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Modern Terraces for Soil Conservation

Intensive cropping with row crops such as corn and soybeans on sloping land, especially long slopes, can cause excessive soil erosion. You can limit that soil erosion, however, by using modern terraces with contouring and conservation tillage. This folder describes modern terraces—their advantages, disadvantages, and where they are practical.

WHAT ARE TERRACES?

Terraces are combinations of ridges and channels constructed across a slope. They reduce erosion, conserve moisture for crops and underground storage, reduce gully formation, and reduce the number of waterways required.

Terraces, in effect, divide a long slope into several shorter ones (figure 1). Dividing a 600-foot-long, 6-percent slope into four, 150-foot lengths will cut erosion in half; and most of the soil that does erode will stop in the terrace channels.

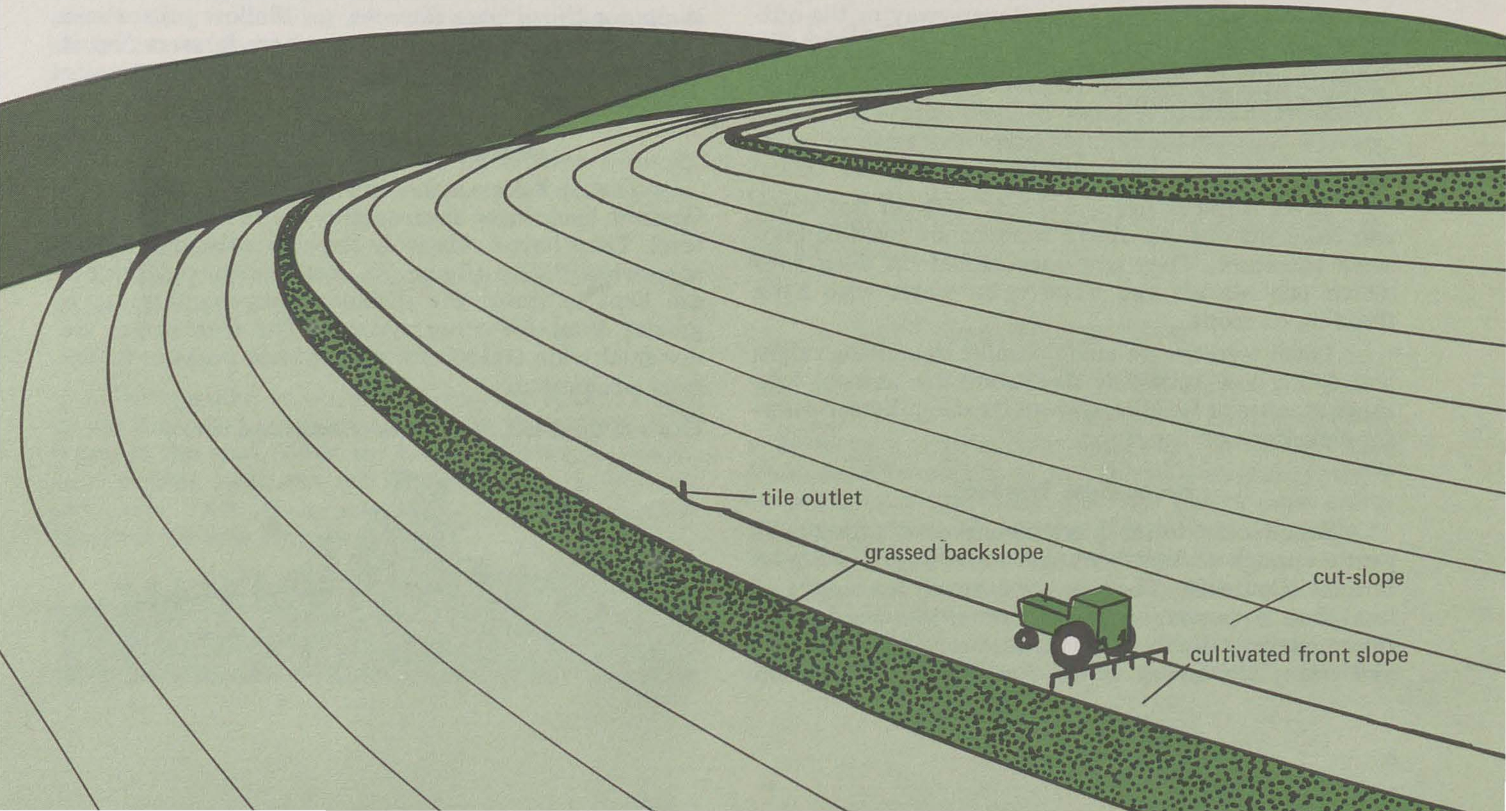
Terraces control water erosion by diverting or storing surface runoff instead of letting it flow uninterrupted down long slopes. Properly constructed graded or gradient terraces conduct runoff to grassed waterways or tile outlets at non-erosive speeds. Level terraces hold runoff on the land so that it will soak into the soil. Terraces reduce the amount of flooding of adjacent bottom land and greatly reduce the amount of sediment which could pollute lakes and streams.

