SAVE the SOIL with Contour Farming and Terracing
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Save the Soil With Contour Farming and Terracing

By E. W. LEHMANN and R. C. HAY

TO STOP or to reduce enormous losses of soil from erosion on 18 million acres of rolling Illinois land, farmers are turning to a definite soil-improvement and erosion-control program. They are applying lime and phosphates in order to grow deep-rooted legumes; they are growing cover crops, retiring land to permanent pasture, planting trees, adopting contour farming or strip cropping, and constructing terraces. All these practices work together to save the soil and its fertility from being washed away by surface water.

One rain washed all this rich topsoil from the adjoining field. A system of terraces would have prevented most of the loss. (Pulaski county)

Many farmers hesitate to begin contour farming and terracing, believing that contour farming, with or without terraces, is difficult. However, even tho extra care is needed in maintaining terraces and in crossing them with farming machinery, it is no more trouble to farm on the contour than to cross gullies or to farm small patches in fields

1E. W. LEHMANN, Chief in Agricultural Engineering, and R. C. HAY, Associate in Agricultural Engineering Extension. The authors wish to acknowledge the assistance of the U. S. Soil Conservation Service in the preparation of this circular.
Sheet erosion and gullying are ruining this field. A deep fill will be required to terrace across the gash in the foreground. (Shelby county)

cut by gullies too deep to cross. At any rate, any inconvenience is well repaid by the greater crop yields that result from saving the fertility of the soil.

Losses of soil carried away by runoff water are sometimes very deceptive. Because sheet erosion is not so noticeable as gullying, it is thought to be less serious, but actually the greatest losses of fertility are often brought about by sheet erosion before serious gullying occurs.

Faulty cultivation is responsible for this desolate scene. Only a planting of trees, which will take years to grow, will redeem the land. (Johnson county)
Terraces built like these will control erosion and also serve as guide lines for contour farming. (McLean county)

**BENEFITS FROM CONTOUR FARMING AND TERRACING**

Whether all the various practices that can be used to reduce erosion losses are needed on a given farm depends upon the character and fertility of the soil, the type of farming followed, the length of the slope and its steepness, and the extent to which erosion has already occurred. Where slopes are gentle and erosion is not far advanced, good soil management alone may serve to keep soil losses in check. But even on moderate slopes and fertile soils, it is impossible to prevent the washing away of soil from cultivated land unless protective measures of some sort are taken—measures such as plowing, planting, and cultivating on the contour, and the construction of terraces.

*Contour farming* is merely the plowing, planting, and cultivating of land across rather than up and down the slope (pages 6 and 7). On cultivated land having a slope of more than 2 or 3 percent (a fall of more than 2 or 3 feet in 100 feet), contour farming is a basic protective practice used to supplement good soil management. The benefit to cultivated land from contour farming and terracing is usually greater than the benefit to uncultivated fields from terracing, for well-managed permanent pasture or timber is a natural protection against
Contour buffer strips and grass waterway were staked out and left in sod when the rest of the pasture was plowed. (McLean county)

erosion. Eroded land being retired to pasture, however, and badly overgrazed and depleted pasture slopes may be benefited by small, close-spaced terraces or furrows (15 to 25 feet apart, depending on the slope), blocked at frequent intervals to hold the runoff. Such pasture furrows not only control sheet erosion and gullying, but conserve moisture—and this conservation of moisture is often as great a benefit as is the saving of soil.

*Strip cropping* carries contour farming one step farther in preventing losses from erosion. The simplest form of strip cropping is that in which contour strips of hay crops one or two rods wide are

Cornfield planted on the contour. The contour guide lines can be seen in the center of the picture. (Schuyler county)
left at intervals on the slope, while the areas between the hay crops are in a cultivated crop. In heavy rainstorms the sod strips check and spread the surface runoff, and thus reduce erosion. They also serve as guide lines for plowing and planting the cultivated areas. Terracing is the final device for holding and controlling the flow of runoff water. A combination of contour farming or strip cropping and terraces gives the best possible protection to cultivated sloping land.

Contour farming, whether done with the added protection of terraces or without, results in better yields of crops because it conserves water and soil and permits power and machinery to be used more efficiently. These benefits have been definitely demonstrated not only in carefully controlled tests at various experiment stations but on many farms throughout the corn belt.

At the Clarinda (Iowa) Erosion Experiment Station, over a four-year period on an 8-percent slope, a field farmed on the contour averaged 1/10 inch of runoff water a year and no soil losses, whereas a field plowed up and down the slope lost 9 1/2 inches of runoff and 40 tons of soil an acre a year. On fifteen farms cooperating in the U. S. Soil Conservation Service project in McLean county, Illinois, the corn yields in 1939 averaged 58 bushels an acre on land farmed on the contour but only 54 bushels an acre on land farmed in straight rows up and down the slopes. Similarly, in Missouri tests, losses of soil were found to be 8 1/2 times as great on unterraced land as on terraced

Contour furrows in this pasture were built with plow, scraper, and farm tractor. (Brown county)
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land; in tests in Wisconsin the losses were 7 times as great on unterraced land. A saving of 9.4 percent in fuel and an increase of 12.8 percent in number of acres covered per hour when the work was done on the contour were reported by the Kansas Agricultural Experiment Station.

SYSTEMS OF CONTOUR PLOWING AND PLANTING

Terraced land should be contour-farmed. On cultivated land sloping more than 3 percent, contour farming is necessary for successful terraces. On slopes of less than 3 percent, terraced land can be farmed in straight rows if the terraces are carefully maintained. Contour farming, however, is recommended even for these slopes because each row becomes a small terrace, tending to conserve moisture and to check any erosion between terraces.

Farming contoured land, whether it is terraced or not, presents some problems in dealing with irregularities in length of rows and shape of areas. Farmers have used successfully four principal systems of plowing and planting. These systems are adapted to buffer strips in strip cropping and to terraces.

System A. When entire field is in a single crop, or when buffer strips of uniform width are left as markers, plowing is commonly done in lands around each guide line or buffer strip. The full-length rows run parallel to the guide lines, both above and below, until they meet. The point rows then come in the center. This method is preferable when corn is to be harvested with a mechanical picker or a corn binder.

System B. Planting starts just below each contour line or buffer strip or terrace ridge, and works down the slope to the next line. With terraces, the turning in planting and cultivating the point rows is done in the terrace channels; with buffer strips, the turning is done on the strips.

System C. When point rows are not cultivated, buffer strips of grass or a hay crop, of various widths, are used. The area between these correction strips is plowed as a land. Whether correction strips are more desirable than point rows will depend on the size of the areas that will be lost to row crops, number of point rows avoided, and advantage of raising hay crops in this way.

