Oklahoma Agricultural Experiment Station,

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WHEAT GROWING.

INTRODUCTION.

The experiments in wheat culture at the Oklahoma Agricultural Experiment Station began in the fall of 1892 when the first plats were seeded. Experiments with the crop have been continued every year since, and now (spring 1905) the thirteenth year's crop is nearing harvest. Some of the experiments have been continued as started in the beginning, with very little alteration, while others have been changed materially, or completed and discontinued and other phases of the work taken up. The personnel of the department in charge of the work has changed several times during the interval which has caused more or less alteration in the plans. The results of all the experiments up to the crop of 1900-1901 have been published in bulletin form. (No. 47, out of print.) While the main object of this bulletin is to publish the results of the years 1901 to 1904 inclusive, the results of previous years will be referred to and compared more or less as found desirable, particularly in the summary.

It is true with wheat experiments as with all crop experiments that the test must continue over several years in order to show the effect of the varying conditions found in different seasons. In view

of this fact, all field experiments at this station are repeated at least for three years and usually not less than five.

The field to be used for crop tests is divided into plats of uniform size in each experiment and where convenient and other conditions allow, the plats are not less than one-tenth acre in size and usually not more than one-half. In the wheat experiments, as with those of all small grains, a bare strip of ground, usually about two feet wide, surrounds each plat. This is for a dividing line between the plats to enable keeping them separate, particularly at harvest time. Except in the point to be tested in an experiment, the plats are put under as uniform conditions as possible. To counteract the various inequalities in the soil of a field, each method or treatment under test is repeated on several plats and these are alternated and arranged so as to eliminate the soil irregularities as far as possible. The plats are all harvested, thrashed and weighed separately and the results of like treatments averaged to secure the data for comparison. The soil on which the wheat experiments have been carried on at this station is a clay loam of a heavy, impervious nature underlaid by a heavy stiff clay subsoil; it is the upland type found bordering on the creek bottoms.

Although the results of field experiments cannot be taken as inflexible and applied as fixed rules, if such results are carefully studied and judgment is used in interpreting and applying them, they will be found valuable guides and if those that are suggested by the wheat experiments given in this bulletin are followed in this way, the yields of wheat on many Oklahoma farms can be materially increased.

The following summary briefly states the important results brought out in the wheat experiments:

SUMMARY OF RESULTS.

WHEAT, CONTINUOUS, WITH AND WITHOUT MANURE.

A half-acre plat that received 7.5 tons of barnyard manure the first year of the test and 5.5 tons the second year of the test, yielded from six consecutive wheat crops 82.9 bu. of wheat.

A like half-acre receiving no manure but the same treatment otherwise produced from six consecutive wheat crops 53.1 bu. of wheat.

A difference of 29.8 bushels in favor of the manured plat, which gives an average for the six years of 9.9 bu. per acre.

The first year the manured plat yielded 18.6 bu. more per acre than the unmanured plat, the second year, 18.7 bu., and the last year 3.1 bu. more per acre. Not quite two and one-third bushels of wheat were obtained for each ton of manure applied per acre.

The above results are from consecutive work on the same land. The following are from isolated cases.

In 1894 the average yield per acre from manured land was 32.4 bu., from unmanured land, 14.4 bushels.

In 1899 four manured plats averaged 27.5 bu., the unmanured, 14.5 bu. per acre.

These results are on practically virgin soil. All of the soil in Oklahoma does not need manure like this but there is much that will respond as well as the above soil to an application of barnyard manure. Even in the face of the facts that there is not enough manure in Oklahoma to cover all the land that needs it, much of the manure produced on Oklahoma farms is wasted.

TIME OF PLOWING FOR WHEAT.

In a test covering five consecutive years, 1899-1905, plats plowed at different times as follows, but otherwise receiving like treatment, gave the following yields.

Early plowing, plats plowed the middle of July, averaged 27.1 bu. per acre.

Medium plowing, plats plowed the middle of August, averaged 24.2 bu. per acre.

Late plowing, plats plowed the middle of September, averaged 22.1 bu. per acre.

A difference of three bushels per acre in favor of early plowing over medium plowing, and five bushels in favor of the early over the late.

At the time of the July plowing, the ground was usually moist and mellow and free from weeds, and plowed with ease.

At the time of the September plowing, the ground was usually dry and hard and covered with weeds, many of which had gone to seed. The work of plowing was very laborious and difficult and a great amount of work was usually required to get the seed-bed in a condition fit for seeding.

For the August plowing the ground was not usually in as good condition to be worked as at the time of the July plowing but was in

better condition than for the September plowing, and there was more time to get the seed-bed in shape.

TIME OF SEEDING.

For early seeding, plats were seeded from the 10th to 20th of September; for medium seeding, 10th to 20th of October; late seeding, 10th to 20th of November. This plan was carried out for five years—1899-00 to 1903-04, with the exception that there was no late seeding made in the fall of 1902, due to the ground being too wet at the time the seeding should have been made. The different seedings averaged as follows, per acre:

Early, 24.28 bu; medium, 27.49 bu; late, 17.38 bu.

The quality of the grain from the late seeded plats was always much poorer than that from the other seedings. Almost without exception, the late seedings were severely damaged by rust, while the earlier seedings escaped more or less. Experiments in the same line as the above, and covering some six years previous to those given, gave results that agree with those related. Usually there is very little difference between the yields from plats seeded from the fifteenth of September to the twentieth of October. Occasionally very fair yields have resulted from seeding late in November, but usually the yields from such seedings are much below September and October seedings. Often they are practically a failure while at the same time the yields from the early seedings are very good. The last point is very well illustrated by the results of 1898-99. Twelve plats sown in September averaged 28.7 bushels per acre and the grain tested 58.5 pounds per bushel. Eight plats sown in October averaged 21.5 bushels per acre and the grain tested 55 pounds per bushel. Twelve plats sown in November averaged 5.4 bushels per acre and the grain tested 45 pounds per bushel.

During several seasons, the very early seeding was but little different from the very late seeding; generally the best yields were from seedings made from the twentieth of September to the tenth of October. Where the wheat is to be used for pasture, seeding ten days earlier is desirable if later seeding is not necessary to escape certain insects.

AMOUNT OF SEED PER ACRE.

The desirable number of wheat plants per acre will vary with the soil and its location and the season. By the natural habit of tillering or stooling, the plants tend to regulate the stand themselves. Within reasonable limits, they will do so if certain conditions are present. Under any circumstances, some stool plants are produced and these go to make up part of the stand, but to what extent to depend upon the tillering to furnish the stand is a question, as well as how many plants should there be per acre. While not as important as some factors in wheat culture, the quantity of seed wheat to use per acre should be given some attention.

In the experiments at this station, plats seeded at the rate of five to six pecks per acre usually gave better yields than plats seeded at the rate of three to four pecks per acre, but the yields differed but little from those on plats seeded at the rate of eight pecks per acre.

The time of seeding, the character and location of the soil, the kind of seed, and the season were all found to influence the results. Late seeding requires more seed per acre as the plants do not have the time in which to tiller that early seeded plants do. A poorly prepared seed-bed or dry weather will lessen the number of stools produced.

A variety of wheat that has a large berry will not contain as many seeds per bushel as one with a small berry, and when seeded at the same rate per acre, will not produce as many plants per acre at the time the plants come up, but the fact should be borne in mind that tillering may equalize the stand later.

A good, rich soil. where there is plenty of moisture, will cause wheat to tiller much more than a poor soil, and if the seeding is done early enough a thin seeding might come out all right on a rich soil when it would not on the poor soil. But the fact should be borne in mind that the fertile soil is capable of sustaining and maturing more plants per square foot than the poor soil.

