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Saving Soil by Use of Mangum Terraces

By E. W. LEHMANN and F. P. HANSON

The Most Familiar Type of Erosion

Gullying usually can be controlled by first preventing sheet erosion.

URBANA, ILLINOIS

Erosion the Most Serious Problem on Many Illinois Farms

About five and one-half million acres of land in Illinois are subject to serious erosion—the biggest problem on many Illinois farms.

Too many farmers fail to realize they have an erosion problem unless their fields are gullied, whereas sheet erosion, which may not be noticeable, is even more serious than gullying.

The aim of every farmer who has rolling or broken land should be to hold the soil in place.

Terracing is the most effective mechanical method of preventing erosion.

The object of the Mangum terrace is to check the flow of the surface water, thereby preventing soil washing and assisting in the maintenance of the productive capacity of the soil.

Mangum terraces have been used successfully for 39 years in other states and have proved practical in Illinois in recent years.

The loss of fertility and the labor required in filling small gullies with manure and other material, a practice sometimes followed, costs more than terracing.

The cost of terracing is largely an item of labor. The cost would be about $2 an acre if the work were hired done.

Terraces that have been built properly are not difficult to maintain.

Deep plowing, an ample supply of humus, and the use of cover crops are important in maintaining terraces.

Except on steep slopes, terraces do not interfere with the usual practice in farming.

Saving Soil with Mangum Terraces

By E. W. LEHMANN, Chief in Farm Mechanics, and F. P. HANSON, Extension Specialist in Farm Mechanics

Maintenance of a fertile soil is the first requirement of prosperous and permanent farming and yet there are relatively few farmers in Illinois who realize the amount and value of fertility lost by soil washing. Soil survey reports show that Illinois has an area of about five and a half million acres subject to serious erosion, as indicated in Fig. 1. This area is spreading each year and some of it is being abandoned for farming purposes. The problem has reached a point in this state where the productive power of many rolling farms is fast dwindling and many other farms are being gullied. In fact, on a large area of the state, where the fall is more than three feet in 100, the greatest single cause of fertility loss is soil erosion. The aim of every farmer who has rolling or broken land should be to hold the soil in place and it is for this purpose that the Mangum terrace, as well as other types of terraces, is designed.

Two Kinds of Erosion

Soil erosion is caused largely by run-off water. Nature originally clothed the earth with forests and plant growth, which shielded it from the millions of hammering rain-drop blows. She provided a covering of dead leaves and plants and put the soil in a good physical condition to absorb the rain water, thereby preventing run-off to a large extent. Now that man has utilized the timber on the rolling lands, the soil has been laid bare and robbed of its organic matter, with the result that the accumulated energy of the rain flowing over the surface of the ground has carried away thousands of tons of soil material. The Mississippi river alone carries nearly 7,500,000,000 cubic feet of soil in suspension each year, according to Hilgard.[1] The value of the phosphorus and potassium alone—two important elements of soil fertility—in this soil, is nearly $3,000,000,000. Phosphorus and potassium worth about half this amount, or $1,500,000,000, are carried in solution by this same river each year. A large part of this $4,500,000,000 worth of fertility is washed out of land that is being farmed. What is even more important is the fact that a portion of it comes from Illinois farms.

The loss of organic matter has made it difficult for soils to absorb water and this has resulted in an increased percentage of run-off and therefore more erosion. On some drainage areas in Illinois as high as 50 percent of the rain water does not soak into the ground, but runs over the surface and in so doing carries soil material with it.[2]

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[1]Soils, E. W. Hilgard. 1906.

[2]Bulletin 207, Illinois Agricultural Experiment Station, Washing of Soils and Methods of Prevention. 1918.

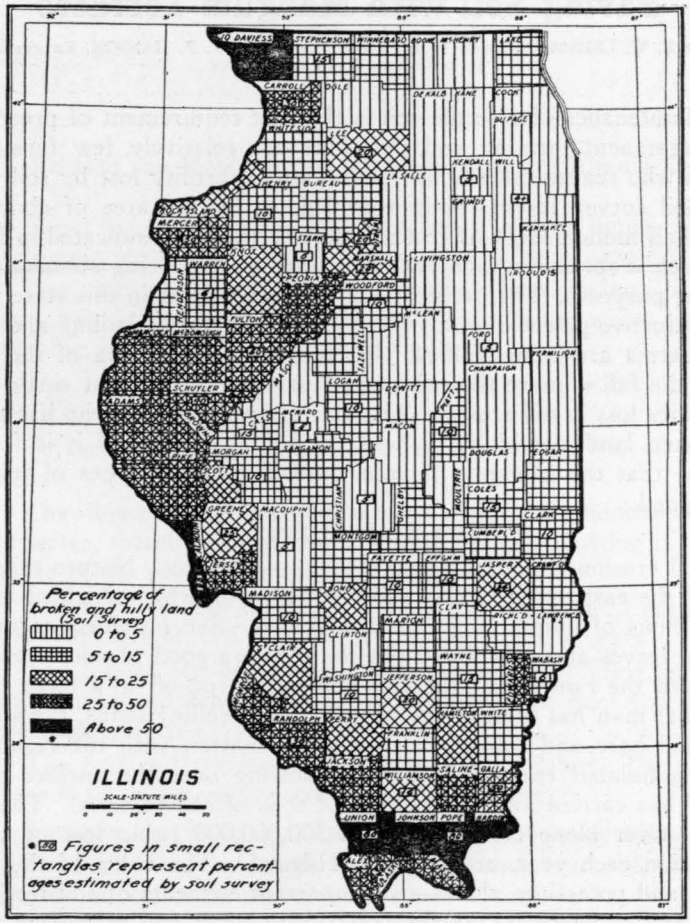

FIG. 1.—WHERE ILLINOIS LAND IS BROKEN AND HILLY

About five and a half million acres of land in the state are subject to serious erosion.