System D. The “key” line is adapted to gentle slopes. All rows are planted parallel to one key line, usually the straightest or longest. This system is not usually suited to strip cropping but is adapted to contour farming on unterraced land without buffer strips.
Four methods of contour planting with terraces on buffer strips

In all four of these systems corn must be drilled; but drilled corn yields as well as checked corn, according to experiments by the Agronomy Department, University of Illinois, and furthermore, mechanical pickers operate more easily when husking one ear at a time than when husking several ears, as they must when the plants are arranged several in a hill.
PLANNING CONTOUR AND TERRACE SYSTEMS

Start Before Erosion Is Serious

It is best, tho not always possible, to begin contour farming and terracing on cultivated slopes before severe erosion occurs. One reason for doing so is that it is easier and far more desirable to prevent the loss of fertile top soil than to try to enrich exposed subsoil. Another reason is that the cost of terracing is less and farming operations are simpler if terraces are constructed before gullyying is far advanced.

On gullied land contour farming without terraces is difficult and often ineffective. If terraces are built, extra work and expense are required to make earth fills across the gullies. With relatively valuable land the extra expense required to make these fills may be justified, but with land of low value the high cost of fills often makes terracing impractical. The greatest return for the expense and effort put into contour farming and terracing comes from highly productive slopes that are not severely eroded.

Contour Farming Is First Step

The lines that are established for contour farming should be so located as to be not only immediately practical for contour farming but at the same time permit terraces to be added after the waterways for the outlets are well sodded. Natural draws tending to erode need to be left in sod to prevent the formation of gullies and to make it easier to cross them with machinery. Wide well-sodded grass waterways are needed wherever land is farmed on the contour, but they are particularly needed on land to be terraced since every terrace requires one or more such water outlets. Development of these two simple erosion-control practices—grass waterways and contour farming—is thus an important step leading to terracing.

When a field is to be farmed on the contour without terraces, as is done on gentle and more or less uniform slopes, only a few contour lines need be established. Where the slopes are steeper and less regular, more guide lines will be needed in order to make it possible to grade the furrows accurately. It is best to consider these lines as future terrace markers; consequently they ought to be located in the field exactly as terraces are located (see cornfield on page 6).

When buffer strips of hay crops are used in contour farming, the change to terracing is simple, for terraces can be built on the sod strips without disturbing the crops growing between them. A second
advantage in starting with strip cropping is that the locations planned for the proposed terraces or outlets can be tested and desirable changes made in the plans before the terraces are built. Strip cropping requires no expense other than the use of a level to locate the strips.

**Preliminary Study of a Field**

When a field is to be terraced—whether the terracing is to be done immediately, or contour farming without terracing is to be practiced for a few years—a plan should be worked out that takes into consideration the entire area involved, including any watershed that drains onto the field, and the other points mentioned below.

**Include entire watershed in plans.** The terrace system must be located with respect to the top of the slope. The vertical distance from the top terrace to the top of the slope should usually not be more than the vertical distance between the other terraces. Sometimes water from a field above drains across the field to be terraced or contour-farmed. If the area above is small, the top terrace may be so located that it will not drain more than 4 acres. When a larger area above is involved, the best solution is to terrace the upper field first. If it is not terraced, a diversion ditch must be built on a nonerosive grade at the upper side of the lower field to carry the water from the upper area to the side of the field, where it can be let down thru an outlet that may also serve as a terrace outlet. Where the runoff from the upper area drains thru one or two draws, it may be possible to establish sod in these water courses and later use them for terrace outlets.

**Locate suitable outlets.** One of the most important things to consider in a terracing job is the location of proper outlets. Well-sodded permanent pastures and draws or unpastured woodlots that have a thin stand of trees and a tough sod make good natural outlets. When a suitable natural outlet cannot be found, a wide, shallow, terrace-outlet ditch can be graded down the slope and sodded and, if necessary, protected by permanent dams. When the outlet channel is graded, all exposed unproductive subsoil should be covered with topsoil before seeding or sodding. Outlets should be prepared a year or more before the terraces are built.

Terraces cannot be emptied legally onto a public highway without permission unless the terraced land drains naturally onto it.

**Consider adjoining fields.** Farmers who own adjacent land can sometimes arrange to utilize jointly good outlets along boundary lines by draining terraces from both sides of these outlets.

Possible future terracing of other land on the same farm should
always be taken into consideration in any terracing plans. Whenever practicable, the outlets should be so located as to drain terraces from the fields on both sides. It is not usually advisable to construct outlets along fence lines or field divisions that are to be changed.

**Analyze the slopes.** Fields without abrupt changes, "hog backs," or deep gullies, are best adapted to terracing. Unfortunately some of the rolling land in Illinois that is subject to harmful erosion is very uneven. Terraces on such land often form queer, irregular patterns that are difficult to farm on the contour. Sometimes the terrace lines on cultivated fields would have to be so crooked and uneven that terracing would be of doubtful value. Contour farming without terraces may nevertheless be worth while on such fields.

Placing all of a slope in one field will often make terracing and contour farming more practicable, as will also fencing into pasture or woodland irregular corners, extremely steep slopes, and badly eroded areas. Electric fences may simplify the making of such changes.

**Does soil erode badly?** Some soils are much more erosive than others. Erosion on a yellow-gray timber soil having a relatively gentle slope may be enough to make terracing worth while, whereas a rich brown silt loam prairie soil on a similar slope may give no evidence of erosion. On the more erosive soils and on soils underlain with an impervious subsoil, terraces are usually spaced at shorter intervals and may well be given more grade than terraces on better soils.

**Estimate length of terraces.** An estimate of terrace length will aid in determining the grade to be used when the terraces are staked. When terraces are longer than 1,600 to 1,800 feet, an outlet is needed near the center or at each side of the field.

**Relate to cropping plan.** If possible, fields should be terraced just before they are seeded to alfalfa or clover, for the terraces will then settle and become well established before a cultivated crop is planted on them. In fields ready to be seeded to permanent pasture, and in need of terracing, narrow pasture terraces or contour furrows may be built more economically than broad-base terraces.

**Make farm roads part of plan.** The farm road should be considered when planning terraces and contours. Sometimes a contour road can be constructed on an enlarged terrace. When the road is placed at the end of the terraces, it should be at the upper end rather than at the outlet. If it must be located at the outlet, it should parallel the outlet on the outside so as not to cross the terraces. Do not allow terraces to discharge directly onto a farm roadbed, for the waterway formed by the implement and wagon tracks will start gullies.
LOCATING AND MARKING THE LINES

Equipment Is Not Expensive

Equipment for staking out terrace and contour lines includes a light drainage level or a farm level, a level rod, a hatchet or hand ax, and several stakes. Twenty dollars will usually buy a suitable level and level rod. A farmer can often find other farmers in the community willing to purchase the outfit with him.

The number of stakes needed will depend on the length of the lines and the unevenness of the ground. Stakes usually are set at 50-foot intervals, but on smooth uniform slopes they may be set at 100-foot intervals. At bends, across draws, and around points they should be set at 25-foot intervals. Plaster lath make satisfactory stakes. They can be used full length, pulled, and used over again a number of times.

