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Summary of

Soil and Water Conservation and Management Research

at the

WHEATLAND CONSERVATION EXPERIMENT STATION

Cherokee, Oklahoma

1953

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
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in cooperation with

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry, Soils,
and Agricultural Engineering

FIELD DAY GUIDE

For 1953
And Summary of

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WHEATLAND CONSERVATION EXPERIMENT STATION
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Methods of controlling erosion and conserving moisture for the northwestern Oklahoma wheat area have been studied since 1939 at the Wheatland Conservation Experiment Station near Cherokee. This Station is conducted cooperatively by the Oklahoma Agricultural Experiment Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture.

The 320-acre Wheatland Station occupies rolling, deep, permeable soil in the heart of the wheat area. The particular site was selected because of the fertile and favorable soil conditions. But the land it occupies is rapidly losing organic matter, which is a valuable aid in soil and water conservation; and water is the first limiting factor in crop production in this semi-arid country. Therefore, methods of water conservation, fertility improvement and cropping systems must be developed in harmony with natural conditions.

The Wheatland Station is now entering the second phase of its work, and the research program has been thoroughly revised during the past year. Moisture conservation experiments, including stubble mulch tillage, plowing, listing, and basin listing, were studied from 1940 to 1952. The operations were performed with the slope, on the contour and on terraced and contour cultivated land. Runoff water was greatly reduced by terraces and contour cultivation. Moisture was also conserved by mulches and rough surfaces. The highest yield of wheat, however, was produced on the plowed areas and the lowest on the mulched plots.

"Plow pans"- very dense soil layers occurring at the bottom of the tillage operations - are very extensive on the Wheatland Station and in similar soils throughout the State. These pans are so tight that roots often fail to penetrate them. Their presence greatly limits the intake of water into the soil, and these restricted layers also affect crop production. The results, therefore, show that more intensive measures are needed to conserve soil and water and improve fertility. These experiments are now designed to determine how to maintain proper soil tilth, fertility, organic matter and surface cover and how to destroy and prevent the formation of plow pans in cultivated soils.

STOP NO. 1 Plowing to Maintain Terraced Land

The proper management of a terracing system includes both maintenance of the terrace ridges and the land intervals between them. When conventional moldboard plows or one-way wheat-land disks are used, a dead furrow occurs midway between terraces if the area is backfurrowed at the terrace ridges. If this method is continued, the deadfurrow area becomes low and the ridges become over-size.

Where the two-way plow was used lowering of the terrace interval did not develop. No dead furrows or backfurrows were left in the intervals. Terraces and channels were maintained and there was no apparent change or lowering of the surface soil in interval areas. Two-way plows, therefore, seem to have a useful place in terraced fields, especially in maintaining intervals between terraces and channels.

Offset disks and heavy tandem disks, along with chisel tools, are offering new possibilities for future study of tilling of terraced lands.

STOP NO. 2 Waterway Design and Management

Heavy rainstorms can result in surplus water which must run off. Such floods can destroy farm lands by their erosive power. Control of such runoff waters, therefore, is essential for proper land use. Grassed waterways are usually satisfactory for this purpose.

Sod grasses offer greatest protection, but bunch grasses can be used if the slope of the channel is not too steep or the soil too sandy. Bermuda is one of the best grasses for protecting waterways in Oklahoma.

The size of the waterway depends on many factors, such as the area of land drained, the slope and on the kind of grass planted. Each must be planned for its individual location.

The shape can be flat-bottomed, V-shaped, or rounded. Each has certain advantages. In any case, the cross-section should be broad to keep the flow depths shallow. This slows down the water and thus reduces the erosive force.

When the waterway is planted, make every effort to get an early and dense stand of grass. After the grass is established, the waterway will still need care. Mowing promotes the growth of a more dense stand and controls weeds. It also helps to prevent silting.

