed July 15, 7 inches deep.....	44.66	4.85	35.73	30.88			
Plowed July 15, 12 inches deep.....	44.00	8.10	35.20	27.10			
Plowed August 15, 7 inches deep.....	41.16	3.55	32.92	29.37			
Plowed September 15, 3 inches deep.....	25.50	2.40	20.40	18.00			

sary to maintain a soil mulch and to prepare a good seed bed. The table gives, in addition to yield per acre and method of treatment, the cost per acre for preparation, which was figured as follows :

\$5.00 per acre for plowing with Spalding deep tillage plow.
 1.25 per acre for 3-inch plowing.
 1.75 per acre for 7-inch plowing.
 .75 per acre for 5-inch listing.
 .40 per acre for disking.
 .35 per acre for Acme harrowing.
 .25 per acre for harrowing.
 .40 per acre for seeding.

The cost of preparation includes all expenses involved in preparing the ground and seeding the wheat. The value of the crop was figured at the market price of wheat at the time the wheat was thrashed. The market price at the time of thrashing this season (1913) was eighty cents per bushel.

DISKING.

Two plots were double disked July 15. One of these was plowed August 15 and the other September 15. The plot plowed August 15 produced 29.84 bushels of wheat per acre. The plot plowed September 15 produced 27.53 bushels per acre. This is a difference of 2.31 bushels per acre in favor of the earlier date of plowing. For the best results, ground that is double disked early in the summer should be plowed within a month after disking. If the plowing is postponed later than this much of the moisture saved by the earlier disking will be lost by the rank growth of weeds and volunteer wheat that grow all the more vigorously after the ground has been disked. Also, if the plowing is not done before the middle of September there is not sufficient time to prepare a firm seed bed before time for planting.

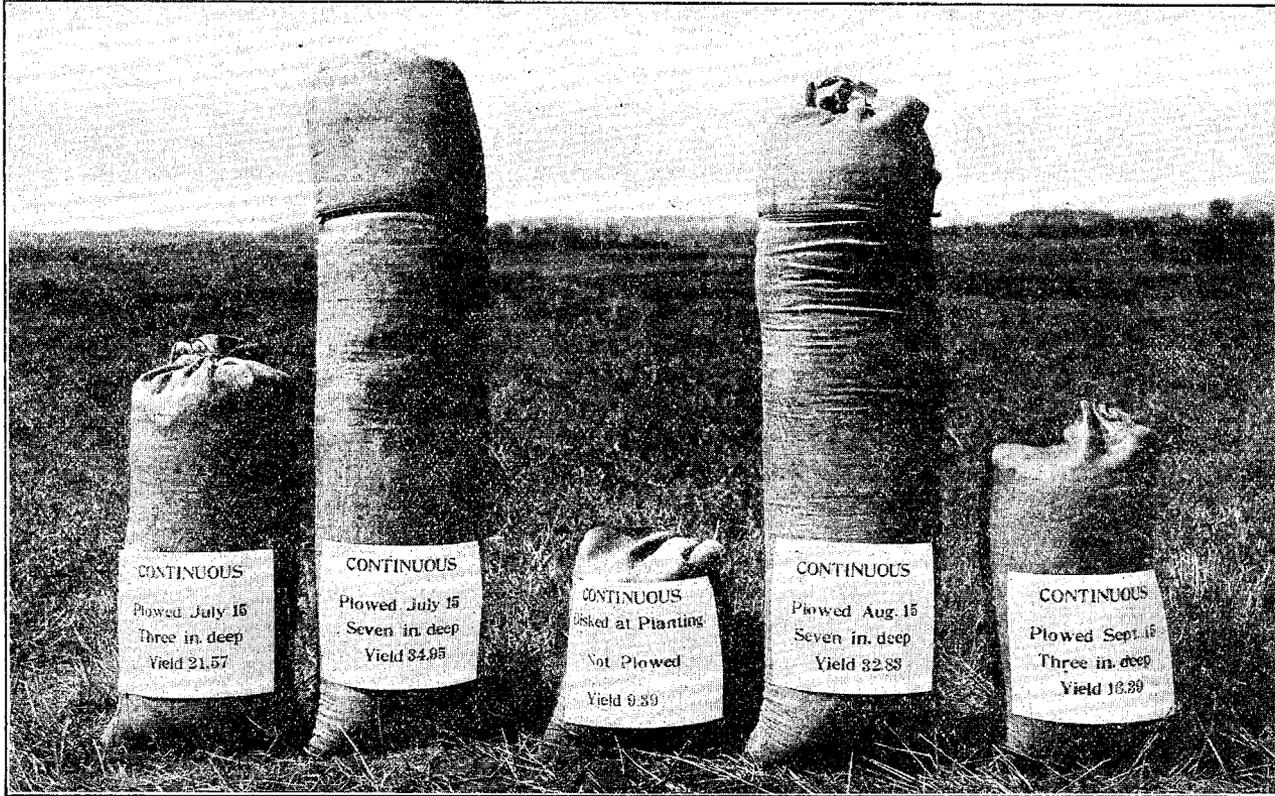
When we compare the plots that were disked early with the plots plowed at the same date but not previously disked, we find for the August plowing that the plot not disked produced three bushels more wheat per acre this season than the disked plot, but for an average of three years the early disking has increased the yield over a bushel per acre. The plot double disked in July and plowed in September produced 27.53 bushels of wheat per acre this season, while the plot plowed on the same date but not double disked produced 16.39 bushels per acre. This is an increase of 11.14 bushels per acre in favor of