There are two kinds of erosion: sheet erosion and gullying. Sheet erosion washes away soil material to a more or less even depth from a whole field or area, while gullying cuts up a field or area and results in a more concentrated loss of soil material. Sheet erosion often is not noticeable and therefore usually is not considered as serious as gullying, but as a matter of fact it is perhaps more serious. Sheet erosion removes the most fertile soil even tho there are few or no gullies cut. Gullying tends to cut fields up into small patches that are hard to farm and in addition destroys some farming land, but this type of soil washing

FIG. 2.—TOO STEEP TO CULTIVATE

Permanent pasture or timber properly handled will prevent erosion on steep slopes having more than 15-percent grade.

usually can be controlled by first preventing sheet erosion. Fig. 3 shows the deposits from sheet erosion, while the illustration on the cover page shows the more familiar type of erosion—gullying.

Terracing Best Erosion Check

Since erosion depends directly upon the amount and speed of the run-off water, protective and preventive measures usually include practices which diminish the amount of run-off and the rate at which it

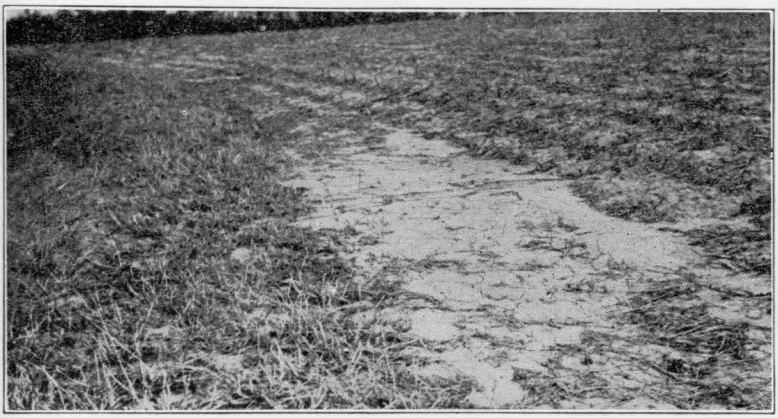

FIG. 3.—EFFECTS OF SHEET EROSION

Sheet erosion, which often is not noticeable even tho it may be serious, removes the most fertile soil. The collection of silt shown here is the result of sheet erosion.

flows over the ground. If the rain water can be made to sink into the soil or flow away slowly over the surface, there will be little erosion. To this end the Mangum terrace can be of great value to many Illinois farmers. In addition, soils that water cannot soak into can be made to absorb more water by increasing the organic matter in them, by plowing under green and barnyard manure, by deep contour plowing, and in some cases by tile drainage. Beating rains are much more destructive to unprotected soils than to those covered with vegetation. Plants absorb the blows of the raindrops, bind the soil particles together, and open the pores in the soil so that more water can be absorbed.

Terracing is the most effective mechanical method of preventing soil erosion and is doubly effective when all the above practices are employed in connection with it. Reports indicate that the first terraces tried in the Middle West to determine if they were practical for this section were those built on the Vienna experimental field in Johnson county, Illinois, in 1906, by this Station. The yield of corn on this field over a period of ten years averaged more than twice as much an acre each year on the terraced portion as it did on the check area where no special treatment was given. The terraced part of the field also made bigger yields an acre than a similar area where manure was put on at the rate of eight loads an acre for eight of the ten years. Deep contour plowing and contour planting also were practiced on the area on which the manure was applied.[1]

Mangum Terrace Best for Illinois

There are several kinds of terraces, but the Mangum terrace, which will be described in detail, is best adapted to Illinois conditions at the

FIG. 4.—RIGHT METHOD OF PLANTING TERRACED FIELDS ON RELATIVELY STEEP SLOPES

It is best to plant row crops parallel to the terraces, if the land has a 12- or 15-percent grade.

[1]The complete results of this work are reported in Bulletin 207, already referred to.

present time and warrants thoro investigation by all farmers who have soils that are subject to erosion.

The Mangum terrace was originated by P. H. Mangum, of Wake Forest, North Carolina, in 1885. It was so satisfactory as a means of checking soil washing that men on near-by farms soon adopted it, and it can now be found on thousands of farms in North Carolina and thruout the South. This type of terrace was not used in the Middle West to any extent until after the summer of 1916, when a representative of the United States Department of Agriculture first demonstrated its use in Saline county, Missouri. Since that time it has been used in a number of other counties of Missouri and more recently has been adopted by farmers of a number of other middle western states as a means of checking soil washing.