STOP NO. 3 Sod-Like Crops to Improve Soil Structure And Permeate the Plow Pan

Sod-like cropping systems are being studied to determine their effect on surface cover, soil tilth, and fertility, and the value of their root systems for permeating and destroying the plow pan. These investigations include various combinations of the following practices: (1) Use of commercial fertilizer; (2) Growing annual, biennial and perennial legumes and grasses; and (3) chiseling and deep plowing. The various combinations are being tested on both terraced and unterraced land. The legumes being used include vetch, sweet clover, Lespedeza sericea, and alfalfa. The grasses include weeping lovegrass, upland switch, and brome.

STOP NO. 4 Water Problems in Wheatland Soils

Prior to starting the new research on this Station, the infiltration rates of water into the soil were determined on each experimental plot, using a recording concentric ring infiltrometer. The soil on this Station has been in cultivation mainly to wheat for about fifty years. Some of the preliminary data obtained are as follows:

Land Conditions	Rate of Infiltration in inches per hour
Continuous Wheat	.168
Formerly Buffalo Grass Sod *	.920
Continuous Wheat on Friable Sandy Clay Land	
Undisturbed Surface Soil	.102
Soil Below Plow Pan	1.330
Continuous Wheat on Friable Silt Loam	
Undisturbed Surface Soil	.040
Soil Below Plow Pan	6.600

* This plot had been in buffalo grass for 5 years. The sod was destroyed by plowing in July before these tests were made in September.

These tests indicate that the entrance of water into the soil was limited by the surface soil and plow pan conditions. They also emphasize the value of grass for permeating the soil. After a plot had been in buffalo grass for five years, the sod destroyed and the seedbed prepared for wheat, the rate of infiltration of water into the soil was five times as fast as that on an adjacent plot of continuous wheat.

STOP NO. 5 Mechanical Shattering of the Plow Pan

Various methods are being studied for mechanically shattering the plow pan. These methods include shallow chiseling, 12 to 14 inches deep, 12 to 16 inches apart; deep chiseling, 22 to 24 inches deep, 36 to 48 inches apart; deep plowing, 12 to 14 inches deep; and Oliver's TNT subsoiling plow, 10 to 12 inches deep. The shallow chiseling is designed to penetrate only to the lower depth of the plow pan, while the deep chiseling is intended to reach into the soil below the pan and possibly cause additional heaving of the pan. The deep plowing was designed to reach below the pan and completely shatter it and mix it with the soil above.

The TNT plow turns a normal furrow slice, with an additional small plow bottom mounted below the regular bottom turning a furrow about 4 inches deep in the bottom of the big furrow. This small furrow completely penetrates the pan and partially mixes it with the surface soil.

These tools were used on land that will be moldboard plowed, one-way disked, stubble mulched and flexible tilled for observing the redevelopment of the pan. Also, annual, biennial and perennial legumes will be used in conjunction with them for preventing the pan development. Level closed-end terraces have been treated with these machines in an attempt to hold all the rainfall on the land.

STOP NO. 8 Grass and Vegetation for Water Channels

Before terraces are built, provision must be made to dispose of the runoff water. Broad, naturally vegetated drainage ways are best for this purpose. When they are not available, channels must be made. Various kinds of plants for lining these channels are being tested on the Wheatland Station at Cherokee. Sod-forming grasses are the best plants for lining water channels. Buffalo grass has made a good cover. Bunch grass and legumes do not provide as dense a soil cover as the sod grasses. Where the soil is deep and fertile, weeping lovegrass, switch grass and mixtures of these and other grasses are giving adequate protection for outlet channels on land slopes of two to three percent. Alfalfa is providing a satisfactory protective cover and normal hay crop in channels on the flatter slopes at this Station.

These studies and field observations show that vegetation in water channels should be frequently mowed or systematically grazed for best results. This promotes good tillering and reduces excessive turbulence in flow of water, which aids in preventing silt deposits.

