# Kansas State Agricultural College.

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ED. H. WEBSTER, *Director*.

## FARM BULLETIN.

### Agronomy Department.

W. M. JARDINE, *Agronomist in Charge*.

# *How to Grow Wheat in Kansas.*

BY

W. M. JARDINE, *Professor of Agronomy*.
L. E. CALL, *Associate Professor of Soils*.

MANHATTAN, KANSAS.
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4-1

# How to Grow Wheat in Kansas.

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AN INCREASE IN WHEAT YIELD FROM 4¼ BUSHELS TO 38⅓ BUSHELS PER ACRE, DUE WHOLLY TO DIFFERENCES IN METHODS OF PREPARING THE LAND BEFORE SEEDING, IS THE RESULT OF AN EXPERIMENT AT THIS STATION THIS YEAR.

*The method and the time of preparation for seeding both exert an important influence upon the yield.*

*Eleven methods of preparing the land were compared, and the following are the results for this year:*

*Land disked, but not plowed, cost $1.95 per acre for preparation, and produced 4¼ bushels of wheat per acre. The crop, when sold, returned $1.47 per acre over the cost of preparation of ground.*

*Land plowed three inches deep (too shallow) September 15 (too late for best results) gave a yield of 14½ bushels, a return of $8.52 per acre after paying for the labor required to prepare the ground.*

*Land plowed a proper depth, 7 inches, September 15 (too late) produced 15¾ bushels per acre, and gave a return of $9.08 per acre after deducting the cost of preparation.*

*Land double disked July 15, to stop the waste of moisture, plowed seven inches deep September 15 (too late for the best results, even when land has been previously disked) produced 28½ bushels per acre, showing a return of $14.50 per acre after paying for the cost of preparation.*

*Land plowed August 15, worked sufficient to preserve soil mulch thereafter, yielded 27¾ bushels per acre, with a net value of $18.29 per acre.*

*Land plowed August 15, seven inches deep, not worked until September 15, showed a yield of 23 2/3 bushels per acre and a return of $15.34 after deducting the cost of preparation.*

*Land double disked July 15, to save moisture, plowed August 15, seven inches deep, produced 34 2/3 bushels per acre and gave a net return of $21.44.*

*Land plowed July 15, three inches deep, (plowed at the right time but too shallow for the best results) produced 33½ bushels per acre, and a net return of $22.32.*

*Land listed July 15, five inches deep, ridges split August 15, gave a return of 34 1/3 bushels per acre, and $23.73 over all expenses.*

*Land listed July 15, five inches deep, worked down level at once, to avoid waste of moisture, gave 35 bushels per acre, from which there was left $24.35 after paying cost of preparation.*

*Land plowed July 15 (the right time), seven inches deep (the right depth), gave a yield of 38 1/3 bushels per acre, the highest yield in the experiment. After paying for the cost of preparation, there was left $25.74 per acre, the largest net return of any method under trial.*

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Credit is due H. F. Roberts, botanist, T. J. Headlee, entomologist, and L. A. Fitz, in charge of the Department of Milling Industry, for the preparation of subject matter relating to the Treating of Wheat for Smut, Important Insect Enemies, and Quality as Well as Quantity in Wheat, respectively.

# How to Grow Wheat in Kansas.

During the ten-year period, 1901 to 1910, inclusive, the farmers of Kansas planted on an average 5,400,000 acres of wheat annually, from which was harvested approximately 74,000,000 bushels. The United States, during the same period, produced annually approximately 680,400,000 bushels. Kansas, therefore, contributed during this time over one-tenth the total annual output of the United States. In total amount harvested Kansas and Minnesota rival each other, with honors about equally divided — they are the two states first in wheat production.

In average acre-yield, however, Kansas is thirty-second. The only states that yield less wheat to the acre are the Southern states, where wheat growing is a side issue.

Kansas and Minnesota rank first as producers of wheat not because of large acre-yield, but because they plant larger areas to wheat than do other states. For example: The average acre-yield in Maine is twenty-five bushels; New York eighteen; Nebraska eighteen; United Kingdom thirty-three; Germany twenty-nine; France twenty and a half; Kansas thirteen and a half, and the United States fourteen and three-tenths. In other words, Maine, inconsequential as a wheat-producing state, harvests practically double the amount to the acre that we do. Nebraska outyields us five bushels to the acre, while England, Germany and France, countries that have been farmed for centuries, harvest double what we do.

Is this average acre-yield of England, France, Germany, Maine, New York and Nebraska due to more ideal conditions than exist in Kansas for wheat production, or is it due to the methods of farming employed? Every one tells us that the climate and soil of Kansas are ideally adapted to winter wheat growing. Experiments and general observations and comparisons bear out such an opinion. Generally speaking the soil and climatic conditions of Kansas are ideal for winter wheat production. The fault must, therefore, lie in our methods. In the countries referred to as producers of large acre-yields, their systems of farming differ from ours in that the farms are smaller and more intensively worked. The fertility of the soil is carefully looked after. Most of the products of the farms are fed on the land and manure returned to the soil, and this again supplemented by occasional applications of certain chemicals and the plowing under of green manure crops, usually legumes. A well organized cropping system is followed, one that experience has proved suitable for the maintenance of a permanent, profitable agriculture. Every operator of a farm is as familiar with the needs of his soil as our growers of pure-bred live stock are familiar with their animals.

Kansas farmers are trying to operate more land than their machinery and labor will cover efficiently. They are not giving attention to the rotation of crops, the growing of live stock or the up-keep of the fertility of the soil, which facts, with the general lack of attention to details, undoubtedly contribute largely to our low acre-yields.

Wherever men are operating in this state upon a modern and scientific basis, that is, where they are working their soil at the right time; where they are handling live stock in conjunction with wheat and corn growing; where they return the manure to the soil; and where they grow their crops in rotation and occasionally plow under a green manure crop, we find the same farmers producing maximum yields, even larger than the maximum yields reported for England, France, Germany or Maine. Such facts simply emphasize our possibilities, if we but take advantage of them.

