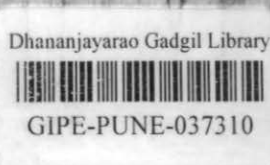


Terraces to control run-off

By

O.R. Zeasman and A.J. Wojta

# TERRACES



to control run-off

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**E**XPERIMENTS AND FIELD TESTS HAVE PROVED that the use of terraces increases corn yields by 10%, and at the same time reduces by 85% the soil lost by erosion on large fields. This reduction of soil loss is brought about because terraces control the run-off water.

There are no substitutes for good land management, but by holding more of such material as fertilizers, manure and organic matter in place, terraces insure soil improvement. Pasturing the hay crop or hogging down corn can be done more conveniently on a terraced field than if the field were strip cropped. Therefore, it is not surprising that the practice of terracing sloping fields is increasing rapidly in some sections of Wisconsin.

Data from the La Crosse Erosion Experiment Station show that from three to five rain storms a year produce nearly all the soil loss from fields during that year. These are storms in which a large quantity of water falls in a relatively short period of time. The rate of rainfall exceeds the rate at which the soil, no matter how good its condition, can take in water.

This leaves a large quantity to run over the surface. Records of the Erosion Experiment Station, covering a 14 year period, reveal the startling fact that nine severe storms caused 60% of the total soil loss during that 14 year period. These are called critical storms and some farmers call them "gully washers".

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Runoff water from these storms and from many that are less intense follow the natural laws of flowing water. They carry away the finer soil particles and the lighter portion of the top soil, the organic matter. Analyses of the material, sediment, carried away by the run-off, reveal that it contains three times as much organic matter as the field from which it came. This sediment carried away contains approximately three times as much available phosphorus and up to 25 times as much available potash as the top soil of the field from which it was removed.

Small wonder then, that crop yields go down as runoff water carries away the better part of the good top soil, by the process we call erosion.

### Terraces Slow Down Runoff Water

In order to protect soils against this sort of destructive force, the runoff water from the intense storms needs to be controlled and the speed slowed down. This can best be done by a properly designed, correctly constructed system of terraces. Such a system of terraces has frequently been called a surface drainage system.

Properly designed terraces divide the runoff and carry it away so slowly that it cannot carry much soil material with it. Terraces are the only known device that hold soil losses on slopes over 250 feet long, down low enough to insure that field against ultimate destruction if used in a rotation of our common crops.

We commonly call a terrace an earth eave trough. It is laid across the hill side with a very gradual slope, or gradient, toward the outlet end. The gradient of the terrace contrasts with the steeper slope of the field, much as the slope of the eave trough contrasts with the slope of the roof. A series of them is built across a long slope breaking the slope into a series of short slopes, each equal to the space between a pair of terraces. This suggests the key to the effectiveness of terraces. You can see no obvious erosion on a short slope, but the lower portions of long slopes have multiple shoe string gullies cut by every intense storm when the field is in corn or grain.

### Terracing Grew Out of Contouring

The practice of terracing grew out of the practice of contouring, that was started by our leading farmers of the eastern seaboard at about the time of the Revolutionary War. In the "cut and try" fashion, about 50 years were consumed developing narrow base, steep sided earth dikes, given the name terraces, about 100 years ago.

The most important early improvement in design was the building of ridges with a broader base and side slopes so flat that the entire terrace could be farmed as part of the field. This occurred about 65

years ago. About 30 years later, the basic principles that make terraces work were set up as design standards. Since that time the practice of terracing has expanded into virtually all the states, and in some counties in southeastern states it is in such general use that all the cultivated land in some counties is terraced.

If you were to look at a standard terrace cross section you would notice that the earth eave trough is a combination channel and ridge. The ridge is shaped like an extra large back furrow. The channel on the up-hill side is shaped like an extra large dead furrow. This broad waterway is given a flat slope so that the water that collects in it as runoff from the band of land between it and the next terrace above, must flow off slowly to the grassed waterway selected for an outlet. Experimental data and general practice has set the standard slope as six inches or less per 100 feet. The object is to compel the water to flow slowly. It is desirable to locate outlets so that terraces need not be longer than about 1300 feet, and shorter lengths are desirable because that reduces the quantity of water a terrace needs to carry.

