WHEAT PRODUCTION In OKLAHOMA

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Wheat in Oklahoma

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SOIL ADAPTATION

Wheat will grow on a wide range of soil types, but well drained medium- and fine-textured soils are generally considered best adapted for wheat production. Deep sandy soils, such as are found along the river valleys and in certain other areas, usually do not produce satisfactory yields of high quality wheat. These soils are better adapted to the production of sorghums and rye. Wheat tends to lodge when planted on fertile bottom lands in central and eastern Oklahoma. On such soils, corn or alfalfa will usually be more profitable.

TIME OF SEEDING

The usual time for seeding wheat in most of the hard red winter wheat area of Oklahoma is September 15 to October 15, the optimum time being about October 1. Slightly earlier seeding may be advisable when wheat is planted on land where soil blowing is a serious problem. Earlier seeding is also desirable when the wheat is to be used for fall and winter pasture.

In experimental tests conducted over a 15-year period at Woodward, highest yields of wheat were obtained from October 1 seedings. The average annual yield of 24.6 bushels from seedings made on October 1, is 1.8 bushels more than the September 15 average and 1 bushel more than the yield from October 15 seedings. The average yield from November 1 seedings was 4.6 bushels less than the October 1 seedings. The results of this test are shown in the following table:

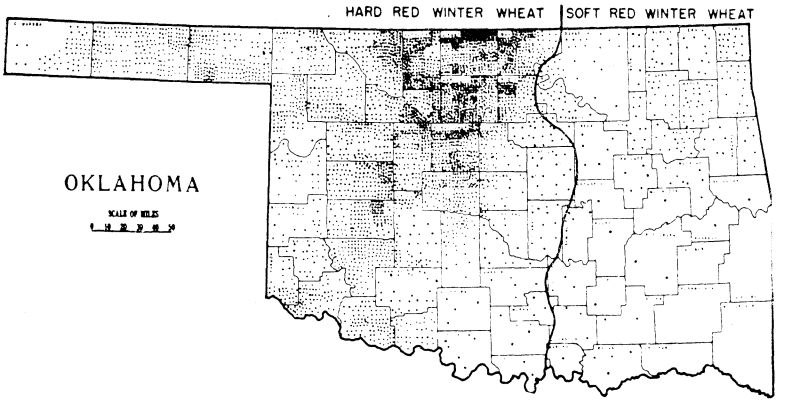

Fig. 1—Distribution of Winter Wheat in Oklahoma. (Each dot represents 1,000 acres) Oklahoma Agricultural Experiment Station.

Table 1.—Effect of Time of Seeding on Yield of Hard Red Winter Wheat, Southern Great Plains Field Station, Woodward, Okla., Average of 15 years*

Time of Seeding	Yield per Acre (Bushels)
September 15	22.8
October 1	24.6
October 15	23.6
November 1	21.0
November 15	19.7

* Unpublished data, Southern Great Plains Field Station, Woodward, Okla.

The optimum time for seeding wheat in the Panhandle seems to be about September 15, although slightly earlier seeding is practiced in seasons when moisture conditions are favorable.

In areas where wheat is likely to be damaged by hessian fly, seeding should usually be delayed until after the fall brood of insects has disappeared. Research data indicate that this will be about October 10 for north central Oklahoma and October 15 for the northeastern section.

RATE OF SEEDING

The usual rate of seeding wheat in Oklahoma varies from 5 pecks per acre in the soft winter wheat section to about 2 pecks per acre in the extreme western part of the state. Studies have been conducted at Woodward to determine the proper rate of seeding wheat in the Great Plains area. The results of these studies are given in Table 2. Yields for the 3- and 4-peck rates of seeding are nearly the same, being 23.1 bushels and 22.9 bushels per acre respectively. The 2-peck rate of seeding averaged only 0.5 bushels less than the 3-peck rate. The results of the studies indicate that the proper rate of seeding at Woodward is about 3 pecks per acre.

At Stillwater, where the average annual rainfall is somewhat higher, 4 pecks per acre seems to be about the proper rate of seeding wheat. Seeding less than 4 pecks per acre reduces the average yield, but increasing the rate of seeding to more than 4 pecks per acre usually does not increase the yield.

Table 2.—Rate of Seeding Wheat in Relation to Yield per Acre, Southern Great Plains Field Station, Woodward, Okla. 7-Yr. Av.*

Rate of Seeding (Per Acre)	Av. Yield per Acre (Bushels)
2 pecks	22.6
3 pecks	23.1
4 pecks	22.9
5 pecks	22.4

* Unpublished data, Southern Great Plains Field Station, Woodward, Okla.

METHODS OF SEEDING

Under average conditions, there seems to be no advantage in the deep furrow 14-inch row drill over the common 7- or 8-inch row drills for seeding wheat. This is indicated in preliminary tests at Stillwater and Woodward. Deep furrow drilling may have a tendency to reduce winter killing and to hold a higher percentage of snow on the land where it falls, but under certain conditions it may also encourage soil blowing. Deep furrows not on the contour tend to cause greater run-off than small furrows; if on the contour, they impound more water which may result in poor stands, particularly if heavy rains occur soon after seeding. Soil erosion and the depth to which the seed might be covered by wind and water after seeding are important factors to be considered.

PREPARING THE LAND FOR WHEAT

A good seedbed is an important factor in producing a crop of wheat. Early preparation is very essential because it favors the storage of summer rainfall and provides more time for the decay of straw and soil organic matter which increases the availability of nitrogen, phosphorus, and other plant nutrients in the soil at seeding time.

Methods of preparation vary in different parts of the state and even on different soils in the same area. The grower who knows the essential characteristics of a good seedbed for wheat can usually follow suitable methods by which the land can be properly prepared for seeding.

A good seedbed for wheat should be rough and open to permit rapid absorption of water and to control wind erosion. Beneath the surface, the soil should be firm and compact. It should be well supplied with moisture and available plant nutrients. The seedbed should also be free of weeds and volunteer small grain.

Nitrogen and phosphorus are the most important limiting factors in wheat production in the central and eastern parts of Oklahoma, while moisture is the first limiting factor in plant growth in the western part of the state. Nitrogen is made available in the soil by the action of bacteria in decomposing the organic matter. The bacteria, however, are not very active during the winter and early spring when soil temperatures are low; consequently, the rate of availability of nitrogen during this period may not be high enough to maintain a normal, thrifty growth of the wheat plants. Early seedbed preparation following harvest will result in the formation of a larger quantity of nitrates in the soil at planting time.

Phosphorus is contained largely in the soil minerals and is slowly made available for plant use as a result of weathering. About one-third of the total phosphorus is present in the soil organic matter and is released for plant use as the organic matter decays.

MOISTURE REQUIREMENTS FOR WHEAT

The water requirement of wheat is very high, and wheat yields in western Oklahoma are influenced materially by the amount of moisture in the soil at seeding time in the fall. The wheat crop makes much of its growth in late fall, winter, and early spring when there is usually very little rainfall, especially in the western part of the state. During this period, growth must depend largely upon moisture which is stored in the soil before seeding time, except in seasons when rainfall is plentiful and well distributed during the growing period. The close correlation between the yield of wheat and the depth of soil moisture at seeding time is shown

Table 3.—Effect of Depth of Moisture at Seeding Time on the Yield of Winter Wheat at Hays, Colby, and Garden City, Kansas, 1909-36, inclusive.*

Depth of Moisture at Planting Time	Percentage of Years the Crop Failed
Dry or nearly dry	71% (7 years in 10)
1 foot of moisture	34% (1 year in 3)
2 feet of moisture	14% (1 year in 7)
3 feet of moisture	10% (1 year in 10)

* Kansas Experiment Station Bulletin No. 273, Soil Moisture and Winter Wheat Production.

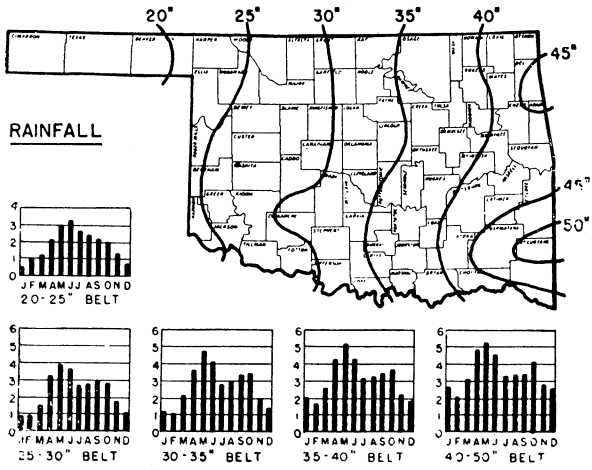

Fig. 2—The amount and distribution of rainfall is an important factor in wheat production. (The small graphs show seasonal distribution of rainfall by months) Oklahoma Agricultural Experiment Station.

in extensive studies conducted by the Kansas Experiment Station. (Table 3) In these studies, wheat planted in dry or nearly dry soils failed 71 percent of the time. When planted in soils with one foot of moisture, the crop failed 34 percent of the time, or about one year in three. Wheat planted in soil with two feet of moisture failed only one year in seven. When the moisture had penetrated to a depth of three feet at planting time, the crop failed only one year in ten.

Since water is the greatest limiting factor in wheat production in western Oklahoma, tillage practices which will contribute to maximum moisture conservation should be used. Losses of moisture are due to evaporation, run-off, and removal by weeds. Unfortunately, there is no practical means by which evaporation losses can be materially reduced. Losses due to run-off may be reduced to some extent by proper tillage practices. Tillage practices which effectively control weeds will reduce these losses to a minimum.

EARLY PLOWING INCREASES WHEAT YIELDS

Early plowing, followed by summer tillage to control weed growth has resulted in substantial increases in wheat yields. In tests conducted by the Oklahoma Agricultural Experiment Station at Stillwater, land plowed July 15 produced an average of 27.1 bushels per acre. Land plowed August 15 averaged 24.2 bushels per acre. When plowing was delayed to September 15, the average yield was only 22 bushels per acre.