Our natural conditions are right for wheat production; the fault lies in our system. Can Kansas farmers afford to go on producing thirteen bushels of wheat to the acre when all of our evidence goes to show that double that amount can be grown if we will revise our methods in a few particulars?

## THE SEED-BED.

Experiments were started at the Kansas Experiment Station several years ago to determine the value of different methods of preparing a seed-bed for wheat. This experiment was conducted during the last year upon upland soil very low in fertility, which had been cropped for many years with small grains, corn and sorghum, without the addition of manure or green manuring crops. The field was in wheat in 1910. The wheat was seeded upon all plots the same date, September 29. Bearded Fife wheat was sown with a disk drill, at the rate of one and one-fourth bushels per acre. Eleven methods of preparing the seed-bed were used. The methods included disking, listing and plowing. The following table shows the results of the various methods of treatment for this season's trial:

*Methods of Preparing a Seed-bed for Wheat.*

| Method of preparation. | Yield per acre in bus. | Cost per acre for preparation. | Value of crop at 80c per bus. | Value of crop less cost of preparation. |
|---|---|---|---|---|
| Disked, not plowed | 4.29 | $1 95 | $3 42 | $1 47 |
| Plowed September 15, three inches deep | 14.46 | 3 05 | 11 57 | 8 52 |
| Plowed September 15, seven inches deep | 15.79 | 3 55 | 12 63 | 9 08 |
| Double disked July 15; plowed September 15, seven inches deep | 23 57 | 4 35 | 18 85 | 14 50 |
| Plowed August 15, seven inches deep. Not worked until September 15 | 23 62 | 3 55 | 18 89 | 15 34 |
| Plowed August 15, seven inches deep | 27.74 | 3 90 | 22 19 | 18 29 |
| Double disked July 15; plowed August 15, seven inches deep | 32.68 | 4 70 | 26 14 | 21 44 |
| Plowed July 15, three inches deep | 33.46 | 4 45 | 26 77 | 22 32 |
| Listed July 15, five inches deep. Ridges split August 15 | 34.35 | 3 75 | 27 48 | 23 73 |
| Listed July 15, five inches deep. Worked down | 35.07 | 3 70 | 28 05 | 24 35 |
| Plowed July 15, seven inches deep | 38.36 | 4 95 | 30 69 | 25 74 |

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 plowing, except where otherwise indicated, and were worked thereafter as was necessary 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:

$1.25 per acre for shallow plowing.
1.75 per acre for deep plowing.
.75 per acre for 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, therefore, includes all expenses involved in preparing the ground and in seeding the wheat. The value of the crop was figured at 80 cents per bushel.

### DISKING.

The plots were double disked July 15. One of these was plowed August 15 and the other September 15. The plot plowed August 15 produced 32.68 bushels per acre. The plot plowed September 15, 23.57 bushels per acre. This is a difference of nearly nine bushels in favor of the earlier date of plowing. This indicates that for the best results the ground should be plowed within a month after disking. If postponed later than this all moisture saved by the early disking is used by the rank growth of weeds, grass and volunteer wheat that grow only the more vigorously after the ground has been disked.

When we compare the plots that were disked early with the plots that were plowed the same date, but not disked, we see that for the August plowing the early disked plot gave an increased yield of 4.94 bushels and for the September plowing an increased yield of 7.78 bushels. What greater evidence is needed of the benefits resulting from early disking?

While disking is the desirable method of preparing the seedbed when used in connection with plowing, the method of preparing the seedbed by disking alone cannot be recommended when wheat follows small grain. In this trial upon the plot where the seed-bed was prepared by disking just before plowing, only 4.29 bushels of wheat were produced. This is not a sufficient yield to pay the cost of production. With a season less dry and on a looser soil this method might produce larger yields, but upon the majority of soils it cannot be expected to equal plowing or other good methods of preparation.

### PLOWING.

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. After plowing both plots were worked alike. 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 and the other left without working until September 15, when it was worked in the same manner as the September plowed plots. Three plots were plowed September 15. Of these, one was disked early, the other two had been uncultivated previously to plowing and were plowed deep and shallow, respectively. After plowing all three plots were worked alike.

Of these methods the early, deep plowed plot gave the largest yield, 38.36 bushels per acre. The next largest yield was from the shallow plowing of the same date. This plot made a yield of 33.46 bushels per acre. Of the plots plowed in August the plot disked July 15 made a yield of 32.68 bushels per acre, as compared with 27.74 bushels for the plot not disked. See next page.

Comparing the other two plots plowed at this date, it will be seen that the plot which was worked made a yield of 27.74 bushels per acre as compared with 23.62 bushels per acre for the plot not worked. This increase in yield, amounting to more than four bushels, was obtained at an additional cost of 35 cents. Of the three plots plowed in September the largest yield was from the plot disked July 15. This plot gave 33.57 bushels per acre. The plot plowed deep at this date made 15.79 bushels per acre, and the plot plowed shallow made 14.46 bushels per acre.

# A CONTRAST.

## The wheat yield resulting from the old and the new system of soil treatment.

1. Wheat produced on one-tenth acre plowed September 15 seven inches deep. Disked twice and harrowed twice before seeding.

   Yield, 15.79 bushels per acre. Cost of preparation, $3.55 per acre.

