TERRACES ON GRASSLAND:

A Study of Terraced and Unterraced Areas on Eroded, Shallow Soil, Before and After Revegetation With Native Grasses

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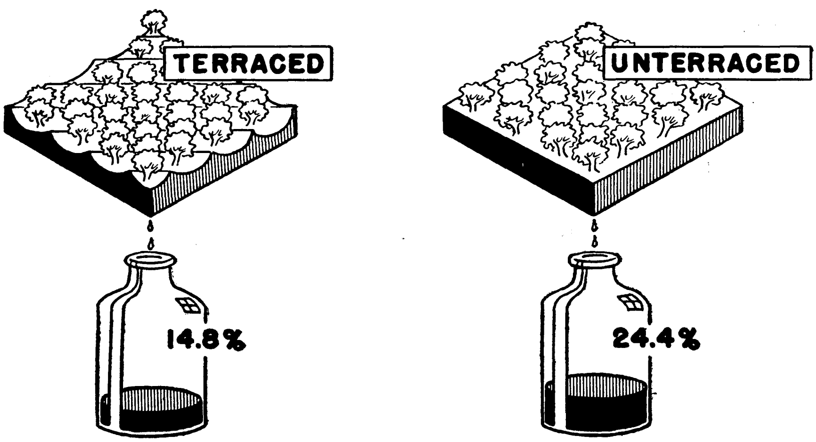

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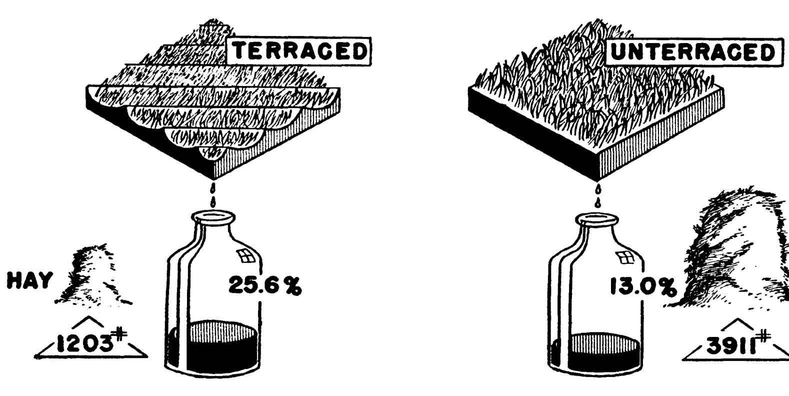

TERRACES ON GRASSLAND:

A Study of Terraced and Unterraced Areas on Eroded Shallow Soil, Before and After Revegation With Native Grasses.

By MAURICE B. COX, HARLEY A. DANIEL, AND HARRY M. ELWELL*

The question of whether terraces are needed on grassland is often discussed. Until recently, however, no research data were available. This bulletin reports a study made at the Red Plains Conservation Experiment Station, Guthrie, Okla.,** on two areas of shallow, eroded, abandoned Class VII land where a cover of native grass had been reestablished. One plot had been terraced before it was returned to grass. The other was unterraced.

THIS STUDY SHOWS that on this type of grassland these terraces caused greater runoff to occur. After the grass cover became established, the percentage of runoff was greater on the terraced plot than on the unterraced one. Grass cover was considerably better on the unterraced plot than it was on the one that had been terraced. Forage yield in 1950, the eighth year after grass was established, was more than three times as great on the unterraced plot.

The results obtained in this study, it is believed, will apply on similar types of land throughout the Cross Timbers and Reddish Prairies of Oklahoma, and probably in other areas having similar soils and limited summer rainfall.

How the Study Was Made

The Soil

This study was made on Class VII land typical of much of the shallow, eroded, abandoned land in the Southwest. The plots are on reddish prairie soil which is shallow, medium textured, and slowly

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permeable.* When the experiment began, they were severely eroded and a compact subsoil was exposed. Approximately 11 inches of topsoil had been removed during 40 years of continuous cultivation.**

The Plots

The two areas used for a study of the effects of terracing were established in 1929. They were laid out so as to be as nearly alike as possible in soil condition, size, natural slope, and other characteristics. Terraces were built on one of the areas, and the other was left unterraced. Devices to measure water runoff and soil losses were set up for each area. Rainfall was measured by recording gauge.