Table 4.—Early Preparation Increases Wheat Yields (Oklahoma Agri. Experiment Station, Stillwater)*

Time of Plowing	Average Yield per Acre (Bushels)
July 15	27.1
August 15	24.2
September 15	22.0

* Ext. Cir. No. 412, A Soil Improvement Program for Oklahoma.

Similar results were obtained in tests which were conducted near Carrier in Garfield County. In these tests, the average yield of wheat on early plowed land was 3 bushels more per acre than on land which was plowed late. Land which was one-wayed early produced 12.8 bushels per acre compared to a yield of only 8.9 bushels for late preparation by the same method. In all cases, regardless of the implement used, early preparation of the seedbed gave higher yields of wheat.

Table 5.—Effect of Time and Method of Tillage on Yield of Winter Wheat, Carrier, Garfield Co., Okla.*

Time	Yield in Bushels per Acre		
	Plowed	One-Wayed	Listed
Early Preparation	17.7	12.8	12.8
Late Preparation	14.7	8.9	8.3

* Soil Survey, Garfield Co., 1939.

Extensive research studies in seedbed preparation for wheat have been made at the Southern Great Plains Field Station at Woodward. At this Station, land plowed in June has produced an average of 4.5 bushels more wheat per acre than land plowed August 15, and 8.8 bushels more than land plowed in October. A delay of one month in plowing the land has reduced the average yield more than 2 bushels per acre.

Table 6.—Effect of Early Tillage on Wheat Yields, Southern Great Plains Field Station, Woodward, Okla., 1922-40*

Date of Plowing	Yield of Wheat in Bushels per Acre	
	Plowed 4″ deep	One-Wayed
Early Preparation (June)	16.7	15.5
Intermediate (August 15)	12.2	13.0
Late (October)	7.9	9.5

* Tillage Practices for Wheat (mimeograph), Southern Great Plains Field Station, 1943.

In tillage tests conducted on a silty clay loam soil at Lawton, land prepared by early shallow plowing averaged 14.7 bushels per acre compared to only 13 bushels for late plowing at the same depth. Land prepared by early, deep plowing averaged 15.8 bushels per acre or 1.1 bushels more than early, shallow plowed. The results of these tests are given in the following table:

Table 7.—Effect of Different Methods of Preparation on Yield of Wheat at Lawton. Av. 22 years, 1924-45.*

Method of Seedbed Preparation	Yield per Acre (Bushels)
Late plowing, shallow (4 in.)	13.0
Early plowing, shallow (4 in.)	14.7
Early plowing, deep (8 in.)	15.8
Early listing	14.5
Discing as needed	12.0
Discing at seeding time	8.9
Alternate summer fallow	20.1

* Okla. Exp. Sta. Bul. B-295, Oklahoma Crops and Soils, 1946, p. 50.

At Granite, land plowed in July produced 2.8 bushels more wheat per acre than land plowed in August. When plowing was delayed until September the yield of wheat was 4.9 bushels less than on land plowed in July.

Table 8.—Effect of Time of Plowing on the Yield of Winter Wheat on the Reformatory Farm at Granite, Okla.*

Time of Plowing	Yield per Acre** (Bushels)
July	16.8
August	14.0
September	11.9

* Soil Survey of Greer County, Okla., 1937.
**5-year average.

METHODS OF TILLAGE

Plowing and One-Waying. Timeliness of tillage, thoroughness of weed and volunteer grain control, and keeping the surface of the soil rough and open for the absorption of maximum amounts of moisture are of greater importance than the kind of implement used. The method of preparation will depend somewhat upon the type and quantity of equipment available on the farm and the moisture content of the surface soil.

Plowing the land with a moldboard plow has usually produced slightly higher yields than one-waying, although the difference has been very small, particularly in the western part of the state. At Woodward plowing in June has produced about one bushel more wheat per acre than one-waying in June. When the land was not worked until August, one-waying has given slightly higher yields than plowing (See Table 6).

On the Experiment Station Farm near Perkins, plowing with a one-way produced an average of 17.6 bushels per acre compared to an average of 16.7 bushels on land plowed with a moldboard plow. In this test, both implements were operated at approximately the same depth. At Carrier, in Garfield County, plowing with a moldboard plow produced an average of 17.6 bushels compared to an average of 12.8 bushels on land plowed with a one-way. Shallow operation of the one-way was largely responsible for this difference in yield. These tests indicate that the moldboard plow and the one-way will give similar results when operated at approximately the same depth.

Preparation of the land by plowing and one-waying in alternate years has given slightly higher yields at Woodward than continuous use of either of these implements. One-waying two years and plowing every third year has given still greater increases in wheat yields. Varying the kind of implement used may have cer-

Table 3.--Effect of Tillage Methods on Wheat Yields, Perkins, Farm, 1941-46*

Method	Yield of Grain (Bu. per acre)	Pounds of Straw
Plowed	16.7	1907
Basin Listed	17.3	1921
One-Waved	17.6	1970
Sweeps	17.1	1955

* Unpublished data, Okla. Agri. Exp. Sta.

tain other advantages. Continuous use of the one-way tends to cause the formation of a dense subsurface layer which retards the capillary movement of water. Occasional use of the moldboard plow will avoid this danger.

Listing. Listing in June has given about the same yields as one-waying or deep plowing in June at the Woodward Station. Listing August 15 has compared favorably with plowing on the same date. At Lawton listing has produced about the same yields as plowing. At Carrier, in Garfield County, land prepared by listing yielded only 12.8 bushels per acre compared to 17.7 bushels per acre on plowed land.

Listing is most useful on sandy soils and in areas where wind erosion is a serious problem. When this method of preparation is used, the land should usually be listed in early July and the ridges cut back with a monitor as vegetation appears. This procedure leaves the straw on the surface to protect the land from wind erosion. A field cultivator can then be used to control vegetation and prepare a smooth surface for planting.

Basin Listing. The principal value of basin listing occurs during the summer. In the final preparation of the seedbed and in seeding the crop, the basins are completely destroyed. Basin listing has consistently resulted in a yield of about one bushel less wheat per acre than one-waying at the Woodward Station. On the Experiment Station Farm at Stillwater, basin listing has produced slightly lower yields than plowing or one-waying when wheat follows wheat. When sweet clover was grown in rotation with wheat, basin listing produced a yield of about one bushel more per acre than plowing and one bushel less than one-waying. Basin listing is most useful in fields where the topography of the land is so variable and uneven that contour tillage would be difficult or impractical.

Discing. Discing alone is not a satisfactory method of seedbed preparation for wheat, partly because it does not loosen the soil to a sufficient depth to permit maximum absorption of water. At Woodward sandy land prepared each year by discing has yielded

approximately 3 bushels per acre less than land prepared by plowing or one-waying. When discing is alternated with plowing or one-waying, the average annual yield of wheat is not reduced. At Lawton the 22-year average yield of 12 bushels per acre on fine-textured soil prepared by discing is 3.8 bushels less per acre than on early plowed land and 1 bushel less than on late shallow plowed land.

If the land is too dry to plow immediately after the previous crop is harvested, the disc or one-way may be used to loosen the surface soil and destroy weed growth. This will permit greater absorption and deeper penetration of moisture. The land can then be worked to the desired depth with the moldboard plow or one-way as soon as there is sufficient moisture in the soil.

SUMMER TILLAGE

For summer tillage the field cultivator, or other types of cultivators, equipped with 14- or 16-inch sweeps are excellent implements to use.

DEPTH OF TILLAGE

Depth of plowing seems to be less important than time of plowing. At Woodward land plowed to a depth of 8 inches in June has averaged 2 bushels per acre more than land plowed 4 inches deep at the same time. At Lawton early plowing 8 inches deep has produced 1.1 bushels more wheat per acre than early plowing 4 inches deep. The results of these tests indicate that there is little to be gained by plowing land for wheat deeper than is necessary to incorporate crop residues, trash, and weeds into the soil and prepare a satisfactory seedbed. The depth necessary to secure best results will vary with soil and climatic conditions but will usually not be more than 6 or 7 inches. Occasional deep plowing usually increases wheat yields, but continuous deep tillage increases the cost of seedbed preparation. As soil fertility decreases deeper tillage may be necessary, particularly in the central and eastern sections of the state.

SUBSURFACE TILLAGE

Subsurface tillage may be used on sandy soil in wind erosion areas where it is desirable to keep most of the crop residue on the surface as a protection against soil blowing. Large 30-inch sweeps attached to a tool bar carrier with rolling coulters ahead of the points to cut the trash and prevent clogging are very satisfactory for this type of cultivation.

CONTOUR TILLAGE AND PLANTING

As a means of conserving both soil and water on sloping land wheat should be seeded on the contour. At the Wheatland Conservation Experiment Station at Cherokee, terraces and contour tillage reduced the water run-off from 13.1 inches to 7.8 inches annually for the 4-year period, 1942-45. By conserving 40 percent more water, these practices increased the yield of wheat 2 bushels per acre in 1944 and 1.3 bushels in 1945.

On land subject to wind erosion, seeding in an east and west direction may be desirable in some cases to reduce the danger of soil blowing.

Fig. 3—Contour seeding of wheat conserves soil and water and increases yields.

EARLY AND THOROUGH PREPARATION OF SEEDBED IS IMPORTANT

Since the yield of winter wheat is materially increased by early seedbed preparation, this work should be started as soon as possible after the preceding crop is harvested. Early plowing to destroy weeds and loosen the soil will permit greater absorption and deeper penetration of moisture. During the summer and early fall prior to seeding time, the land should be worked often enough to control weeds and volunteer small grain and break surface crust following heavy rains to keep the surface of the soil rough and open for the absorption of water. This procedure will result in the accumulation of larger amounts of moisture, nitrates, phosphorus, and other essential plant nutrients in the soil. The land should be worked a few days before seeding time to destroy all undesirable vegetation such as weeds, cheat, and volunteer small

grain. A seedbed that is firm, moist, and well supplied with essential plant nutrients is a distinct aid to better stands, more vigorous fall growth and better winter survival.