The stalks produced by the plants tillering, and particularly those thrown out late in the fall or spring, are later in heading and maturing than the plants that spring from the seed, and these plants suffer more from rust and chinch bugs and produce a poorer quality of grain which reduces the yield. This point argues against depending very much on the tillering of the wheat plants to produce the desirable number of plants per acre.

For the above reasons, moderately thick seeding is the safest and gives the best results as a rule. The experiment station seeds wheat at the rate of six pecks per acre. Four to five are sufficient for counties in the western part of the territory, in most cases.

PASTURING WHEAT.

The experiments in this line have been under way but two years and the results of other seasons will be necessary to cover all conditions. So far the results indicate that on our heavy soils, pasturing wheat will lessen the yield slightly and if it is permitted when the soil is not in a suitable condition, or if continued late in the spring, the quality of the grain will be injured and the yield lessened. But where pasturing is judiciously practiced, any slight reduction in yield due to it will many times over be returned in value in the feed furnished in pasturing. From the two years' work the following results are given:

Plats not pastured averaged 2.45 bushels per acre more than plats pastured until March 1st; 3.5 bushels per acre more than plats pastured to the end of March; 9.66 bushels per acre more than plats pastured up to the middle of April. The late spring pasturing damaged the crop by retarding the ripening period of the wheat, which made it much more subject to rust.

VARIETY TEST.

The following varieties have been given sufficient trial at this Station to demonstrate that they are good varieties for Oklahoma, most of them have been in the variety test eight to ten years:

Soft, smooth wheats: Early Red Clawson, Fultz, and German Emperor.

Soft, bearded wheats: Fulcaster, Missouri Bluestem, and New Red Wonder.

Hard, smooth wheats: Red Russian and Oregon Red.

Hard, bearded wheats: Sibley's New Golden, Turkey, Weissenburg, Crimean, and Theiss.

The term "hard," as applied to wheats, is relative and the same variety varies somewhat in this characteristic when taken from one locality to another. None of the above varieties belong to the true hard wheats, such as the Durum wheats.

While the variety test demonstrates that there is a great difference in the productive power of some varieties as compared with others, it does not show that any one variety is greatly superior to all others. The old standard varieties included in the above list and grown on the Station farm for the past ten years yield as well as any of the new varieties introduced from year to year. The variety is kept from deteriorating by careful grading of the seed each year.

SEASONS.

Before taking up the experimental data, a short review of the seasons through which this list of tests was carried will be given. The season changes have a marked influence upon the yields obtained in any given year. In fact, the season is quite often more of a determining factor than either soil or manure, hence a consideration of some of these changes is almost imperative when a study of field work is to be made and definite conclusions drawn. The notes given have special reference to the district in which the experiment station is located.

The season of 1899-1900 was quite favorable to a large wheat crop. July gave an excellent opportunity for plowing, and August fair. September and the first twenty-five days in October were very dry, and untilled, or poorly tilled, ground became very dry and hard; but early plowed and well cultivated land remained in fine tilth, and conditions for seeding and growth were fair even during the severest of the drouth. Heavy rains late in October and excellent conditions during November greatly helped all the wheat, and especially that on the late plowing and late seeding. Considerable wheat that otherwise might have perished came through in fair shape. The winter and spring were very favorable and wheat improved as each month passed. May afforded the very best conditions,—cool and moist. Frequent rains and hot moist weather early in June developed a large amount of rust, and while the early wheat was damaged but very little by this, late wheat was cut short over twenty-five per cent. Chinch bugs arrived in the usual number and multiplied rapidly, but were checked by frequent rains, and very little damage was done. Conditions for harvesting were excellent.

The season of 1900-01 was conducive to another large wheat crop. The early part of the summer furnished fair conditions for plowing, but late in the season the ground was too dry to plow, and

up to the 20th of September but a small part of the wheat ground had been stirred by farmers, and it appeared as though the wheat acreage might be small. These extreme conditions were overcome by a rainfall of 9.22 inches that fell during the last ten days in September. This was followed by good rains during the rest of the fall and the ground was thoroughly soaked and settled by the middle of November and prospects for a large wheat crop were excellent. The growth was phenomenal and heavy pasturing was necessary on early seeded wheat in order to prevent damage from overgrowth. The winter was very mild and, while the rainfall was light, wheat came through in excellent condition. The spring was cold and backward and wheat started much later than usual, but the outlook was good until the April-May drouth struck it. No rain, to speak of, fell from April 13th to May 18th. The prospects for the crop were very gloomy for many days and much of the wheat was damaged. A fine, gentle rain of 4.2 inches on May 18th turned the tables again and conditions remained favorable for the balance of the season. Very little damage was done by rust, and chinch bugs were few, and plant lice that were complained of so much in some parts of the territory could not be found in our fields. A dry wheat harvest enabled putting the grain in the bin in the very best condition.

The season of 1901-02 was a little below the average for a wheat crop. Commnecing with July, the rainfall was below the average during almost every month up to March. In this month the rainfall was almost double the average and it brought out all the wheat that had lived through the winter in first class shape. The excessive rainfall of May, 10.86 inches, which fell while the wheat was in bloom, probably was as much the cause of the light yield as any other factor. The wheat ground was water-soaked and soggy for weeks, but about the time that the wheat was ripening, the ground got hard and dry. Chinch bugs had no particular effect on the crop and damage from rust was slight.

The season of 1902-03 on the whole was quite favorable to a large wheat crop of fine quality. Heavy rains fell in September, the precipitation for the month being 4.64 inches, and in November the conditions were extreme, as 7.78 inches fell in that month. Enough moisture fell during the month of November to keep the soil wet until a short period during the first week in May, when the ground in the wheat fields was getting a little dry, but this spell was broken early

in the month and there was a precipitation of 9.27 inches before the close. The fall for April and June was light for those months but sufficient for a maximum growth of wheat. Cool weather kept the rust from developing to anv marked extent and the wet weather literally exterminated the chinch bugs.

The season of 1903-04 was not an ideal one so far as the production of wheat was concerned. A wet spring in 1903 was followed by a comparatively drv summer, consequently wheat ground that was not plowed and worked down at an early date did not contain a full supply of moisture and crops grown upon such soil suffered severely before the end of the season. Generally speaking, the major portion of the wheat in eastern Oklahoma made a fair growth during the fall and gave promise of good returns for the coming harvest, but the dry weather throughout the latter part of the winter and early spring changed the outlook materially. In the latter part of April, it was doubtful whether the wheat crop would return the seed which had been used. The rainfall from November 1st, 1903, to May 1st, 1904, was but 3.08 inches. Rain commenced to fall April 22nd, and from May 4th to the date of ripening the supply of moisture in the soil was abundant. The wheat revived and continued improving up to the time of maturity. The crop, however, was well advanced when the first rains fell and there was not the same chance for marked improvement to take place as if these showers had occurred at an earlier date. It was a noticeable fact that the wheat plants did not tiller to the same extent this season as in seasons when the supply of moisture was fairly abundant during the growing period. Even in places where the wheat did tiller, that portion dried up long before the advent of rain. In spite of these adverse conditions, the work of the year was not a total failure. In making a study of the season changes and the yields of grain that are reported for the respective years, it is evident that conclusions deduced from one year's work alone would not in all cases be indicative of the practice that should generally be adopted. However. the results of the work for the entire period, five years, will lead to the establishment of certain principles which have already been indicated as essential factors in the production of first class crops of wheat.

DETAILS OF EXPERIMENTS.

WHEAT, CONTINUOUS, WITH AND WITHOUT MANURE.