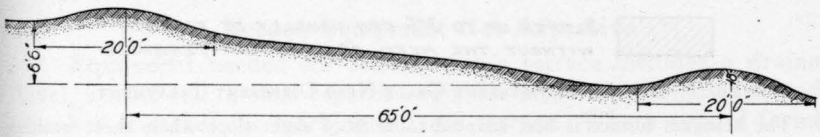

FIG. 5.—CROSS-SECTION OF TERRACES ON A 10-PERCENT SLOPE

The terraces usually are from 16 to 20 feet wide and are spaced far enough apart so that each one will take care of the water that falls between it and the one above.

The Mangum terrace, like other types, is designed to retard the flow of surface water, thereby allowing more of it to be absorbed and preventing it from gaining enough speed to wash the soil. Its value in checking soil washing on Illinois farms not only has been demonstrated by the results obtained on one of the state experiment fields, but also by the results which farmers of the state have had with it during the last two years.

It is best adapted to fields of slight slope where sheet washing carries away vast amounts of soil fertility each season. The steeper the slope the more likely the terrace is to break, especially if the field is planted to a cultivated crop. Land with a fall of three to fifteen feet in 100 can be terraced and used to advantage for a cultivated crop, but if the slope is more than this it is best to keep the field planted either in pasture or in hay crops to get the best results from terracing. In many localities orchards are planted on rather steep slopes, some of which have grades of more than 15 percent. When such land is used for orcharding it is best to terrace first and then plant the trees between the terraces.

The Mangum terrace is a ridge of dirt built up to a definite grade and having a broad base and relatively flat sides. It is the most satisfactory type of terrace for Illinois where fields are to be cultivated with modern machinery. When it is finished the terrace looks like a graded

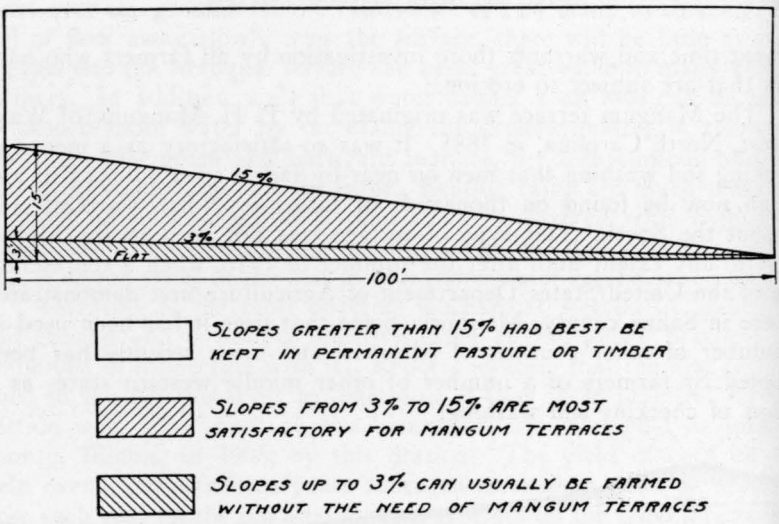

FIG. 6.—SLOPES OF DIFFERENT GRADE NEED DIFFERENT TREATMENT

The Mangum terrace is best adapted to fields of slight slope where sheet washing carries away vast amounts of soil fertility each season.

road running across the slope of a hill. In terracing an entire field a series of such ridges is built at regular intervals from the top to the foot of the hill, each of these terraces usually being from 16 to 20 feet wide. The direction in which they are built across the slope is such that there is not more than six inches of fall in each 100 feet of terrace, and the more absorptive the soil is the less this fall needs to be. This is due to the fact that on an absorptive soil the water soaks into the ground and does not collect at the terrace, thereby reducing the amount of fall that is needed to carry the collected water off and prevent its breaking over the ridge.

The terraces are spaced so that each one will take care of the water that falls between it and the one above and are close enough together so that the run-off water from average storms will not have an opportunity to descend in small rivulets between them. Where the terraces are built on a slight slope, practically all the sediment that may be carried to the terrace under abnormal conditions will be deposited immediately.

The grade of the terrace in Illinois should never be more than six inches' fall in 100 feet. For long terraces it is desirable to have a variable grade to check the flow of water as much as possible, but there must always be enough slope to discharge the water fast enough to prevent its breaking over the terraces. Table 1, from Farmers' Bulletin 997, U. S. Department of Agriculture, may be used in this connection.

The distance between terraces usually depends upon the slope of the land and the type of the soil. Loose soils will absorb more water

TABLE 1.—INCHES OF FALL IN EACH 100 FEET OF VARIABLE GRADED TERRACES

Length of terrace *feet*	Slope of land		
	5 ft. in 100 ft. *inches*	10 ft. in 100 ft. *inches*	15 ft. in 100 ft. *inches*
0 to 300	½	¾	1
300 to 600	1	1½	2
600 to 900	2	3	4
900 to 1200	4	6	7[1]
1200 to 1500	6		

and therefore the terraces can be placed farther apart on them. As a rule there should be a vertical drop of four to six feet between terraces on land having a fall of five to ten feet. More vertical distance can be allowed between terraces on land with greater slopes. Table 2 can be used as a guide in determining what distance apart to build terraces on different slopes.

