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Summary of

Soil and Water Conservation and Management Research

at the

WHEATLAND CONSERVATION EXPERIMENT STATION

Cherokee, Oklahoma
1954

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For 1954

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By Harley A. Daniel, Maurice B. Cox, and Harry M. Elwell*

Methods of controlling erosion and conserving moisture for the northwestern Oklahoma wheat area have been studied since 1939 at the 320-acre Wheatland Conservation Experiment Station near Cherokee. This 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 semiarid 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 recently been thoroughly revised. 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

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more intensive measures are needed to conserve soil and water and improve fertility. The experiments now under way, therefore, are designed to find ways of maintaining proper soil tilth, fertility, organic matter, and surface cover, and of destroying and preventing the formation of plow pans in cultivated soils.

STOP NO. 1 Maintenance of Terraced Land

Proper management of a terracing system includes maintenance of both the terrace ridges and the land intervals between them. When conventional moldboard plows or one-way wheatland 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 oversize.

Where the two-way plow is used, no dead furrows or backfurrows are left in the intervals. Terraces and channels have been maintained and there has been no apparent change or lowering of the surface soil in interval areas.

Offset and heavy tandem disks, along with chisel and sweep tillers, are offering new possibilities for future study on terraced lands. Terraced plots on this station were cultivated satisfactorily in 1953 with an offset disk, sweeps, and chisel tools.

STOP NO. 2 Waterway Design and Management

Methods of controlling sedimentation in vegetation-lined waterways are being studied because heavy rainstorms 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 the land drained, the slope, and the kind of grass planted. Each must be planned for its individual location.

The shape may 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, it is essential 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, controls weeds, and also helps to prevent silting.

STOP NO. 3

Crops to Improve Soil Structure and Permeate the Plow Pan

The value of cropping systems of legumes and grasses is being studied to determine the effect of such crops on surface cover, soil tilth, and fertility, and the ability of their root systems to permeate and destroy 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, sericea lespedeza, and alfalfa. The grasses include weeping lovegrass, upland switchgrass, and brome.

STOP NO. 4 Water an Important Factor in Wheatland Soils

Different methods of improving the intake of water into the soil are being investigated. 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 50 years. Some of the preliminary infiltration data obtained are as follows:

Land Conditions	Rate of Infiltration in Inches per hour
Continuous Wheat	.168
Formerly Buffalograss 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 buffalograss 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 buffalograss for 5 years, the sod destroyed, and the seedbed prepared for wheat, the rate of infiltration of water into the soil was 5 times as fast as that on an adjacent plot of continuous wheat.

Since 1953 was abnormally dry, little runoff water was measured. However, the following data give some indication of the effectiveness of mechanical shattering of the plow pan:

Land Treatment	Rates of Infiltration in Inches per Hour	
	Before treatment	One year after treatment
Deep Plowed	.171	.482
Chiseled	.126	.346
Check	.174	.201

According to these results, the infiltration rate was increased 182 percent by deep plowing and 175 percent by chiseling.

STOP NO. 5 Disrupting 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 "TNT" subsoil plowing, 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 below 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 flexibly tilled for observing the redevelopment of the pan. Annual, biennial, and perennial legumes are being used in conjunction with tillage methods to determine their effect in 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. Due to the low rainfall in 1953, results are indefinite. The infiltration rates in inches per hour were: deep plowed, 0.616; shallow chiseled, 0.596; TNT plowed, 0.342; and untreated, 0.249.

STOP NO. 6 Vegetation for Water Channels

Before terraces are built, provision must be made to dispose of the runoff water. For that reason, the effectiveness of various kinds of vegetation is being observed for water channel protection. Broad, naturally vegetated drainage ways, such as pastures or meadows, 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. Sod-forming grasses are the best plants for lining water channels. Buffalograss 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, switchgrass, and mixtures of these and other grasses are giving adequate protection for outlet channels on land slopes of 2 to 3 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, reduces excessive turbulence in the flow of water, and aids in preventing silt deposits.

STOP NO. 7 <u>Fertilizers for Wheat Production</u>

Previous fertility studies on this station have shown 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 lbs. 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 increase in wheat yields.

The soil fertility work presently underway deals with nitrogen fertilization on plowed and stubble mulched soils, and phosphorus fertilization with and without nitrogen fertilizer. In the former, the tillage variables were introduced in the fall of 1953, so no yields are available as yet. The nitrogen treatments were begun last year. Yield data from 1953, a very dry season, show that the nitrogen applications had no effect on yields. In the latter experiment, the nitrogen fertilizer had no effect on the yield of wheat; however, the 20 pounds of P_2O_5 per acre increased wheat yields by 5.9 bushels per acre (from 17.2 to 23.1 bushels per acre).

STOP NO. 8 <u>Experiments to Fit Land Capabilities and Use</u>

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 is reported in Okla. Agri. Exp. Sta. Mimeo. Cir. M-223 (1951).

Where all cultivation was conducted up and down the slope, runoff was least from the mulched 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.

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 contour cultivation and terraces has been studied since this station was established. These experiments are conducted on land slopes ranging from 1.25 to 5.00 percent. During this period, rainfall has been about average. However, there were two extremely wet seasons and also two abnormally dry ones. The percentages of runoff are as follows:

Cultivation	Runoff Percent of Precipitation		Difference Percent***	
	Annual*	Big Rains**	Annual	Big Rains
With slope	14.99	37.00		
Contour	11.98	31.52	20.0	14.8
Terrace - Contour****	9.69	25.72	35.4	30.5

*Results of runoff in percentage of annual precipitation for crop year (July 1 to June 30), 1942 to 1951.

**Average of high intensity rains that cause runoff from all plots.

***Proportion expressed as a percentage of that from plots cultivated with the slope.

****Short, level terraces, one end open.

Contour cultivation conserved water, but contouring alone was not enough for controlling erosion on the long, steeper slopes. On land of this nature, the best results were obtained from a combination of terraces and contour cultivation. On land slopes of less than 3 percent there was no serious gully erosion on the contour cultivated plots with vertical intervals of 6 feet between terraces.

Effect on Yield of Wheat. The first and second years 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, the yields have been slightly higher on the terraced plots, except in 1949 which was an abnormally wet season. The effects of contour cultivation and terraces on wheat yields are reported in Mimeo. Cir. M-223.

STOP NO. 12 Sweet Clover and 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 was chiseled and the other left untreated, and all of them are cultivated on the contour.

The rotation will cover 4 years. Wheat was planted in the fall of 1952 in rows 20 inches apart, and the sweet clover over-seeded in early spring of 1953. Rock phosphate was applied at the rate of 500 pounds per acre when the sweet clover was seeded.

This experiment is just being started. Sweet clover failed in 1953;

consequently, 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 is being studied and compared with nitrogen fertilizer on stubble mulched and flexibly tilled land. These different treatments are being 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 are contour tilled without terraces; the other half are terraced and contour cultivated. These studies are conducted on Class II and III land.

The flexible system of tillage consists of 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 is moldboard plowed. If it is too dry after harvest to plow, the one-way disk is used. After the first cultivation following harvest, all other tillage on these plots is with sweeps or field cultivator.

Superphosphate is 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 is also applied in a top dressing at the beginning of spring growths on plots scheduled to receive nitrogen. This is usually about the middle of March.

Vetch seed was properly inoculated and mixed with the wheat immediately before seeding, and the two 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. Vetch failed in 1953; consequently, 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.