The distance between terraces depends on the steepness of the slope on which the terraces are to be built. This is determined with a surveying instrument in the field at the time the terraces are staked. Set up the instrument and determine per cent of slope above the terrace to be staked, because all table and formula for spacing terraces depend on that. An idea of distance between terraces can be obtained by applying the formula  $\frac{\% \text{ slope of land} + 3}{2}$ . The figure that this equation gives is the vertical interval between terraces in feet.

### Provide Grassed Waterways for Run-off

The runoff water from terraces is discharged into an outlet. The most practical device is a naturally sodded draw or grassed waterway that has been developed to dispose of water that naturally accumulates there. If no such draw is available, one needs to be constructed at least a season before the terraces are built in order to allow time for a dense grass cover to form.

The location needs to be selected with a few principles in mind. Select a location where there is least danger of clogging with ice. This means a south or southwest exposure. Perhaps it can conveniently be located next to the field boundary where it can serve as a head land. Avoid placing it where it would be used as a field road. The same principle ought to be applied to any permanent grass waterway. Avoid forming ruts in it because they will invite gully formation.

A waterway that you may build ought to meet some standard qualifications. Obviously it must be large enough to carry the water. It

ought to be made easy for crossing with machinery. That means gentle side slopes not over one foot of rise for six feet in width. The velocity of the water that is to flow down it needs to be held down to a safe speed. This can be accomplished by increasing the width to such an extent that the flowing water is held to moderate depth. These two requirements are consistent.

The size of channel is also influenced by the steepness of the side-hill on which it is located. With these facts at hand a qualified individual can compute the size required. A farmer's common standard is to provide two feet of channel width for every acre of land to be terraced. One thing that can be given due consideration in design of the terrace outlet is that the peak runoff from a terraced field is less than half that from the same field when unterraced.

### **Diversion Terraces Suited to Steeper Land**

Standard terraces described above are suited to fields with slopes not in excess of 10%. But we have a more serious erosion problem on the steeper slopes. Modifications have been introduced that make it possible to use to a considerable degree the benefits of terracing. We call these modified terraces, diversion terraces.

The diversion channels are spaced two to four times as far apart as standard terraces. In order to carry the extra quantity of water in a moderate size terraced channel, the terrace grade is increased up to two feet per hundred. In order to prevent erosion in such a steep terrace, the channel is kept permanently in sod.

Since the diversion terrace cannot be used for an intertilled crop, it can have steeper side slopes and thereby reduce the per cent of the field kept permanently in sod. Erosion can be reduced on the fields between terraces by practicing strip cropping on them. If it is desired to farm the fields between terraces as single units, long rotations and extra heavy fertilization are essential.

### **Deficient Drainage of Heavy Soils Can Be Improved**

Terraces were developed as a safe means of disposing of unavoidable runoff and thereby controlling soil erosion. The use of terraces for this purpose in the Spencer soils area, revealed the fact that they also improved the drainage. This is brought about because terraces reduce the distance water is allowed to flow overland, from the original length of the slope down to the interval between terraces, which is from 100 to 150 feet for the slopes prevailing on the Spencer soils. If at the same time depression storage is reduced by leveling the land between terraces, excess rainfall is removed more quickly, the drainage improved, and erosion damage to land held to a low amount.