Terraces broaden your planting choices. They permit more intensive use of row crops and larger fields on sloping land which otherwise would erode excessively, and permit greater choice and variation in crop sequences.

Many design considerations must be made; thus, it is important that professional conservation engineers plan terrace systems. Terraces and the land above them should be farmed on the contour to adequately control erosion and maintain the usefulness of the terraces. Terrace systems should be designed to fit the width of field machinery. They should not be crossed with field roads or tillage equipment. Continuing maintenance with proper tillage and quick repair after damaging rains is important.

Construction costs are substantial and should be considered long-term investments.

Figure 1. A long slope divided into shorter slopes by terraces.



Characteristics of Good Terrace Systems

Good terrace systems:

- are **parallel** with few if any point rows and no excessive turning;
- have **gentle turns**, with the least curvature that is practical;
- **are spaced to easily accept present and future field equipment;**
- have channels and ridges which are **easy to farm with present and future equipment;**
- provide for **convenient access** and travel for machinery and/or livestock;
- **are spaced as far apart as possible** (spacing depends on the steepness of the slope and its influence on erosion).

Topography and Soil Conditions Best-Suited for Terraces

The following characteristics describe land best-suited for terraces:

- The average slope is 12 percent or less.
- None of the slope exceeds 17 percent.
- The soil is deep, not sandy, and has few stones. (Sandy, shallow, and stony soils limit economical construction and maintenance of terraces.)
- The topography is quite regular. (Designing an acceptable terrace for extremely irregular topography is very difficult, and construction is very costly.)

TYPES OF TERRACES

Graded Terraces

Graded (gradient) terraces have channels with slight grades or slopes, so that surface runoff is conducted to a non-eroding grassed waterway or tile outlet at non-erosive velocities. Graded terraces normally are used where soils are not permeable enough to absorb sufficient runoff.

Level Terraces

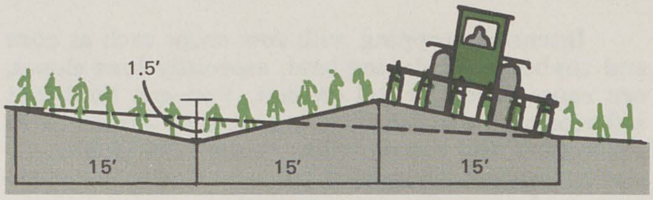
Level terraces have channels that do not drain and have no outlets. Level terraces are used to conserve moisture. They are constructed on deep soils which can absorb and store extra water with little flooding of crops.

Level terraces are made parallel by cutting ridges and filling low spots, by separating the terraces into short reaches or lengths, and by locating them at varying elevations on the slope.