Needed Equipment Not Expensive

Equipment needed for staking out a terrace includes a drainage level, a level rod, a steel tape or chain for measuring, a hatchet, and a number of stakes for marking out the terrace. Where several farmers in a community have terracing to do, a complete outfit may be secured at a small outlay by each person, because a farmer's level and rod can be bought at relatively slight cost. Instead of a regular surveying tape or chain, a 50-foot length of picture wire may be used. In some ways

FIG. 7.—DEEP GULLIES STARTED BY CULTIVATION

Planting and cultivating along the slope started these gullies, but terracing and contour planting will reclaim the field.

[1]A terrace 1,100 feet long should have a fall of 6 inches in 100 feet at the lower end, where the land has a fall of 15 inches in 100 feet.

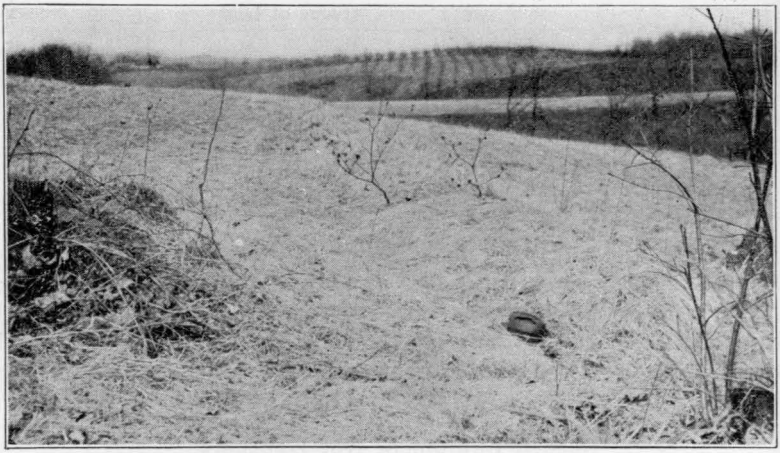

FIG. 8.—THE BEST PLACE TO DISCHARGE WATER FROM THE TERRACES

There is no better place to discharge the water from terraces than a permanent, well-sodded pasture or wood lot.

the wire is better than the tape, as one end can be easily fastened to the level rod and the other end held by the man who drives the stakes. The actual number of stakes needed will depend upon the length of the terraces. The stakes usually are driven every 50 feet and enough should be provided to stake out two or three terraces. If the field to be terraced is free from weeds, stalks, and trash the terraces can be marked out with a spade or the man with a plow can follow immediately behind the man with the rod.

Three men are needed to stake out a terrace with a drainage level. One handles the level, the second holds the rod to which one end of the 50-foot wire is fastened, and the third man holds the other end of the wire and drives the stakes. If a stake or iron rod is fastened to the wire it is easy to hold and the chain-man can stick it in the ground while he is driving a stake at the point marked by the rod man.

TABLE 2.—DISTANCE BETWEEN TERRACES ON DIFFERENT SLOPES

Slope in feet per 100 feet	Vertical drop between terraces	Distance between the terraces along the slope, feet
3	3 feet	100
4	3 feet 6 inches	87½
5	4 feet 3 inches	86
6	5 feet	83
7	5 feet 9 inches	82
8	6 feet 3 inches	78
10	6 feet 6 inches	65
12	7 feet	58