In 1892 an acre of virgin soil was laid out and seeded to wheat and cropped continuously with wheat without the addition of manure or fertilizer of any kind until the fall of 1898, when the acre was divided into two plats. One of these received an application of barnyard manure at the rate of fifteen tons per acre in the fall of 1898, and a second application at the rate of eleven tons per acre in the fall of 1899. Since that time no manure or fertilizer in any form has been applied. The remaining half of the original plat has received no manure or fertilizer whatever. Both of the plats have been cropped continuously to wheat since the experiment was started in 1892 and no catch crops were grown on the ground. Throughout the experiment, both plats were plowed in the same manner and at the same time. The plowing was generally done as early as possible, the time ranging during the six years from July 10th to August 7th. The soil was turned to a depth of seven or eight inches and the plats were worked down immediately with a disc harrow. The subsequent treatment was of such a nature as to keep the soil in good tilth and at the same time prevent the evaporation of moisture. In dry seasons, the unmanured plat was more difficult to plow than the manured ground, and also required more work than the latter to bring the soil into proper tilth. The grain was put in with a drill at the rate of one and one-half bushels per acre, the seeding being done from the 20th of September to the 8th of October. Without exception, the soil was in good condition at seeding time. Fultz wheat has been seeded on these plats each time. Before giving the table showing the results from the manured and unmanured ground, the following results are given in order that the yields for the entire period may be compared.

TABLE I.
WHEAT, CONTINUOUS, WITHOUT MANURE

YEAR	YIELD PER ACRE	
	Grain, Bu.	Straw, Lb.
1892-93	10.55	1422
1893-94	20.90	2077
1894-95		
1895-96	7.10	1889
1896-97	17.80	2268
1897-98	7.25	1241

TABLE 2.

WHEAT, CONTINUOUS, WITH AND WITHOUT MANURE

YIELDS PER ACRE

TREATMENT	98-99		99-00		00-01		01-02	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
Manured	30.6	2.76	36.8	2.50	37.7	1.43	17.4	1.08
Unmanured	12.0	1.37	18.1	1.16	28.0	.....	15.3	.74
Diff. in favor of manuring	18.6	1.39	18.7	1.34	9.7	.....	2.1	.34

TABLE 2.—CONTINUED.

TREATMENT	02-03		03-04		Avg. 6 Yrs.	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
Manured	27.6	2.16	15.7	.73	27.6	1.77
Unmanured	20.3	1.39	12.6	.57	17.7	1.04
Diff. in favor of manuring	7.3	.77	3.1	.16	9.9	.....

In six years the manured land produced 165.8 bushels of grain and 10.6 tons of straw per acre, while the unmanured land produced 106.3 bushels of grain. A mistake was made in entering the weights for the year 1900-01 in connection with the yield of straw for the unmanured ground, consequently no insertion was made and the average yield of straw reported covers a period of five years only. The total difference in favor of the manured ground is 59.5 bushels for the entire period, or an average of 9.9 bushels per acre per year. This result was obtained through the application of thirteen tons of barnyard manure to a half acre of land, or twenty-six tons per acre. The returns from the manured plat for the first three years after the manure had been applied were decidedly in favor of this plat, and during the six years it will be observed that the manured plat always gave a better yield than the unmanured ground. During two seasons, 1902 and 1904, the yields were exceptionally low on account of drouth, but in both cases the manured ground gave better results than the plat which received no manure. Generally speaking, there has been quite a marked difference in the appearance of the wheat on these

two plats each season. The plants on the manured ground always had a rich green color, while those on the unmanured soil were light green in color, and in the former case the growth was much ranker. Again, it was a noticeable fact that the plants tillered much more and ripened earlier on the manured plat than on the unmanured plat. The manured plat also produced wheat superior in quality to the wheat from the unmanured plat.

In this experiment, the manure was applied in both cases as soon as the season's crop had been removed. The ground was plowed and worked down immediately so that the manure had ample time to become practically decomposed before the plat was seeded. When manure is applied, to be followed by a wheat crop, it should be scattered and turned under at an early date so that the seed-bed may have a chance to settle throughly. If coarse manure is incorporated with the soil late in the season, it will have a tendency to keep the soil somewhat open and a loss of moisture will result.

The plan is to continue the above experiment a long series of years and another application of manure was given the manured plat in the fall of 1904. In considering the yields from these plats, attention is called to the fact that the very best tillage feasible was given the soil in both cases.

TIME OF PLOWING.

In this test the ground was plowed on or about July 15th, August 15th, and September 15th, each year, and these plowings were designated Early, Medium, and Late, respectively. Duplicate plats were used in each case. The soil was turned to a depth of seven to eight inches, and worked down immediately. Subsequently, the plats were given light cultivation after each shower or heavy rain. The plats were all drilled at the same time to Fulcaster wheat at the rate of one and one-half bushels per acre. The time of seeding for the five years through which this experiment was carried ranged from September 15th to October 1st. The yields for the entire period are given in the following table:

TABLE 3.

TIME OF PLOWING FOR WHEAT

YIELDS PER ACRE

TREATMENT	1900		1901		1902	
	Bu Grain	Ts Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
Early	31.32	1 81	43.60	I.99	17.05	.63
Medium	23.48	1.23	38.20	1.74	18.15	.61
Late	15.30	1.00	40.20	1.92	19.35	.81

TABLE 3.—CONTINUED.

TREATMENT	1903		1904		Avg. 5 yr.	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
Early	28.20	1.74	15.25	.82	27.10	1.39
Medium	28.50	1.82	12.54	.56	24.20	1.19
Late	27.80	1.73	7.51	.34	22.00	1.15

In five years the early plowed plat produced a total of 135.5 bushels of grain and 6.99 tons of straw per acre; the medium plowing produced 120.7 bushels of grain, with 5.96 tons of straw, while the late plowing produced a total of 110.1 bushels of grain and 5.78 tons of straw. This makes a total difference in five years of 14.8 bushels of grain and 1.03 tons of straw in favor of the early plowing as compared with medium plowing, and a total difference of 25.4 bushels of grain and 1.21 tons of straw in favor of early plowing as compared with late plowing. These results lead to the conclusion that better yields can be obtained by plowing the land which is to be seeded to wheat early in the summer. This means from July 1st to August 15th.

It should also be observed that these results were obtained on ground that was given good cultivation after early plowing. Early plowing alone will not suffice. The seed-bed must be thoroughly prepared. On a great many farms the plowing is done at an early date but the fields are allowed to remain in an open, broken condition until a few days before seeding commences, when the surface of the field is given a stroke with the harrow and the grain is drilled immediately.

In the interval between the time of plowing and seeding the mechanical condition of the soil has not been improved. It is covered with weeds, and moisture has been evaporating rapidly, consequently a poor seed-bed and an imperfect germination are the result of such treatment. The field should receive surface cultivation as soon as the soil is turned, and a thorough mulch should be preserved during the remaining part of the summer by frequent harrowings. This will mean a little extra work after each shower, for with each rain the mulch becomes firmly packed, capillarity is restored and the moisture comes rapidly to the surface where it passes off by evaporation. Cultivating the soil breaks this crust and restores the mulch, thus the evaporation of moisture does not take place to any appreciable extent, and many weeds are destroyed at a small expense. Early plowing and thorough cultivation should go hand in hand. But the difference in yield does not represent all that was gained by the early plowing, as the labor required for the different plowings varied widely and was quite an item. Usually the ground was moist and mellow at the time of the July plowing and turned with ease and was left in a mellow condition and was easily worked down with one stroke of the harrow. On the other hand, with an exception or two, at the time of the August plowing the ground was dry and hard and turned up in large lumps and the work was very difficult and could be done, most of the time, only with a disc plow. These plats usually had quite a growth of weeds on them, some of which had gone to seed. This dry, lumpy soil was gone over once with a disc immediately after the plow, but little was accomplished other than reducing the size of the clods.