The unterraced area measured 3.21 acres and had an average slope of 5.13 percent. The terraced area was 3.13 acres and had a natural land slope of 3.42 percent. Four large, level, ridge-type terraces were built at vertical intervals of 2.5 feet. They occupied about one-third of the total land surface and markedly increased the land slope. The back slopes of the terrace ridges were quite steep. One end of each terrace ended in the dike separating the experimental watersheds. The other end emptied into a channel, and the runoff water was measured at the outlet of the lower terrace.

Management of the Plots

The two plots were cultivated alike from 1930 through 1938, using a rotation of cotton and cowpeas. Yields were poor*** because this Class VII land is not suitable for cultivation. It is very droughty and low in plant nutrients. Therefore in the spring of 1939 both areas were seeded to a mixture of native grasses.

What the Study Showed

About Runoff

Table I shows the annual rainfall at the experimental plots, and the percentage of rainfall which escaped as runoff from each of the two plots.

During the period of cultivation, both runoff and soil losses were much greater on the unterraced land.† Average annual runoff was 7.11

* Soils on the experimental area are classified as Chickasha and Zaneis (shallow phases).

** A more complete description is given in U.S.D.A. Tech. Bul. 837 (1943), "Investigations in Erosion Control and Reclamation of Eroded Land at the Red Plains Conservation Experiment Station, Guthrie, Oklahoma, 1930-40," by Harley A. Daniel, Harry M. Elwell, and Maurice B. Cox.

*** See U.S.D.A. Tech. Bul. 837 cited in previous footnote.

† See U.S.D.A. Tech. Bul. 837 cited in previous footnote.

inches from the unterraced plot and 4.10 inches from the terraced plot. Annual soil loss averaged 83.72 tons per acre from the unterraced plot and only 4.43 tons from the plot that was terraced.

The foregoing figures show that terraces were effective in preventing soil from leaving the field while the land was being cultivated, even though much washing occured between terraces. But after the land was regrassed the story was different. The changes are shown in Figure 1.

While the grass was becoming established, the terraces continued to reduce runoff water losses. But, as the grass cover improved, the terraces became less valuable. The fourth year after grass was seeded the amount of runoff from the two plots was practically the same, and the fifth year it was higher from the terraced land. Since that time, runoff conditions have been almost exactly the reverse of what they were while the land was being cultivated. In fact, the percentage of runoff from the terraced land in grass has been slightly higher than it was from the unterraced plot during cultivation.

The relatively greater runoff from the terraced land after regrassing probably can be explained as follows:

Table I.—Percentage of Runoff from Terraced and Unterraced Land.

YEAR	Percent Runoff		Difference[1]	Annual Rainfall (Inches)
	Terraced	Unterraced		
	Cultivated, Rotation: Cotton and Cowpeas			
1932	24.10	37.57	13.47	37.40
1933	8.69	14.05	5.36	31.40
1934	20.81	26.74	5.93	35.30
1935	13.33	20.91	7.58	31.73
1936	11.14	22.52	11.38	21.45
1937	9.99	15.47	5.48	24.15
1938	15.84	33.87	18.03	31.36
	Grass-seeded, and Period of Development[2]			
1939	8.47	20.20	11.73	23.57
1940	6.55	11.95	5.40	32.07
1941	19.72	23.49	3.77	39.71
1942	11.31	11.23	— .08	34.36
	Grass-cover Established			
1943	22.44	15.05	— 7.39	25.82
1944	15.58	12.41	— 3.17	30.21
1945	22.00	17.60	— 4.40	33.46
1946	20.40	7.10	—13.30	27.40
1947	34.10	15.00	—19.10	27.19
1948	26.40	7.70	—18.70	25.24
1949	35.50	19.94	—15.56	40.89
1950	23.15	10.28	—12.87	28.22

[1] Difference in the percent runoff obtained by subtracting terraced from the unterraced percents.
[2] Seeded to a mixture of native grasses during the spring of 1939. Prior to this time both areas were in cultivation.