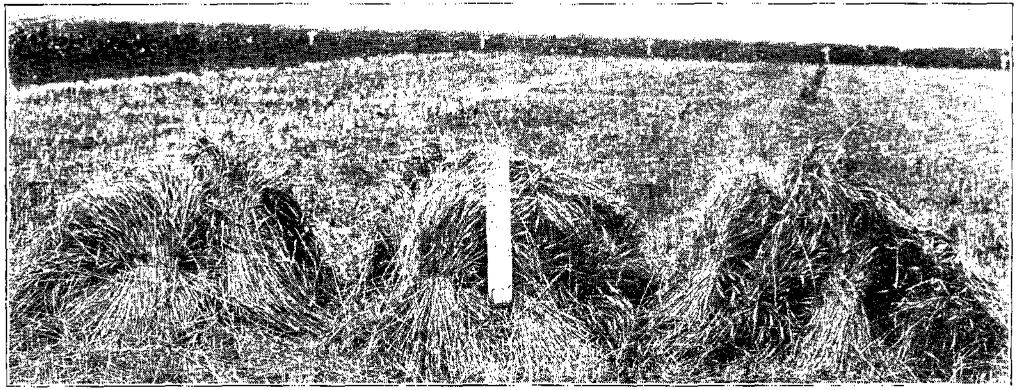
2. Wheat produced on one-tenth acre plowed August 15 seven inches deep, not worked until September 15. Preparation after plowing the same as for the wheat shown in No. 1.

   Yield, 23.62 bushels per acre. Cost of preparation, $3.55 per acre.

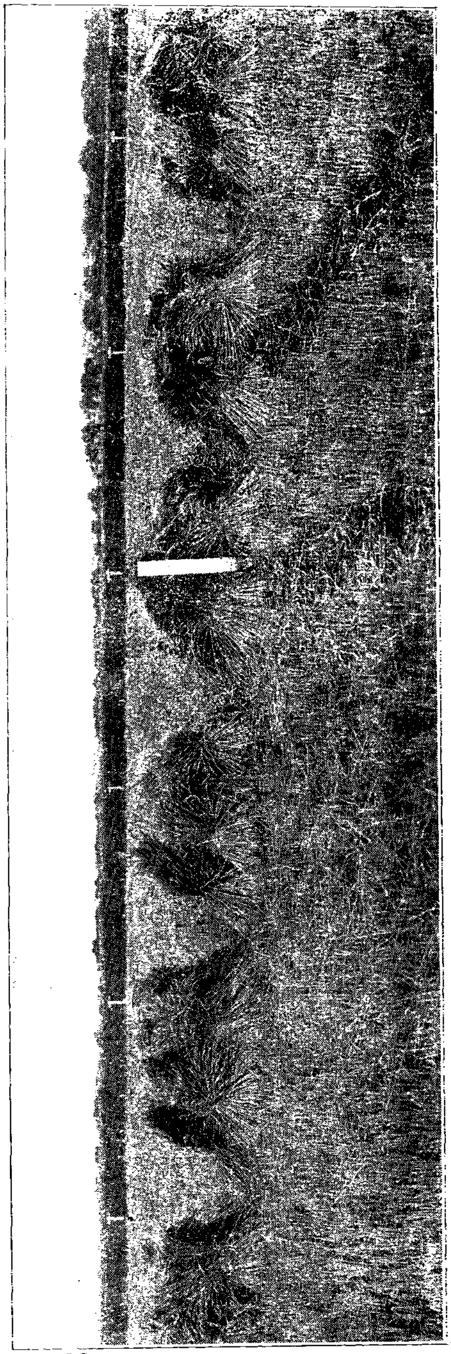
3. Wheat produced on one-tenth acre plowed July 15 seven inches deep. A soil mulch maintained throughout the summer.

   Yield, 38.36 bushels per acre. Cost of preparation, $4.95 per acre.

1



2



3

It usually is considered advisable, if the plowing is to be done late, to plow shallow. It is thought that a better seed-bed can be prepared on late shallow plowing than upon late deep plowing. Under ordinary conditions this is true. In this instance, however, the ground was in fairly good condition when plowed in September and the deep plowed plot was cultivated sufficiently to prepare a firm seed-bed. Under these conditions the deep plowing slightly outyielded the shallow plowing. In past seasons when it was impossible to prepare a firm seed-bed on ground plowed deep in September larger yields have been obtained from the shallow plowed plots. In practice it will undoubtedly prove more profitable, if the plowing must be done late, to plow shallow, due to the increased expense incurred by plowing deep.

### LISTING.

Two methods of listing were tried. One plot was listed July 15 and worked down, the work being done as necessary to maintain a soil mulch and to prevent the growth of weeds. The other plot was listed at the same date, and left without working until a month later, when the ridges were split. After this the ridges were worked down in the same manner as the other listed plot. The plots single listed and worked down gave 35.07 bushels per acre. The plot double listed made 34.35 bushels per acre. There was almost no difference in yield between these two methods of treatment. Since the double listing was slightly more expensive than the single listing and gave a slightly decreased yield the single listing would, undoubtedly, be the more profitable method. The cause for the decrease in yield from double listing undoubtedly resulted from the drying out of the ridges during the latter part of July and the first of August, when the field was left unworked.

Listing is a good method of preparing a seed-bed for wheat, providing the work is done properly. Ground can be listed much more rapidly than it can be plowed. If the listed ground is worked down before the soil becomes dry a suitable seed-bed can be prepared in this way. The danger with listing in preparing ground for wheat comes from permitting the listed ridges to dry out. When this dry soil is thrown into the furrow it leaves a loose, open seed-bed that closely resembles late plowing. Under such conditions very unsatisfactory results will be obtained from listing.

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. This corroborates our observations and the results of past trials. There may be an exception to this 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 plant lodges, resulting in a decreased yield. Under those conditions medium early plowing is advisable. In dry seasons and on soils of average fertility the best yield will be produced by starting the preparation of the seed-bed as early in the season as possible.