Broad Base Terraces

Broad base terraces are constructed with slopes gentle enough so that both sides of the ridges can be farmed (figure 2). They are best-suited for slopes of less than 5 percent and are not recommended on slopes steeper than 12 percent. Some planting and cultivating machinery slides downhill excessively on

Figure 2. Cross-section of a broad base terrace designed for farming.

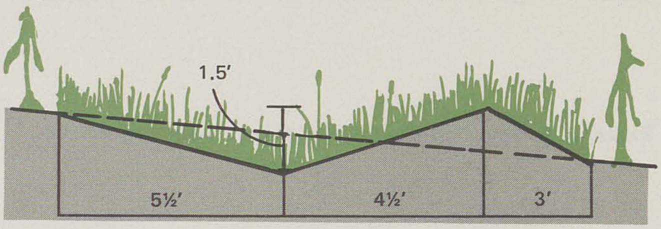


the steeper slopes. The earth for construction usually is taken from the channel side of the ridge. This increases the average slope of the field, because the land on the uphill side of the channel and the downhill side of the ridge is made steeper; this steeper land erodes easier. Broad base terraces may be either graded or level.

Narrow Base Terraces

Narrow base terraces are built with a narrow ridge; both frontslopes and backslopes are steep and grassed (figure 3). The cutslope (above the channel) usually is gentle and farmed, but may be steep and grassed. Earth for these terraces normally is taken

Figure 3. Cross-section of a narrow base terrace with grass slopes.

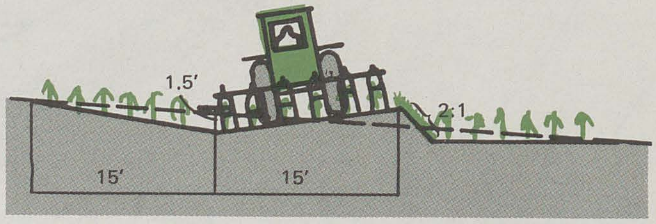


from the downhill side to reduce the slope of the field. The narrow base terrace generally is used on land too steep for broad base terraces, on shallow soils where deep cuts are not practical, or where farmers find it inconvenient to farm the terrace slopes.

Grassed Backslope Terraces

The backslope is the downhill side of the terrace. Grassed backslope terraces may be either graded or level. They have a relatively steep backslope of 2:1 or somewhat flatter (figure 4). Because the backslopes are kept in grass, the distance between terraces is greater than for other systems. The frontslopes are designed wide enough for current and possible future field equipment.

Figure 4. Cross-section of a grassed backslope terrace.

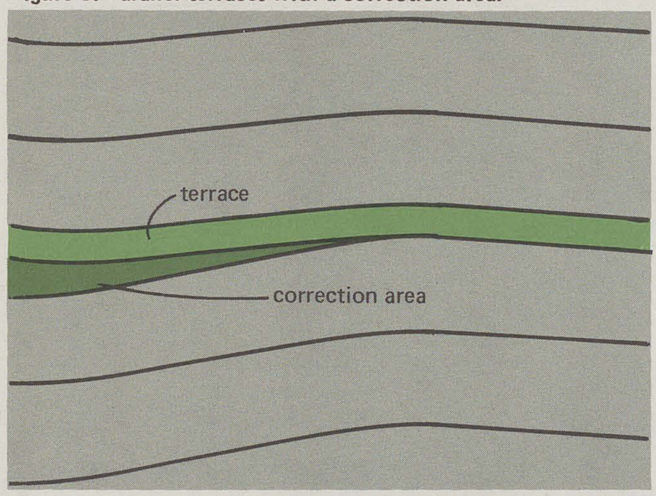


The soil for this type of terrace generally is taken from the downhill side in order to decrease the field slope and reduce soil erosion. Some of the soil may be taken from the uphill side: 1) where land is quite steep (in order to reduce construction costs); 2) where soils are shallow; and 3) where cuts and fills are necessary to construct a more parallel alignment, smoother curves, suitable channel grade, and smoother land between terraces.