double disking and an increased return of \$7.71 per acre after paying for the disking. There is absolutely no doubt of the benefit resulting from double disking ground early in the season when it can not be plowed or listed. Double disking early in the summer not only insures an increased yield of wheat, but holds moisture in the ground, so that the plowing can be done later with greater ease and at less expense.

Disking is a desirable method of preparing the seed bed when used in connection with plowing, but is a poor method when used alone. In this trial the plot that has not been plowed for three years, but where the seed bed has been prepared by disking just before planting, produced only 9.39 bushels of wheat, and the average yield for the past three years has been but 6.63 bushels per acre. This is not a sufficient yield to pay for the cost of production. On lighter types of soil, in the central and western part of the state this method has produced satisfactory crops of wheat for a single season, but when the method is followed year after year it can not be expected to equal plowing or any other good method of preparation.

LISTING.

Two methods of listing were tried in this test. One plot was listed July 15, leveled with a lister cultivator about August 1, and worked as necessary thereafter to maintain a soil mulch to prevent the growth of weeds. The other plot was listed on the same date, left one month without being worked, then the ridges split with the lister. About two weeks later the land was leveled with a lister cultivator and thereafter worked as was considered necessary. The plot single listed produced 27.81 bushels per acre, while the plot double listed made 29.40 bushels per acre, a difference of 1.61 bushels in favor of double listing. For the first two seasons of the test single listing produced slightly more wheat than double listing. This year, however, the reverse is true. It will undoubtedly be found, as this test is continued, that the plot double listed will produce more grain than the single listed plot. When single listing is practiced, especially when the listing is done each year in the same direction, there is a tendency for the lister to follow the old lister track, leaving a portion of the soil unturned from year to year.



A CONTRAST.

Wheat grown upon one-tenth acre of land, showing the effect of five methods of preparing the ground where wheat has been continuously grown. The method of preparation has been the same for three consecutive years.

Listing is a good method of preparing a seed bed for wheat, providing the work is properly done. Ground can be listed more rapidly than it can be plowed, thus where a large acreage of ground is to be prepared it can be prepared earlier in the season by listing than by plowing. It is advisable, however, when listing is the general practice followed, to plow the land occasionally. The plow pulverizes and inverts the soil more thoroughly than the lister, and thereby puts it into better physical condition.