### THE IDEAL SEED-BED.

Experience has taught us that an ideal seed-bed is a firm, well-compacted soil. To prepare a firm seed-bed from a soil that has been previously worked deep 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 with the disk, Acme or spike-tooth harrow. Thus, the time necessary for the preparation of the ideal seed-bed is at hand only when the preparation of the ground is started early. The advantages of a firm seed-bed that result from early plowing or listing and frequent subsequent cultivation cannot be overestimated. A firm seed-bed is absolutely necessary if the subsoil water is to be utilized by the young wheat plant. On loose, poorly packed soil there is such poor connection between the soil particles that moisture cannot be raised by capillary attraction from the subsoil. Under this condition the soil may be well supplied with subsoil moisture and the wheat fail to germinate because of the loose condition of the soil, which prevents the rise of water.

A firm seed-bed is only one of a number of benefits that result from the early preparation of the soil. Moisture is conserved and plant-food is made available in this way. The conservation of moisture results from the killing of the weeds that sap the ground of water, and from a looser condition of the soil that more readily absorbs rain. The cultivation of the soil after packing rains forms an earth mulch which prevents the loss of moisture by evaporation. In the drier parts of the state perhaps the greatest benefit resulting from an early preparation of the soil is the conservation of moisture. Where moisture is more plentiful the greatest benefit results from the liberation of plant-food, and especially of the plant-food nitrogen. Plants use nitrogen in the form of nitrates. Nitrates are formed as the result of bacterial action. The bacteria that form nitrates work only in well-aired soils. Thus the better the soil is aired the more nitrates are formed. It is evident, therefore, that the greatest development of nitrates takes place in soils plowed the earliest and given the most frequent cultivation throughout the summer. Thus the firmest seed-bed, the most plant-food, the greatest accumulation of moisture and usually the largest yield results from the earliest preparation of the soil.

## THE SUMMER FALLOW.

The foregoing discussion on seed-bed preparation applies most forcibly to Central and Eastern Kansas conditions, where the annual rainfall, usually, is considered ample for profitable winter wheat production. The same methods, however, that bring best results under Central Kansas conditions, also produce larger yields in Western Kansas, under a much lighter rainfall, than any other continuous cropping methods known. Where the all-important consideration in growing crops is moisture, as is the case in Western Kansas, all farming methods should be adapted to the conservation of the greatest amount of moisture in the soil until the growing crop can utilize it to the best advantage.

While the time elapsing between harvest and planting is sufficient to bring about desired changes in the soil under Central Kansas conditions, the same is not true farther west, where the rainfall is more limited. As already indicated, early seed-bed preparation produces larger yields than late seed-bed preparation, even under dry-farming conditions, but it is only in favorable years that profitable yields are obtained from land continuously cropped, even when the seed-bed is prepared early in the season.

As a result of this uncertainty in growing profitable crops, every year by ordinary methods, there has grown up within the dry-farming region a system of farming based on the *Summer Fallow,* which has for its main object the storing in the soil of as much of two years' rainfall as possible to produce one crop.

The fallow accomplishes for the dry farmer, but in a longer period of time, what early seed-bed preparation accomplishes for the farmer farther east. The same changes that take place in the soil under early seed-bed preparation in Central Kansas take place in the fallow soil in the dry-farming region. That is to say, moisture is conserved, plant-food liberated, and ideal seed-bed conditions brought about. Other things being equal, the drier the conditions the longer the soil should lie fallow to accomplish the desired end.

By means of the summer fallow, land is brought into ideal condition for winter wheat planting, where otherwise the soil would be too dry to make autumn planting a safe proposition. The high value derived from the summer fallow comes from the fact that it puts land in good condition for winter wheat planting. In this connection it might be said that practically the only wheat worth while that will be harvested in the western third of Kansas this year will be on land that was summer fallowed during the season of 1910.

The moisture precipitated a year ago was stored in the soil for the use of the crop that has just matured, and as a result it was able to endure the severe drouth of the past six months. In years of abundant rainfall, such as we may, occasionally, expect in Western Kansas, almost any method of working the soil will bring profitable yields. But farmers should keep constantly in mind the fact that any year may be a dry year, and use only such measures as will insure a crop under the most extreme conditions; such methods, also, will bring comparatively larger returns from the land during favorable seasons.

Experiments have been running at the Fort Hays Branch Experiment Station, at Hays City, Kansas, and at Garden City, Kansas, in the last few years, to determine the best methods of cropping the land under dry-farming conditions. As a result of the methods of preparing the land for wheat, the summer fallow has proved most satisfactory. Invariably the yields are in favor of the fallow. This year, 1911, the difference will be more noticeable than ever; in fact the summer fallow is the only soil preparation that is making good.

At a dry-farming station at North Platte, Nebraska, where the national government and the state of Nebraska are demonstrating what can be done in the way of growing crops under limited rainfall, it has been clearly shown that the summer fallow is the only sure way of producing crops under their conditions. Their soil is much similar to ours in Western Kansas; their rainfall is less than twenty inches; they are subject to hot, dry winds—in fact their conditions are very similar to our own. Five years' results comparing summer fallowing with continuous cropping is reported in Bulletin No. 118 of the Nebraska Experiment Station. The following figures have been taken from it, and are given here because the information is the most conclusive we have for the Great Plains area with respect to the comparative value of the fallow with continuous cropping:

TABLE 1. Relation of yield of winter wheat to available water.

| YEAR. | Yield per acre. | Available water in upper six feet of soil at seeding time. | Precipitation from September 15 to July 1. | Total water available during season. |
|---|---|---|---|---|
| SUMMER TILLED. | | | | |
| | *bushels.* | *inches.* | *inches.*② | *inches.* |
| 1907 ........ | 59.0 | ............... | 13.74 | ............... |
| 1908 ........ | 57.0 | 7.0① | 13.65 | 20.65③ |
| 1908 ........ | 57.0 | 8.2 | 13.65 | 21.85 |
| 1909 ........ | 37.6 | 7.0 | 15.80 | 22.80 |
| 1910 ........ | 30.2 | 7.6 | 10.18 | 17.68 |
| LAND CONTINUOUSLY CROPPED. | | | | |
| 1907 ........ | 24.4 | ............... | 13.74 | ............... |
| 1908 ........ | 20.8 | 1.9① | 13.65 | 15.55③ |
| 1908 ........ | 29.0 | 2.2 | 13.65 | 15.18 |
| 1909 ........ | 19.0 | 1.1 | 15.80 | 16.90 |
| 1910 ........ | ............... | ............... | 10.18 | ............... |

① In computing the available moisture at seeding time, we have considered seven per cent as nonavailable water, and have taken eighty pounds per cubic foot as the average weight of our soil. The hygroscopic coefficient of these soils is slightly above six per cent.