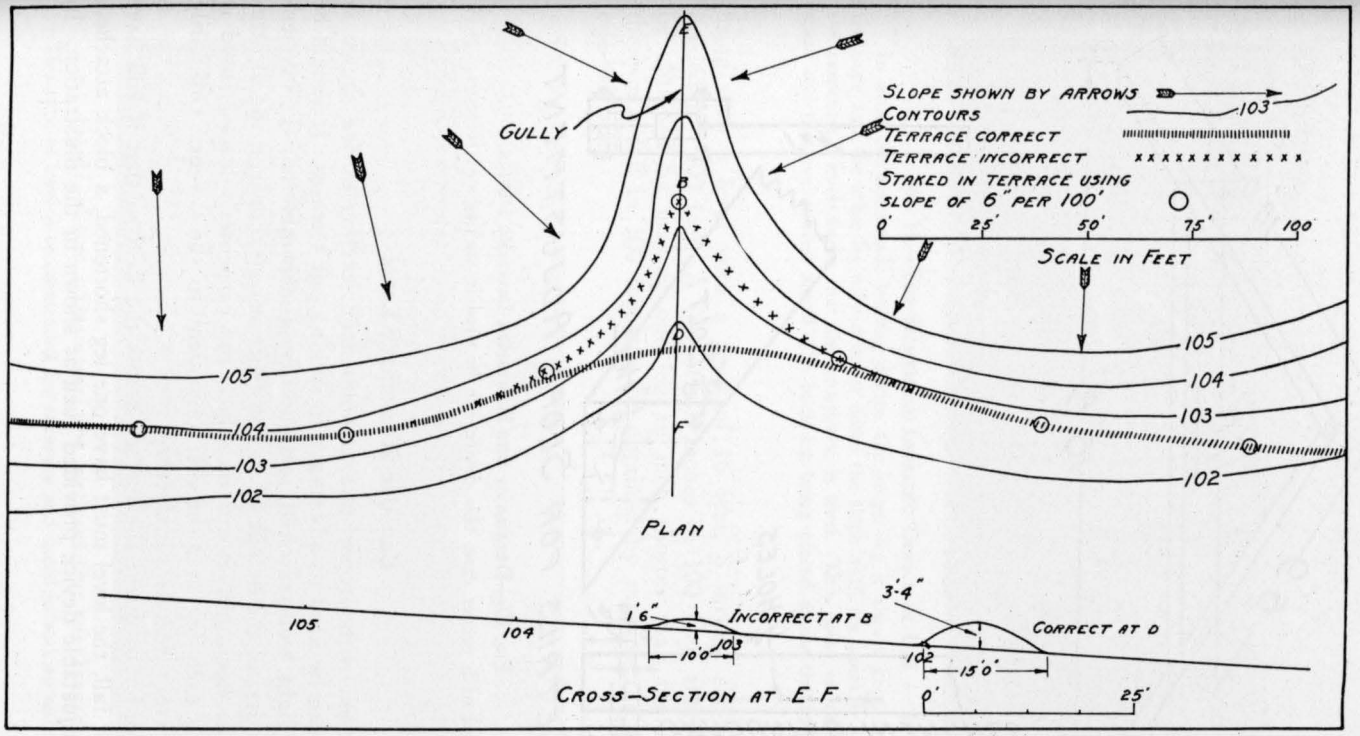

FIG. 9.—WHERE THE TERRACE SHOULD CROSS A GULLY

In putting terraces across low places it is better to build them almost directly across than to have them follow the contour of the land.

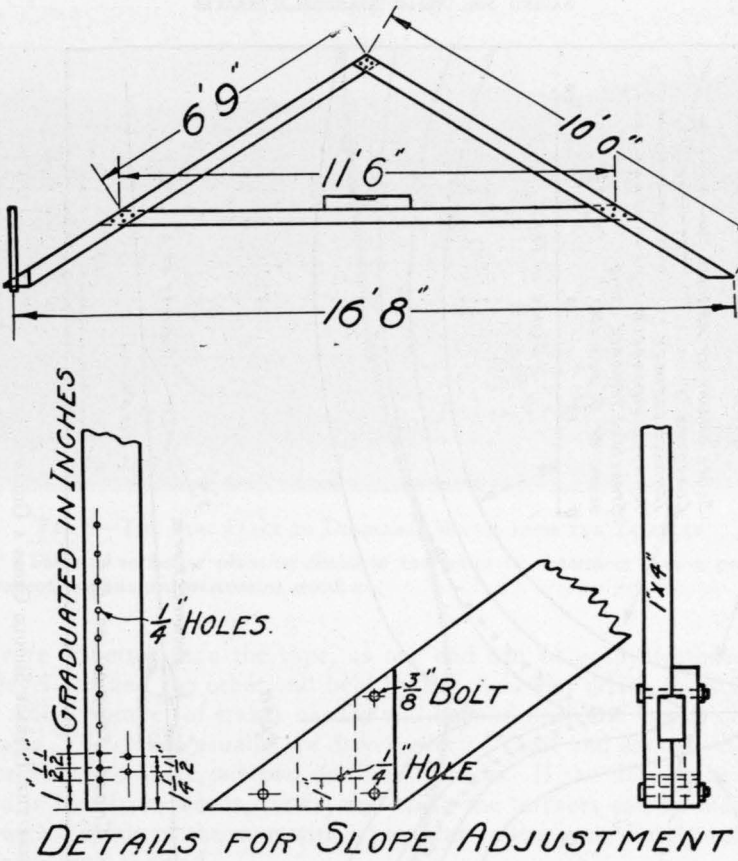

FIG. 10.—DETAILS OF THE HOMEMADE LEVELING DEVICE

If used with proper care, this device can be used in staking out terraces.

Can Use Homemade Level

If used with proper care, a homemade leveling device shown in Fig. 10 can be used to advantage in staking out terraces. It should be made of light, well-seasoned, straight 1-by-4-inch material. The dimensions for it and the details of its construction are shown in the illustration. The horizontal board on which the carpenter's level is used is nailed to each leg at a height convenient to the owner. Ordinarily three or four feet is satisfactory.

In order to direct the terrace across the field so that it will have the right fall, the level must have one leg shortened, a block attached, or an adjustable device provided such as shown in the illustration. In

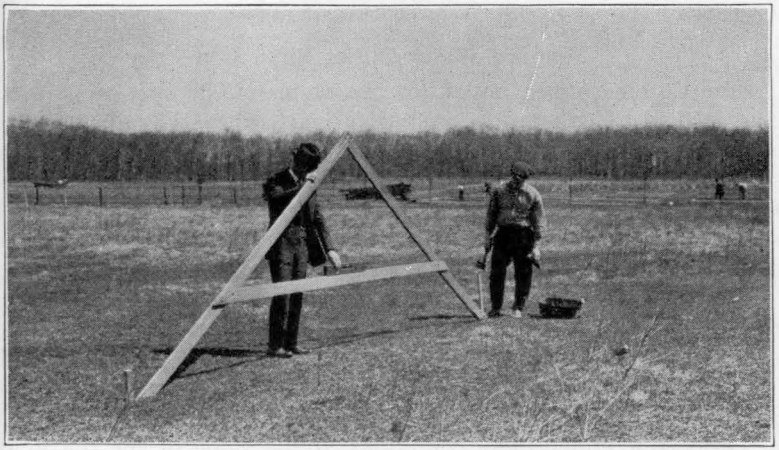

FIG. 11.—THE HOMEMADE LEVELING DEVICE IN USE

In using the homemade leveling device, the longer leg is always kept farther down the slope and the other leg moved up or down the slope until the point is found where the carpenter's level shows that the crosspiece is level. This point is marked with a stake and the level moved ahead, the back leg being placed where the front one was.