A drainage level is recommended for staking out terraces, but a farm level, if carefully used, will give equally good results.

Two men are needed to stake out a line. One handles the level and the other holds the rod, moves the target, steps off the distances between points where readings are taken, and sets the stakes.

Locating Contour Lines

When simple contour farming is to be practiced, contour guide lines can be located with a minimum of effort by starting at some convenient point on the slope (usually on the steepest part) and then
proceeding a measured distance (usually an even number of corn rows) down from the highest point. Set a stake at this point.

Set up the level a little higher than this stake and 200 to 300 feet away from it. Take a reading on the target, while the rodman holds the level rod on the ground beside the stake. If this setting is 5 feet 6 inches, this is the height of the instrument above the contour line. With this target setting unchanged, the rodman paces across the slope about 100 feet nearer the instrument. He locates another point at the same elevation as the first stake by moving up and down the slope until the level sights on the target within the nearest inch. He repeats this process until he is 200 to 300 feet from the level, on the opposite side from which he started. The series of located points are thus level, that is, on the contour.

The instrument should now be moved forward and set up 200 to 300 feet beyond the point where the last reading was taken. With the rod held at this stake, change the target to a reading for the new position of the instrument, which is the new height of the instrument above the contour line. After taking the back sight, proceed as before, setting other stakes until the line is located across the field or farm.

Other contour lines farther down the slope are needed on long and uneven slopes. They also may be located in the manner described above.

Locating Terrace Lines

Locating lines for terraces requires more care and accuracy than locating simple contour lines. Before actual staking can be started, the high point of the area must be found, the approximate length of terraces determined, and the slope measured in several places.

Measure the slope. See drawing below. When there is considerable variation in slope, several such measurements are made in order to determine the most common or controlling slope. This per-

To measure the slope, set up level and take a rod reading at top of slope, then pace 100 feet down the slope and take another rod reading. Difference between two readings gives percent of slope (fall in 100 feet).
cent of slope is used to determine the vertical spacing of the terraces, as given in Table 2, page 16.

**Locate top terrace first.** Usually the top terrace line is staked out first. This is a trial line and may require restaking several times before it is finally located. Often the top terrace needs to be restaked in order to intercept the heads of small gullies or run above areas showing sheet erosion. In rich, porous soils showing no appreciable erosion at the top of the slope, the top terrace may be placed farther down the slope than indicated in Table 2, provided the area drained does not exceed 4 acres. Be sure the location of the top terrace line is satisfactory before locating terraces below it. When a steep slope starts in a field, locate the first terrace just above the break.

If there is an obstruction of some kind in the field—a sink hole, a tree, a deep gully, or a large boulder—it is often best to stake a lower terrace first in such way that it will come just above or below this obstruction. The other terraces are then located with reference to this one.

**Determine the terrace grade.** In Illinois the grade of a terrace along the channel should never exceed 4 inches in 100 feet. Short terraces are usually built with a uniform grade, but terraces longer than 400 feet are more satisfactory and have a greater capacity when built with a variable grade, the grade being reduced at 400-foot intervals from the outlet toward the upper end (see Table 1).

(\text{Table} 1)

**PROPER FALL IN VARIABLE GRADED TERRACES**

<table>
<thead>
<tr>
<th>Length of terrace</th>
<th>Fall in 100 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On average soil</td>
</tr>
<tr>
<td></td>
<td>inches</td>
</tr>
<tr>
<td>Lower 400 feet</td>
<td>4</td>
</tr>
<tr>
<td>400-800 feet from outlet end</td>
<td>3</td>
</tr>
<tr>
<td>800-1200 feet from outlet end</td>
<td>2</td>
</tr>
<tr>
<td>1200-1600 feet from outlet end</td>
<td>1</td>
</tr>
</tbody>
</table>

*Adapted from U.S.D.A. Farmers' Bulletin 1789.*

Terraces on more absorptive types of soil can usually be given slightly less grade than terraces on tight soils. On a few fields having a sandy, porous subsoil, short level terraces with closed ends are being used successfully in Illinois, but this practice is not generally recommended. Terraces longer than 1,800 feet should have outlets at both
ends or at some central point, if possible. When terraces more than 1,800 feet long must drain in one direction, the lower end should be built wider and higher than the recommended terrace cross-section.

Contour buffer strips on which terraces will be built later should have the same grade as the terraces will need.

**Decide on spacing.** The best distance to allow between terraces or contour buffer strips that are to serve as terrace markers varies with the slope and to a less extent with the soil type, extent of erosion, and rainfall. A guide to such spacing is supplied by Table 2.

(Table 2)

<table>
<thead>
<tr>
<th>Slope per 100 feet</th>
<th>Vertical drop between terraces</th>
<th>Distance between the terraces down the slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foot</td>
<td>1 foot 9 inches</td>
<td>175</td>
</tr>
<tr>
<td>2 feet</td>
<td>2 feet 6 inches</td>
<td>125</td>
</tr>
<tr>
<td>3 feet</td>
<td>3 feet</td>
<td>100</td>
</tr>
<tr>
<td>4 feet</td>
<td>3 feet 6 inches</td>
<td>87½</td>
</tr>
<tr>
<td>5 feet</td>
<td>4 feet 3 inches</td>
<td>86</td>
</tr>
<tr>
<td>6 feet</td>
<td>5 feet</td>
<td>83</td>
</tr>
<tr>
<td>7 feet</td>
<td>5 feet 9 inches</td>
<td>82</td>
</tr>
<tr>
<td>8 feet</td>
<td>6 feet 3 inches</td>
<td>78</td>
</tr>
<tr>
<td>10 feet</td>
<td>6 feet 6 inches</td>
<td>65</td>
</tr>
<tr>
<td>12 feet</td>
<td>7 feet</td>
<td>56</td>
</tr>
</tbody>
</table>

Note.—The spacings listed in this table are intended for use as a general guide. On erosive timber soils and soils having an impervious subsoil they should be decreased by as much as 10 percent; and they may be increased by 10 percent on rich, porous, loess soils.

On open absorptive soils, especially in the northern part of the state, this spacing can be increased; but on tight badly eroded soils, such as frequently occur in southern Illinois, the space between terraces must be reduced. Contour buffer strips to be used as terrace markers should be spaced exactly as terraces are spaced.

**Staking Out the Terraces**

Start with top terrace. (1) **Start at the outlet of the top terrace unless the high point or some other controlling feature is not visible or is more than 400 or 500 feet from the outlet.** Set up the level 200 to 400 feet from the outlet (200 feet is the limit with a farm level; with a better quality level, sights of 400 feet or more may be taken). Take a rod reading on the high point, and add to that reading the proper
Stakes are located with rod and level. If rod reading at high point is 2 feet 6 inches, and controlling slope is 4 percent, the proper vertical spacing (3 feet 6 inches, Table 2) will give a rod reading of 6 feet at the outlet stake.