② In this column we have considered only the precipitation from September 15, the average seeding date, to July 1, when wheat had completed growth, or, in other words, only the entire growing season.

③ In computing the total available moisture no consideration was taken of the run-off from the surface of the soil during heavy rains.

In commenting on these results the writers say "that if the yields on the summer-tilled land for the four years preceding 1910 are divided by two, on account of the land being used two seasons to produce one crop, there will be still three bushels per acre in favor of the summer-tilled land. The summer-tilled land produced six bushels per acre, more than twice that produced on the land not summer tilled. The seed required to produce two crops under ordinary methods of tillage is twice as much as that required to produce one crop on summer-tilled land. The labor required to produce the two crops is much more than that required to produce the one crop."

In another part of Bulletin No. 118 the writers say that "in 1907 we harvested 4.5 acres of winter wheat on summer-tilled land in the south half of Field 45 and in Field 46. The average yield was fifty-nine bushels per acre. The north half of Field 45, which was not summer-tilled, gave an average yield of 24.4 bushels per acre. This part of the field had been in alfalfa from 1902 to the spring of 1906. It was then plowed and planted to corn. The corn was a very poor crop, making not to exceed five bushels per acre, due to lack of moisture. The corn was cut and drawn off the field, the land thoroughly disked and the wheat put in with a press drill, as on the summer-tilled land."

If such results can be accomplished by means of the fallow in Western Nebraska why not give the fallow a trial in Western Kansas?

## OBJECTIONS TO FALLOW.

The principal objection advanced in opposition to the use of the summer fallow under Western Kansas conditions is that it promotes the blowing of the soil, and is therefore impracticable. The writer, however, has been unable to obtain any positive evidence that would tend to bear out such an opinion where the summer fallow has been properly maintained. It matters not what methods are used under Western Kansas conditions; if great care is not exercised in working the soil it is likely to blow during certain periods of the year, especially during the months of late fall, winter and early spring.

While there is a diversity of opinion as to the relative merits of fall versus spring plowing for fallow, the facts are that sometimes spring plowing and sometimes winter plowing brings best results. Their relative importance depends upon seasonal and soil-moisture conditions. On the whole we rather favor spring plowing for summer fallow in Western Kansas. Land plowed in April or May can usually be turned over in prime condition to a good depth, and thus avoid the danger of blowing. On the other hand, September or October plowing is often poor because of dry soil conditions — the soil is left loose and dry at the very time when blowing is most likely to occur.

We doubt the advisability of plowing in the fall when the ground is to lie fallow the following season. If farmers will handle their fallow as it should be handled, that is, if they will plow their land in the spring, while plowing is good, at right angles to the prevailing wind, and maintain a clod mulch rather than a dust mulch during the summer, they will experience very little trouble with soil blowing. Another precaution against blowing, that we recommend in connection with the foregoing suggestions, is that every farmer divide his land into long narrow fields running at right angles to the prevailing wind, the fallow land to alternate with a cropped field to the windward side of the fallow. If such a system is followed in cropping the land the soil will not blow to any extent; the soil will be placed in ideal seed-bed condition; most of two years' moisture will be retained for the growing crop; abundance of plant-food will be made available; and profitable yields will be harvested.

## THE KIND OF SEED TO PLANT.

Next to the preparation of an ideal seed-bed the kind of seed to plant is the most important consideration in obtaining a perfect stand and maximum yield of wheat. It matters not how much attention is given to seed-bed preparation, unless similar care is exercised in the selection of the seed the largest possible yields cannot be produced.

During the last ten years thousands of varieties of wheat brought together from all parts of the world have been tried out in comparison with one another on the agronomy farm at the Kansas State Agricultural College, at Manhattan, and at the various outlying substations over the state. The results from these comparative tests show conclusively that the hard red winter sorts, to which class Turkey Red and Kharkof belong, are the most ideally adapted to our conditions. Invariably these varieties have outyielded all others except in the extreme eastern tier of counties, where more semi-humid conditions prevail. In this area the soft red winter sorts, such as Zimmemann, Fultz, Currell, etc., seem the best adapted.

The hard red winter varieties came to us from Russia, where they have been grown for ages under conditions similar to our own. Since their arrival here an endeavor has been made, and with a great deal of success, further to improve them for our conditions, in both yield and quality. As a result of all the work done in the last ten years in breeding and distributing strains of this group of wheats we now have varieties excellently suited to our conditions. We therefore recommend that every farmer suitably situated to grow hard red winter wheat get his seed from within the state and as near home as possible, providing it can be obtained of good breeding and free from mixture with other varieties.

The farmers operating in the Eastern tier of counties, where the soft red winter wheats do best, should take similar precautions in obtaining their seed; that it to say, get home-grown seed whenever it is possible to obtain it pure and of good breeding. If the farmers of Kansas can be persuaded to grow one kind of wheat there will be much less danger of mixing, and the state will become even more noted than it now is as the producer of a special kind of wheat, which, undoubtedly, will result in a better market and a more uniformly higher price.

## CLEAN YOUR SEED.

Not only is it necessary to use seed of an adapted variety, but it is as important that it be pure, unmixed with other kinds of wheat or other kinds of grain, such as oats, barley, rye, etc., or weed seeds. Only seed that will grow and produce strong plants is fit to sow; yet at least twenty per cent of the five millions or more bushels used for seed every year in Kanstas consists of cracked, immature or injured kernels that will not grow. This condition is a result of the general lack of appreciation on the part of the farmer of the benefits to be derived from the use of the fanning mill or grain grader in the preparation of seed wheat for planting. The common practice among our farmers is to plant seed in the condition in which it came from the thresher, notwithstanding the fact that they realize that such seed always contains a large percentage of damaged grains and weed seeds.