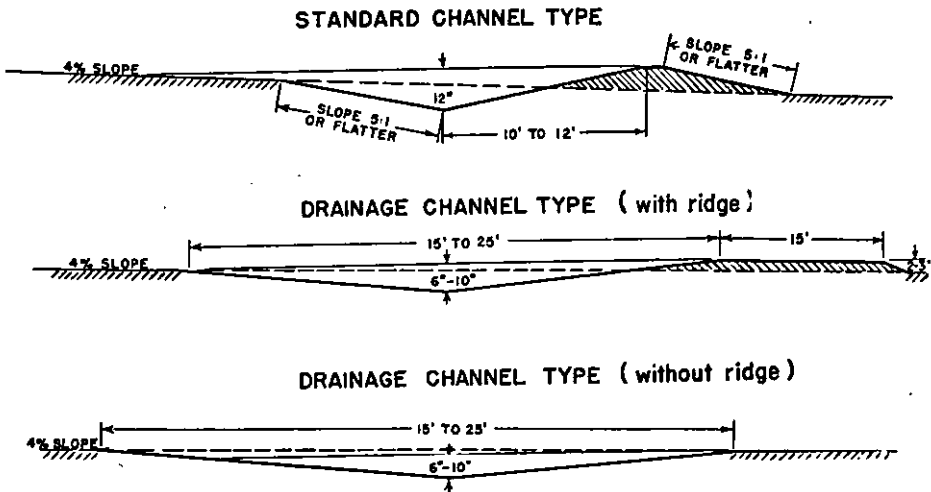
The fields of this soil area seldom have a slope in excess of 4%. Many shallow pot holes are found in some fields. These delay timely seeding and cultivation, mire machinery, and constitute a general nuisance. They cause uneven ripening and reduce yields. The damage to general productivity of the land by loss of top soil is not appreciated by the average farmer. He thinks only of deficient drainage as a handicap, and wants drainage devices that offer least interference to his traditional methods of managing land.

In order to fulfill these requirements, the channel type terrace has been developed and tested. It is evidently superior to the ridge-channel type terrace described above, in several ways: (1) The water is carried in a channel below the ordinary surface of the ground. (2) This means that over-topping from an extremely heavy rain does not cause severe damage. (3) Channel terraces are but little obstruction to the passage of machinery. (4) It is easier to locate them in a true parallel pattern. (5) Earth removed by the excavation of the channel can be used to fill the objectionable pot holes and draws in the field, thereby eliminating ponds and soft spots.

### What is a Channel Type Terrace?

The shape of the ordinary channel terrace is a ditch shaped like an extra wide dead furrow, 15 or more feet wide on top with flat side slopes to a flat or V-shaped bottom. The channel is from 6 to 10 inches deep. In places where the channel does not have sufficient capacity as such, the earth from the excavation is used to reinforce

### TERRACE CROSS SECTIONS



Channel type terrace systems offer little or no resistance to tillage and planting machine.

the downhill side by building a very wide ridge, 10 to 15 feet, a few inches high. The object is to provide a channel cross section of about six to seven square feet.

The layout pattern is very similar or may be identical with the conventional terrace system. Since it is desirable that the land be worked in the direction of the terraces, it is well to locate terraces in parallel, if practicable. Frequently, locations in parallel can be obtained if part of the terrace is cut as a channel and the earth thus excavated is used to reinforce the channel or build a ridge terrace across the depressed section of the field.

### How to Lay Out Terraces

Field judgment, gained by experience, and the skills needed to use a surveyor's level, are necessary to qualify a person to stake terraces in a field. Space here will permit of merely a skeleton outline. The first step to take is to determine the slope of the land from the crest of the hill down to the probable location of the top terrace. Using this figure, apply the rule for vertical interval given on page 5. Spot your rodman on the location of the top terrace as much below the elevation of the crest of the hill as required by the answer above. Then set stakes at points on the line of the terrace as needed, generally 50 feet apart, allowing the proper fall, 6 inches or less per 100 feet toward the outlet end. To locate the second terrace, obtain the field slope below the top terrace and proceed as above.

Practically all counties of Wisconsin in which terracing is being done are Soil Conservation Districts. Technicians of the Federal Soil Conservation Service who are servicing these districts have training and experience in laying out and building terraces. They will be glad to help farmers with terracing and other soil conservation practices.



Motor graders are effective in building terraces.

## How to Build Terraces

Construction of the common ridge-channel type terrace requires the movement of a rather large quantity of earth from the channel, a short distance downhill to the ridge. Any type of machine designed to roll earth can be used. Motor graders, bulldozers, whirlwind terracers, and ordinary farm plows have all been successfully used.