STOP NO. 7 Fertilizers for Wheat Production

Previous fertility studies on this Station have indicated that both nitrogen and phosphorus fertilizers will increase wheat yields in this area. The results are given in Oklahoma Agricultural Experiment Station Mimeographed Circular M-223. Wheat yields in 1952 with various times and rates of nitrogen fertilization were: No treatment, 37.2 bushels per acre; 20 lbs. nitrogen in fall, 38.2 bushels; 20 lbs. in spring, 42.0; 40 pounds in fall, 41.3; 40 lbs. in spring, 44.2; 80 lbs. in fall 40.7; and 80 lbs. in spring, 44.9 bushels.

This work, along with studies conducted at other locations, indicates that 30 to 40 pounds of nitrogen per acre, applied in the spring, will give economical increases in wheat yields.

The soil fertility work under way at the present time deals with nitrogen fertilization on plowed and stubble mulched soils, and phosphorus fertilization with and without nitrogen fertilizer.

STOP NO. 8 Experiments Designed to Fit Land Capabilities and Use

The soils on this Station recently were classified according to their capabilities and the experiments are designed to fit each capability class. The purpose of classifying soils and the basis on which they are classified will be explained with the aid of a soils map of the Station Farm.

STOP NO. 9 Stubble Mulch Tillage

Stubble mulch tillage has been studied since this Station was established. The effect of different methods of tillage on runoff water and yields of wheat has been as follows:

Kind of Recurring Annual Tillage *	Runoff (Percent)	Yield Per Acre ** Straw (Tons)	Grain (Bu.)
Stubble Mulch	13.4	1.08	14.8
Plowed	15.2	1.33	18.8
Listed	16.3	1.27	18.1
Basin-Listed	15.1	1.30	18.1

* Cultivation with the slope.

** Average for 10-year period, 1942-1951.

Where all cultivation was conducted up and down the slope, runoff was least from the mulch land and most from the listed. Runoff on basin-listed plots was about the same as that on the plowed, probably because the dams in the furrows often broke during heavy rains. But both listing and basin-listing greatly reduced runoff water when listing followed the contour.

Under continuous, or annually recurring tillage of the same nature, the highest average yield of wheat has been produced on the plowed land and the lowest on the stubble mulch plots. During the 10-year period the plowed plots have produced a total of 40 bushels per acre more wheat than the mulched. The yields on the listed and basin-listed land have been about the same. They were only slightly less than on the plowed.

The mulched plots have consistently contained a heavy growth of cheat and weeds, and the wheat plants have been attacked by an infestation of foot rot each season, beginning with 1944. During 1943 some straw worm damage was also observed on the mulched plots.

STOP NO. 10 Wheat, Oats and Barley Varieties

Variety tests of wheat, oats and barley have been studied on this Station since 1946. The results are summarized in a sheet to be distributed at this stop. Copies may be obtained by writing: Director, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.

STOP NO. 11 Terracing and Contour Cultivation

Water conservation value of different methods of seedbed preparation, contour cultivation and terraces has been studied during the past ten years. During this period rainfall has been about average. However, there were two extremely wet seasons and also two abnormally dry ones. A large amount of the water from high intensity rains was saved by both mulches and rough surfaces. The results of contour cultivation and terraces on the percentage of runoff water from deep, permeable soil have been as follows:

Method of Tillage *	Effect of Kind of Cultivation on Runoff **			Proportion of Runoff Saved ***	
	With Slope	Contour	Terrace & Contour	Contour	Terrace & Contour
Stubble mulch	13.4	12.6	9.3	6	31
Plowed	15.2	13.7	10.3	10	32
Listed	16.3	11.8	10.1	28	38
Basin listed	15.1	9.8	9.1	35	40
Average	15.0	12.0	9.7	20	35

* Terraces short and built level with one end open.
** Results of runoff in percentage of annual precipitation for crop year (July 1 to June 30) 1942 to 1951.
*** Proportion expressed as a percentage of that from plots cultivated with the slope.