By immediately following every light shower, or heavy one, with the disc or drag, and frequently the harrow also, the soil was gradually pulverized and by seeding time was in as good condition as the July plowing, except as a rule it did not contain as much moisture. The plats to be plowed in September were always covered with weeds and grass and with one exception were as hard and dry as a road and plowed about as well. In order to get them in readiness for seeding at the time of the other plats they had to be gone over time after time with the disc and drag and the clods literally ground up. Even after all this, the seed-bed was cloddy and open and not until showers fell did the greater part of the seed germinate and grow. It would not be practical to put the labor on a large field that was necessary to get the late plowed plats in condition for seeding at the time they

were seeded. By waiting for showers to soften the clods turned up in plowing, less labor would be required to pulverize them, but later seeding would be necessary, which would not be objectionable if it was not after the middle of October. The latter method would be more preferable than seeding in September before the seed-bed was in shape. It is probably true that the results obtained on the August plowing are better than the average farmer would get, as in our experiments no labor was spared in getting the ground in shape and the diskings and harrowings were made just when they were needed and would do the most good. Unless the farmer is pretty well equipped and is raising a rather small acreage of wheat, he may not be able to take advantage of July or early August plowing altogether. But if he will go on the ground as soon as the wheat is cut and give it a good disking, which will enable him to cover quite an area in a day, he can by stirring the surface soil prevent the weeds from starting and the ground from drying out until it can be plowed. But, in any event, the ground should be plowed early enough to allow it to be thoroughly settled and pulverized before seeding time.

TIME OF SEEDING.

The plan of this experiment has been to make a seeding the 15th of September for early seeding, the 15th of October for medium seeding, and the 15th of November for late seeding. The different seedings were carried through in duplicate each year. The plats were all plowed at the same time and in the same manner. The time of plowing for the five-year period ranged from July 9th to August 20th. The plats were worked down as soon as the plowing was done and kept in good condition up to the time of seeding. Red Russian wheat was used each year and was seeded at the rate of one and one-half bushels per acre.

The yields for the respective years, with the average for the entire period, are given in the following table:

TABLE 4.

TIME OF SEEDING WHEAT

YIELDS PER ACRE

TIME OF	1900		1901		1902	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
Early	36.79	1.89	24.10	1.24	19.45	.91
Medium	34 84	1.98	37.80	1.76	22.90	1.02
Late	23.47	1.82	26.80	1.33	11.25	.72

TABLE 4.—CONTINUED.

TIME OF	1903		1904		Average.	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts Straw
Early	30.60	2.16	10.41	.42	24.28	1.32
Medium	28.70	1.82	13.24	.48	27.49	1.41
Late	..	.....	8.01	.46	17.38	1.08

Owing to excessively wet weather during the season of 1902-03 the late seeding plats were not drilled to wheat, hence the average for this seeding includes a period of only four years. With one exception the October seedings gave the best returns throughout this period. There is an average difference of 3.21 bushels per acre in favor of the medium seeding as compared with early seeding. The average yield for the late seeded plats is 10.11 bushels per acre below the average reported for the medium seeding. In the year 1900-01 the wheat that was seeded in September made a very rank growth during the early part of the season. On November 8th the plants were eight to twelve inches tall. As this was not a desirable condition the experiment was modified slightly. Two-thirds of each of the September seeded plats were cut with a mower and the tops were allowed to remain on the plat as they dropped over the drag bar. The growth under neath was damaged only in a few places. No bad effects due to the large growth on the uncut portions could be seen in the fall, but when

the winter nipped the tops, the growth wilted down and smothered out patches from one to two feet in diameter. Other portions were damaged to some extent. The cut and uncut portions were harvested separately and the results are as follows:

TABLE 5.

WHEAT MOWED AND NOT MOWED IN FALL

TREATMENT	Yield of Grain and Straw.	
	Bushels of Grain.	Tons of Straw.
Wheat mowed	43.1	1.55
Wheat not mowed	24.1	1.24

In this case, the heavy growth on the plats which were not mowed lowered the yield appreciably. The yield given for the unmowed ground is used in the regular report for this particular seeding. In press bulletins reporting results of wheat experiments the average of these two treatments was taken and used in obtaining the average for the early seeding during the several seasons under consideration. This places the early and medium seedings almost on the same plane so far as yields are concerned. Omitting this particular season when conditions were somewhat abnormal and taking the average for four seasons, 1900,-02,-03,-04, the early and medium seedings stand 24.3 bushels and 24.9, respectively. Taking these facts into consideration, it may be stated that there is very little difference in results obtained from these two treatments, September and October seedings. The slight difference shown above is in favor of the October seeding.

In general, seeding from October 1st to October 15th will give as good results as earlier seeding; however, the earlier sown wheat will usually furnish a larger amount of pasture. Pasturing would also tend to overcome any detrimental effect which might be caused through an excessive early growth. It should also be noted that the early seeding favors the development of the Hessian fly, thus in sections where the fly is prevalent, seeding in October would be preferable to the September seeding. The late seeding is often quite uncertain owing to the fact that the plants get a poor start and when ad-

verse conditions are met, they are not able to stand the rough treatment as well as plants which have a well-developed root and top. In considering the above results, the fact should be borne in mind that the October and November seedings were made on land prepared in ideal condition, which is not the rule when the farmer seeds in October or November. He seeds late because he has plowed late, and generally the seed-bed is open and loose and lacks sufficient moisture, and wheat on such ground will not make the yield obtained in the above experiments. One important factor that has prevented the late seeding from producing as well as the earlier ones is that wheat seeded after the first of November is much later in maturing and is always badly affected with rust which prematurely ripens the grain and allows the berry only to half fill, which makes a very poor quality of grain.

PASTURING WHEAT.

Wheat pasture on the farms of Oklahoma is an important item and more especially in those sections where stock raising is becoming the principal branch of the farm program. This is a new country and the farmer who is interested in the stock industry has not had time nor spare cash to build a silo in which to store a supply of palatable food for winter feeding, but he has broad acres of wheat land which will furnish, in a measure at least, a supply of succulent food during a period when the amount of such material is necessarily limited. The plan of feeding a liberal supply of silage or roots to young growing stock or dairy cows is highly recommended. Since the practice of growing roots in any quantity for feeding purposes has not been adopted, and since no provision has been made for the ensilage of corn, the stockman is forced to look elsewhere for a supply of succulent material to use in connection with roughage as corn and Kafir stover, or prairie hay, of which there is generally an abundant store. During favorable seasons the wheat fields furnish a liberal amount of fresh green pasture. The weather is generally mild and the young stock or even the dairy cows can be allowed to run at will upon the fields.