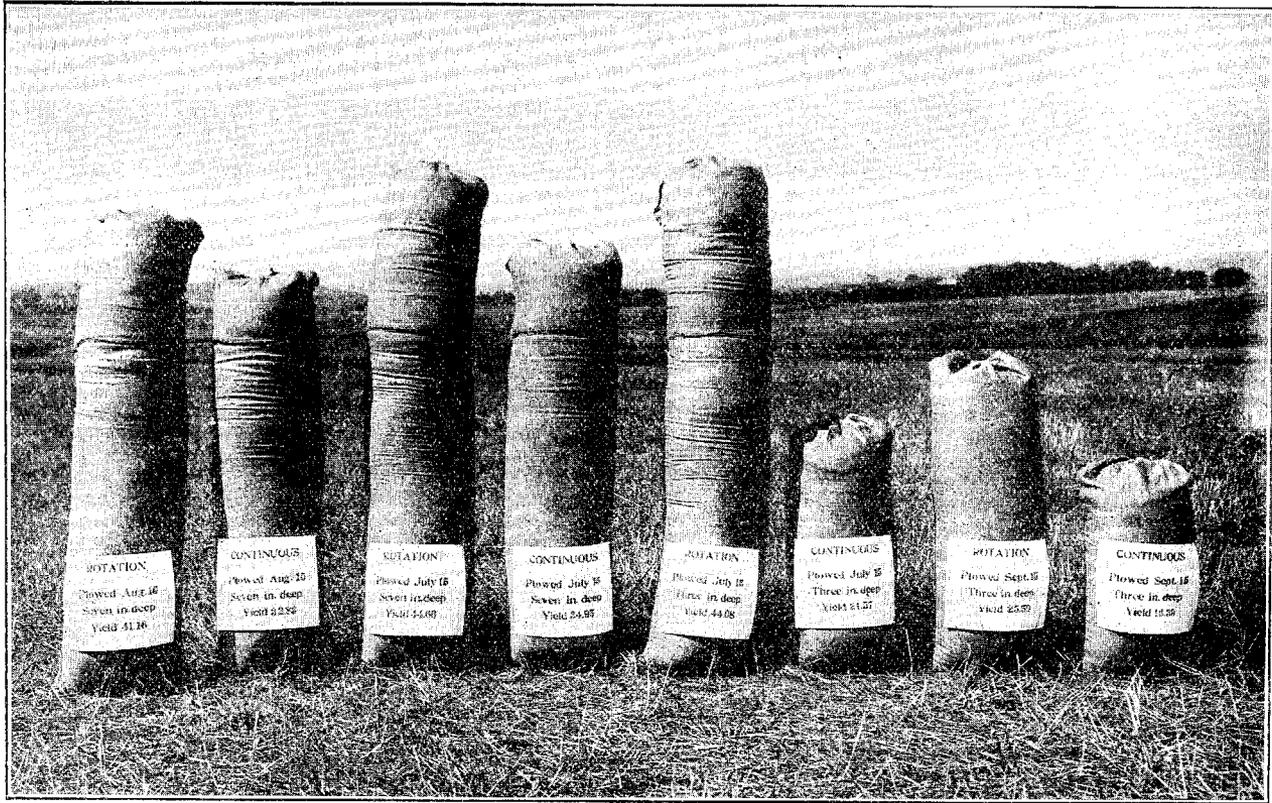
PLOWING.

On the field continuously cropped to wheat ground was plowed July 15, August 15 and September 15. Two plots were plowed in July, one seven inches deep and the other three inches deep. Three plots were plowed in August, all seven inches deep. One plot had been disked in July, and of the other two one was worked as thought desirable throughout the summer, while the other was left without working until September 15, when it was treated in the same manner as the September plowed plots. Three plots were plowed in September, one seven inches deep, another three inches deep, and the third, which had been double disked in July, was plowed three inches deep. The three plots were worked alike after they were plowed.