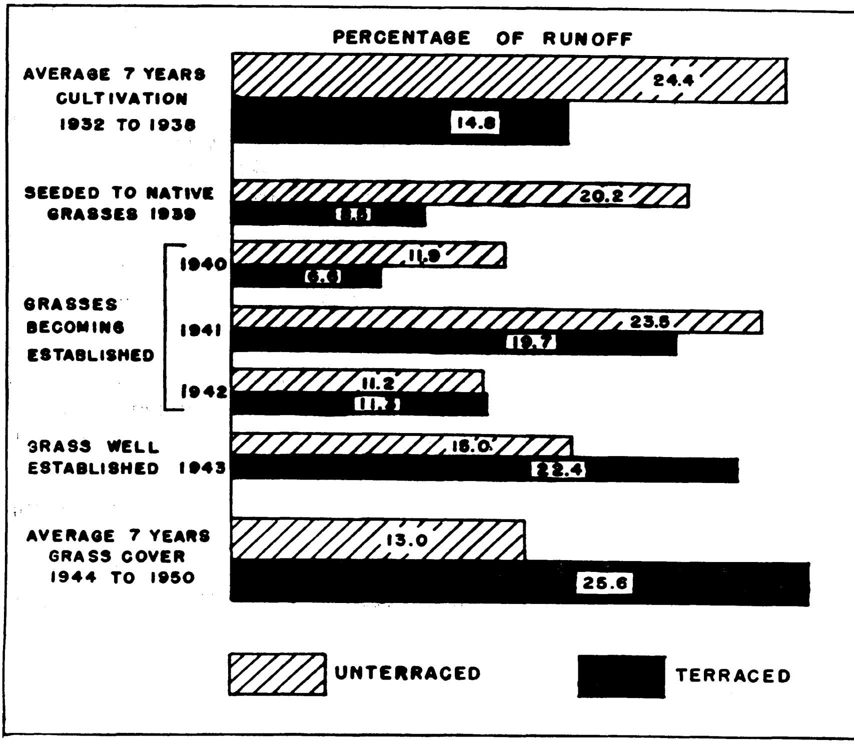

Fig. 1.—Runoff from Terraced and Unterraced Land, While in Cultivation and After Re-establishment of Grass.

While the land was cultivated (cotton and cowpeas), terraces were effective in reducing runoff. But after the land was regrassed, conditions were almost exactly reversed and runoff was greater from the terraced area.

Building and maintaining the terraces on this shallow, severely eroded land moved most of the small remaining amount of permeable topsoil into the ridges, and at the same time exposed more of the compact, unweathered subsoil in the channels and terrace intervals. This subsoil layer does not take water readily (Figure 2).* Therefore the rainfall not absorbed immediately by the soil on the ridges accumulated rapidly in the channels and was quickly drained off the land. Rapid runoff also was favored by two other conditions existing on the terraced area but not on the unterraced plot. First, the runoff water had a

* The measurements reported in Figure 2 were made by inserting 5-gallon bottles filled with water into holes dug into the soil. The bottles were supported by metal rims 8 inches in diameter set into the upper part of the holes that extended 7 inches below the necks of the bottles. Absorption rates were recorded by measuring the drop in the water level in the bottles.

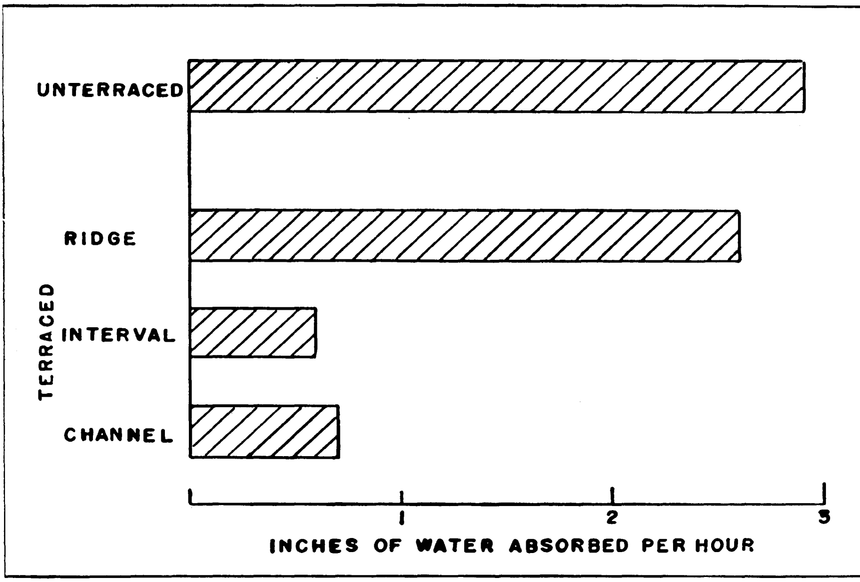

Fig. 2.—Rates of Water Absorption on Terraced and Unterraced Land.
These figures help explain why runoff was higher from the terraced land after it was regrassed. The ridges took moisture almost as well as the unterraced soil; but, where a tight subsoil had been scraped bare in making the ridges, rainfall did not penetrate easily. (These data present only an indication of water absorption, and not true infiltration rates. See footnote, page 8.)

shorter distance to travel before it accumulated into channel flow conditions. This gave it less time to soak in. Second, the terraces greatly increased the original land slope, therefore the water from the ridges not only had a shorter distance to travel but also moved over the surface more rapidly.