Parallel Terraces

Parallel terraces are two or more terraces spaced a uniform distance apart. They make row crops easier to grow than do non-parallel terraces. Correction areas may be included between the terraces (figure 5) and cropped or kept in grass.

Figure 5. Parallel terraces with a correction area.



Parallel terraces are used where the topography and soils lend themselves to such a layout with reasonable cutting and filling or earthmoving. Eliminating sharp curves and reverse curves where possible and interrupting or leaving terraces open on sharp ridges improves alignment of the terraces and makes farming easier.

Terraces are made parallel by cutting through high spots and filling low ones, by varying the grade along the terrace, by using more waterway outlets, and by using tile outlets.

Parallel terraces are more costly to build than non-parallel terraces.

Non-parallel Terraces

Non-parallel terraces have varying distances between them and more closely follow the natural contours of the land. They are better adapted to irregularly sloping land and are relatively easy to lay out and build. They are more suitable for small grain and hay than for row crops.

DIMENSIONS OF GRADED TERRACES

The height of the ridge of graded terraces above the channel for those with grassed outlets ranges from 0.7 feet at 200 feet from the outlet to 1.1 feet at 1,000 feet from the outlet (figure 4). These figures apply to both broad base and grassed backslope terraces.

The height of graded terraces above the channels having tile outlets varies with the topography, the amount of water storage needed, and the type of cross-section.

The grades of the channels are normally between 0.3 and 0.8 feet per 100 feet of distance. These grades can be exceeded for short distances in order to improve alignment. Level grades may be used for short distances. The maximum allowable velocity of flowing water in the channels is 2 feet per second.

DISTANCE BETWEEN TERRACES

The distance between terraces depends on the slope of the land, the type of tillage systems that will be used on the field, and the erodibility of the soil. The distance between terraces should not be greater than the maximum length of slope allowed for contour cultivation alone. Conservation tillage will make it possible to use wider distances without excessive erosion.

Table 1 lists maximum distances between terraces.

Table 1. Maximum Distance Between Terraces

Land slope	Horizontal spacing
1-2%	400 feet
3-5%	300 feet
6-8%	200 feet
9-12%	120 feet

Certain factors can affect the spacing. Spacing may be increased as much as 10 percent to allow for better alignment or location of terraces, to accommodate farm equipment, to reach a satisfactory outlet, or for terraces with underground outlets. Also, spacing should be adjusted to provide for complete round trips of anticipated row-crop equipment and maximum opportunity for changing row widths to accommodate new equipment.

WATER OUTLETS

Grassed Waterways

The surface outlet may be a natural grassed waterway, a constructed waterway, or some other well-vegetated area such as a permanent grass pasture or permanent grass hayland. The outlet must carry the runoff from the terrace system to a point where the runoff will not cause damage (figure 6).

Waterway outlets must be installed and have a good grass sod before terrace construction to eliminate erosion in the waterway channel. Obtain approval from proper authorities before using road rights-of-

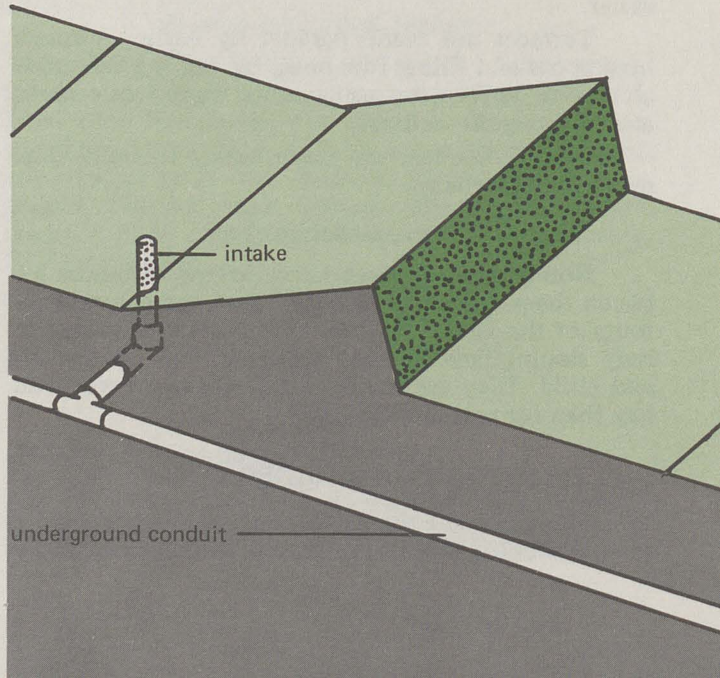
Figure 6. A grassed waterway as a terrace outlet.