WHEAT VARIETIES

Wheat variety recommendations are based upon data and information obtained through an extensive wheat research program which is being conducted by the Oklahoma Experiment Station in cooperation with the experiment stations at Woodward and Lawton. This work is also closely coordinated with similar research programs in the other states throughout the hard red winter wheat region. Varieties are thoroughly tested and their characteristics are carefully determined. In the tests, data on yield per acre, resistance to disease and insect injuries, test weight, resistance to lodging and shattering, and other factors are recorded. Milling and baking tests are made to determine the commercial value of varieties. In appraising each variety, all of these factors are considered. No single factor can be used as the basis for evaluating a variety.

VARIETY TESTS AT STILLWATER

Wheat variety tests have been conducted at Stillwater during the 16-year period 1931-46. The average annual yields of 14 varieties grown during part or all of this period are shown in the following table:

Of the four varieties, Cheyenne, Kharkof, Tenmarq, and Early Blackhull, which were grown during the entire period, Cheyenne produced the highest yield, exceeding Kharkof (Turkey) by 1.6

Table 10.—Average Annual Yields of Wheat Varieties at the Oklahoma Agricultural Experiment Station, Stillwater*

Variety	No. Yrs. Grown	Ave. Annual Yield (Bu. per A.)	% of Kharkof Same Yrs.
Cheyenne	16	27.2	106
Kharkof	16	25.6	100
Tenmarq	16	25.3	99
Early Blackhull	16	23.1	90
Turkey	15	24.5	95
Blackhull	15	26.5	99
Chiefkan	10	23.8	100
Pawnee	8	28.7	124
Comanche	8	27.5	120
Red Chief	5	21.8	110
Reliant	4	23.7	125
Triumph	4	21.8	115
Wichita	3	18.1	80
Westar	2	22.1	113

* Oklahoma Exp. Sta. Bul. B-297, Winter Wheat Varieties for Oklahoma.

bushels per acre and Tenmarq by 1.9 bushels. The yields of Kharkof and Tenmarq were 25.6 and 25.3 bushels per acre respectively. Early Blackhull yielded 2.2 bushels per acre less than Tenmarq and 4.1 bushels less than Cheyenne.

Although Pawnee and Comanche have been tested only 8 years, these varieties show a decided advantage in yield over the standard varieties Cheyenne, Tenmarq, and Kharkof. For the 8-year period 1939-46, the yields of Pawnee and Comanche were 28.8 and 27.5 bushels respectively. For the same period Cheyenne averaged 26.4 bushels, Kharkof 23 bushels, Tenmarq 22.1 bushels, and Chiefkan 23.3 bushels per acre. In five of the seven years, Red Chief averaged only 21.8 bushels per acre. Chiefkan, Red Chief and Early Blackhull are inferior in milling and baking characteristics.

Fig. 4—A field of Comanche wheat.

VARIETY TESTS AT WOODWARD

The results of the variety tests which have been conducted at Woodward during the 9-year period 1939-46 are shown in Table 11. Of the varieties included in this test, Pawnee and Comanche are most promising. For the 9 years, Pawnee averaged 38.5 bushels per acre and Comanche averaged 36.2 bushels per acre. In the same period the average yields of Cheyenne and Tenmarq were 33.9 and 33.5 bushels per acre respectively. Chiefkan averaged 5.4 bushels per acre less than Pawnee and 3.1 bushels per acre less than

Comanche. Early Blackhull averaged 8.5 bushels less than Pawnee and 6.2 bushels less than Comanche. In the 5 years, 1942-46, Red Chief averaged 35.9 bushels per acre. In the same years, Comanche averaged 36.9 bushels; Pawnee, 36.5 bushels; Cheyenne, 35.7 bushels; and Chiefkan, 32.1 bushels per acre.

Fig. 5—A field of Pawnee wheat

VARIETY TESTS AT LAWTON

The wheat variety tests which have been conducted at Lawton are of particular value in determining the adaptation of varieties in southwestern Oklahoma. The results of these tests are shown in Table 12.

Table II.—Average Annual Yield of Nine Varieties of Winter Wheat for the Period 1938-46, Southern Great Plains Field Station, Woodward*

Variety	No. Yrs. Grown	Ave. Annual Yield (Bu. per A.)	% of Kharkof SameYrs.
Pawnee	9	38.5	128
Comanche	9	36.2	121
Cheyenne	9	33.9	113
Tenmarq	9	33.5	112
Chiefkan	9	33.1	110
Blackhull	9	30.6	102
Turkey	9	30.4	101
Kharkof	9	30.0	100
Early Blackhull	9	30.0	100

* Unpublished data, Southern Great Plains Field Station, Woodward, Okla.

Of the varieties which have been tested 12 years or longer, Cheyenne and Tenmarq have given the highest average yields. Blackhull and Early Blackhull have averaged 1 bushel per acre less than Cheyenne. Turkey has averaged only 21 bushels per acre, or 16 percent less than Cheyenne. The newer varieties included in the test are Comanche, Pawnee, Chiefkan, Red Chief, Wichita, and Westar. The 7-year average yield of Comanche was 1.2 bushels per acre higher than Pawnee and 2.4 bushels more than Tenmarq. Chiefkan has averaged 5.3 bushels per acre less than Comanche and 2.9 bushels per acre less than Tenmarq during 7 comparable years. Red Chief averaged 7 bushels per acre less than Comanche and 4 bushels less than Tenmarq over a 4-year period. Chiefkan and Red Chief are inferior in baking characteristics. Wichita out-

Table 12.—Average Annual Yields of Wheat Varieties at the U. S. Field Station, Lawton*

Variety	No. Yrs. Grown	Ave. Annual Yield (Bu. per A.)	% of Tenmarq Same Yrs.
Tenmarq	13	24.9	100
Kanred	13	24.4	98
Cheyenne	12	25.0	96
Early Blackhull	12	23.9	94
Blackhull	12	24.0	92
Kharkof	12	23.5	91
Turkey	10	21.0	89
Chiefkan	8	22.7	90
Comanche	7	26.3	110
Pawnee	7	25.1	105
Wichita	5	29.1	110
Westar	2	32.4	119
Red Chief	4	22.4	85

* Oklahoma Experiment Station Bul. B-297. Winter Wheat Varieties for Okla.

yielded Tenmarq 2.6 bushels per acre during the 5 years 1941-45. Westar, included in the test only 2 years, averaged 1.4 bushels per acre less than Comanche in the same period.

A comparison of the grain yields of 8 varieties at each of the three stations is shown in Table 13.

Table 13.—Average Grain Yields in Bushels per Acre of Eight Hard Red Winter Wheat Varieties Grown Uniformly at Three Oklahoma Stations During All or a Part of the Period 1938-46.*

Variety	Lawton 1940-44	Stillwater 1939-46	Woodward 1938-46	Weighted Average (22 station-years)
Pawnee	26.5	28.8	38.5	32.2
Comanche	28.4	27.5	36.2	31.2
Cheyenne	25.1	26.4	33.9	29.2
Tenmarq	27.4	22.1	33.5	28.0
Blackhull	22.9	25.9	30.6	27.1
Early Blackhull	26.2	23.8	30.0	26.9
Chiefkan	22.9	23.3	33.1	27.1
Kharkof	21.9	23.0	30.0	24.1

* Revision of Table 8.—Oklahoma Exp. Sta. Bul. B-297, Winter Wheat Varieties for Oklahoma.

A weighted average, based on the average yields of each variety at the three stations, is also shown. Pawnee was highest in average grain yield at Stillwater and Woodward, but third at Lawton. Comanche was first in grain yield at Lawton and averaged only 1.0 bushels per acre less than Pawnee for the three stations. Cheyenne ranked third for all three stations, averaging 3.0 bushels per acre less than Pawnee and 2.0 bushels less than Comanche. Tenmarq ranked fourth for the three stations but was second at Lawton. Blackhull and Early Blackhull ranked fifth and sixth respectively at the three stations. The average yield of Chiefkan was 5.1 bushels per acre less than that of Pawnee and 4.1 bushels less than Comanche.

SOFT WINTER WHEATS

The soft red winter wheats which are grown in northeast Oklahoma comprise only about 5.5 percent of the total wheat acreage in the state. The results of soft wheat variety tests conducted at Stillwater are given in Table 14. Of the recommended varieties, Clarkan and Fulcaster have given the highest yields.

Table 14.—Average Annual Yields of Soft Red Winter Wheat Varieties at the Oklahoma Agricultural Experiment Station, Stillwater*

Variety	No. Yrs. Tested	Yield (Bu. per A.)	% of Kharkof Same Yrs
Denton	15	26.2	101
Kawvale	15	25.8	99
Harvest Queen	13	22.0	84
Fulcaster	11	24.7	89
Penquite	10	30.5	103
Clarkan	11	25.3	102

* Oklahoma Experiment Sta. Bul. B-297, Winter Wheat Varieties for Oklahoma.

WHEAT VARIETY RECOMMENDATIONS

Wheat variety recommendations are based on yield per acre, resistance to disease and insect damages, resistance to lodging, nonshattering, milling and baking characteristics, and other factors which affect the desirability of a variety from the standpoint of the grower, the miller, and the baker. The following varieties are recommended for Oklahoma:

A. For the hard red winter wheat area—
Comanche, Pawnee, Cheyenne, Tenmarq, Turkey and Triumph*

B. For the soft red winter wheat area—
Clarkan and Fulcaster

TEST WEIGHT PER BUSHEL

The average test weights per bushel of 10 varieties at Stillwater, Woodward, and Lawton are shown in Table 15. At Stillwater, the varieties Cheyenne, Comanche, and Pawnee have about the

Table 15.—Average Test Weight of Wheat Varieties Grown at Different Locations in the State.
Test Weight per Bushel

	Stillwater	Woodward	Lawton
Variety	1939-46	1941-46	1941-45
Blackhull	58.9	62.1	60.1
Kharkof	57.1	58.7	57.8
Early Blackhull	60.1	61.1	61.5*
Cheyenne	58.0	61.1	60.0
Tenmarq	58.1	60.3	57.8
Chiefkan	58.9**	60.5	60.2
Comanche	57.8	61.0	59.6
Pawnee	58.0	61.9	59.1

* 4-yr. average, 1941-44.
** Average of 7 yrs., 1942 omitted.