Taken in the aggregate, the value received from wheat pasture by the farmers of the territory amounts to quite a large sum of money. Estimating the value at three dollars per acre—a very moderate sum—this would mean a net return of $4,929,390 for the Territory. This

leads up to the question which has probably come to the man who studies and plans as he endeavors to reap a profit in his business, namely: to what extent is it advisable to pasture wheat during the fall and winter months? What effect will very close grazing or keeping stock upon the fields late in the spring have upon the yield of grain which is to be harvested the coming season? These and other questions suggest themselves when the question of pasturing is considered. In order to answer some of these questions, the station commenced some work in wheat pasturing during the season of 1902-03 and the work was continued in 1903-04 under almost the same plan. Nine one-half acre plats were used in this work during 1902-03 and 1903-04. These plats were located in a farmer's field about one mile west of Stillwater and six of them were surveyed and fenced as soon as pasturing commenced, the date being October 15th for 1902 and December 1st in 1903. Pasturing did not commence until quite late in the second year, owing to the fact that dry weather prevented, hence the wheat crop made a very meager growth. The three plats that remained unfenced were pastured in the same manner as the regular field in which they were located. The soil in this field is classed as medium upland (clay loam in character). This type is considered a good wheat soil. The two seasons, one exceptionally wet and the other exceedingly dry, afforded an excellent opportunity for making a study of the effect of pasturing under these conditions. The plats were grouped in series and the following treatment was given in the respective cases. The tests were carried in duplicate except in series 2 and 4 in 1902-03.

Group No. 1. Not Pastured.—During both seasons the cattle were turned into the field before the plats were fenced but the wheat in this particular portion of the field was scarcely touched, hence they are considered as control plats—i. e., those receiving no treatment.

Group 2.—The wheat on this series was pastured up to March 1st, each season. In 1902-03 the plan was modified slightly in order to obtain extra data during this particular season. The ground throughout the winter months was very wet at times and cattle could not be turned upon the wheat without tramping the same to a considerable extent. During the winter, one plat was pastured only at such times when the soil was perfectly firm and no tramping resulted, while the

other plat was pastured when the soil was soft and contained an excessive amount of moisture.

Group 3.—The wheat on this series was given general field treatment, that is, the lots were not fenced, but the cattle were permitted to run upon these plats just as they passed over the regular field.

Group 4.—This series was given the same treatment as series 3, and in addition the plats were pastured severely until April 15th and 16th, the cattle being confined to the lots until the wheat was pastured quite closely.

There was also a slight modification in connection with the plan for the series during the season of 1902-03. One of the lots was given light winter treatment, that is, the wheat was not pastured close during the winter season, and then the cattle were turned upon the wheat on the 14th of April. The second plat was pastured quite close from March 31st to April 14th. The cattle were turned into the lot March 31st and April 8th to the 14th omitting the 10th day of April, when the soil was rather soft.

The following results were obtained:

TABLE 6.

TREATMENT	02-03		03-04		Average.	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw
1. Not pastured	23 21	1.49	12.35	.63	17.78	1.06
2. Pastured to March 1st.	20.88	1.35	9.79	.48	15.33	.91
2. B Pastured heavily	18.70	1.06	.....	.....	.....	.....
3. Pastured to March 31st.	20 50	1.17	8.06	.43	14.28	.80
4. Pastured to April 15th.	10.70	.83	5.55	.43	8.12	.63
4 B. Late Spring Treatment.	14.00	.94	.....	.....	.....	.....

The field and plats during the season of 1903-04 were perfectly firm, and the soil was not tramped and put into a poor physical condition as it was the previous season. When the ground is very wet and cattle are allowed to pasture upon the wheat, the texture of the soil is not only impaired, but a large number of the wheat plants are destroyed. It will require more work the succeeding season to prepare the same land for wheat than would be required if the necessary pre-

cautions had been taken and stock had not been permitted to run on it when the soil was very wet. Such conditions are not met every year but the precautions noted above should be observed during exceptionally wet seasons. In 1902-03 the half-acre plat that was given moderate treatment during wet periods yielded 2.2 bushels per acre more than a plat of the same area upon which the cattle were permitted to run when the soil was very soft. The latter plat was also rough for the binder at the harvest season.

Taking the average yields for two years into account, the unpastured ground stands 2.45 bushels per acre in advance of wheat pastured to the end of February, 3.50 bushels per acre in advance of wheat that was pastured to the end of March, and 9.66 bushels per acre in advance of close late pasturing. The yield of straw decreases with the heavier treatment. Pasturing wheat, which has made but a normal growth, even to a moderate degree has a tendency to lower the yield of grain and straw but the value received in pasture would in most cases cover the difference which exists. The above results lead to the conclusion that stock should be taken out of the wheat field by March 1st or March 15th at the latest if reasonable returns are to be expected. Close, late, pasturing in the above experiment lowered the yield almost one-half as compared with moderate pasturing. The quality of the grain deteriorates perceptibly with late pasturing. Where wheat makes a very heavy top it is advisable to pasture. It has been observed that where wheat makes a very heavy growth in the fall, and the heavy green mass settles down close to the ground, the plants in many places are completely destroyed. Pasturing will prevent the accumulation of such a heavy mass of green material on the field and return any loss due to the fact that the stand has been weakened. The wheat on the plats pastured late in the spring was considerably later than wheat not pastured or fall-pastured only. This made it more subject to damage by the rust. It is probably true that most of the damaged wheat resulting from pasturing is due to the fact that it is pastured after the spring growth starts, which retards the maturing and makes it more likely to suffer from the rust.

VARIETY TEST.

This test was started in 1892-93 with 254 varieties gathered from all sources where varieties of merit could be found. The varieties

which gave very low returns or were synonymous were soon separated from the varieties which appeared to have desirable characteristics and a list of some sixty-five varieties was continued under test for a few years. The most promising varieties in this case were again singled out and during the past five years some twenty-three of these varieties have been included in the trials. In addition to the above, new varieties have been added from time to time and thus in 1904 thirty-four varieties were grown side by side. The new wheats which were introduced within the past year can hardly be compared with the old varieties which have been grown on the farm for the past eight or ten years. Climate and soil are frequently important factors in determining the yields during a given season. A new variety may be introduced from another section of the country where it has probably given excellent yields, but under new conditions of soil and climate it fails to maintain the old record. On the other hand, there are old varieties that give exceedingly good returns under the same conditions. During 1903-04, an exceptionally dry season, the Turkey wheat gave a yield of 17.05 bushels per acre, while out of a list of seven new varieties which were introduced from other sections that same season there was not a single variety that reached the ten bushel mark. These same varieties under favorable conditions would undoubtedly give yields almost if not equal to the former variety. This would appear to emphasize the fact that if one has a variey of wheat which has a good performance record it should not be exchanged for a variety that has not been tested, because in the latter case the result is somewhat doubtful. The mere fact that a given variety of wheat makes a good appearance while growing in the field, or perhaps the grain looks plump and bright when well cleaned, should not be the sole basis for our judgment when making a selection. In addition to desirable outward characteristics, the wheat should be able to make a good record throughout a successive period of years. The term record implies that the wheat be able to return a high average yield of grain and straw, and be able to resist adverse conditions, as dry weather or fungus diseases. Where so many varieties are under trial, it is impossible to have the plats very large or duplicate the plats of each variety. In order to indicate the differences in yields due to the irregularities of the soil where the plats are situated, what are called check plats are put in. Every so often, generally about every eleventh and

twelfth plat, two of the standard varieties are seeded. From these check plats it is found that a difference of from one to three bushels per acre may be due to a difference in the soil when the varieties compared are several rods apart in the field. When the average of yields covering four or five years are compared, a very good idea can be obtained of the comparative worth of the different varieties.

The following table gives the yields of varieties grown during the past five years and the average of each for the number of years shown:

TABLE 7.