way for terrace outlets. Detailed guidelines for constructing grassed outlets may be obtained in other publications or from qualified soil conservationists.

Tile Outlets

A tile outlet is composed of three parts—the intake, the underground conduit, and the outlet (figure 7). The **intake** is a vertical metal or PVC pipe with holes or slots in the sides to take in water but hold back trash. There can be a joint and collar at ground level to allow temporary removal for passing machinery and replacement in case of damage. The intake should be far enough away from the top of the terrace so that the widest farm equipment that will be used can pass easily between the intake and the ridge of the terrace. The minimum distance is 15 feet. The top of the intake pipe should be no lower than 6 inches below the top of the terrace. The minimum height of the pipe above ground is 2 feet. The channel around the intake should be constructed so that it drains completely and does not pond water.

Figure 7. Cross-section of terrace channel and ridge with tile outlet, showing intake and underground conduit.



The **conduit**, or underground tile line, must be deep enough below ground to avoid frost or machinery damage—preferably 3 feet or more.

The **outlet** at the end of the tile line must be located where it will not cause erosion and must be of sufficient capacity to carry all the water for which it is intended.

Tile outlet systems drain water slowly through underground tile. The system should remove all surface water from each terrace channel within 48 hours (or sooner if required by special crops).

A major benefit of tile outlets is that they eliminate the need for grassed waterways.

ASSISTANCE AVAILABLE

Soil and water conservation districts (SWCD) and the Soil Conservation Service (SCS) can assist in determining the feasibility of terraces on your land, in designing and staking-out terraces, and in supervising construction.

Cost-sharing for construction and names of reputable conservation contractors are available from the Agricultural Stabilization and Conservation Service (ASCS) and from your SWCD. The ASCS will cost-share up to 75 percent of the cost of construction, depending on levels set by the county ASCS office (maximum in 1979 was $3,500 annually per farmer). The SWCD also will share up to 75 percent of the cost of construction.

TERRACE CONSTRUCTION COSTS

Terraces usually are built by earth-moving contractors. During the spring of 1979, earth-moving cost between $.75 and $3.00 per foot of terrace. If terraces were spaced about 120 feet apart on a square field of 40 acres, about 13,200 feet of terrace would be required in addition to drainageways. If construction cost $1.00 per foot, the total cost would be $13,200, or $330 per acre. Installing grassed or tile outlets is another cost. The average per acre cost for complete installation of terrace systems in 1979 was about $500.

Although terrace construction is expensive, the cost may be considered an investment in land improvement. Cost-sharing, amortizing, and other tax considerations can reduce the land operator's share of the expense to a relatively small portion. The cost may be amortized over a period of 10 years, for example, although with proper maintenance the system can last much longer.

PREPARING FOR TERRACES

Here are some suggestions for considering a terrace system on your land:

- Visit with farmers in the neighborhood who have terraces.
- Discuss the possibilities with professional soil conservationists.
- Make preliminary plans.
- Get construction cost estimates and cost-share information.
- Consider alternatives to terraces—for example contouring, more hayland, contour strips, loss of soil due to excessive erosion.
- Plan step-by-step procedures with soil conservation district technicians.