## THE FANNING MILL.

Experiments show that it pays to use the fanning mill in grading wheat for seed. Even if the seed be clean, that is, clean with respect to such foreign matter as weed seed and chaff, the elimination of small, shriveled, undeveloped kernels and injured kernels, will warrant its use. Unless the fanning mill or some other means as effective be used to clean the grain that is to be put into the ground, it will be impossible to know how much of that planted will germinate and grow. It will also be impossible to determine when sufficient seed is being sown to produce a one-hundred-per-cent stand.

Experiments at this Station to determine the relative germinating power of kernels of different density and size show that the large kernels are not, necessarily, the most prolific ones. Rather, it was found that kernels of the greatest density rather than greatest in size were the ones that grew best. In other words, a small, plump, substantial-looking kernel may produce a stronger plant than a large, soft kernel of the same variety. Because of these results we recommend that fanning mills or graders be used which separate the seed into grades according to density as well as size. There are such machines on the market. Large kernels of high density are the kind we should try to plant. While the greatest density is not always associated with the largest berries, it usually is the case.

## TREATING WHEAT FOR SMUT.

Wheat is attacked by two principal kinds of smut — stinking smut and loose smut. Stinking smut attacks the kernels only, not the chaff. For this reason it is more difficult to recognize the presence of the stinking smut or "bunt." The head looks very much as usual, but when the chaff is opened the grain is seen to have turned to a mass of smut. Often the smutted kernels remain unbroken in threshing. They can be recognized among the grain by their darker color, greater size, and the absence of the germ and the crease in the kernel. By crushing the smutted kernels the black "spores," or reproductive bodies of the smut, can be seen.

Bunt, or stinking smut, not only destroys the grain but lowers the value of good wheat on account of the strong, disagreeable odor it gives to the grain and the flour. Wheat containing much bunt is worthless for flour-making. The annual loss from stinking smut in the United States is estimated at eleven million dollars.

The smut spores get on the healthy grain from smutted fields, especially during threshing. Upon planting, the smut spores germinate and put out germ tubes which penetrate the seedling and grow up inside the plant. The smut cannot be seen until the plant sets seed, when it usually is found that every head of a smutted plant, and every grain on the head, is smutted.

### TREATMENT.

The best treatment for stinking smut is formaldehyde. Add one pound (pint) of formaldehyde to fifty gallons of water, or at the rate of one ounce of formaldehyde to three gallons of water. One gallon of the mixture will treat a bushel of grain. One pound (pint) of formaldehyde, therefore, when made up with water, will treat forty-five to fifty bushels of wheat. Formaldehyde costs fifty to seventy-five cents per pound (pint), at retail.

Spread the wheat in a thin layer on a smooth, clean floor or tarpaulin. Sprinkle the grain with the formaldehyde mixture until it is thoroughly and evenly wet through. Then shovel the grain over to be sure to have all the seed wet, and cover the pile of seed with canvas, blankets, bagging or the like, to keep in the fumes of the formaldehyde. The seed should stand for six to twelve hours, and then should be shoveled out in a thin layer to dry, stirring frequently. It can then be stored. Bins, etc., should be disinfected with formaldehyde, and also the drill. All seed to be treated should be fanned previously to being treated.

### LOOSE SMUT.

Loose smut has not been so abundant in the past, but it is steadily increasing in amount. The loss of wheat from loose smut is estimated at three million dollars annually. In some places it causes a loss of more than half the crop.

Loose smut is easily distinguishable from stinking smut. The whole head is attacked, turns to a powdery mass (the smut spores) and blows away, leaving the naked stalk of the head, with neither the grain nor the meshes on it. Infection from loose smut occurs only at blossoming time. At all other times the plants are immune. The smut spores blow into the open flowers from the smutted heads. They germinate there and send germ tubes into the young grain. The smut fungus then continues dormant inside the kernel, which continues to develop. Such an internally infected grain can not be told from a healthy one. When the infected kernel is planted, the smut plant, or fungus, grows up inside the stalk of the seedling wheat. When the wheat first produces its head, even before it gets out of the boot, the smut has consumed most of the tissues of the head, and has produced a mass of smut spores in its place. These again are sown by the wind amongst the blossoming wheat, to spread the infection as before.

*Treatment for Loose Smut.*

The formaldehyde treatment is not effective against loose smut. Weeding-out the diseased plants when they first show the smutted heads will diminish the disease, but will not entirely get rid of it, since some smutted heads are always missed. The best way is to have a special seed plot on which the seed wheat is grown, and on which seed from selected heads is planted, heads which are unsmutted and which have been taken from an unsmutted part of the field. This seed plot should lie by itself, away from the general field, and in such a location that prevailing winds at blossoming time will not blow the smut spores to the seed plot from diseased fields.

The seed for the seed plot should be thoroughly cleaned in a fanning mill. An extra precaution which it is wise to take if possible, is to treat the seed of the seed plot by the hot water method. Soak the seed from five to seven hours at the ordinary temperatur of sixty-three to seventy-two degrees Fahrenheit. Drain the seed in loose bags or wire baskets, in not more than half-peck lots. Have two galvanized-iron tubs containing twenty to forty gallons of water each, on a gasoline stove if possible, since the temperature is more easily regulated than on a cookstove. Get the water in both the tubs to a temperature of 129° Fahrenheit, (no higher). Use a reliable tested thermometer. The drained half-peck sacks of seed should be plunged, one at a time, in the first tub, for one minute, to raise the wet grain to the required temperature, 129°. Then change to the second tub and keep immersed for ten minutes, stirring the grain while submerged to get it thoroughly exposed to the hot water. If the temperature falls below 125°, the time of treatment should be prolonged.