VARIETY TESTS

YIELD PER ACRE

VARIETY	1900		1901		1902		1903		1904		Average	
	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts. Straw	Bu. Grain	Ts Straw	Bu. Grain	Ts. Straw
Sibley's New Golden	39.50	1.98	37.60	1.13	21.80	1.02	39.30	2.24	15.40	.74	30.52	1.42
Missouri Blue Stem	38.51	2.15	39.60	1.61	17.70	.88	39.45	2.41	15.76	.51	30.20	1.51
Early Red Clawson	41.31	1.77	36.30	1.86	22.70	1.28	39.00	2.29	10.81	.61	30.02	1.56
Pickaway	42.52	1.85	35.60	1.73	20.30	1.20	39.00	2.70	9.71	.91	29.43	1.68
Turkey (local)	42.12	2.29	34.60	1.04	20.30	1.12	33.70	2.13	15.58	.63	29.26	1.44
Turkey (Wash.)	42.92	2.65	36.60	1.80	20.00	1.12	29.20	2.18	17.05	.80	29.15	1.71
Big English	37.70	1.88	34.60	1.04	22.70	1.40	38.20	2.76	11.91	.63	29.02	1.54
Early Ripe	40.11	1.93	36.30	1.96	21.20	1.13	34.30	2.12	12.46	.50	28.87	1 53
New Red Wonder	38.12	1.81	36.00	1.08	22.20	1.19	37:20	2.70	9.90	.63	28.68	1.48
Crimean	32.89	1.72	38.30	1.85	18.40	1.05	38.40	2.53	14.66	.71	28.53	1 57
Fultz	39.31	2.07	37.00	2.19	20.60	1.15	32.80	2.02	11.55	.75	28.25	1.64
Fulcaster	40.51	2.11	35.07	1.59	20.60	1.06	34.32	2.62	10.20	.50	28.14	1.58
Red Russian	39.50	1.88	35.43	1.58	21.60	1.12	36.20	2.48	7.54	.46	28.05	1.50
German Emperor	39.14	1.91	29.95	1.43	20.75	1.02	37.72	2.64	8.98	.72	27.31	1.54
Oregon Red	38.51	2.09	31.00	1.69	22.00	1.11	35.20	2.72	9.84	.55	27 31	1 65
Eversaw	38.11	2.16	32.00	1.79	20.35	1.13	32.85	2.47	12.37	.58	27.14	1.63
Theiss	29.84	2.19	37.00	2.09	20.00	1.12	35.85	2.52	12.10	.79	26.96	1.74
3822	27.18	2.17	31.70	2.05	16.50	1.10	36.30	2.46	13.01	.76	24.94	1.71
Weissenburg	19.89	1.99	31.30	2.06	19.00	1.07	31.80	1.79	13.27	.59	23.05	1.50
Big Frame	29.68	1.52	38.30	1.70	22.00	.71	15.90	1.68	6.96	.78	22.57	1.28
Pester Boden	13.26	1.39	32.30	2.18	15.30	1.09	34.80	3.23	12.28	.56	21.59	1.69
Zimmerman	24.07	1.38	35.60	1.78	15.70	1.30	18.15	1.57	7.88	.53	20.28	1.31
2957	1.33	.32	27.00	1.50	21.40	1.08	38.80	2.92	9.90	.52	19.69	1.27
Gypsey Amber					20.50	1.02	35.10	3.19	6.23	.52	20.61	1.58
Paris					12.80	.99	36.10	2.87	2.56	.36	17.15	1.41
Fultzo Mediterannean							37.05	2.53	5.13	.45	21.09	1.49
White Wonder									6.78	.40	6.78	.40
Frost Proof May									2.56	.25	2.56	.25
Macaroni									2.75	.46	2.75	.46
Malakoff									9.44	.51	9.44	.51
Belogian									8.25	.41	8.25	.41
Mediterannean									6.05	.42	6.05	.42
Turkey Red									8.40	.50	8.40	.50

The varieties at the end of the list with the results for one or two years are new varieties tested here for the first time or varieties from seed grown in other states, introduced for comparison with varieties grown on the station farm without change of seed for several years. The seven varieties at the end of the list were situated on soil not quite as good as where the balance of the plats were, and the lower yields of these are somewhat due to this fact. A dozen varieties in the list have been grown on the station farm for seven to ten years and as yet no new varieties introduced have equaled them in yield. The seed of these wheats is used without change but each year the seed is carefully graded and there is no evidence of any deterioration in these varieties.

DURUM WHEATS.

These are often called macaroni wheats from the fact that they are used very extensively for making macaroni. Although varieties of this peculiar group of wheats have been grown to a very limited extent in parts of the United States for thirty or forty years past, they have not been looked upon with much favor and very few farmers heard anything of these wheats until the past few years. In certain parts of the country now, there is quite an niterest in the Durum wheats and there are good indications that they will be extensively grown in the future in several sections.

A few years ago the United States Department of Agriculture imported new varieties of the above wheat, distributed them in suitable localities, made known the characteristics, and acquainted our millers with the worth of the flour of such wheats for bread making. Now the Department reports a great increase in the acreage grown and a good demand for the grain on most of the leading markets.

One of the characteristics in which the Durum wheats differ, to a marked degree, from our common wheat is in the extreme hardness of the grain. This characteristic of the grain makes it necessary to provide special machinery for grinding it, consequently the wheat can be used only by mills so equipped. The above fact and the lack of knowledge that fine bread could be made from flour of these wheats when properly milled, has kept the Durum wheats in disfavor in the past in this country as wheats for general cultivation. Mills equipped to use these wheats are found now in many of the milling centers

and it is reported that the demand exceeds the supply and that the Durum wheats bring a premium in price over the common wheats. This being the case, wherever the grain is grown in car load quantities, there should not be any serious trouble in marketing it.

The Durum wheats are recommended as having a great power to resist drouth and fungus pests. Often they have been found to give fair results where our hardiest common wheats have failed on account of drouth. Such reports come from eastern Colorado, parts of the Dakotas, western Nebraska, and Kansas and similar sections. On the other hand, where damp conditions prevail during the spring these wheats do not yield as well as the common wheats. In the brief test of Durum wheat at this station they fell considerably below the common wheats in yields. A few farmers in some of the western counties of Oklahoma have been trying these wheats and apparently at the present time are divided in their opinions as to the worth of Durum wheat for Oklahoma. Some report better yields than with the common hard wheats, while others have had poor success with their tests. The farther west and the dryer the season, the greater advantage the Durum wheats seem to have in Oklahoma. One great drawback to the introduction of these wheats in Oklahoma is that practically all of the varieties are spring wheats and when seeded in the fall will not live through many of the winters here. Spring wheat usually does very poorly in Oklahoma and this will make it very desirable to obtain a variety of Durum wheat suitable for fall seeding. There is very good promise of this at the present time. When seeded in the fall, the growth is very rank and some farmers seed it in the fall just for the pasture, as it affords so much more grazing than the common wheats. It has been demonstrated that the Durum wheats have some characteristics that make them well suited to the conditions found in some sections and where wheat frequently suffers from drouth, as in the western part of our Territory, it will be well to give these wheats a further trial.

GENERAL NOTES ON WHEAT CULTURE.

INTRODUCTION.