MAJOR STEPS IN TERRACE CONSTRUCTION

Designing and installing a good terrace system is a complex effort. It should be done by highly qualified and experienced conservation engineers, technicians, and contractors who consider:

- suitability of the land for terraces
- availability of outlets
- soil types and land slope
- types of terraces that will work—parallel terraces if possible
- fitting the terrace system with the type of farm equipment used
- terrace maintenance requirements

The engineer or technician goes through these steps:

1. surveys the land to be terraced
2. designs the terrace system
3. stakes the terrace system on the land
4. supervises construction

These are the major steps after planning:

1. smoothing the land where needed
2. installing grassed or tile outlets
3. staking and constructing terraces, beginning at the top of the slope
4. plowing and fertilizing the field
5. fertilizing and seeding grassed backslopes

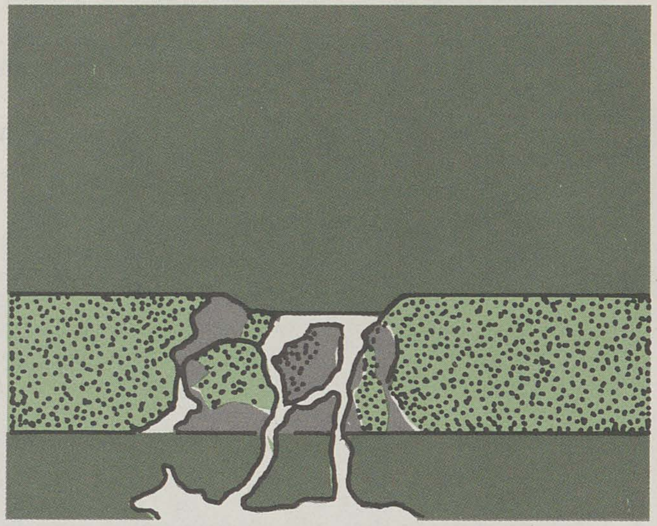
FARMING TERRACED LAND AND MAINTAINING TERRACES

Terraces are very effective in controlling erosion; but continuing, careful maintenance is necessary. It is important that the terrace ridges and channels be maintained in the same shape as when they were constructed, or improved where necessary. Very heavy rains and ice in the channels can cause water to overtop and wash out terraces (figure 8). When there is a break in one terrace, all the terraces on the same slope below usually are washed out, too. Pocket gophers and other rodents also can cause terrace failures by digging tunnels. Rodents should be controlled.

Terraces should be inspected after spring runoff and after each heavy rain. Damage should be repaired as soon as possible.

All field tillage operations should be on the contour. It generally is recommended that land between

Figure 8. A wash out that needs immediate repair.



two terraces be contour-planted starting at the lower terrace. Point rows then will be at the upper side of the strip. Terraces should not be crossed with field equipment. The SCS has detailed instructions on farming terraced land.

CONCLUSIONS AND SUMMARY

Much of the sloping land in Minnesota can be row-cropped intensively if terraces are used. Terraces reduce the length of the slope and greatly reduce the erosion hazard. Terrace systems are expensive to design and construct; they must be properly farmed and maintained to be useful over the long run.

Graded broad base and grassed backslope terraces are very suitable in Minnesota. Parallel terraces are the most desirable. Terrace systems should be planned to be adaptable to the field machinery that will be used. Tile outlets rather than grassed waterways are preferred, because the former can make farming the terraced land much easier.

Expert assistance in terrace design and installation is available from the soil and water conservation districts (SWCD) and the Soil Conservation Service. Cost-sharing for construction is available also from the SWCD and the Agricultural Stabilization and Conservation Service. Very experienced and reputable conservation contractors should build the terraces.

Terraced land must be farmed on the contour and the terraces properly maintained, if the terraces are to be permanently effective.

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