*It is not safe to run above 129 F. under any circumstances.* Test the temperature of the water before putting the wheat in, by stirring the water well, and suspending the thermometer half way down in the middle of the tubs. Two men working together can treat a bushel an hour, or enough in a day to sow a seed plot of from six to ten acres. Spread the wet grain out thin on a clean floor or canvas to dry, shoveling frequently. Do not let the grain sprout. Before sowing test the germinating power of the wheat, and if there is any falling off allow seed accordingly. Keep up a seed-plot as long as there is any smut in the field. Seed from a treated seed-plot does not have to be treated the following year, providing it is free from smut.

## IMPORTANT INSECT ENEMIES.

Chinch bugs, Hessian fly, and greater wheat-straw worm may, under favorable conditions, make vain the most careful preparation of the seed-bed and the most painstaking selection of seed wheat. Although these creatures may, they rarely do appear in damaging numbers at the same time, because of differences in distribution and differences in response to weather conditions. The chinch bug is everywhere throughout the state but does its serious damage where wheat and corn are grown together. It is rarely harmful in extreme Western Kansas, and has not for many years done serious damage in the northeastern part of the state. The Hessian fly may be found throughout the state east of a north-and-south line running through the eastern edge of Ford, Trego and Norton counties.

The greater wheat-straw worm is found throughout the state, but during the last outbreak did most of its harm in the western half. No one of these insects appears regularly every year in damaging numbers; and years of serious damage are invariably followed by years when its work is not noticed, and these in turn by years of serious damage. Of the past four years the chinch bug has done serious harm during the last two. During the forty years that the Hessian fly has been in Kansas, it has produced five outbreaks, the last of which, in 1908, destroyed at least ten million bushels. During the last four years the greater wheat-straw worm has done serious harm for only one season.

The fact that these creatures appear and disappear makes it necessary for the farmer to be able to recognize them, and to tell some months beforehand whether measures against them will be necessary.

If the clumps of bunch-grass along the fences, in pastures, and in waste places shelter hundreds of chinch bugs in the late fall, measures must be taken to protect the wheat from chinch-bug damage during the following spring and summer. If the wheat at harvest time shows flaxseeds between the leaf sheaths and the stems in considerable numbers, regardless of whether the work has been serious enough to cause the plants to fall, measures must be taken to protect the following crop from fly. If the wheat at harvest time shows small greenish-yellow worms working entirely inside of the straw, to be seen by splitting the straw from end to end, measures must be taken to protect the following crop from the greater wheat-straw worm.

All chinch-bug infested grasses should be closely burned so late in the fall that cold weather will prevent the survivors from making their way into unburned grasses and thus leave them exposed to the rigors of winter. For Hessian fly, where wheat follows wheat, the following measures will prove satisfactory: (1) Disk the stubble immediately after harvest; (2) plow at least six inches deep three or four weeks later, and plow so carefully that the stubble, weeds and trash will be thrown into the bottom of the furrow and covered; (3) by use of proper tools, compact the surface slice into a good seed-bed, putting about four inches of pulverized soil between the old infested stubble and daylight; (4) sow on or after the fly-free date, which ranges from October 2 at the north line of the state to October 14 at the south line of the state, and varies about one day for each sixteen and two-thirds miles. When wheat is planted on corn ground or fallowed land, it may be protected from Hessian fly by sowing on or after the fly-free date. For the greater wheat-straw worm destruction of the stubble, either by fire or by plowing under, and disposal of the straw pile either by burning or hauling away, will prove satisfactory.

## TROUBLESOME WEEDS.

The greatest care must be exercised by farmers if their fields are to be kept free from weeds, especially such as the bind-weed, smart-weed, cheat, cockle-bur, etc. Bind-weed already is so firmly established in certain wheat-growing areas of the state as greatly to endanger the continuation of the industry, or, in fact, the production of any other crops from the land. It is practically impossible to eliminate bind-weed from the soil once it has become established. It usually gets its start from weed seeds introduced in grains of various kinds. It is a plant that spreads by means of underground stems or root-switches, which grow eighteen or twenty inches below the top of the ground and send up shoots which make new vines. These vines twine around and over whatever may be within their reach, and in the case of plants usually smother them out. The bind-weed resembles the morning glory but differs from the common morning glory of the corn field in having white flowers usually, and leaves shaped like an arrow head.

The Kansas State Agricultural College has conducted elaborate experiments in its eradication, but with very little success. Farmers cannot watch their seed too closely to avoid planting seeds of this plant. They should make special effort to control its growth if present in their soil. The opportune time to strike it is at the time it makes its first appearance.

Seed of smart-weed is often found in the grain after it is threshed. The smart-weed common in wheat fields differs from the common smart-weed, however, in having rather pointed leaves and a vine-like habit of growth. The seeds look like buckwheat seeds but are smaller and black in color. They are not easily screened or fanned out, and if present in very large quantities affect the color of the flour. For this reason millers do not care to handle wheat that contains seed of this weed. This still further emphasizes the necessity of every farmer's fanning and grading his grain before planting it.

## QUALITY AS WELL AS QUANTITY IN WHEAT.

Practically all the wheat produced in Kansas is used ultimately in the manufacture of flour for human consumption. Price nowadays prevents the use of any considerable amount as feed for stock. Consequently, the value of our wheat depends upon the amount and character of flour it will produce by modern methods of improved milling. The amount of flour that can be obtained from a given weight of wheat is important to the miller, since flour is by far the most valuable product, straight flour being worth about twice as much as bran and shorts.