If a grade of 3 inches in 100 feet is desired on the terrace, the target is moved down 1½ inches to 5 feet 10½ inches in order to locate the stake 50 feet from the outlet. Thus the second stake is set at a point 1½ inches higher than the outlet.

vertical spacing. This vertical spacing will depend on the percent of slope (see Table 2).

The rodman now raises the target to correspond to the rod reading on the high point plus the vertical spacing; then to locate the outlet stake of the top terrace, he moves down the slope along the outlet until the instrument man sights on the target. The stake is set here. The rodman then lowers the target to give the proper grade (Table 1), paces 50 feet in the general direction the terrace line will follow, and moves the rod up and down the slope, as directed by the instrument man, until the desired elevation is located. The second stake is set here. Other stakes are located in a similar manner until it is necessary to move the level again.

This use of rod and level in staking out a terrace line is illustrated by the drawings at the top of this page. More complete information is given in the Appendix, pages 40 to 43.

(2) When the high point, or other controlling feature, is more than 500 feet from the outlet, space the top terrace directly below this
controlling point, in the same manner as described above. Then stake the lower end of the terrace toward the outlet, beginning not at the outlet but at the stake directly below the controlling point. The procedure will be the same as that described for staking from the outlet end except that in going downgrade the target must be raised at each new location. General rule: in going upgrade in staking a terrace line, lower the target; in going downgrade, raise the target. When the lower end of the terrace is staked, stake the upper end, proceeding upgrade from the stake directly below the controlling point.

Staking the other terraces. To locate the outlet stake of the second terrace down the slope, set up the level as before, 200 to 400 feet from the outlet and somewhat below the first terrace line. Then take a rod reading at the outlet stake of the top terrace and add to that the vertical spacing, proceeding from there in the same way as in staking the top terrace.

In staking the next terrace and succeeding terraces below, it is usually best to measure the slope again at several points. These slope measurements may be taken by the rodman and instrument man as they return to the outlet from the upper end of the terrace just staked out. By this method the instrument man has the necessary data for staking the next terrace when he reaches the outlet.

When sights are long. Stakes are located as directed in the foregoing paragraphs until the rodman has moved away from the level the maximum distance for accurate readings—200 to 400 feet, depending on the quality of the level. Then it is necessary to move the instrument (see below).

Judgment and accuracy required. Responsibility for the accuracy of the work in staking out terraces rests with both the instrument man and the rodman. Care must be taken to see that the bubble is centered before each reading is taken. The level should be checked

When moving the level, the rodman holds rod at last located stake while level man moves level to new location past the rodman along the terrace line, and sets it up again. Rodman then moves target until sighted again by level man. Additional stakes are located with reference to this stake as if starting at outlet again.
frequently and kept in proper adjustment. The judgment and care of the rodman determines to a large extent the accuracy of the grade and location of the terraces. Since readings are taken on the ground, it is important that the rod always be set on average ground surface and not in depressions or on high spots. (See Appendix, pages 40 to 43, on use of the level.)

**Cross gullies with smooth curve.** When a terrace is to be constructed across a draw or gully, set the stakes to form a smooth curve bending up the slope at the gully, somewhere between the grade line and a line straight across the gully (*above*). Never run the line so as to form a V. Terraces can frequently be staked almost straight across narrow gullies.

In no case should the grade of a terrace ridge leading into a draw or gully be greater than the grade leading toward the outlet; preferably it should be less. If possible, the terrace grade should be increased as it leaves the gully. Terraces having outlets at both ends can sometimes be staked to drain in both directions from a gully or a bend near the middle of the field.

**Walking Out and Plowing the Lines**

After a terrace is staked, the short sharp bends and irregularities should be smoothed out. To do this the man in charge of the work
walks along the terrace line and moves the stakes where necessary. Stakes may be moved farther on gentle slopes than on steep slopes.

Unless the terracing machine is in the field ready to start, each terrace line should be marked out with a plow following the walking-out. Marking each line with a furrow as soon as the line is staked prevents losing stakes or having them changed inadvertently.

GRASS WATERWAYS AND TERRACE OUTLETS

Poor Outlets Cause Much Trouble

Terrace outlets are the source of more difficulty than any other part of a terrace system. When not properly located and protected, they develop serious gullies that soon get beyond a farmer’s control. Even when they are correctly placed and constructed, failure to maintain them properly will cause a great deal of trouble.

The most common faults of terrace outlets are allowing water to drain onto steep slopes or areas not properly covered by sod, and allowing it to drain into small narrow ditches or over a vertical bank or head (waterfall) in the outlet.

Choosing the Outlet Locations

Other considerations being favorable, the terrace outlet should be located on that side of the field having the least slope. Usually a draw

A well-sodded natural drainageway will carry heavy runoff from terraces without eroding. (McLean county)
Creosoted plank dam with concrete apron and notch spillway protects lower end of this long sodded terrace outlet ditch. This dam was built by the farmer himself. (Montgomery county)

or drainageway can be selected in this location. Natural draws make desirable outlets when protected by sod as shown in the picture on page 20. A well-sodded permanent pasture adjoining the field to be terraced also makes a good terrace outlet when the terraces can be drained directly onto it.

Unprotected outlets are often the cause of serious overfall erosion. An outlet structure, built since this picture was taken, is preventing further damage at this spot. (Williamson county)
When terraces discharge on a pasture or in a woodlot, the ends of the terraces should be offset if possible. That is, the top terrace should be carried farthest out, and each succeeding terrace down the slope should be stopped at least 25 feet short of the one above it. Water flowing out of the terraces constructed in this manner will not be concentrated on one narrow strip as it flows down the slope.

![Diagram of terraces](image)

**Outlets Prepared Before Terracing**

When an outlet ditch or draw must be prepared and sodded to prevent erosion, the sod should be established before water from the terraces is emptied into the outlet; otherwise there is danger of serious gullying. This means that the outlet must be prepared a year or more before terracing, or water from the terraces must be diverted temporarily into an adjoining field that has a good cover of sod.

Preparation of a sodded terrace outlet may be comparatively simple on a field already in sod that is to be plowed up. The outlet may be located on a well-sodded natural drainageway carefully marked off, and then left undisturbed when the field is plowed and the terraces constructed. If small cuts due to erosion occur in the sodded outlet, they may be filled in with transplanted sod.

When no sodded draw is available or the most suitable outlet is gullied, the following steps are recommended in the preparation and maintenance of a sodded waterway:

**Step 1.** Shape a uniform waterway as straight as practicable and of a width suited to the steepness of slope and the area to be drained (see Table 3). Plow or grade in the low places. Disk, harrow, and roll to form a firm seedbed for the channel.

**Step 2.** Apply 8 to 10 tons of manure an acre and work it into the seedbed. If manure is not available, a nitrogenous fertilizer can be used. Fertility is essential for a rapid, heavy growth of sod.
Preparing seedbed for a grass waterway to serve as a terrace outlet. After disking, harrowing, and rolling to make a firm seedbed, manure should be applied to give the grass a quick start. (St. Clair county)

Step 3. Seed 10 to 15 pounds each of redtop and timothy—twice the normal seeding—along with a nurse crop of small grain. Bluegrass and white or alsike clover may be added. The seed can be broadcast and harrowed lightly or seeded with a disk drill and grass-seeder attachment. Scatter plenty of seed on the banks.