The wheat crop occupies a prominent position on the farms of Oklahoma. Since the country was opened for settlement sixteen years ago, the area devoted to this crop has increased rapidly. In 1899 the acreage was 1,279,826 acres, with a total production of 18,124,520 bushels, or an average of 14.1 bushels per acre. The above figures are given in the last census report. At that time the corn crop ranked first in point of acreage, but the difference was not marked, there being only 40,680 acres more in Indian corn than in wheat. The area for the season of 1903 comprised 1,643,130 acres, which produced 24,482,637 bushels or an average of 14.9 bushels per acre. The area planted to corn during the same season was not much in advance of the record for 1899, hence the wheat crop gained enough to place it at the head of the list so far as acreage is concerned. In view of the fact that the wheat crop occupies a paramount place in the list of cereals which are grown in Oklahoma, and that the acreage appears to be on the increase from year to year, it is important that the men who are interested in the production of wheat have definite information in regard to the culture of this crop. It is true that a great many experimental tests have been carried out with wheat in other states and countries, and certain principles or rules have been laid down as guide lines for the men who are growing wheat in those sections. These principles can be applied in general and good results may perhaps be obtained, but there are special conditions under which the same rules would not apply, hence it is necessary quite frequently to repeat the same work in a new district in order to obtain accurate information. Again, a new country always presents new problems and Oklahoma is by no means an exception to this rule. One may be perfectly familiar with the culture and treatment of a given crop in his home state, but he moves out to a new section and discovers in a very short time that the old plans do not always bring success, and if there is no information at hand, work is experimental in character for a few years. Experience obtained in this manner is generally expensive for in many cases a large crop is sacrificed. This difficulty may

be obviated, in a large part at least, for the establishment of experiment stations in every state has given to the public a fund of information which if used in the proper manner will save years of useless toil. Many problems remain unsolved, but the more important items have been worked out and definite conclusions have been reached in regard to methods of culture so that men who are not acquainted with the soil and climate of this Territory may commence and carry on their work intelligently.

IMPORTANCE OF THE WHEAT CROP.

Since the wheat crop occupies such an important position on the Oklahoma farm, some attention should be directed toward the improvement of this cereal so that larger returns may be obtained. The average yield for the year 1903—14.9 bushels per acre—is comparatively low. On many farms a yield of twenty to thirty bushels was obtained, and in other cases even higher yields than these were reported. Assuming this to be correct, it can readily be seen that in order to get an average yield of 14.9 bushels per acre for the entire Territory, many farms gave a return of less than ten bushels per acre. When the average production runs below this scale, wheat raising ceases to be a profitable line of work. The yields have been reduced to such an extent in some cases that the farmer has been forced to ask the question: "How can I increase my yield of wheat?" The suggestion has been made that the time has arrived when Oklahoma farmers will have to resort to the use of commercial fertilizers in order to bring the yield up to a maximum point. It may be stated emphatically that this is not the case. There are other methods and means that are at the disposal of every farmer and all that is necessary for him to do is to put these plans into actual practice and reap the benefits immediately. The yield of wheat can be increasd, first, by better methods of tillage; second, by the judicious use of farmyard manure; third, by better methods of seed selection; fourth, by breeding varieties that are particularly adapted to Oklahoma conditions; and, fifth, by the introduction of a systematic plan of cropping, or, in other words, following a well-defined rotation.

IMPROVEMENT IN TILLAGE.

Improved methods of tillage will aid materially in increasing the yield of wheat. By tillage is meant the preparation of a suitable seed-

bed for the grain that is to be sown, and the control of conditions which are necessary for the proper growth and development of the young plant. It is essential to have the soil in the best condition in regard to texture. In speaking of texture, reference is made to the mechanical condition of the soil particles. A soil is made up of small fragments or particles. These particles may be in a compact condition or they may be fairly free, leaving considerable air space in the soil. It is desirable to have the soil firm enough to afford proper support to the plants that grow in it and yet loose enough to admit the most delicate rootlets. The soft growing points of roots do not force their way through compact clods or earth that has been firmly packed, but they push into the open spaces and between the lumps and grains of which the soil is composed. Hence, if the soil has been well tilled the roots of the plant penetrate all parts of the soil freely. A soil that is placed in this condition, having the particles of the proper size, presents a much larger feeding area for the plant than a soil of the same character which is in a poor physical condition. Thus by improving the tilth of a soil, the feeding area is increased and a better product obtained. Again, the roots of plants come in contact with the soil grains and absorb moisture which contains plant food in solution. This water is held in the soil by surface tension, or, in other words, as a thin film surrounding each soil particle. By a subdivision of these particles the water-holding capacity of the soil is increased. The fertility of the land, or its power to produce crops, is largely dependent upon the moisture contained within the soil. Plants consume a large amount of water in the building up of tissue and a considerable quantity is transpired or given off through the leaves. It has been estimated that a crop like wheat will consume over three hundred times its dry weight of moisture during the growing season. Then, if an acre is to produce one ton of dry matter during a given season, about three hundred tons of moisture will be required by the crop. If moisture is such a necessary element in plant growth it is certain that some care must be exercised in handling the soil so that it will be able to take up and retain a full supply of moisture for the crop. During one part of the year the supply may be super-abundant while at other times the supply is insufficient for the needs of the plant. The practice of plowing the ground early in the summer where wheat is to be sown and then giving thorough and frequent tillage up to the time of seeding should be adopted by every Oklahoma farmer.

Again, tillage aids in securing a proper temperature and in admitting air to the roots of plants. A proper temperature is one of the requisites to early and rapid growth and it is also necessary to the development of the germ life in the soil. The nitrifying organisms which are found in the soil require a temperature of from 65 to 70 degrees for normal growth. It is hardly necessary to pay very much attention to this item in preparing the seed-bed for wheat, because where the moisture content of the soil is properly regulated, the temperature is in turn controlled. The fact, however, should not be overlooked when the soil is being prepared for the reception of seed in the spring of the year. The utility of tillage is also shown in its influence upon nitrification. One authority states that a thorough breaking up of the soil and the upper layers of the subsoil is necessary to the aeration which is an indispensible condition to the progress of nitrification. Good drainage and cultivation secure a free circulation of air through the soil and this is essential to nitrification, which is simply a change brought about by low vegetable organisms whereby inert or unavailable nitrogen is rendered available for the plant. Nitrogen is one of the essential constituents of plant growth and unless the supply of nitrates is adequate the plant will suffer and the yield of grain may be reduced materially.

Tillage aids in destroying weeds which are injurious in many ways. When the annual loss occasioned by weeds is taken into consideration, the work of destruction becomes imperative and the farmer who would have his land free from this pest must study the question of eradication seriously. Weeds crowd and choke useful farm crops, first, by using plant food and thus depriving the regular plant of that amount; and, secondly, by using a large amount of moisture, thereby diminishing the supply to the crop. Weeds also decrease the value of farm crops and are troublesome and injurious to the stock. In Oklahoma, fields that are plowed for wheat late in September generally have an abundant crop of weeds growing upon them. Throughout the summer months these weeds have been removing moisture and plant food from the soil and thus at the time of seeding, the supply of plant food is limited and the wheat crop makes a slow growth. Then, too, after plowing, the heavy growth of weeds which has been turned under prevents the soil from settling into a compact condition, consequently an additional amount of moisture evaporates. In a great many instances the weeds have sufficient time to develop a new crop of seed

and an increased growth may be expected the following season. It would be safe to make the statement that if better methods of tillage were adopted the average yield of wheat could be increased at least five bushels per acre.

DEPTH TO PLOW.

The depth of plowing is governed largely by the time at which the work is done, the condition of the surface and sub-soil, and the previous treatment of the field. Where the soil is turned up to a considerable depth, it should be done early in the season so that it will be possible to secure a compact seed-bed. In cases when the soil is plowed late in the season, deep turning should not be the rule, for two reasons which are quite apparent. In the first place, unavailable plant food is placed upon the surface and the available material is covered up or placed in such a position that the growing plants cannot make use of the food which is found within the surface layer. Again, with deep plowing late in the season there is liable to be a greater loss of moisture than in the case of shallow plowing, unless additional care is taken to have the loose soil thoroughly packed either with a sub-surface packer or a good roller. In this way a compact seed-bed may be obtained and under certain conditions good results may be expected. Unless the plan indicated is followed, deep plowing late in the season should not be done. Late plowing nearly always entails a larger amount of labor in order to get the seed-bed in first class condition for the wheat.