About Grass Production

The mixture of native grasses planted on the two experimental areas included both short and tall types: blue grama, buffalo, dropseed, little bluestem, big bluestem, switch, and Indian grasses. An excellent stand developed on the unterraced land, including previously gullied portions (Figure 3). Little bluestem and blue grama predominated everywhere except in the channels and on the ridges of the terraced plot.* In the channels, upland switch grass made up the greatest percentage of the cover; and on the ridges plant growth was largely weeds

* Percentages by species and location are given in Table VII of Okla. Agri. Exp. Sta. Bul. B-257, "Conservation and Better Land Use for Oklahoma," by Harley A. Daniel, Harry M. Elwell, and H. F. Murphy.

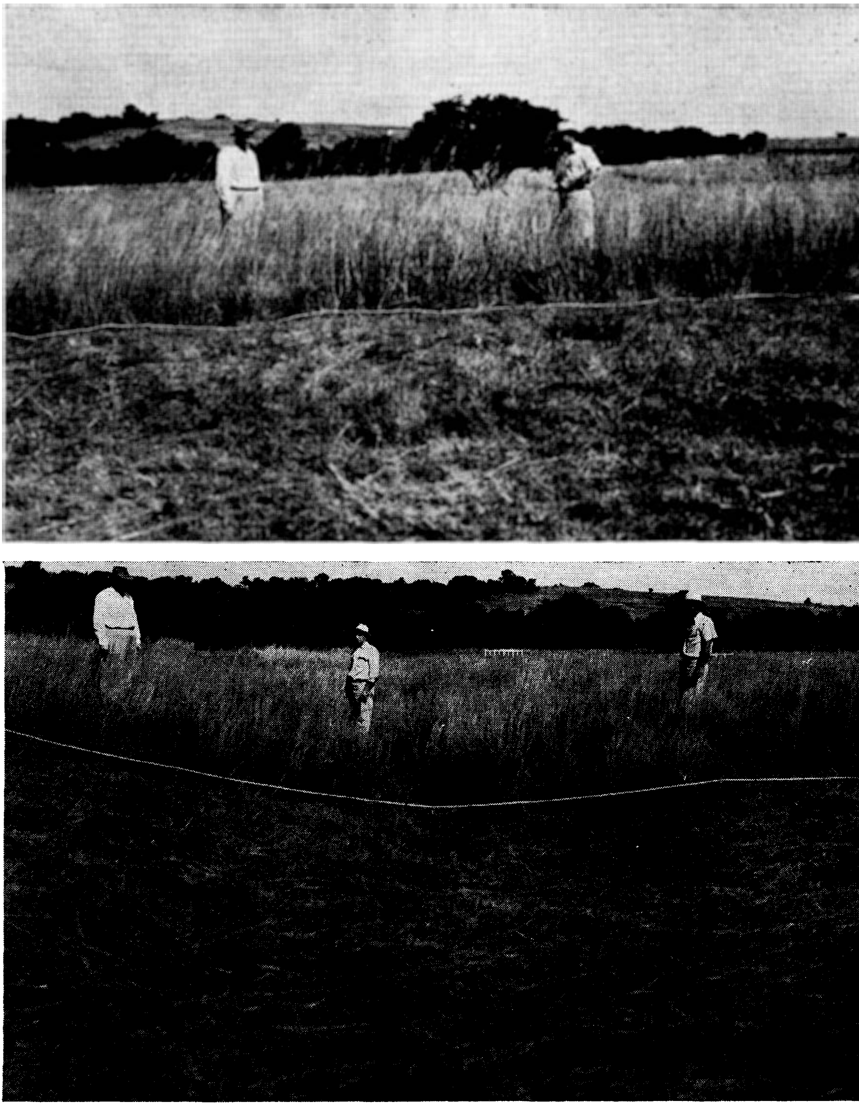

Fig. 3.—Vegetation on the Unterraced Area.

Little bluestem predominated and developed a uniform stand and cover (upper photo). It made a good root system and developed a heavy surface mulch. A gully on the unterraced plot was seeded to grass after the banks were sloped, and a good cover developed to protect the soil against runoff and erosion (lower photo).