Step 4. If the first seeding washes out, try again. If necessary, use a mulch of straw or low check dams of straw, sod, wire or brush to hold the soil in place until the sod is formed.

Step 5. Mow the channel regularly in order to prevent the nurse crop from ripening and to control weeds. Make it a productive meadow strip instead of waste land full of weeds.

Use Table 3 (page 24) to find the right dimensions for a terrace outlet ditch. The approximate acreage drained by the outlet and the steepness of slope in the channel (feet fall per 100 feet length) must be determined in order to use the table. For example, an outlet ditch draining 15 acres on a 4-percent slope must be 8 inches deep, 11 feet wide at the bottom of the channel and 17 feet wide at the top. Outlets on steeper slopes require wider and shallower channels in order to spread the flow of water over a larger surface and hold it below an erosive velocity. There is no objection to maintaining wider waterways than specified in Table 3, but there is danger in narrower ones. For additional safety, they may be slightly deeper (up to 6 inches more).
(Table 3)

**SUGGESTED DIMENSIONS FOR TERRACE OUTLET DITCHES PROTECTED BY SOD**

(For rolling, cultivated land; channels to have at least 4:1 side slope)

<table>
<thead>
<tr>
<th>Slope of ditch</th>
<th>Width and depth of channel</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
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<tr>
<td>1% W ft.</td>
<td>6</td>
</tr>
<tr>
<td>D in.</td>
<td>6</td>
</tr>
<tr>
<td>W ft.</td>
<td>10</td>
</tr>
<tr>
<td>2% W ft.</td>
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</tr>
<tr>
<td>D in.</td>
<td>5</td>
</tr>
<tr>
<td>W ft.</td>
<td>10</td>
</tr>
<tr>
<td>3% W ft.</td>
<td>6</td>
</tr>
<tr>
<td>D in.</td>
<td>5</td>
</tr>
<tr>
<td>W ft.</td>
<td>10</td>
</tr>
<tr>
<td>4% W ft.</td>
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</tr>
<tr>
<td>D in.</td>
<td>5</td>
</tr>
<tr>
<td>W ft.</td>
<td>10</td>
</tr>
<tr>
<td>5% W ft.</td>
<td>6</td>
</tr>
<tr>
<td>D in.</td>
<td>5</td>
</tr>
<tr>
<td>W ft.</td>
<td>10</td>
</tr>
<tr>
<td>6% W ft.</td>
<td>4</td>
</tr>
<tr>
<td>D in.</td>
<td>5</td>
</tr>
<tr>
<td>W ft.</td>
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</tr>
<tr>
<td>7% W ft.</td>
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</tr>
<tr>
<td>D in.</td>
<td>4</td>
</tr>
<tr>
<td>W ft.</td>
<td>8</td>
</tr>
<tr>
<td>8% W ft.</td>
<td>6</td>
</tr>
<tr>
<td>D in.</td>
<td>4</td>
</tr>
<tr>
<td>W ft.</td>
<td>9</td>
</tr>
<tr>
<td>9% W ft.</td>
<td>7</td>
</tr>
<tr>
<td>D in.</td>
<td>3</td>
</tr>
<tr>
<td>W ft.</td>
<td>9</td>
</tr>
<tr>
<td>10% W ft.</td>
<td>7</td>
</tr>
<tr>
<td>D in.</td>
<td>3</td>
</tr>
<tr>
<td>W ft.</td>
<td>9</td>
</tr>
</tbody>
</table>

*Adapted from tables in U.S.D.A. Farmers' Bul. 1814, "Terrace Outlets and Farm Drainageways."

In the above table the dimensions to right of and below the heavy black line (5'/sec.) are not as safe as those above and to the left. On steep slopes having larger drainage areas, extra precautions must be taken.

**Outlet Structures Sometimes Needed**

Most slopes suitable to terrace outlets can be stabilized with sod, so that outlet structures are not needed. The lower end of some outlet ditches or draws, however, have abrupt overfalls or heads that continue to cut back uphill. Under such conditions another outlet location should be chosen, if possible, to divert the runoff water from the head and thus avoid having to build an outlet structure. When another outlet is not practical, a dam will have to be built, usually a notch spillway type of reinforced concrete, creosoted plank, or masonry construction.
Reinforced concrete dam with notch spillway, apron, and wing walls protects this terrace outlet. Note that headwalls extend well into side banks.

Masonry dam with notch spillway protects the lower end of this terrace outlet. An earth levee on each end of the head wall prevents water from cutting around the structure. (Schuyler county)
to control the gully head (pages 21 and 25). Usually not more than one or two dams are needed in an outlet.

Such outlet dams should be carefully designed to have an adequate weir notch (opening for water flow), head walls extending well into the side banks, and an apron with suitable wing walls to prevent cutting at the overfall. The grade between structures should not exceed a fall of $\frac{3}{4}$ foot in 100, $\frac{1}{2}$ foot in 100 is preferred. Most farmers need an engineer’s services in building a dam if it is to be over 3 feet high.

**CONSTRUCTING THE TERRACES**

**Broad-Base Terrace for Illinois**

The broad-base, or Mangum, terrace is the best type under Illinois conditions; for broad ridges and wide channels that will permit the use of tractors, multiple-row cultivators, grain binders, and other modern farm machines are essential. Thousands of farms throughout the South and Middle West have terraces of this type.

The broad-base terrace is a ridge of earth with a wide flat channel above, constructed to a definite grade. Dimensions of newly built terraces that meet Illinois conditions are shown on page 27. In some sections of Illinois, particularly in the southern part, where horses and smaller equipment are used, narrower terraces are satisfactory.

*A broad flat top ridge and wide channel are characteristics of a good broad-base terrace. Ropes show exact outline just after construction.*
Many Terraces Built Too Small

Building good terraces requires the moving of considerable earth and usually calls for more time and power than an inexperienced person realizes. Farmers who attempt to build their own terraces often stop before the terraces are wide enough and high enough to function properly.

On steeper slopes (C) terraces must be built narrower and higher than on gentle slopes (A). These dimensions are for newly built terraces. After settling, the ridges will not be so high as those shown.

Some farmers have built terraces too small and have counted on gradually increasing the size by contour plowing and running over them with a drag or small grader each time the field is plowed. After a few years the terraces have attained proper dimensions. This practice is not, however, recommended when there is suitable equipment for building the terraces to proper size in the first place.

As one gains experience in terrace building, he will be able to reduce the number of rounds required to build a good terrace, and thus keep down the cost.

Detailed directions and diagrams for constructing terrace ridges are given on pages 31 to 34.
A motor grader in the hands of a skilled operator is a rapid terrace builder. This terrace is being built from the upper side only.