Suppose a mill of five hundred barrels daily capacity can by using a good quality of heavy wheat make a barrel of flour from four bushels and twenty-five pounds of wheat, but on buying a poorer quality of lighter wheat finds it requires four bushels and thirty pounds to make a barrel of flour. That means it takes twenty-five hundred pounds, or about forty-two bushels, more wheat to make a day's run of five hundred barrels. It also makes considerable difference in the profits whether this twenty-five hundred pounds is made into straight flour worth about two dollars per hundred, or into feed, with a value of about one dollar per hundred.

Wheat, to be satisfactory, must also produce *good* flour. The character of the flour depends upon the quality of the wheat and the way in which it has been milled. Although the miller may, by proper methods, eliminate some defects he cannot put into the flour good qualities which do not exist in the wheat. The question naturally arises, what is meant by *quality* in flour? What are the characteristics of a good flour? The answer depends somewhat upon the viewpoint.

The baker desires a flour that will make a large number of loaves per barrel, hence he is concerned especially with the absorption, or the amount of water it will take up. At the same time it should produce a large loaf of good color and texture. The housewife, on the other hand, is not concerned with the number of loaves but demands that the flour produce bread that is white and light and that the dough handle easily.

These characteristics are all important, but good bread should have at least three others that are usually not regarded with sufficient importance: viz., flavor, nutritive value, and ability to retain moisture.

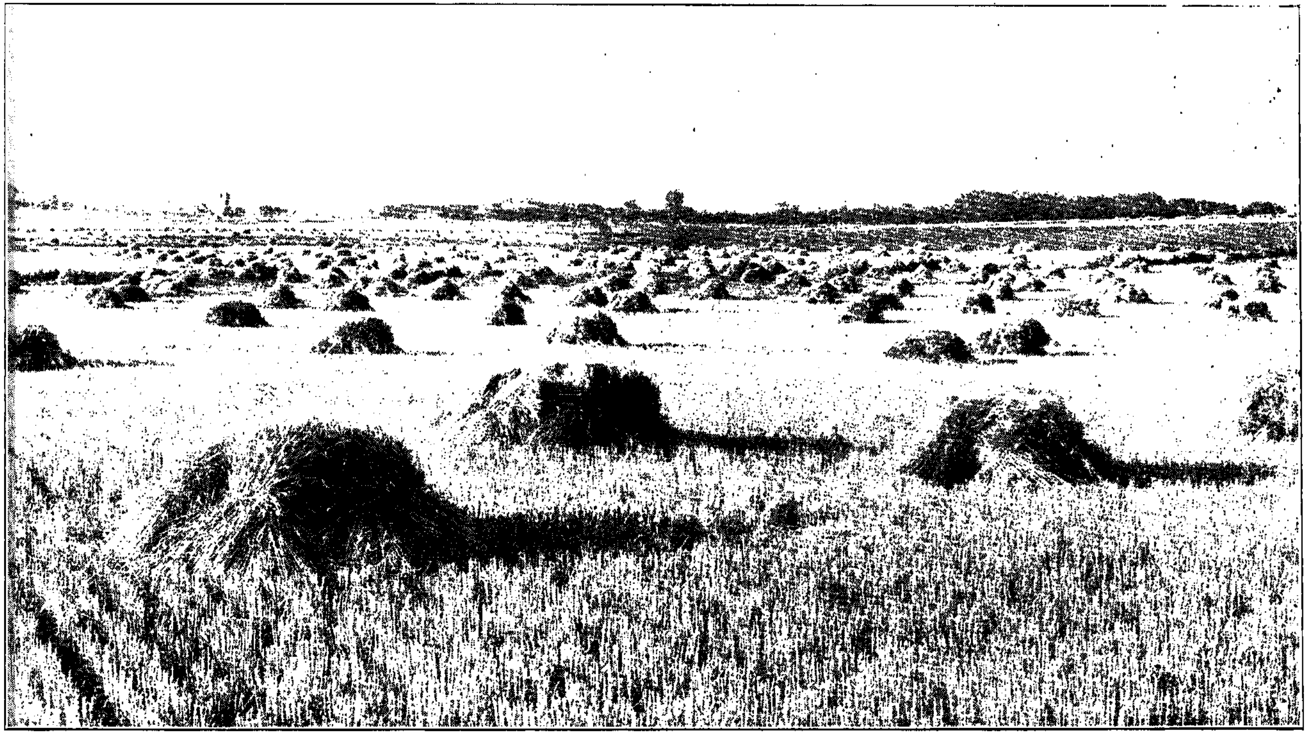
The quality of the bread depends upon the method and the flour used. To produce a good light loaf of high nutritive value requires a flour with sufficient amount of gluten of good quality, and this must be originally in the wheat. Fortunately Kansas hard wheat, when produced under proper conditions, ranks among the very best in this particular. However, there is a tendency in all hard wheats to deteriorate when conditions are unfavorable; consequently, good seed alone does not solve the problem. Unless there be proper rotation of crops and thorough preparation of the seed-bed, sufficient moisture and plant-food properly to mature the wheat plant may be lacking. This injuriously affects the flour-making qualities of the wheat.

The responsibility of the farmer does not cease when he has matured a good quality of grain in the field. If this wheat is to make good flour it must be cared for properly until it reaches the mill. Exposure, while standing in the shock, to effects of alternate rain and sun causes bleaching, sprouting, increase in moisture-content and consequent decrease in test weight per bushel. This means a lower commercial grade and, hence, a lower price.

Sprouted wheat cannot produce good, sound flour that will make good bread. Also, taking up moisture while in the shock or in poorly built stacks may cause heating to take place, and the result will be "bin burnt" or "stackburnt" wheat, which is unfit for flour-making.

The presence of smut balls from "bunt" or stinking smut, imparts a disagreeable odor and a dark color to the flour as well as to the wheat. All these facts serve only to emphasize the importance of thoroughly good farming to produce *quality* as well as *quantity* in Kansas wheat.

On page 28 there is a picture showing what can be done by early preparation of seed-bed.



Kharkof wheat grown on early seed-bed preparation, new agronomy farm, 40 to 50 bushels per acre, 1911.