* The recommended varieties are not necessarily in the order of preference.

test weight. Early Blackhull and Chiefkan have higher test weights, but these varieties are inferior in milling and baking characteristics. Tenmarq averages 2 pounds lighter than Cheyenne. At Woodward, Pawnee, Blackhull, and Wichita have averaged 62 pounds in test weight per bushel. Cheyenne and Comanche have averaged 61 pounds per bushel while Tenmarq has averaged 60 pounds per bushel. Of the recommended varieties tested at Lawton Cheyenne has the highest test weight, with Comanche and Pawnee ranking second and third respectively.

MILLING AND BAKING CHARACTERISTICS OF WHEATS

The commercial value of a variety of wheat depends primarily upon its milling and baking characteristics. Hard red winter wheats containing a relatively high percentage of protein and which produce good yields of creamy white flour with a strong gluten are desired by the commercial trade. The protein content of wheat depends more upon soil fertility and climatic conditions than on varietal differences. The quality of the protein or gluten strength is primarily a heredity factor, and to a large extent, is a matter of varietal difference. Gluten strength is important to the baker since it determines the mixing qualities of the dough, size of the loaf, and the texture and quality of the bread. Bakers prefer flours capable of producing large loaves with good texture and quality of crumb.

The milling and baking characteristics of wheat varieties grown in Oklahoma are given along with the variety description on pages 20,21, 22, 23.

CERTIFIED SEED

The importance of planting high quality seed of adapted recommended varieties cannot be overestimated. Certified seed is the best class of seed available for general distribution. It is produced from approved seed stocks of known origin and is grown by farmers who specialize in the production of high quality planting seed. The fields are inspected to determine the condition of the crop with respect to purity, freedom from disease, objectionable weeds, and other factors which affect the desirability of the seed for planting purposes. The harvested seed is tested for germination and purity. Planting certified or registered seed is the farmer's best assurance that he is getting good seed of a desirable variety.

DESCRIPTION OF VARIETIES

The varieties described below include those which are grown extensively in Oklahoma, together with new varieties which are being tested in the state at the present time.

Recommended Varieties of Hard Winter Wheat

COMANCHE was selected from an Oro x Tenmarq cross and was released in Kansas in 1942. It is a bearded, medium early, moderately winter-hardy, hard red winter wheat. It has a fairly stiff straw and a good test weight. The variety is susceptible to loose smut and to many forms of bunt. It is also susceptible to leaf rust but is not seriously injured by stem rust. Comanche is susceptible to hessian fly damage. The milling and baking characteristics are similar to those of Tenmarq.

PAWNEE, first distributed in Nebraska in the fall of 1942, was selected from a Kawvale x Tenmarq cross made by the Kansas Experiment Station. It is a hard red winter wheat with white glumes and a short stiff straw. Pawnee is 2 to 4 days earlier than Tenmarq and has considerable resistance and tolerance of hessian fly. It has very high resistance to loose smut and moderate resistance to bunt or stinking smut. It has some resistance to certain races of leaf rust, but is very susceptible to the races of this disease which are most prevalent in Oklahoma at the present time. Pawnee either has some resistance to stem rust or may escape severe damage because of earliness. It has a slight tendency to shatter when ripe, but this is usually not of a serious nature. While Pawnee is not outstanding in quality, its milling and baking characteristics are slightly better than those of Blackhull and nearly equal to Turkey.

CHEYENNE was developed from a Crimean selection made at the Nebraska Agricultural Experiment Station 1922. The variety has very stiff straw and short erect heads. It stools vigorously, is slightly more winter-hardy than Turkey, and does not shatter easily. The variety is bearded and the glumes are white in color. The red kernels are hard in texture, but the protein content of the grain is slightly lower than in other varieties. Cheyenne is susceptible to leaf and stem rusts and to bunt and loose smuts but is tolerant of hessian fly. It is intermediate in milling and baking quality but is acceptable to the trade. The dough requires a longer mixing period than that of Turkey, but if properly mixed, it is satisfactory for baking.

TENMARQ is the result of a cross between Marquis, a hard spring wheat of superior milling and baking quality, and a selection from Crimean, which is a winter wheat. The variety was developed by the Kansas Experiment Station and distributed in that state in 1932. It is bearded, has a white chaff, and has short plump kernels. Tenmarq is less winter-hardy than Turkey, but has stiffer straw and is 3 to 5 days earlier than Turkey. It is susceptible to hessian fly damage, and to loose and bunt smuts. The variety is susceptible to leaf rust but because of its earliness it may escape serious damage from stem rust. The milling and baking character-

istics of Tenmarq are satisfactory to the trade. Tenmarq flour produces a bread of desirable quality but the dough requires a relatively long mixing time. The chief objections to the variety are its tendency to produce yellow kernels and its low test weight. It occupied 40.3 percent of the total wheat acreage in the state in 1944.

TURKEY is the name applied to the Crimean group of hard red winter wheats grown in the United States. It is not a pure variety but is composed of many hard red winter wheat types which are similar in appearance and habits of growth. Turkey was introduced into the United States in 1873 from Russia by a group of immigrants. It is bearded, has a white chaff, and produces a hard red grain. The variety is susceptible to loose and bunt smuts, and to both leaf and stem rusts. It is very winter-hardy and is midseason in maturity. Turkey has excellent milling and baking qualities and is usually regarded as the standard for comparison of the hard red winter wheats in this respect.

TRIUMPH was developed by Joseph Danne of El Reno, Oklahoma, and distributed about 1940. It is an early maturing, bearded, stiff-strawed, hard red winter wheat. It is susceptible to leaf rust, and is susceptible to stem rust and bunt smut but has some resistance to loose smut. Triumph seems to have desirable milling and baking qualities.

Recommended Varieties of Soft Winter Wheat

CLARKAN, a soft red winter wheat, was developed by Earl G. Clark of Sedgwick, Kansas, from a natural hybird found in a field of Blackhull. It is believed to have been a Blackhull x Harvest Queen cross. The variety is beardless and has white glumes that sometimes develop faint black stripes. Clarkan is slightly less winter hardy than Fulcaster. It is very susceptible to loose and bunt smuts and is susceptible to leaf and stem rusts. The grain is higher in test weight than most soft wheat varieties, but the flour yield is not as high as the test weight would indicate. Clarkan has been one of the highest yielding soft red winter wheat varieties in Kansas, Oklahoma, and Missouri.

FULCASTER was selected from a Fultz-Lancaster cross by S. M. Schindel in Maryland in 1866. It has long been one of the popular and widely grown varieties of soft winter wheat in the United States, and in 1944 it was the leading variety of this class of wheats in Oklahoma. Fulcaster is bearded, has purple straw and white glumes with prominent orange-colored stripes. It is very winter-hardy, but its weak straw and its tendency to shatter make it unsuitable for combine harvesting. It has desirable milling and baking qualities. Although not outstanding in yield, Fulcaster is a good average variety.

Varieties Not Recommended

BLACKHULL is a bearded hard red winter wheat. In most seasons, the glumes develop black stripes which serve as an easy means of identification. The kernels are dark in color, medium large, and semihard to hard in texture. It has a high test weight, but the flour yield is relatively low. Blackhull is earlier than Turkey and is distinctly less winter-hardy. Lodging, particularly in wet seasons, is often of a serious nature. Blackhull is susceptible to leaf and stem rusts and to stinking smuts. The variety produces a weaker flour and is less desirable in milling and baking than Turkey and Tenmarq.

CHIEFKAN is a beardless black-glumed, hard red winter wheat. It probably originates from a natural cross between Blackhull and Harvest Queen. It is mid-season in maturity and is less winter-hardy than Turkey. Chiefkan is very susceptible to bunt and loose smuts and is susceptible to both stem and leaf rusts. The grain is dark red in color and has a high test weight. It mills satisfactorily, but the dough will not stand long mixing and is generally unsatisfactory to the trade. Baking tests indicate that in loaf volume and general characteristics bread baked from Chiefkan flour is inferior to that of Blackhull.

EARLY BLACKHULL was selected from a field of Blackhull in 1921. It is about one week earlier than Blackhull and has a shorter straw. The variety has some resistance to loose smut but is susceptible to bunt. It is also susceptible to leaf and stem rusts and to hessian fly injury. The grain is high in test weight, but the flour is poorer in baking quality than that of Blackhull. Early Blackhull is regarded as unsatisfactory to the milling and baking industry.

RED CHIEF was distributed in 1940. It is a beardless, red glumed, hard red winter wheat. The exact origin of the variety is not known, but it may be a selection from a natural Redhull x Chiefkan hybird. It has little or no resistance to disease and is actually more susceptible to bunt smut than Chiefkan. The grain is dark red in color and has a high test weight. In loaf volume and quality of the baked bread, Red Chief is similar to Chiefkan and is not satisfactory to the milling and baking industry.

WICHITA is a very early maturing variety of hard red winter wheat. It was selected from an Early Blackhull x Tenmarq cross. It has a weak straw and matures one to two days later than Early Blackhull. The variety has a higher average yield and has more desirable milling and baking characteristics than Early Blackhull. On the basis of preliminary data the variety is not recommended for Oklahoma.

KAWVALE was selected from Indian Swamp wheat and distributed in 1929. It is usually classed as a soft winter wheat, although the kernels are dark red and semihard. The variety has awned heads, white glumes, and purple colored strong straw. It is highly resistant to leaf rust and loose smut, has considerable resistance to stem rusts but is suspectible to bunt smut. It is resistant to hessian fly but is very susceptible to shattering. Kawvale is a high yielding variety, but some difficulty is caused in grading the grain since it is intermediate in texture and cannot be classed either as a soft or a hard wheat. It mills more like a hard than a soft wheat, and its baking qualities are objectionable to the trade.

HARVEST QUEEN is a soft red winter wheat, the origin of which is not definitely known. The variety is beardless, has white glumes, dull red kernels, and tall bright colored strong straw. It is susceptible to bunt and loose smuts and to leaf and stem rusts. Harvest Queen has good milling and baking qualities but is not outstanding in grain yield.

CURRELL was selected from a field of Fultz in 1881. It is beardless, has brown glumes, and purple colored straw. The variety is susceptible to loose and bunt smuts, susceptible to stem rust but has some resistance to leaf rust.