Machinery for Terrace Construction

Altho machines designed especially for terrace construction are most desirable for this work, equipment of other kinds found in most communities can be adapted to terracing. The motor graders now widely used on township and county roads will solve the problem in many communities, for they are also good machines for terracing. Light road graders, V-shaped steel ditchers, and V-dragS and plows are

"Whirlwind" terracer, developed at the Iowa State College, builds a terrace by throwing earth with a helical drum after it is loosened by a moldboard plow. The labor and power requirements of this machine are relatively low and its capacity high.
A blade terracer and crawler tractor are being used to build this terrace in Tazewell county. The local soil conservation association owns the terracer.

slow and inefficient. Large highway graders and crawler-type tractors throw up earth rapidly but lose considerable time in turning.

Small-blade terracers pulled by farm tractors or horses are quite satisfactory. Such machines are sometimes owned cooperatively by several farmers in a neighborhood. By providing their own power and labor, farmers can terrace with these machines at a comparatively low cash cost. When large acreages are to be terraced and the investment can be justified, the larger 8- and 10-foot blade terracers pulled by crawler-type tractors can be used at a lower cost and more rapidly and satisfactorily than any of the smaller blade machines.

A small blade terracer pulled by a tractor is building this terrace satisfactorily. (Madison county)
Two Ways to Build Ridge

Building from upper side only. On slopes steeper than 5 percent most of the earth can be moved more economically from the upper side, only enough work being done from below to smooth up and slope the lower side of the ridge (pages 31-33). Following are some of the special features and procedures under this method.¹

1. Before beginning to construct a terrace, all the shoestring gullies crossing the proposed terrace line are filled. This may be done with a team and scraper. Allow for settling of loose earth in the fills.

2. None of the cut earth is used for filling a cut section; all cut earth is placed in the ridge over the existing ground line.

3. The number of rounds needed to construct a terrace varies of course with the topography, condition and type of soil, and equipment. The construction shown on the following pages is intended specifically for a 40-hp. crawler-type tractor and a terracer with a 10-foot blade. The same procedure can be used with a 6-, 7-, or 8-foot terracer or a road grader of any length of blade.

4. To obtain a uniform ridge and prevent the earth from being spread over a large area, the tractor must be driven parallel to the ridge.

5. When a small terracer and wheel tractor are used, the ridge should be kept as flat as possible at all times. A common mistake is to try to build the ridge too high immediately, making it impossible to get up on it with a farm tractor. Farm operations are difficult to perform on the small peaked ridges resulting from faulty construction.

6. The top of the ridge must be flattened, as shown in Trips 10, 16, and 21. A peaked ridge will cause the middle of the tractor to drag so that little or no traction is possible.

7. The back slope, channel, and ridge should be smoothed with regular farming equipment—a harrow, for example.

Building from both sides. On slopes of 5 percent or less terraces are sometimes constructed by moving earth from both sides onto the ridge (page 34). A satisfactory terrace can be built in this manner; however, the down-grade portion of the terrace ridge is difficult to construct and to maintain. Let the ridge thrown up by the first two cuts be the center of the terrace ridge. The lower edge of the terrace channel, and consequently the grade of the channel, (turn to page 35)

¹Method was first developed by the U. S. Soil Conservation Service and has been used in several Extension demonstrations in Illinois, gaining considerable favor in the past few years. The description is reproduced here, with a few minor changes, from Regional Bulletin SCS-418, CCC-389, by M. T. Ekovich and A. Feltner, U. S. Soil Conservation Service, Edwardsville, Illinois.
CONSTRUCTION FROM ONE SIDE ONLY

ROUND I

Trip 1: With blade at 30°, run the tractor so that the upper track is on the stake line, thus putting the point of blade on the stake line. Cut to a depth that will permit rolling earth well off the blade.

Trip 2: Run on the opposite side of stake line with one track just above the cut. A cut of uniform depth all along the blade is made.

ROUND II

Trip 3: With point of blade cutting just enough to make movement of earth possible, move the earth from Trip 2 against the earth cut in Trip 1.

Trip 4: With point cutting lightly and heel held high, roll the earth of Trip 3 over the earth of Trip 1, being sure to carry a full load on blade. Place the toe and heel so that movement of earth is taking place over the full length of blade.

ROUND III

Trip 5: Make a complete new cut the full length of the blade, cutting to a depth of about 2 inches with the point, and deep enough with the heel to pick up a full blade of dirt. This cut will clean any stubble or weeds that may hamper subsequent rounds.

Trip 6: With blade flat, move cut made in Trip 5 laterally as far as possible, making sure that the blade is delivering as much earth as possible.

ROUND IV

Trip 7: Repeat the operation of Trip 6, moving earth laterally.

Trip 8: With the point cutting slightly, roll the loose dirt on top of the ridge.

ROUND V

Trip 9: With point cutting lightly, move the earth and trash over the ridge, widening the ridge and preventing the ridge from crowding the channel.
Trip 10: Straddle the ridge with the tractor, setting the blade at an angle of 45° or more. Take care to keep the blade from sliding off the ridge. Flattening the ridge makes it easier to build the ridge to the required height in later rounds.

ROUND VI

Trip 11: With the angle of the blade back to 30° and the heel running at the junction of the ridge and channel section, make a cut the full length of the blade, moving earth to the base of the ridge so that in following trips it can be moved on top of the ridge.

Trip 12: With the point cutting enough to roll earth, move the earth from the base to the top of ridge. Carry earth to the side as far as possible.

ROUND VII

Trip 13: Cut to a uniform depth all along the blade with heel placed as shown in drawing.

Trip 14: Move earth over to ridge, to the side as far as possible.

ROUND VIII

Trip 15: Move earth from Trip 14 and Trip 12 to the center of the ridge.

Trip 16: With blade set at about 45°, straddle the ridge and move earth as shown in drawing. This packs the ridge and makes it broader.

ROUND IX

Trip 17: This trip starts building the backslope. Set the blade at about 45° and run the toe very lightly in the earth so as to eliminate the wavy effect which often develops in cutting the backslope or cutting with the heel of the blade.

Trip 18: Move the cut made in Trip 17. Cut lightly with the point for maximum side movement.
ROUND X
Trip 19: Move earth onto the ridge.
Trip 20: Move earth onto top of the ridge.

ROUND XI
Trip 21: With blade at 45° and tractor on top of ridge, spread earth uniformly over top of ridge. Low spots in the ridge can be filled by raising the heel.
Trip 22: With blade at 30° make a uniform cut in the channel over entire length of blade.

ROUND XII
Trip 23: Move earth onto ridge.
Trip 24: Spread earth uniformly over ridge.

ROUND XIII
Trip 25: With blade at 45° and in the position shown on the drawing, cut lightly with the heel. This cut is made to smooth up the backslope.
Trip 26: With blade at 45°, move earth to the side. No cut is made here.