Contour farming alone was not enough, however, for controlling soil and water losses on the steeper slopes. Where a combination of terraces and contour cultivation was used the average annual amount of runoff from the four types of tillage was reduced 36 percent. This water was stored in the soil for plant use and did not contribute to the flood waters of local streams.

Effect on Yield of Wheat. The first and second year after the terraces were built, the yield of wheat was lower on the terraced and the contour cultivated plots than it was on plots cultivated with the slope. But, beginning with the third year (apparently after nature had time to adjust soil conditions in the disturbed portion of the ridges and channels) the yields have been slightly higher on the terraced plots except in 1949, an abnormally wet season. The results of contour cultivation and terraces on wheat yields have been as follows:

Years	Difference in Yield as Compared to Plots Cultivated With Slope * (Bushels per acre)		Total Annual Precipitation (Inches)
	Cultivated on Contour	Terraced and Cultivated on Contour **	
1942	-0.5	-1.9	30.0
1943	0.7	-0.5	20.3
1944	1.5	1.7	20.4
1945	1.4	1.3	34.3
1946	3.0	2.8	23.7
1947 ***	0.7	1.2	24.6
1948	0.6	2.0	17.9
1949	0.8	0.0	42.1
1950 ****	1.9	3.0	18.2
1951	1.7	1.8	38.5
Average	1.3	1.3	27.0

* This data was obtained by subtracting the yield of the plots cultivated with slope, from those on contour and those terraced and contour cultivated. The average yield in bushels per acre for plots cultivated with slope was 16.5, contour 17.6 and terrace-contour, 17.6. The yields of wheat are averages of stubble mulch, plowed, listed and basin-listed areas.

** Short level terraces, one end open.

*** The rainfall was below the average during the summer, fall and winter, but above the average during the spring growing seasons.

****There was good sub-soil moisture at seeding time. Precipitation, however, was extremely low during the fall, winter and early spring months, but rainfall was slightly above average in May.

STOP NO. 12 — Sweet Clover With Wheat

This experiment is designed to determine the effect of a rotation of biennial sweet clover, using stubble mulch tillage, for moisture conservation and wheat production. It is located on terraced and fertilized mainly Class III land. One series of the plots will be chiseled and the other left untreated, and all of them will be cultivated on the contour.

The rotation will cover four years. The sweet clover will be established in early spring by over-seeding in wheat planted in rows 20 inches apart. Rock phosphate will be applied at the rate of 500 pounds per acre as the sweet clover is seeded.

This experiment is just being started and no data are available. However, sweet clover rotations on the Red Plains Station at Guthrie, Oklahoma have been very effective in reducing soil and water losses.

STOP NO. 13 Wheat and Vetch

The value of vetch in wheat for soil and water conservation in wheat production is being studied on stubble mulch and flexible tilled land and compared with nitrogen fertilizer. These different types of surface tillage and these treatments will be conducted on plots where the plow-pan has been disrupted by both chiseling and deep plowing. One-half of the plots used in each tillage treatment will be contour tilled without terraces; the other half will be terraced and contour cultivated. These studies will be conducted on Class II and III land.

The flexible system of tillage will require both moldboard plowing and surface tillage, depending upon soil moisture conditions. If rains occur near or during harvest times and the soil is adequately moist, it will be moldboard plowed. If it is too dry after harvest to plow, the one-way disk will be used. After the first cultivation following harvest, all other tillage on these plots will be with sweeps or field cultivator.

Superphosphate will be applied to all plots at the rate of 100 pounds per acre each fall as the wheat is seeded. An application of 33 pounds per acre of nitrogen will also be applied in a top dressing at the beginning of spring growths on plots scheduled to receive nitrogen. This will usually be about the middle of March.

Vetch seed will be properly inoculated and mixed with the wheat immediately before seeding, and the two will be planted together at the rate of 10 pounds of vetch and 40 pounds of wheat per acre on the plots that include vetch. This study is just being started and no data are available. However, results of some preliminary tests of legumes and fertilizers on this Station are given in Oklahoma Agricultural Experiment Station Mimeographed Circular M-223.