New Varieties Being Tested

RELIANT was developed by Joseph Danne, a farmer living near El Reno, Oklahoma, and first distributed in 1940. It is a bearded, white-glumed, hard red winter wheat maturing about the same time as Turkey. Reliant is susceptible to loose and bunt smuts and to stem rust but shows some resistance to leaf rust. Preliminary tests indicate that it has acceptable milling and baking characteristics. A longer testing period will be required in order to satisfactorily evaluate the variety.

WESTAR was selected, increased, and distributed by the Texas Agricultural Experiment Station. The variety was developed for the Panhandle of Texas. In plant characteristics it is similar to Comanche and Tenmarq and is reported to have satisfactory milling and baking qualities. It is reported to be resistant to leaf rust but susceptible to stem rust. Westar has been tested under Oklahoma conditions only two years, and a longer period of testing will be required before the variety can be satisfactorily evaluated.

WINTER SURVIVAL

Winter survival of wheat is affected by the inherent winterhardiness of the variety and the cultural practices which are followed in preparing the land and seeding the crop.

Turkey and Cheyenne are the most winter-hardy varieties of hard red winter wheat grown in Oklahoma. Tenmarq, Comanche, Blackhull, Early Blackhull, Chiefkan, and Red Chief are less winter-hardy than Turkey. Pawnee is slightly less winter-hardy than Turkey, but is superior to Tenmarq and Comanche in this respect.

Early and thorough preparation of the seedbed and seeding in a firm, moist soil provide conditions favorable for more uniform germination and rapid growth of the young wheat plants which increases winter survival. On phosphorus-deficient soils in eastern Oklahoma, phosphate fertilization will stimulate greater root development which reduces the danger of winterkilling.

FERTILIZERS FOR WHEAT

Commercial fertilizer, properly used, will increase the yield and improve the quality of wheat on prairie soils in central and eastern Oklahoma. Phosphorus increases the yield but tends to lower the protein content of the grain. Phosphorus also stimulates early fall growth, increases root development, and reduces the danger of winterkilling. Nitrogen increases the protein content of the grain. An excess of nitrogen delays maturity and may cause shriveled kernels.

Fig. 6—Superphosphate applied at the rate of 150 pounds per acre increases the yield of wheat from 15.2 bushels to 21.4 bushels per acre (10-year average).

On dark colored soils containing a sufficient amount of nitrogen to produce a good growth of straw, superphosphate can be used to increase the yield of wheat when moisture is not a limiting factor in plant development. The rate of application may vary from 100 to 200 pounds per acre, depending upon the fertility of the soil. On light colored soils which are low in organic matter, a mixed fertilizer containing nitrogen, will increase the rate of plant growth which may be important when the crop is to be used for winter and early spring pasture. A 2-12-6 or 4-12-4 fertilizer is suitable for this purpose.

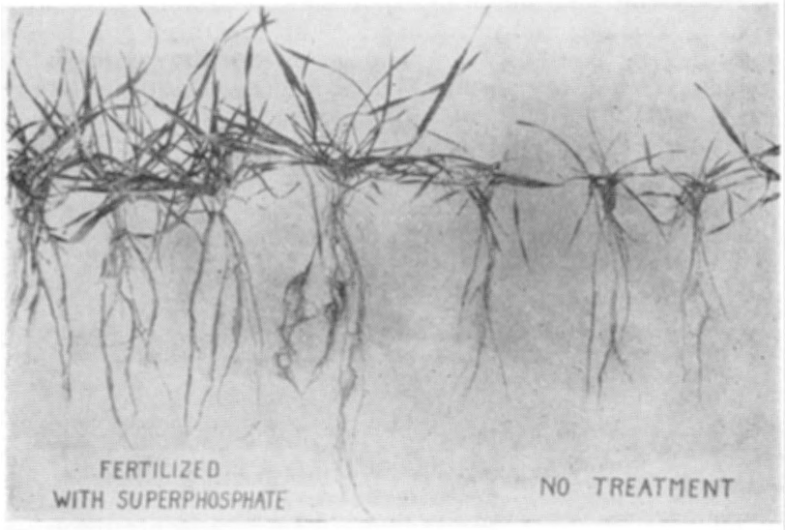

Fig. 7—Superphosphate increases the root development of wheat plants.

When phosphate fertilizer is used to secure higher yields of wheat, the soil should have an adequate supply of nitrogen to maintain a high percentage of protein in the grain. Phosphate fertilization may utilize soil nitrogen more efficiently, but yields will eventually decrease, and the protein content of the grain will also decrease unless some additional soil improvement practices are used. It is advisable to grow wheat in rotation with adapted legumes to maintain a good supply of organic matter and nitrogen in the soil. Agricultural limestone and phosphate fertilizer will be needed on many prairie soils to secure a good growth of the legume.*

* Okla. Exp. Sta. Bul. No. B-298. Wide Row Planting of Small Grains to Establish Sweet Clover and Lespedeza.

ROTATION SYSTEMS FOR WHEAT

Much of the land normally planted to wheat in [illegible] eastern Oklahoma is rapidly becoming deficient in [illegible] and organic matter. Phosphorus is also an important limiting factor in wheat production on prairie soils in eastern Oklahoma. Adequate quantities of available phosphorus and nitrogen in the soil are necessary to maintain good yields of high quality wheat. Phosphorus can be supplied in the form of phosphate fertilizer, but legume rotations are needed to provide nitrogen and organic matter for soil improvement.

Sweet clover is the most important legume for soil improvement in Oklahoma and rotations which include this legume should constitute the basis for maintaining soil fertility in the wheat producing section of the state. Other legumes which may be used in rotations with wheat are alfalfa and Austrian winter peas. Korean lespedeza may be used in the eastern part of the state.

In addition to maintaining soil fertility, a good crop rotation system aids in the control of harmful insects and destructive plant diseases. It also aids in the control of weeds, especially annuals, such as cheat, dodder, and field sorrel.

Fig. 8—Sweet Clover Increases Wheat Yields. Wheat grown continuously on the same land in Logan Co. averaged 16.2 bu. per acre. Wheat grown in rotation with sweet clover averaged 30.6 bu. per acre.

Rotation studies conducted by the Oklahoma Experiment Station indicate that wheat yields can be materially increased by growing wheat in rotation with legumes. At Stillwater wheat grown in rotation with sweet clover has averaged more than 20

bushels per acre over a period of 15 years. Wheat grown on the same land each year has averaged less than 14 bushels per acre. Wheat yields were increased from 16.6 bushels per acre to 24.4 bushels per acre by growing wheat in rotation with Austrian winter peas. At Carrier in Garfield County the yield of wheat was increased from 20 bushels to 42 bushels per acre following Austrian winter peas. The results of these tests are shown in Tables 16 and 17.

Fig. 9—Growing Wheat in Rotation with Austrian Winter Peas in Garfield County.

Table 16.—Effect of Sweet Clover on Yield of Wheat*

Treatment	Yield in Bushels per Acre Stillwater	Guthrie
Wheat (continuous)	13.8	16.2
Wheat following sweet clover (with lime and phosphate)	20.5	30.6

* Unpublished data, Oklahoma Agricultural Experiment Station.

Table 17.—Effect of Austrian Winter Peas on Yield of Wheat*

Treatment	Yield in Bushels per Acre	
	Stillwater	Carrier
Wheat (continuous)	16.6	20.0
Wheat following Austrian winter peas	24.4	42.0

* Unpublished data, Oklahoma Agricultural Experiment Station.

The following wheat-legume rotations are suggested for the main wheat producing section of the state:

Upland in central Oklahoma—

1. Oats or barley, sweet clover
   Sweet clover
   Wheat
   Wheat
   Wheat
2. Austrian winter peas, 1 year
   Wheat, 3 years

Bottom land and deep upland soils in central and eastern Oklahoma—

1. Alfalfa, 4 years
   Corn or sorghum, 1 year
   Oats, 1 year
   Wheat, 2 years
2. Oats
   Sweet clover
   Wheat
   Corn or sorghum
3. Also the wheat-sweet clover rotation mentioned above.

Sandy soils in central Oklahoma—

1. Hairy vetch, 1 year*
   Wheat, 2 years

Upland soils in eastern Oklahoma—

1. Spring oats, and lespedeza, 2 years
   Wheat, 2 years

Sweet clover should be planted with oats or winter barley as a nurse crop. The small grain should be planted in 14- or 16-inch rows to provide a more favorable condition for the development of the young sweet clover plants. This can be done by closing alternate holes in the seed box of the drill. The sweet clover should be drilled or broadcast in February or early March.

* If a large amount of vetch appears in the wheat, it can be separated with a spiral cleaner.

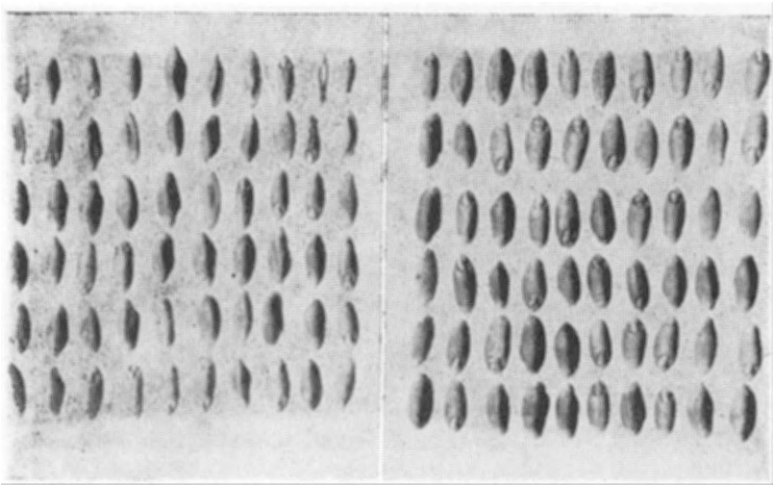

Fig. 10—Maintaining a good supply of organic matter and nitrogen in the soil increases the yield and improves the quality of wheat. The shriveled kernels (left) were grown on soil which was deficient in nitrogen. The large plump kernels (right) were grown on the same land following Austrian winter peas.