ROUND XIV
Trip 27: Move earth to the side with sufficient cut to smooth the section.
Trip 28: With blade at 45°, clean out the channel, placing earth on the ridge.

ROUND XV
Trip 29: Spread earth over the ridge.
Trip 30: With blade square, smooth the toe of the ridge as shown in the drawing.

The last three rounds might be omitted in many instances, if a harrow is used to dress up the terraces.
CONSTRUCTION FROM BOTH SIDES

ROUND I

Trips 1 and 2: Make first trip with point of blade at stake line, moving earth downhill. On the return, move earth upgrade, leaving an uncovered strip 2 to 3 feet wide.

ROUND II

Trips 3 and 4: Place the two ridges made in Trips 1 and 2 together at the center of the undisturbed strip.

ROUND III

Trips 5 and 6: Make a new cut just outside those made in the first round. Roll earth the full length of the blade.

ROUND IV

Trips 7 and 8: Move the earth loosened on Round 3 to the center of the ridge.

ROUND V

Trips 9 and 10: Make a deep cut just outside that of Trip 5 and a shallow cut just outside that of Trip 6. Avoid leaving a secondary channel below the ridge.

ROUND VI

Trips 11 and 12: Move the earth loosened on the previous round onto the sides of the ridge. Always keep loose earth moved well into place before making another cut.

ROUND VII

Trip 13: Make a new cut outside that of Trip 9. This trip starts the backslope.

Trip 14: Move loose earth toward the ridge.

ROUND VIII

Trip 15: Cut with the heel of the blade, moving earth into the channel.

Trip 16: Move earth loosened in Trip 15 against the ridge.

ROUND IX

Trip 17: Smooth the earth moved against the side of the ridge on Trip 16.
will follow the stake line. Leave as wide an undisturbed area under the center of the ridge as practicable, for it is best not to move earth from the section where a fill is needed. This undisturbed width will vary with the size and type of terracing equipment used.

A high narrow central portion of the ridge should be built up in the first few rounds, for earth can be moved more efficiently when the point of the blade is cutting undisturbed earth at all times. The terrace is completed by moving dirt against it from both sides and cutting a wide channel above the ridge.

Avoid leaving a channel on the lower side of the terrace ridge, for water will accumulate there, break over, and cut small gullies down to the next terrace.

Top Terrace Is Built First

Regardless of which terrace is staked out first, the top terrace should always be built first. It must be well constructed, for the safety of the lower terraces depends upon its success. It is much better to build the two upper terraces well than to build four or five carelessly or inadequately.

The completed terrace ridge should be 16 to 22 feet wide and 16 to 18 inches higher than the channel. The channel should be approximately the same width as the ridge. The bottom of the channel should be 4 to 6 feet wide.

Terrace cross-sections suited to Illinois conditions are shown on page 27. After settling, the ridge should at no point be less than one foot higher than any point in the channel below. A minimum cross-section of 10 square feet should be maintained throughout.

Making Fills Across Gullies

A slip scraper, fresno, or rotary scraper is needed to build the terrace ridges across gullies. These fills must be made wide enough and high enough so they will not break. To allow for settling they should be built about 20 percent higher than the ridge on each side of the fill. Failure to build fills properly is one of the most common causes of failure of terraces.

To take care of water that would otherwise stand in gullies crossed by terrace ridges until it evaporated or seeped away, a line of tile can be laid in the gully. Ordinarily if the slope of the tile in the gully is more than 3 percent, sewer tile should be used, for farm drain tile would wash out. Second-grade, or cull, sewer tile can often be obtained at no greater cost than farm drain tile.
Check the Finished Terrace

No terrace should be considered completed until it is carefully examined for minor construction faults and those faults corrected. Use the level and rod and take readings on the ridge and in the channel at every 50-foot station and at intervening spots that are noticeably high or low. High spots in the terrace channel and low spots on the ridge should be marked and corrected to assure the flow of water in the direction desired.

If further work extending over several hundred feet needs to be done, the terracer is the best implement to use. For short deep cuts and fills a fresno or a slip scraper is usually more economical. A bulldozer on a crawler-type tractor will make fills rapidly.

**Checking the grade** is the final job in building a terrace. No terrace should be considered complete until this is done. The stake line on which this terrace is laid out is shown on page 13.

**Corrections** are likely to be found necessary when a terrace is checked over. In the above example, the ridge at A is too low and must be built up about 6 inches. Channel and ridge at B are correct. Channel at C is too high, must be cut 3 inches deeper. Ridge at C is 6 inches higher than necessary; dirt can be used to fill in at A.
MAINTAINING A TERRACE SYSTEM

No system of terraces, however well planned and constructed, will over a period of years give the protection they are expected to give unless they are kept in good repair. Careful watching and promptness in making needed repairs will greatly simplify the problem of maintenance. In fact, some terraces rather poorly planned and not properly built have been notably successful because of the owner's persistence in repairing and maintaining them.

Inspect after heavy rains. Careful inspection of terraces the first year after they are built is very important. Ridges and fills are settling rapidly this first year. After each heavy rain the terraces should be gone over and any breaks immediately repaired with a shovel before damage becomes serious.

Watch the outlets. The outlet ditch also should be watched so that prompt measures can be taken to stop any serious washing. A good sod should be maintained in the outlet ditch and in the lower 15 to 20 feet of the terrace channel. If small gullies start cutting in the outlet, they should be filled with sod tamped firmly into place. Any breaks or leaks around permanent dams must be filled and tamped tightly before they become serious, or the structure may be washed out and the entire outlet endangered.
Ridge is built up and widened by backfurrowing to its center. To keep the ridge well shaped and not unnecessarily high, vary the location of backfurrows on the terrace with each plowing. To prevent the dead furrows from coming at the same line on successive plowings, vary the width of the lands backfurrowed on each terrace.

**Backfurrow to ridge.** Once a terrace is well established, little attention is required other than backfurrowing to the center of the ridge each time the field is plowed. This practice tends to build up and widen the ridge. In plowing terraced land on the contour, a back-

**No turning** on plowed ground is necessary when this method of plowing contoured land is followed. Full-length rounds are run parallel to each terrace or buffer guide line until a fairly narrow strip of unplowed ground is left. Short rounds are then plowed out at the wide places so as to make the unplowed area uniform in width. This unplowed area is plowed last.
Properly plowed ridges. These terrace ridges have been back-furrowed but the lands between terraces have not yet been plowed. (Whiteside county)

furrow is started on each ridge and the land between terraces is plowed out on the contour. A method of plowing out the lands between terraces or buffer strips is illustrated on page 38.

It is also necessary to keep the channel cleaned out. A round or two with a small grader or a homemade V-drag in the channel following plowing leaves the terrace in good condition.

COST OF TERRACING

The cost of terracing varies widely with the slope, extent of gullyng, and equipment. The cost per unit of length is more dependable than acreage as a basis for estimating. When terracing is done on a custom basis, the cost should not exceed one cent per linear foot of terrace. This does not include fills across gullies or outlet preparation—two items whose cost may vary from zero to more than the terracing cost, depending on the condition of the field and outlet.