Of these methods of preparation the plot plowed deep in July produced the largest yield, 34.95 bushels per acre, and as an average of the three-year trial has produced 4.71 bushels more wheat than any other method employed. The plot plowed three inches deep on this date for the last three years produced 21.57 bushels per acre, or 13.38 bushels less than the seven-inch plowing.

Of the plots plowed in August, the one which was worked during the first month after plowing produced 32.83 bushels per acre, while the other, which was not worked, produced 28.80 bushels, a difference of 4.03 bushels per acre in favor of working the ground the first month after plowing. This increase in yield was secured at an additional cost of sixty-five cents.

Of the three plots plowed in September, the plot disked July 15 gave the largest yield, 27.53 bushels per acre. The plot plowed deep at this date produced 17.55 bushels per acre, while the plot plowed shallow made 16.39 bushels.



CONTINUOUS CROPPING vs. ROTATION.

Similar methods of preparing the land were used both on land continuously cropped to wheat and when wheat was grown after oats in rotation with corn and oats. Each sack contains the wheat produced upon one-tenth acre.

These tests show that 2.12 bushels less wheat were obtained for August than for July plowing, and that September plowing produced 15.23 bushels of wheat per acre less than August plowing. Of the two plots receiving identically the same amount of work, one plowed in August and the other in September, the August plowed plot made 11.25 bushels per acre more than the September plowed plot. What greater evidence is needed of the benefit resulting from early plowing?

ROTATING WHEAT WITH OTHER CROPS.

Wheat was grown this season (1913) on ground that was in oats in 1912 and corn in 1911. The ground was plowed seven inches deep in the fall of 1910, for corn, and six inches deep in the fall of 1911, for oats. Five plots were prepared upon this field for wheat. Three of these were plowed in July, at depths of three inches, seven inches and twelve inches, respectively. One was plowed on August 15, seven inches deep, and the other was plowed September 15, three inches deep. The plot plowed twelve inches deep in July was plowed with the Spalding deep tillage implement. There was practically no difference in the yield of the plots plowed at different depths in July; the three-inch plowing produced 44.08 bushels per acre, the seven-inch plowing produced 44.66 bushels per acre, and the twelve-inch plowing produced 44 bushels per acre. The cost of preparing the land, however, was \$8.10 per acre for the twelve-inch plowing, \$4.85 for the seven-inch plowing, and \$4.35 for the three-inch plowing, leaving a return of \$27.10 after paying for the cost of preparation for the twelve-inch plowing, \$30.88 for the seven-inch plowing and \$30.91 for the three-inch plowing.

It appears that little or no benefit results from deep plowing for wheat when the ground is rotated with other crops and when it receives a thorough and deep plowing at least once in three years. The benefit of deep plowing as compared with shallow plowing, when each method is practiced continuously, has already been indicated and shows an increased yield for deep plowing of 13.5 bushels per acre. The plot plowed August 15 produced 3.53 bushels per acre less wheat than the July plowed plot, while the September plowed plot produced 19.16 bushels per acre less than the plot plowed seven inches deep in July. These results again emphasize the benefits secured from early plowing.

The results obtained from wheat grown in rotation, compared with that grown continuously, are shown in the following table:

Wheat Grown in Rotation vs. Wheat Grown Continuously.

Time and depth of plowing.	YIELD OF WHEAT PER ACRE.		
	Wheat in rotation.	Wheat continuously.	Difference.
July 15, 7 inches deep.....	44.66 bu.	34.95 bu.	9.71 bu.
July 15, 3 inches deep.....	44.08 bu.	21.57 bu.	22.51 bu.
August 15, 7 inches deep.....	41.16 bu.	32.83 bu.	8.33 bu.
September 15, 3 inches deep.....	25.50 bu.	16.39 bu.	9.11 bu.