Sweet clover and Austrian winter peas require a soil which is well supplied with lime and phosphorus for successful growth. The soil should be tested for lime and phosphate deficiencies, and these minerals should be applied if needed. Lime should be spread evenly over the surface of the land and thoroughly mixed with the plowed layer of soil. The fertilizer should be drilled in the row with the seed at the time it is planted. If a fertilizer drill is not available, the fertilizer may be broadcast and disced into the soil before planting.

Management of Wheat Following Sweet Clover

In regions of moderate or low rainfall, excessive amounts of readily available nitrogen in the soil may cause injury to wheat by stimulating a growth that the moisture is incapable of maintaining to maturity. In central and western Oklahoma wheat following sweet clover will require careful management to avoid injury from the large amount of nitrogen which the sweet clover adds to the soil. Tillage methods which leave part of the sweet clover residues on the surface of the soil will reduce the amount of nitrogen which would otherwise be available the first year. In some cases, heavy vegetative growth may be controlled by late planting. Drilling the wheat in 14- or 16-inch rows will bring about a better balance between the number of plants per acre and the available

Fig. 11—Sweet clover may be planted with small grain drilled in 14-16-inch rows as a nurse crop. The sweet clover plants are making agood start between the 14-inch rows of wheat on the left. Only a few plants have developed between the 7-inch rows on the right. (Oklahoma Agricultural Experiment Station, Stillwater.)

moisture, especially during seasons when rainfall or soil moisture is low as the crop approaches maturity. Experiments show that this method of seeding will not materially reduce the yield of wheat under normal conditions. If excessive growth develops, fall and spring pasturing may be advisable.

Cropping Systems in the High Plains Area

In the Panhandle area regular rotation systems which include legumes are not practicable because of the low average annual rainfall. Fallowing is generally advisable because it permits an increase in the amount of available water and plant nutrients in the soil during the fallow period. Fallowing in alternate years is considered a good practice in the western part of the Panhandle. This system is followed regularly by many farmers in that area. In the eastern part of the Panhandle area, fallowing the land every third or fourth year is a good practice. A 3-year rotation of wheat, sorghums ,and fallow may be used on medium- and fine-textured soils where wind erosion is not a serious problem. The sorghums should follow the wheat in the rotation. The fallowing period should begin the following spring as vegetation appears and after the danger of wind erosion is past.

If the grower wishes to take full advantage of soil moisture for wheat production, a flexible cropping system may be used. Wheat may be planted each year when there is sufficient moisture in the soil and an adequate amount of crop residues on or near the surface to prevent soil blowing. If conditions are unfavorable for seeding wheat or if the wheat fails, the land should be contour listed or cultivated with some implement which will leave a rough, uneven surface to reduce the danger of wind erosion. Sorghums may be planted the following season, after which the land should be fallowed one year and again seeded to wheat.

Cropping systems which include fallow are not recommended in the eastern part of the Great Plains Area since the yield of wheat following a year of fallow have been only slightly higher than when wheat is grown continuously. On medium- and fine-textured soils wheat may follow wheat when there is sufficient moisture in the soil at planting time. If conditions are unfavorable for seeding wheat, oats or spring barley may be planted in the spring, or if a summer crop is preferred, sorghums, mungbeans, or tepary beans may be planted.

INSECTS INJURIOUS TO WHEAT

The principal insect enemies of wheat in Oklahoma are the hessian fly, green bug, chinch bug, army worm, army cutworm, wireworm, and false wireworm.

Hessian Fly

The hessian fly occurs mainly in north central and northeastern Oklahoma. In some years it causes severe damage to the wheat crop in those areas. Early plowing of the land, particularly if it is wheat stubble, will cover and destroy large numbers of the fly while in the flaxceed stage. Timely surface tillage during the summer and fall will prevent the growth of volunteer wheat and, thus, eliminate the food supply for the flies remaining. Seeding of wheat should be delayed until after the fall brood has disappeared. This will usually be about October 10 in eastern Oklahoma.

The Green Bug

Green bug injury to wheat and other small grains is usually noticed in the fall and winter. It is characterized by more or less circular spots or areas in fields in which the plants have been killed or severely injured. In some cases the infestation becomes general and the typical brownish spots many not develop.

The green bug attacks all small grain, barley and spring oats being most susceptible. Mild dry winters, followed by cold dry backward spring weather, are most favorable to green bug infestations. Because of the migratory habit of the insect, control

measures are not usually effective. When wheat fields have become so heavily infested as to make profitable crops unlikely, the field may be pastured to secure some return from the crop. Since green bug infestations develop rapidly, most good will be secured by turning in as many animals as possible. It is usually advisable to plow up heavily infested fields or portions of fields and plant some other crop.

Parasitic enemies of the green bug, which are always present, become active on warm, sunny days when the temperature is above 65 degrees. If favorable weather continues, the parasites will usually check the green bug infestations. Warm weather and an abundance of soil moisture which are conducive to rapid, vigorous growth of the small grain plants also aid in control.

Chinch Bug

The chinch bug sometimes attacks wheat in the fall killing the plants in large areas and causing considerable damage. Chinch bugs are also frequently found in wheat fields in the spring and they may cause some damage to the crop at this time.

There is no effective control for chinch bugs when they are in wheat. Since the chinch bug attacks corn, sorghums, wheat, barley, and oats, in addition to wheat, the control of this insect should be considered in relation to all susceptible crops grown on the farm. Complete directions for chinch bug control are given in Oklahoma Extension Circular No. 369.

Army Worm

The army worm is a serious pest on wheat, barley, corn, and sorghums in some years. Damage to wheat usually occurs about the time it is heading. The worms feed first on the leaves after which they may also feed on the heads. Wheat fields can be protected from army worm damage by scattering poisoned bait. A good mixture to use consists of 100 pounds of wheat bran, 2 quarts of sodium arsenite, and 10 to 12 gallons of water. The bait should be scattered late in the afternoon or very early in the morning.

Army Cutworm

The army cutworm attacks the young wheat plants in the spring and may destroy entire fields of wheat in 2 or 3 days. The insects also attack other small grains, alfalfa, and vegetables. Army cutworms can be controlled by using the poison bran mash recommended for control of army worms.

Wireworms and False Wireworms

Wireworms and false wireworms cause some damage to wheat in the High Plains Area. The insects may feed on the wheat kernels before they germinate and on the tender seedlings. Damage is most likely to occur when wheat is seeded in loose dry soil. Seeding in a firm, moist soil promotes rapid germination and seedling growth and reduces the danger of wireworm injury. In the Panhandle fallowing the land in alternate years aids in the control of wireworms.

Other Insects

In some years white grubs cause serious damage to wheat by destroying the roots and killing the plants. Damage from the insect is first noticed in the fall and is indicated by patches of dead and dying plants. The white grub is found throughout Oklahoma, but most serious injury occurs in the western part of the state, particularly on land where wheat is grown continuously. The insect can usually be controlled by growing wheat in rotation with crops other than cotton and soybeans.

The red spider occasionally does some damage to wheat in the southwestern and northwestern parts of the state. Damage from this insect usually occurs in the fall and is most serious in dry seasons when there is not sufficient soil moisture to enable the young wheat plants to make normal growth. Early seedbed preparation and complete turning under all crop residues are the most effective means of control.

Grasshoppers sometime cause damage to wheat in the fall by feeding on the young wheat plants around the edges of fields. If the damage becomes severe, the insects can be controlled by the use of poison bran mash.

DISEASES OF WHEAT

The most important diseases of wheat in Oklahoma are leaf rust, stem rust or black stem rust, bunt or covered smut, loose smut, and foot rot or root rot.

Leaf Rust

Leaf rust, also known as orange leaf rust, is the most destructive wheat disease in Oklahoma. It appears on the leaves in powdery masses of bright, orange-colored spores, after which the leaves may die. When severe attacks occur early in the season, the yield will usually be reduced and the grain may be light in weight. Leaf rust is prevalent throughout the wheat producing section of the state nearly every year. It sometimes occurs in the fall, especially on early sown wheat, damaging the leaves and weakening the vitality of the wheat plants. Development of the disease in the

spring is especially favored by mild winters and cool, damp early spring weather.

Seed treatment is not effective in the control of leaf rust. The only means of control is the inherent resistance in wheat plants. None of the varieties of wheat recommended in Oklahoma are resistant to the races of leaf rust which are most prevalent in the state at the present time.

Stem Rust

Stem rust, also known as black stem rust, first appears in dark red masses of powdery spores, mainly on the stems of the wheat plants. The disease soon reaches the black-spore stage, giving the stems a black and roughened appearance. Severe outbreaks of the disease result in shriveled kernels and greatly reduced yields. Fortunately, stem rust occurs rather infrequently in Oklahoma, and the disease usually does not cause severe damage in the state.

There is no direct means of control for stem rust. Seed treatment is not effective. Of the recommended varieties of hard red winter wheat, Comanche, Pawnee, and Tenmarq either have some resistance to stem rust or may escape serious injury because of earliness. None of the recommended varieties of soft red winter wheats are resistant to stem rust.

Bunt or Covered Smut

Bunt smut, also known as stinking or covered smut, is widespread in the wheat section of Oklahoma, and causes considerable damage each year. In addition to reduced yields, smutty wheat is also penalized in price. Bunt first becomes apparent just before harvest time. Instead of grain, the heads contain balls of smut which resemble grains of wheat in size, but are shorter and wider. When the smut balls are crushed, they are found to contain a black, foul-smelling powder, which consists of the spores of the fungus causing the disease.

In threshing, hauling, and storing the wheat, many of the smut balls are crushed and the spores are mixed with the grain, adhering to the surface of the kernels. In this way, the entire lot of grain may become infected with the spores of the disease. When infected grain is planted, the spores germinate along with the wheat kernels, sending fine fungus threads into the seedling plants. These fungus threads continue to grow within the developing wheat plants which show no outward sign of disease. At heading time, however, smut balls are formed instead of kernels.