The cost per acre can be estimated from the following figures.

<table>
<thead>
<tr>
<th>Average spacing of terraces (feet)</th>
<th>Approximate length of terrace per acre drained (feet)</th>
<th>Average spacing of terraces (feet)</th>
<th>Approximate length of terrace per acre drained (feet)</th>
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<td>175</td>
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<td>485</td>
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APPENDIX: USE AND CARE OF THE LEVEL

Kinds of Levels

Builders' or architects' levels (sometimes called drainage levels) are available at the offices of some of the county farm advisers. They are comparatively expensive but highly accurate. In experienced hands they make for more rapid and accurate work in staking out terrace or contour lines than can be done with other types of levels.

There are two common kinds of architects' levels—dumpy levels and wye levels. In the dumpy level the telescope is rigidly fastened to the crossbar; in the wye level, it rests in two Y-shaped supports and is removable.

Farm levels are similar in design and operation to builders' levels but are less accurate and consequently less expensive. They are satisfactory for practically all erosion-control work that a farmer is likely to do. Farm levels are owned by many farm bureaus as well as by farmers and contractors.

With the turret-type of farm level, as with the wye level, checking is easily done without the use of a rod and at a single setup by merely loosening and inverting the telescope. If the reading on a fixed point remains the same both before and after inverting the telescope, the instrument is in adjustment.

Hand levels can be used for staking out contour lines and for rough, quick measurements of slopes and grades. They cannot be depended on for staking out terraces. For accuracy, all readings with a hand level should be relatively short. The most simple hand level consists of a sight tube, a level bubble vial, and a mirror.

Carpenters' levels may be used for rough work, as in staking out contour lines. One plan is to fasten sights and mirror on a carpenter's level for use on a staff in the same way that a hand level is used. Another plan is to use the carpenter's level on an "A" frame.

To Set Up the Level

1. Spread the tripod legs far enough apart to insure stability.
2. Press the legs firmly into the ground, keeping the leveling head as nearly level as possible.
3. Tighten the wing nut on each tripod leg.
4. Turn the telescope so that it is over a pair of leveling screws.
5. Grasp both screws between thumb and forefinger of both hands and turn them in opposite directions in order to loosen one and tighten the other at the same time. Thus the thumbs move either toward or away from each other. The rule to remember is that the bubble follows the left thumb. For levels having three screws, level over each of the three—in this case, the bubble follows the right thumb.
6. Bring the bubble to the center so that the leveling screws are snug against the plate but not too tight.
7. Turn the telescope over the other pair of leveling screws and center as before. Repeat in both positions for a check.
The parts of a level with which one who is going to stake out contour or terrace lines should become familiar are shown above. Besides these parts, three others should be pointed out: the eyepiece at the small end of the telescope (A), the cross hairs which can be seen by sighting thru the eyepiece, the objective lens at the large end of the telescope.

The bubble in the level tube (B) is centered by means of the leveling screws (D on farm level and F on builder's level). The tripod is the stand on which the level is fastened for use in the field.

**Precautions:** Do not attempt to force a leveling screw when it is tight. If you do, you may damage the instrument. Loosen the other pair of screws if necessary.

Always carefully center the bubble before taking a reading.

Touch the instrument as little as possible. Avoid kicking or bumping against the tripod legs. Do not rest your hand on the level while taking readings.

Be sure that you understand the proper use of the rod when it must be extended. Remember that the target must be set at the same reading on the face of the rod as the lowest reading for the extended rod.

**Field Signals**

When the rodman is too far away to hear spoken instructions, signals must be used. Even when he is within hearing distance, signals are preferable because they are less likely to be misunderstood than spoken instructions. The following are the common signals:

**Raise the target.** Extend right hand and move it upward. For long moves raise the hand a considerable distance, but for short moves raise it only slightly.
Three types of target rods. A is graduated in feet and inches; B is graduated in feet and tenths and hundredths of a foot. C is called a self-reading rod because it is read thru the telescope without the use of a target. It also is graduated in decimal parts of a foot.

**Lower the target.** Use left hand as indicated above for the right hand, except lower it instead of raising it.

**All right.** Extend both hands horizontally and move them up and down. When the target reaches the point where the horizontal cross hair cuts directly thru the middle of the target, the rodman notes the “reading” indicated by the center of the target.

**Move to right or left.** Extend hand in direction wanted, using a long sweeping motion for a long distance and a short quick motion for a short distance. In staking a terrace line this signal will be used in locating points of nearly equal elevation at definite intervals across a slope.

**Plumb the rod** (hold rod exactly upright). Extend arm full length above head and move slowly in the required direction, as shown by the vertical cross hair.

**Hold the point.** Extend arm full length above head and wave in a circle. (This signal is used when the level is to be moved; the rodman must not move the rod until a back sight has been taken after the level has been set up again at another point.)

**Adjustments of the Farm Level**

**Level tube.** To test the level tube, first carefully level the instrument as described above. With bubble centered, reverse the telescope end for end (180°). If bubble remains centered, the level tube is in adjustment. If bubble moves out of center, bring it back halfway by means of adjustment screws on ends of level tube. Center bubble again and repeat this test; adjust the level again if necessary, always bringing the bubble halfway back from its movement out of center.

**Two-peg test for telescope.** To test telescope to see if the line of sight is level when the bubble is centered, proceed as follows (see page 43): On a fairly level area drive a stake into the ground. From this stake
Positions for two-peg test

(A) measure off 100 feet, or some other convenient distance, and set another stake (B). In the same line but in the opposite direction set a third stake (C), the distance AC being equal to AB. Remember that the tops of stakes B and C are finally to be set exactly to the same level; therefore, the ground at these points must be at nearly the same level.

Now set up the level over stake A. Hold rod on stake B and set target so horizontal cross hair cuts target in halves. The vertical hair should be near the rod, but it does not need to bisect it. Read target setting on scale and make a note of it. Then carry rod to stake C, holding it on stake C. Do not change target setting, but change the stake up or down until cross hair bisects target when rod is held on this stake and the bubble is in the center. If it is necessary to raise the stake, pull it up too far and then drive it back gradually until it is at the right elevation. This must be done carefully, as the accuracy of the result depends on these two stakes being set so the rod reading on each will be the same. The two stakes will be at the same level, even if the instrument is in error, because the distances AB and AC are equal.

Now set up the level about 3 or 4 inches to one side of the stake B, and level the instrument carefully. Set the rod on top of the stake and adjust the target until the center is at the same height as the center of the telescope tube. This can be judged quite accurately. Leave the target at this same setting and carry the rod to stake C. Center the bubble if necessary, and see if the horizontal cross hair bisects the target. If it does, the instrument is in proper adjustment. If it does not, consult the instruction book for the level or secure some skilled assistance.
Every county in Illinois has some harmful erosion