Wheat grown in rotation produced 22.51 bushels per acre more on shallow July plowed ground, 9.71 bushels per acre more on deep July plowed ground, 8.33 bushels per acre more on August plowed ground, and 9.11 bushels per acre more on September plowed ground, than when continuously cropped.

It will be seen from these tests that the largest yields of wheat and the largest profits result from those methods of preparation by which the soil is worked early in the season and kept cultivated until the wheat is sown, and when the wheat is grown in rotation with other crops. This corroborates our observations and the results of past trials. There may be an exception to very early plowing on fertile soils in wet seasons. Upon soils rich in plant food and well supplied with moisture very early cultivation and continuous working of the seed bed may liberate plant food in such large amounts that the wheat lodges, resulting in a decreased yield. Under these conditions medium early plowing is advisable. In dry seasons and on soils of average fertility the best yields will be produced by starting the preparation of the seed bed as early in the season as possible.

SUMMER FALLOW.

In western Kansas, where the annual rainfall is less than twenty-five inches, profitable crops of wheat are not certain every year when ordinary methods of cultivation are followed. In this section of the state a few farmers have practiced, with success, what is known as summer fallow. The object of the summer fallow is to store in the soil as much of two years' rainfall as possible to produce one crop. The summer fallow accomplishes for the western Kansas farmer, in a longer period of time, what July plowing accomplishes for the eastern Kansas farmer. By means of the fallow moisture is con-

served, plant food is liberated and an ideal seed bed is produced. The frequency with which it is necessary to practice summer fallow and the length of time that land should lie fallow in preparation for a crop will depend upon the rainfall and evaporation. In the eastern limits of the summer fallow area it may not be necessary to fallow oftener than once in four or five years in a rotation of crops, while farther west land must be fallowed more frequently, and under some conditions profitable crops of wheat can not be grown even by means of alternate cropping and fallow.

At the Fort Hays Branch Experiment Station, at Hays City, Kan., summer fallow has been practiced for a number of years, and the yield of wheat secured by this method of preparation compared with continuous cropping where the seed bed was prepared both early and late in the summer. The following table gives the results of this test for the last four years, 1910 to 1912, inclusive:

*Methods of Preparing Land for Wheat, Fort Hays Branch Experiment Station.**

Method of preparation.	YIELD PER ACRE.				Total yield, four yrs. bus.	Average yield. bus.
	1910. bus.	1911. bus.	1912. bus.	1913. bus.		
Late fall plowing	20.3	0.0	2.3	0.7	23.3	5.8
Early fall plowing	27.8	0.3	13.8	2.2	44.1	11.0
Fallowed	42.5	2.6	29.2	10.0	84.3	21.1

* These data were obtained by the Fort Hays Branch Experiment Station in cooperation with the Office of Dry-land Farming, Bureau of Plant Industry, United States Department of Agriculture.

It will be seen from this test that in the past four years the fallowed land produced nearly twice as much wheat as the early fall plowed land and nearly four times as much wheat as land late fall plowed. Similar results to these have been secured by a number of farmers in western Kansas who have properly handled summer fallowed land. Such results would indicate that the practice of summer fallow was worthy of a more general trial in the western part of Kansas.

Maxims for Wheat Growers.

Plow early for large wheat yield.

Early listing is better than late plowing.

Double listing is better than single listing.

Early disking followed by medium early plowing is good farm practice.

Deep early plowing is advisable.

Never plow deep late in the season.

Summer fallow is the safest practice in western Kansas.

Summer fallow accomplishes for the western Kansas farmer what early fall plowing accomplishes for the eastern Kansas farmer.

Rotate wheat with other crops.

Continuous wheat growing eventually spells disaster.

Plant only pure, clean seed.

Use barnyard manure or straw spread lightly as a top dressing on wheat—it pays everywhere in Kansas.