IMPROVEMENT BY MANURING.

The judicious use of farm-yard manure will also effect a permanent improvement in the yield of grain. In applying manure to the soil new stores of plant food are added, and the crop is able to obtain the necessary elements which may have, under certain conditions, become deficient. When manure is incorporated with the soil, chemical action takes place and inert plant food is rendered available for the crop. Manure also improves the physical condition of the soil. When applied to compact soils they become somewhat more open in character, and when incorporated with loose, sandy soils they are rendered more compact. In bringing about this physical improvement, the water capacity of the soil is increased to quite an extent and larger

yields can be expected. Humus or vegetable matter is valuable in many soils in that it prevents washing, or, as in the case of very fine clay soils, running together of the soil particles so that in time the surface becomes a solid mass. As a general rule it is a better plan to apply the manure to some other crop, as corn, and then follow with wheat. In this way the organic material has sufficient time to become thoroughly decomposed and there is a supply of available plant food for the wheat crop. The wheat crop has been classed as a weak feeder, consequently the plant food in the soil should be in a form that is readily available when this crop is sown. Manure can be applied at the rate of twelve to fourteen tons per acre. It is probably a better plan to make light applications, say, eight or ten tons per acre, at intervals of three or four years rather than to make heavy applications of sixteen to twenty tons per acre at intervals of seven or eight years. Well rotted farm-yard manure is sometimes applied to the field after the wheat has been sown and good results obtained. In such cases the field should be perfectly firm so as to prevent cutting and tramping in passing over the wheat. In making applications in this manner care should be exercised in getting the manure scattered evenly. When the manure is scattered in large lumps or bunches some of the wheat plants are liable to be destroyed and in such cases the yield may be reduced considerably. The use of legumes, as, for example, cowpeas, either as green manures or as nitrogen gatherers, should be considered here. The plants belonging to this class are able through the medium of the bacteria which are found associated with the root system, to make use of the free nitrogen contained in the soil air. This essential element is in turn made available for crop use. Hence, by using such crops as soy beans or cowpeas, plant food is not only added directly to the soil but the mechanical condition of the same is also improved.

IMPROVEMENT BY SEED SELECTION.

Experiments which have been conducted within recent years prove conclusively that an increase of five bushels per acre may be secured by following better methods of seed selection. Ordinarily the wheat is taken directly from the bin, without even having been cleaned, and used to seed the field. In addition to a large amount of weed seed which has, of necessity, accumulated in the wheat, due to the

fact that this crop has been grown continuously upon the same field from year to year, and thus no opportunity has been afforded for the control of these classes of weeds, the sample contains small, shrunken, immature grains. The continued use of such seed will result in a reduction of the yield and deterioration in quality. A very simple test will convince one that well developed seed is superior to small, shrunken grain. Two seeds answering the above description are placed in the soil side by side under the same conditions of temperature and moisture. In a few days the large, plump seed will send up a vigorous sprout which grows very rapidly, while the inferior seed takes a longer time to germinate and develops a root and leaf that lacks in vigor and makes a very slow growth. In the large seed an abundant supply of food was stored up for the young embryo and a maximum growth is maintained until the root becomes firmly fixed in the soil and the leaf blade reaches the atmosphere. Thus the young plant is able to elaborate material to supply the growing parts. In the small, shrunken seed, the supply of food is limited and the plant makes a slow, imperfect growth. A study of this question will, undoubtedly, lead to the conclusion that it pays and pays well to use clean, well-developed seed.

It is not absolutely essential to change seed in order to effect improvement. A great many varieties that are imported or brought in from sections outside the Territory are not adapted to the soil and climate of Oklahoma. It will take several years to bring these varieties to the place where yields can be secured equal to those obtained in the use of standard varieties. It is well to remember that the laws that govern the animal breeder in his work apply equally as well in the realm of plant-breeding. The fact that the characteristics of the parent are transmitted to the progeny cannot be overlooked. Judgment, then, should not be based upon outward appearances alone because there are qualities which lie hidden beneath the outward form that are vital. The reason why one variety of wheat is able to withstand adverse climatic conditions better than another variety may be explained by the fact that certain qualities, which enable the plant to overcome these conditions, have been established in the course of several years of successful breeding. Improvement by breeding is not beyond the reach of the practical farmer.

IMPROVEMENT THROUGH SYSTEMATIC CROPPING.

A systematic rotation may be used to advantage in bringing about improvement in the yield of wheat. To commence with, this means diversified farming. Many arguments have been advanced in favor of a systematic plan of cropping. The feeding capacity of plants varies greatly, certain of them requiring more of one particular element than another. Some are surface feeders while others send their roots deeply into the soil. Hence the growth of a variety of plants with different capacities will have a tendency to prolong the period of profitable culture or, in other words, the fertility of the soil will be maintained for a longer period. The nitrogen found in cereal crops is obtained directly from the soil, while leguminous crops collect free nitrogen from the soil air by a particular process. Thus, if cereals are grown successively on the same piece of land, they will of necessity exhaust the nitrogen, while if legumes had been introduced the store of nitrogen could have been increased. Continuous wheat culture without the addition of any manure to the soil will exhaust the humus or decayed vegetable matter and in time the physical condition of the soil will be much impaired. Again, a systematic rotation not only affords an opportunity to make economical use of the land but it can also be used to good advantage in overcoming or eradicating noxious weeds and in preventing the increase of insect enemies and fungus diseases.

DEPTH TO SEED.

The depth of sowing will vary with the type of soil, the amount of moisture present and the condition of the seed-bed. If the quantity of moisture in the soil at the time of seeding is somewhat limited, it will be necessary to place the seed deeper in the soil than if the moisture were more abundant. Seed can be put in deeper in the case of sandy or gravelly soils than with clay soils. The condition of the seed-bed is also a determining factor, for it is evident that if the soil is in perfect tilth it will not be necessary to place the seed very deeply in the soil in order to be able to secure sufficient moisture to promote germination, but if the soil is made up of coarse particles and lumps, deeper seeding will be necessary in order to facilitate germination. Where the soil is placed in the proper condition in regard to texture, a depth of one inch will give as good results as deeper seeding.

DRILLING.

In somewhat dry sections, drilling the seed will invariably give better returns than broadcasting. In the former case a more uniform distribution is secured, hence a smaller quantity of seed will be required. In drilling, the seed is placed directly in contact with the moist earth and germination takes place quite readily, whereas, when wheat is sown broadcast a portion of the seed at least remains on the surface, and, if dry weather prevails, germination will not take place. Drilling also enables the wheat to get a firmer hold upon the soil than in the case of broadcasting. This is a very desirable condition, especially on soils that are liable to blow during the winter months.

AMOUNT OF SEED.

There are many factors which determine the quantity of seed to be used in any given season. Plants tiller more on a rich soil than on a soil in which the essential elements are limited in supply, hence a larger amount of seed should be used in the latter case. A good seed-bed will require less seed than where the field has been poorly prepared. More seed will be rquired when the wheat is put in late in the season than in the case of earlier seeding. The varity of grain as well as the size and quality of the seed are important items. The method of seeding and climate are also determining factors. The station uses from five to six pecks in seeding wheat in the regular experiments. This amount for eastern Oklahoma will give very satisfactory results.

In summing up these few paragraphs it would be safe to make the statement that if the methods which have been suggested above could be put into practice, and it is evident that they are not beyond the reach of a single farmer, the average yield for the Territory could be doubled. In place of reporting an average yield of 14.9 bushels per acre at least 30 bushels should be secured.

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