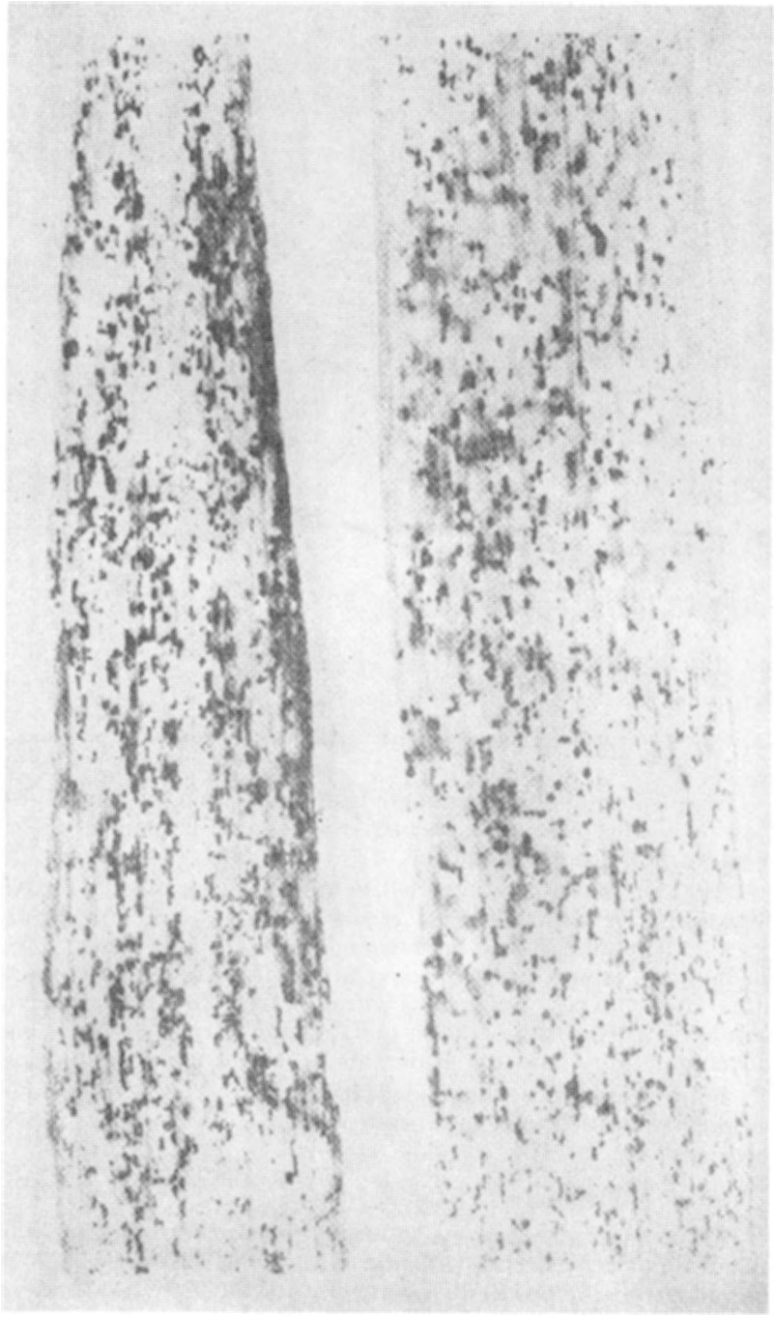

Fig. 12—Leaf Rust of Wheat

Fig. 13—Left: Loose Smut of Wheat. -- Right: Covered Smut of Wheat.

Smut spores do not germinate in the soil when the temperature is above 65 degrees; consequently, wheat germinating in a warm soil may escape smut infection.

Bunt smut can be controlled by dusting wheat seed with New Improved Ceresan at the rate of one-half (½) ounce per bushel of seed. The dust should be thoroughly mixed with the seed. This can be done rapidly and economically by using a gravity mixer of either of the types shown in Figures 14 and 15. The revolving barrel type treater can be used, but the gravity type treater is more convenient to use and the grain can be dusted more rapidly.

Before applying the dust chemical, the seed should be thoroughly cleaned to remove smut balls, weed seeds, and shriveled kernels.

Loose Smut

Loose smut in wheat is readily apparent at heading time. When plants are affected with the disease, the heads become dark-colored masses of powdery spores which soon blow away, leaving naked stems in place of heads. The disease is less noticeable at harvest time after the spores have blown away.

Infection of the wheat plant takes place at blossoming time. The spores from the infected plants blow to healthy heads and germinate to form fungus threads which grow down into the flowers and infect the developing kernels. At the time the wheat is ready for harvest, the infected kernels contain a network of fungus threads but show no outward signs of the disease. The fungus infection is inside the kernels. When infected wheat is planted the following year, the fungus starts its growth and destroys the head at blossoming time.

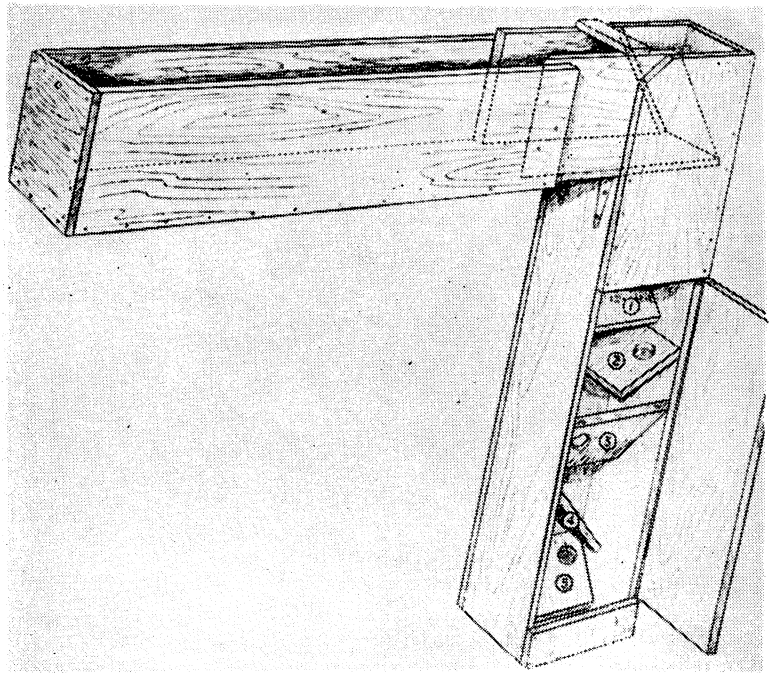

Fig. 14— Wooden Gravity Seed Treater

Since the loose smut fungus is on the inside of the seed, dusting with chemicals will not control this disease. The only effective method of control is to heat the seed to a temperature which will destroy the fungus inside the seed without injuring the seed itself. This can be accomplished by the hot water treatment. Loosely sacked grain is soaked in cold water for 4 hours. It is then dipped for 1 minute in water at 120 degrees, and finally immersed for 10 minutes in water at 129 degrees, after which it is spread out to dry immediately. Complete drying will usually require about 6 hours in summer in full sunlight.

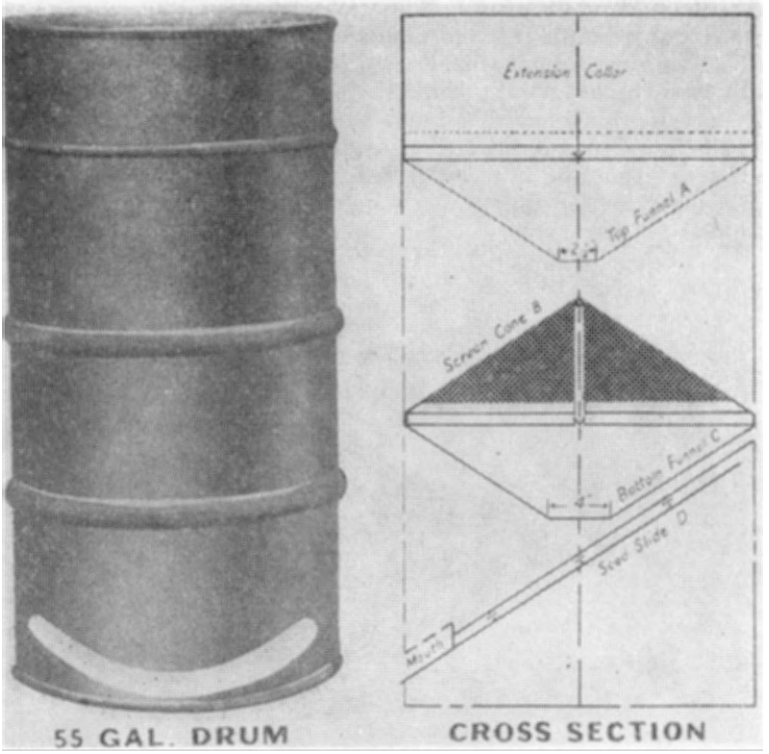

Fig. 15—Metal (oil barrel) Seed Treater

Treating large quantities of seed is not practical, unless special equipment is available. It is sometimes desirable to treat a small quantity of seed for planting a seed block, the increase of which can be used to plant the main crop the following year. In most cases, it is best to purchase new disease-free seed for planting, rather than undertake to treat infected seed.

Of the varieties recommended for commercial wheat production in Oklahoma, only Pawnee is completely resistant to loose smut.

Foot Rot or Root Rot

Foot rot or root rot is a common disease throughout the wheat section of the state. It usually attacks wheat plants which are not growing vigorously. Presence of the disease is indicated by plants dying in small areas or spots in the field. Although the disease may occur at any time during the growing period, it is most frequently observed after the wheat starts heading. Affected plants

may die soon after the heads appear and before the kernels are developed. The base of the stems becomes discolored and the roots decay. The heads may be white and empty, or overgrown with black molds.

Seed treatment is not effective in the control of root rot disease. Rotation of crops, early and thorough preparation of the seedbed, planting adapted varieties, and seeding at the recommended time but not earlier, are among the practices which will tend to reduce the danger of the disease. Phosphate fertilization may be beneficial in areas where moisture is not a limiting factor in plant growth.

RYE MIXTURES IN WHEAT

Mixtures of rye in wheat constitute a serious threat to the market quality of wheat in some sections of the state, particularly in areas where wheat is grown on sandy soil. Flour made from wheat containing a mixture of rye is dark in color and inferior in baking characteristics. It produces small-volume, coarse, heavy loaves of bread.