Fig. 4.—Vegetation on the Terraced Area.
Ridges produced a poor cover of tall native grasses. Plant growth was largely weeds, although ridges on the better soil had poor stands of blue grama and buffalo grass. Little bluestem and other native grasses occupied the intervals.

and early annual grasses (Figure 4). In the channels, switch and Indian grasses grew best. They made considerable root development in some channels, but apparently did not penetrate the soil enough to influence water absorption.

Table II shows native grass production in 1950, when the unterraced land produced 3¼ times as much hay as the terraced land. Rainfall was above the average all during the growing season for grass that year. Observations made on these plots in previous seasons, and on adjacent terraced pastures on Class IV land, agreed with the measured results obtained on the experimental plots in 1950.

Table II.—Grass Production on Terraced and Unterraced Grassland, 1950.

	Pounds of grass per acre
Unterraced	3911
Terraced	1203
Terrace Ridges	748
Terrace Channels	1432
Terrace Intervals	1430

The poor yield from the terrace ridges probably was due to soil moisure conditions, as shown by Figure 5. Other studies show that terrace ridges often become very dry and produce poor yields of cultivated crops, and the same condition apparently affects grass. The exposed subsoil between the terraces allowed heavy runoff and failed to produce good grass.

Conclusion

The results obtained in this study show that large, over-sized terraces were actually detrimental to grass production and water conservation on the shallow, eroded Class VII land on which the study was made.

Soil conditions are important factors to consider in making conserva-

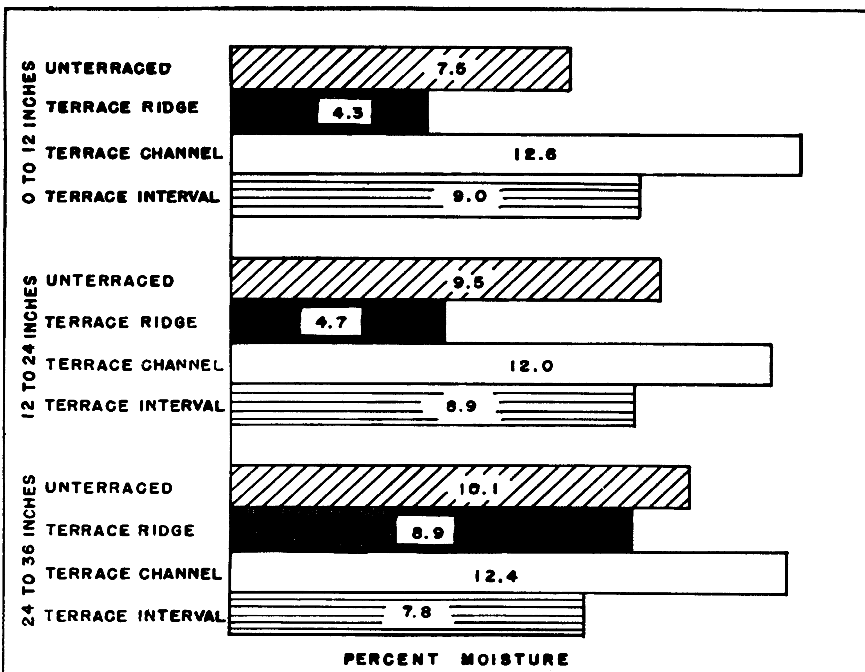

Fig. 5.—Percentage of Moisture at Different Depths on Terraced and Unterraced Land. Moisture samples were taken in the fall of 1950, after a summer that was the wettest on record. This was 11 years after the grass was seeded. The dry ridge was supporting a very sparse stand of grass. The unterraced land had an excellent cover of tall native grasses, which possibly may account for the low moisture content in the first foot layer of soil on this area.

tion farm plans. Shallow, sloping, highly erodible Class VII land is more stable and useful when put to permanent vegetation.

In regrassing gullied land, special treatment may be necessary. The first step will be to reduce further erosion and stabilize the seedbed. In some areas, it may be necessary to divert the runoff water from the original channels by small diversion terraces above the heads of the gullies, since the over-sized terraces used on the experimental tract were not desirable. Another step is the installation of vegetative barriers of brush and crop residues, and plowing and grading down the gully banks. The seedbed is now ready for fertilizer and lime as needed and the planting of legumes. Following the establishment of legumes, grasses may be seeded by the seed hay method.