using such a level with a span of 16 feet, 8 inches, six spans are needed for 100 feet. A fall of six inches in 100 feet, therefore, can be obtained by making one leg an inch shorter than the other. A three-inch fall in 100 feet can be obtained by making the difference one-half inch.

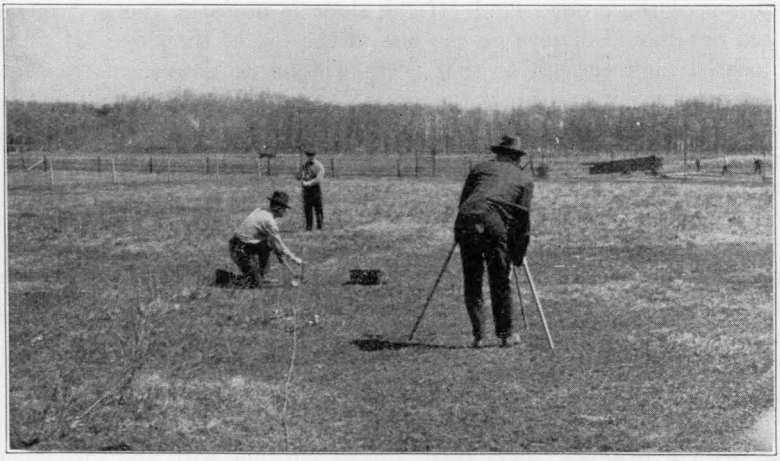

FIG. 12.—USING A DRAINAGE LEVEL TO STAKE OUT THE TERRACE

This type of level is recommended for accuracy and speed in staking out terraces.

Finding Water Outlet First Step

Finding the proper outlet for the water is the first step in terracing a field. Cooperation among farmers who own adjacent land often makes it possible to get good outlets which otherwise could not be used. There is no better place to discharge water from terraces than a permanent, well-sodded pasture or wood lot. It also may be discharged along the roadside where there is no danger of gullying and no objection on the part of the road commissioners.

In some cases earth dams must be built as a part of the terrace across gullies that have formed and a line of tile with surface inlets above each dam laid in the gully to take care of the water from the terraces. When a tile outlet of this kind is used, each terrace may be built so that it discharges from both sides of the gully toward the tile. Ordinarily under these conditions, if the slope of the tile in the gully is more than 3 percent it is necessary to use sewer tile as an outlet, since farm drain tile would wash out. Second grade, or cull, sewer tile can be secured for an outlet of this kind at no greater costs than farm drain tile.

Where terraces must be extended across gullies and other low places in the manner just described, they must be built higher and made stronger where they cross the gullies than at other points. This is necessary because there always is more danger of a terrace breaking at a low place, owing to the greater shrinkage in the ridge at such points and to the extra water which collects. The fill at any low point should be enough to allow at least 10-percent shrinkage.

The terrace to be staked out first will be determined by the natural condition of the eroded land. If the slope is uniform, the first terrace staked out should always be the one at the top of the slope. It should be located high enough so that there will be no danger of the water collecting above it and breaking across. In general, the vertical distance from the top terrace to the top of the slope should not be more than the vertical distance between the other terraces in the field. Table 2 is a guide in this connection.

If there is a sink hole, the start of a steep slope, or the beginning of a gully in the field, it is best to start the first terrace above this particular point and stake out all the rest of the terraces, both above and below it, with reference to this one. Another point to remember in deciding where to start the first terrace and the direction to give it is the desirability of discharging the water opposite to what the natural flow of it would be if it were not for the terrace.

The responsibility for the accuracy of the work in staking out terraces with a drainage level rests almost entirely with the instrument man. Care must be taken to see that the tripod is firm in the ground and that the instrument is leveled over the leveling screws. This leveling is done by revolving the telescope to a position parallel to one set

of leveling screws, bringing the bubble to the center, and then turning the telescope and repeating the leveling process. It should be remembered that the leveling screws must be turned in opposite directions and that the bubble will go in the direction in which the left thumb moves. The leveling screws should not be allowed to bind against the plate when they are being turned.

Staking Starts at Outlet

The outlet of the terrace should be made the starting point in staking out the terraces and the instrument should be set up a short distance beyond the outlet at a point from which several terraces can be staked. A level reading is made at the outlet of the first terrace and a stake driven at this point by the man driving the stakes. The rod man then moves forward 50 feet across the slope to locate the next point for a stake, this point being determined from the previous reading. For example, if the first reading was five feet and it is thought desirable to have a grade of six inches fall in 100 feet, the rod man moves to a point 50 feet away, where the reading is three inches less than the reading at the outlet, or four feet and nine inches. In other words, the second stake is set at a point which is three inches higher than the outlet. This point is marked and the rod man moves forward, the man holding the other end of the chain placing stakes at each of the points where a reading is taken. A walking plow is satisfactory for marking out the terraces after the stakes are set, and the stakes can then be used for other terraces.