The most important requirement is to move enough earth to form broad enough channels and ridges, so that their slopes are flat enough to reduce the interference with machinery operation to a minimum. A second desirable consideration is to move all the earth required for the ridge from the channel. Any subsoil uncovered in the channel will be improved much more rapidly than will the strip below the terrace if soil is moved from the downhill side into the ridge.

For building the channel type terrace, a type of machinery adapted to earth hauling is required. The wheel scraper of a size that can be operated with a two or three bottom plow tractor is a very practical unit. The larger wheel scrapers used commonly for highway construction can also be used.

The important requirement is that the machine be adapted for cutting a channel and transporting the material to the pot holes and depressions that need to be filled or into low segments of the terrace where a ridge needs to be constructed or reinforced. On many locations the farm plow can follow the scraper and construct the ridge. This combination of the farm plow and wheel scraper is most effective.

The builder of terraces needs to be careful that they have sufficient capacity to carry all the water brought to them without overtopping and bad breaks. Under average Wisconsin conditions, wherever good rotations are used, a cross sectional area of seven to eight square feet is adequate for the ridge-channel type. Somewhat smaller size may be used for the channel type because slight overtopping does not produce serious damage.

## What It Costs to Build Terraces

The cost of building terraces varies widely with conditions. If the field is quite uniform, construction of the ridge channel type terraces with a patrol grader, farm plow, or similar equipment is commonly done for about \$5.00 per acre. If the field is severely gullied, so that considerable earth must be moved with hauling equipment to reinforce the weak spots, the cost may be several times this figure. The costs of channel type terraces have ranged from \$7.00 to \$15.00 per acre. In these cases additional benefits were secured by the filling of depressions and also in securing terraces easier to work.



## How To Farm Terraced Land

Objectionable features of operating farm machinery in a terraced field can be reduced to a minimum by (1) Building the channel type terrace where fields are not too steep. (2) Building the ridge-channel type terrace with a broad base ridge that will result in less steep side slopes. (3) Carry on field operations in the direction parallel to the terraces, or nearly so. (4) Remember, that no matter how you manage terraced land, terraces are easier to cross with machinery than shoestring gullies that are prevented by terraces. (5) Remember also, that the top soil saved by terraces, and the extra water held by field operations on the contour result in larger yields of crops than would be obtained without terraces. (6) The drainage type terrace offers less obstruction to the passage of machinery than do the waterlogged depressions that can be filled by the material from the channel.

Most of the soil material that is carried into the terrace channel by the runoff between terraces lodges there in the channel. Field operations also tend to fill the channel and lower the ridge. This means that some effort must be made to maintain the capacity of the terraces. Experimental data and field observations indicate that sufficient capacity will be maintained if in one plowing per rotation, preferably that following corn, a back furrow is placed on the ridge and a dead furrow left in the channel. If this back furrow is always located exactly on the crest there is a tendency to form a bench. This can be avoided if the crest of the ridge is crowded uphill very gradually by placing the back furrow slightly to the uphill side of the crest.

In the Spencer soil area farmers who have built terraces commonly testify that this practice permits them to get out on to the land a week to ten days earlier. This is particularly true of the combination channel type and field leveling.

Here is a specific illustration. Near the upper side of a 60 acre field was located a depression about two acres in area. This was always too wet to sow to grain when the balance of the field was fit. Channel terraces were built in this field and all of the material used to fill this depression. Now it is fit to farm as early in the spring and as soon after rains as the rest of the field. The first year after terracing, this two acres yielded 186 bushels of oats where no oats could be seeded before.

Another field of 10 acres, proved after clearing to be too wet for crops, and was producing poor grade pasture. The first year after terracing this field produced 77 bushels of oats per acre.

A common mistake made by farmers is to delay terracing a field until much of the most productive top soil has been carried away and gullies are getting so deep that it is difficult to farm it at all. Then they terrace as a last resort. Result: the job is more expensive then, and there is not as much land value to save as if the terracing had been done years earlier. Why not resolve to do the job in time?