Most wheat growers are fully aware of the seriousness of the problem and are constantly trying to prevent their wheat fields from becoming infested with rye. Once it becomes established as a mixture in wheat, the percentage of rye will increase very rapidly unless prompt and effective control measures are taken. This is indicated in a test which is being conducted by the Nebraska Experiment Station. Plots were planted in 1943 with wheat containing known percentages of rye varying from 1 percent to 10 percent. The percentage of rye in the harvested grain is determined each year and new seedings are made with the rye-mixed wheat. The surprisingly rapid rate at which rye has increased in the mixture is shown in Table 18.

Table 18.—The Rate of Which the Percentage of Rye Increases When Planted as a Mixture in Wheat*

Percentage of Rye in Wheat planted in 1943	Percentage of Rye in Harvested Crop, 1944	Percentage of Rye in Harvested Crop, 1945
1	7.8	50.4
3	18.8	71.3
5	29.4	89.4
10	41.5	89.1

* Improving the Quality of Nebraska Grain, Nebraska Grain Improvement Association, March 1946.

Planting wheat which is free of rye mixtures, summer tillage to control all vegetative growth, and the use of good crop rotation systems are among the most effective methods of preventing rye mixtures in wheat. If rye plants occur in wheat fields, they should

be removed as soon as the heads appear and before grain is developed to prevent rye mixture in the harvested wheat. Rye plants growing in fence rows and along road sides should be destroyed before they mature seed.

WEED CONTROL

Weeds cause considerable losses in Oklahoma each year. Cheat, field bindweed, and Johnson grass are the most troublesome weeds on land devoted mainly to wheat production. Other weed pests of a less serious nature are goat grass, wild garlic, and curled dock.

Cheat

Cheat or Chess is one of the most troublesome weeds in Oklahoma wheat fields. It is a winter annual, maturing its seeds about the same time as wheat, and the presence of cheat seed in wheat is highly objectionable.

Planting wheat containing a mixture of cheat seed is a common method of spreading this weed pest. Cheat growing along fence rows, roadsides, and in waste places is likewise a source of infestation in cultivated fields. Cheat tends to become more prevalent in fields where wheat is grown continuously. The seeds often remain buried in the soil for several years before germinating and cheat plants may appear in wheat fields even when clean seed has been planted. It was probably this condition which led to the belief that wheat changed into cheat as it grew, but obviously that does not happen since wheat and cheat belong to different tribes of the grass family and each comes true from its own seed.

Wheat containing a mixture of cheat should not be used as seed. If the cheat cannot be removed by cleaning, new seed should be obtained for planting. Summer fallowing the land and growing wheat in rotation with a legume or a cultivated row crop are very effective in controlling cheat. If traces of cheat are observed in wheat fields, they may be removed and burned before the wheat is harvested. Destroying cheat plants along fence rows and around the edges of fields before seed is formed will also aid in preventing the spread of this weed.

Field Bindweed

Field bindweed occurs throughout the state and is rapidly becoming a serious problem in the wheat section. The plants develop deep and extensive root systems and are extremely difficult to eradicate. Bindweed spreads both by seeds and by underground stems. Planting small grain or other seeds containing a mixture of bindweed seeds is a common method of spreading this dreaded weed pest.

Small patches of bindweed may be eradicated by applying sodium chlorate in dry form at the rate of 4 pounds per square rod. The applications should be made in September or early October. The chemical prevents the growth of vegetation on treated areas for 2 or more years.

Preliminary tests indicate that the new chemical 2,4-D, when properly applied, will kill 50 to more than 90 percent of the bindweed plants, but it will not give complete control. It should be applied soon after growth starts in the spring or just before the plants start blooming. If infested land is planted to wheat, an application of 2,4-D on the young bindweed plants in the spring will kill all top growth for a period of about 60 days, which will permit the wheat to make a normal crop. The application should be made before the wheat plants start jointing, as severe injury to wheat will result if 2,4-D is applied after the joints start forming. The use of 2,4-D in connection with the tillage method of bindweed control will reduce the number of tillage operations necessary to completely eradicate the bindweed plants.

Special tillage methods have been developed to eradicate bindweed when the infestation extends over large areas. The land should be plowed about 4 inches deep as soon as growth starts in the spring. It should then be cultivated at 15-day intervals throughout the growing season. A field cultivator equipped with overlapping sweeps or duck foot plows is a very satisfactory implement to use. This intensive cultivation, if continued throughout one season, will weaken the plants but will not kill them. It should be repeated the second season, or at least until about July 1 when sorghums or Sudan may be drilled for hay. A few plants may survive this treatment and seedlings will occasionally appear. These should be destroyed. Only small grain and other seeds known to be free of bindweed seed should be planted.

Johnson Grass

Johnson grass is usually not a serious pest on farms where wheat is grown regularly and good tillage practices are followed.

Small patches of Johnson grass can be killed by spraying with sodium chlorate. The solution is prepared by mixing sodium chlorate with water in the proportion of 1½ pounds of chemical to each gallon of water. The spray should be applied just before the plants start heading.

If the infestation of Johnson grass is widespread on land where wheat is grown, summer fallowing is recommended. The land should be plowed immediately after the wheat is harvested, and tillage should be repeated about every 12 to 15 days during the summer and early fall or often enough to control weed growth. The one-way disc plow is perhaps the best implement for summer tillage

to control Johnson grass. The one-way should be used at least for the first few cultivations, after which a field cultivator equipped with sweeps or a spring tooth harrow may be used. If the fallowing period can be prolonged, better results will be obtained. This may be done by planting an early maturing variety of wheat and by delaying fall seeding to permit cultivation later in the fall. Summer fallowing, if properly done, will usually give satisfactory control except where the plants have developed deep secondary root systems in which case fallowing should be repeated the following year. A more complete discussion of the methods of controlling Johnson grass is given in a circular published by the Oklahoma Experiment Station.

Wild Garlic or Wild Onion

Wild garlic or wild onion, a perennial weed, is found in the eastern part of the state. The plant resembles garlic in appearance. The seed head consists of a cluster of small bulbs by which the plant reproduces. Mixtures of wild garlic bulbs in wheat severely injure the milling and baking qualities of the wheat. Summer fallowing is usually effective in controlling wild garlic. If the land is in small grain, it should be plowed immediately after harvest. Plowing should be repeated at intervals of 12 to 15 days during the summer and until seeding time in the fall. Crop rotation also aids in controlling this weed pest.

Curled Dock

Curled dock is another perennial weed which occurs in eastern Oklahoma, usually on poorly drained, acid soils. Good drainage, liming to correct soil acidity, early and thorough seedbed preparation, and planting clean seed will usually give satisfactory control. In some cases the use of a chemical spray such as sodium chlorate or 2,4-D may be desired.

Goat Grass

Goat grass and other annual weeds can be effectively controlled by the use of good wheat tillage practices, crop rotation, and planting weed-free seed.

UTILIZING WHEAT FOR GRAZING

The large acreage of wheat normally planted in Oklahoma, with proper management and in favorable seasons, will provide a considerable amount of winter and spring pasture without any apparent reduction in yield of grain. During open winters when conditions are favorable, well established fields of wheat utilized for grazing will reduce the amount of dry feed required to maintain dairy cows in production by 30 to 40 percent and will reduce the amount of dry feed necessary for wintering beef cattle 75 to

85 percent. Wheat pasture is very rich in protein and minerals, and the amount of these nutrients obtained by livestock from the young and tender growth of the wheat plants may be sufficient to meet the needs of the animals.

Clipping tests conducted at Woodward during the six-year period, 1938-43,* indicate that wheat may be moderately grazed to March 15, or about jointing time, without materially decreasing the grain yield. Moderate clipping to April 1 decreases grain yields only slightly. The five-year average grain yield in bushels per acre of five varieties of wheat as reported by the Woodward Station was as follows:

Not clipped	26.8 bushels
Moderately clipped to March 1	26.6 bushels
Moderately clipped to March 15	27.9 bushels
Moderately clipped to April 1	25.4 bushels

Of the varieties tested, Cheyenne, Turkey, Blackhull, Early Blackhull, and Tenmarq, there was little difference in forage production. Early-maturing varieties produced slightly more forage in the fall and early spring, but not during the entire grazing period. Adapted varieties of hard red winter wheat will generally produce about the same amount of grazing as winter barley in the main wheat section of the state.

At Stillwater, clipping to March 25 has reduced the average grain yield of hard winter wheat varieties an average of 2.3 bushels per acre and the soft wheat varieties 2.8 bushels per acre. These tests indicate that wheat can be moderately grazed in the central part of the state to about March 15 with little or no reduction in grain yield. When grazing is continued later, the grain yield is progressively reduced.

When clipped to March 25, Blackhull and Cheyenne have produced more forage than other hard winter wheat varieties. In total forage production the varieties ranked in the following order: Turkey, Cheyenne, Tenmarq, Blackhull, and Chiefkan.

The soft wheat varieties on the average produced about 10 percent more forage than the hard wheats. The soft wheat varieties also are more upright in growth habit and can be grazed more easily. In total forage production, the soft wheats ranked in the following order: Kawvale, Currell, Clarkan and Fulcaster.

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* Okla. Exp. Sta. Cir. M-161 (Mimeograph), Forage Production of Winter Small Grains, 1942-46, and
Okla. Exp. Sta. Bul. No. B-297, Winter Wheat Varieties for Oklahoma.

1946 Wheat Yields (Bus. per Acre) in Field Plots Stillwater and Woodward, Oklahoma

Variety	Yield (Bus. per Acre) Woodward	Stillwater
Cheyenne	25.9	24.1
Comanche	28.5	19.0
Pawnee	28.4	27.8
Tenmarq	22.7	14.2
Turkey (Kharkof)	21.1	18.8
Triumph	28.6	18.0
Early Blackhull	26.1	18.1
Blackhull	24.6	20.8
Wichita	31.1	19.2
Westar	29.9	20.8
Reliant	(not in test)	23.9
Red Chief	30.3	23.5
Chiefkan	30.7	22.1

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