In using the homemade leveling device to stake out the line of the terrace, the longer leg, which is always kept farther down the slope, is placed at the proposed outlet of the terrace and the other moved up or down the slope of the hill until the carpenter's level shows that the crosspiece is level. The device is then carried forward, the back leg, or longer one, being placed where the front one was and the front leg again swung up and down the hill until the crosspiece is level. A stake should be driven at each point where the front leg rests when the crosspiece is level, this line of stakes serving as a guide in building the terrace.

It often is necessary to stake out the first terrace more than once in order to get it located so that it will take care of the water from the area above it. The amount of slope cannot be judged accurately by the eye and the point where the terrace is first started may be such that by the time it is extended across the field the area which it will be required to take care of will be too large.

Few Building Tools Needed

The equipment needed for building the terraces usually can be found on the average farm or can be borrowed easily. A team and plow should be provided for the preliminary work and a light type of road

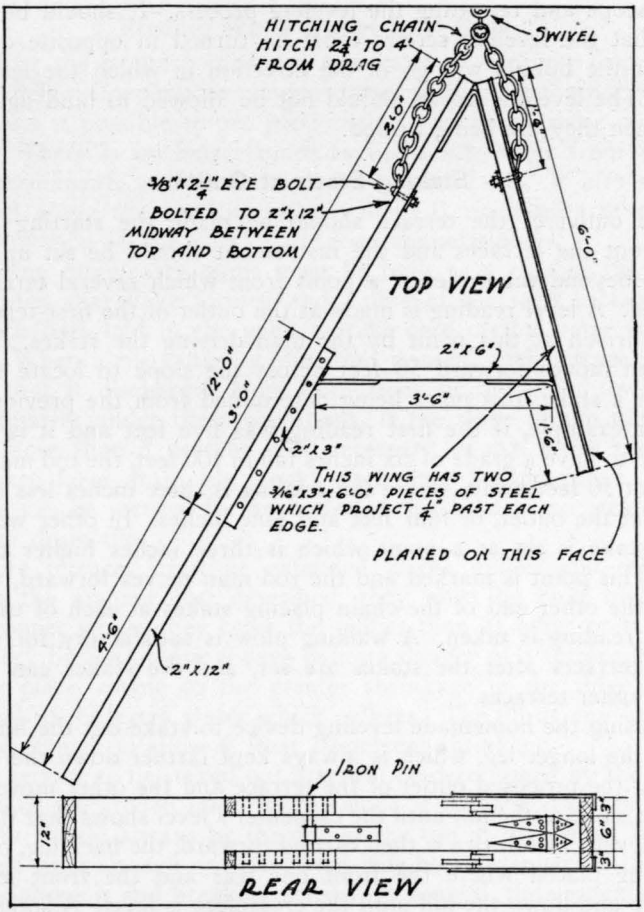

FIG. 13.—DETAILS OF THE V-SHAPED DRAG

grader, a V-shaped steel ditcher, or a V-shaped drag with plenty of horse or tractor power will be needed for the construction work. A slip scraper will be needed if there are gullies on the field to be terraced.

The terrace at the top of the slope should be built first, regardless of which one was staked out first. If the lower terraces were completed first and a rain came, they very probably would be damaged. Each terrace should be run on a smooth curve, and when low places are being crossed it is better to build the terraces on a slight curve instead of attempting to make them conform to the contour of the land. At such places the terraces must be built high enough so that they will not break across.

Very little plowing is needed in building terraces in loose soils. Ordinarily six or eight furrows are thrown together, and then the dirt

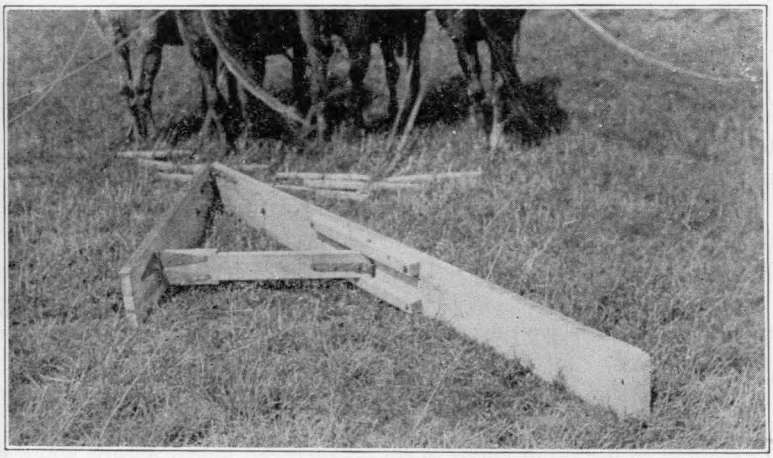

FIG. 14.—THIS DRAG CAN BE MADE ON THE FARM

is pushed to the center with a grader or a steel ditcher. This work is continued until the top of the terrace is from 12 to 18 inches higher than the low point above the terrace. Some terraces are built with the use of a plow alone. When this is done, the furrows are thrown together until a place about 20 feet wide has been plowed and then each terrace is plowed a second time from the center out. Several plowings will be required to get the terrace the desired height. A disk plow is the best type to use for this work and if one is not available it is much better to get some form of a ditcher or grader. In fact, the ditcher or grader is much to be preferred under all conditions.

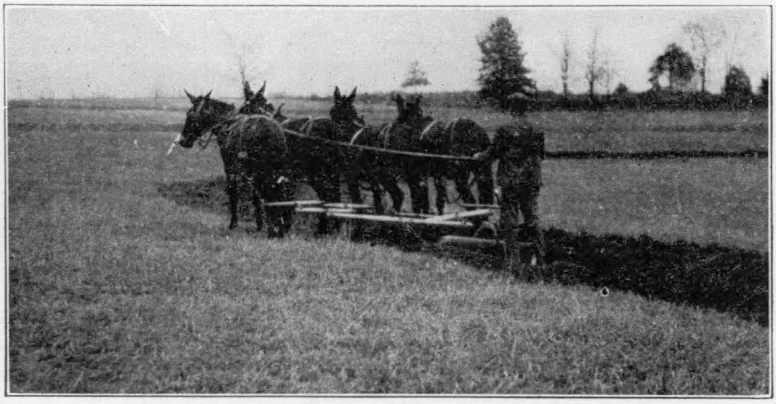

FIG. 15.—BUILDING TERRACES WITH A V-SHAPED STEEL DITCHER
This ditcher is more efficient than the homemade drag for building terraces.

Terraced Land Easily Farmed

When completed, the terraces should be fairly well compacted with no low points that would be likely to break across during the first rain. It always is desirable to check the height of each terrace with a level at questionable points to make sure that there are no low spots. Where a terrace is constructed across a gully or low place, there always is danger of not getting it high enough.

Farming terraced land is not difficult, altho there are some precautions that should be kept in mind. It is desirable in plowing to plow across the slope and to make the lands conform to the terraces as far as this is possible. If the land has a slope of 8 percent or less and the terraces are well established, they can be ignored in the whole farming scheme.

If the land has a 12- or 15-percent grade and a row crop is to be planted, it is best to plant the rows parallel to the terraces. There is little trouble in handling small grain on terraced fields, except when the harvest season is wet. In this case the ground very likely will be soft just above each terrace where the silt has accumulated. This may cause a little trouble in handling the binder.

No established practice is followed in planting orchards on terraced land. For convenience in spraying and other work it has been found that planting just below the terrace is good practice. This makes it easier to maintain the terraces and easier to care for the trees. The spacing of the terraces is sometimes adapted to the distance between trees. There is no special advantage in rectangular planting on hilly land, but there is some advantage, in addition to the checking of soil washing, in contour planting.

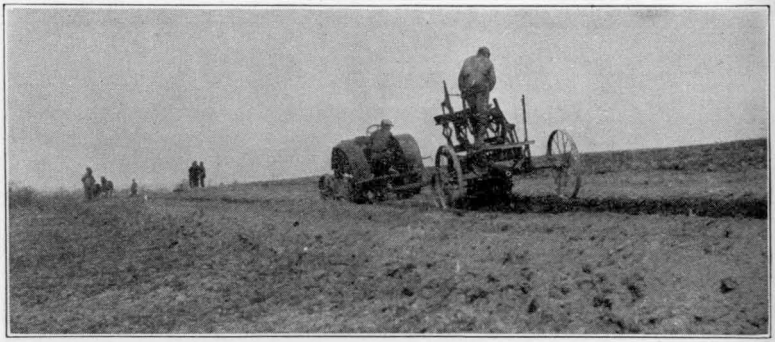

FIG. 16.—USING A SMALL ROAD GRADER

A small road grader of this type usually is the best implement for building the terraces.

FIG. 17.—THE COMPLETED TERRACE

When completed the Mangum terrace looks like a graded road running across the slope of a hill. The top of the ridge should be from 12 to 18 inches higher than the low point just above the terrace.

Terracing Costs About $2 an Acre

The expense of terracing is almost entirely an item of labor. It has been estimated that $2 an acre is a fair cost for building terraces. In addition it probably will cost a small amount each year to maintain the ridges in workable condition. The fact that this is practically a labor cost makes terracing appeal to the man who is interested in reducing soil washing.

Maintaining terraces is neither difficult nor expensive. The new terraces should be watched rather carefully the first year so that any breaks can be repaired before serious damage is done. This is especially important if the field is planted to row crops, for with cultivation there always is danger of break-overs. If possible, it is desirable to plant the field to a crop which does not require cultivation, so that the terraces may become thoroly settled the first year. After the terraces are established they require very little attention. The soil should be thrown toward the center of them in plowing and in some cases it will be necessary to clean the channels above the terraces of sediment, plant growth, or other material that might start break-overs. Some attention also must be given to the outlets to prevent washing at this point. The practice of leaving the outlets in sod, as shown in Fig. 8, often is followed and is to be recommended.