A264-919-5M

BULLETIN

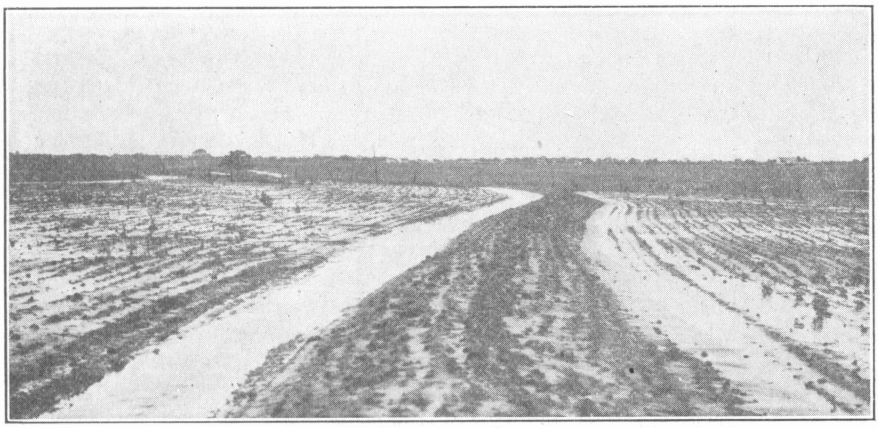
OF THE

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

(In cooperation with the United States Department of Agriculture)

JUNE 1, 1919 EXTENSION SERVICE No. B-51

TERRACING IN TEXAS



Terrace carrying water to the fence in a relatively broad and shallow stream at a low velocity.

ADDRESS

T. O. WALTON

DIRECTOR OF EXTENSION SERVICE, COLLEGE STATION, TEXAS

FOREWORD

Usually soil erosion is so gradual that few farmers realize the great loss through depletion of soil fertility. Too often the perceptible reduction in acre production is attributed to adverse seasons, insect injury and other causes when the washing of the available plant food content from the soil by heavy rains has been the controlling factor, and the error is not realized until the rolling hillside is eventually washed away. In fact, many farms are damaged as much as five dollars an acre in soil fertility by one washing rain. This estimate does not include the heavy tax levied on crop production in future years.

There are no more cheap lands in Texas. More attention must be given to the conservation of the soil as well as soil rebuilding, if the people of today and their descendants are to be prosperous as tillers of the soil.

Poor soils encourage poor farming. Poor farming engenders discontent among farm people, resulting in dissatisfied citizens. A prosperous man is usually a contented citizen, while a prosperous and contented citizen is generally a good citizen.

Should additional evidence be needed to convince anyone of the importance of having his "rolling" land terraced, it may be found in the provisions of the Federal Land Bank not to make loans on lands which are not properly terraced unless the prospective borrower will agree to have terraces properly constructed and keep them in good condition during the life of the loan, as evidenced by the following extract taken from the loan agreement:

"It is agreed that during the term of this loan that the land herein described shall be at all times fully protected from deterioration by washing or lack of drainage, by the construction and maintenance of reasonable, proper and adequate terracing and drainage, and, if at any time during the period of this loan such terracing and drainage is not constructed and maintained as will fully protect said land from deterioration, of which fact *The Federal Land Bank of Houston* is to be the sole judge, the said bank may, at its option, declare the entire indebtedness secured hereby immediately due and payable."

When a banker who makes a loan of not over one-half the value of the land cannot afford to take chances on the soil deteriorating in value from "washing," is it sound business judgment for the owner to take such risks?

It is not the purpose of the author of this bulletin to give an exhaustive treatise on the subject of terracing, but rather to bring the importance of the subject to the attention of the Texas farmers and give sufficient information to enable the farmer, after a little practice, to survey and construct terraces on his own farm.

Those desiring a more comprehensive treatise on the subject should write to the Extension Service of the A. and M. College of Texas for the following bulletins and circulars:

Farmers' Bulletin No. 997.

Circulars

No. 262. Filling Gullies in Advanced Stages of Erosion.
No. 208. The Soil Saving Dam for Large Gullies.
No. 258. The Concrete Drop for Large Gullies.

No. 259. Tile Drainage to Prevent Washing.

No. 261. The Level Bench Terrace.

No. 257. Relation of Cultivation, Plowing, Cover Crops, and Humus to Terracing.

No. 260. Home-made Farm Levels.

No. 256. Special Pointers on Terracing.

T. O. WALTON,
Director.

TERRACING IN TEXAS

J. C. OLSEN, TERRACING SPECIALIST, EXTENSION SERVICE, A. AND M. COLLEGE OF TEXAS.

Soil-saving and soil-building are two of the important problems confronting farmers on the hilly lands in Texas. At least 75 per cent. of the cultivated hilly farm lands of Texas (slopes over 2½ feet per 100 feet) are subject to serious erosion. This great loss may be stopped at a relatively low cost by terracing.

The shaded area on the map shown in Figure 1 constitutes about 60 per cent. of the area of the State (100,000,000 acres). Practically all of this is affected more or less by soil erosion. The Gulf Coast and Plains Region are very level and need little terracing. The mountainous and ranch country in Southwest Texas receives very little rain, is principally range land and being sparsely settled will probably not receive very much attention in terracing work.

About 40 to 50 per cent. of the shaded area, amounting to about forty or fifty million acres, may be greatly benefited by terracing so as to prevent erosion and provide for holding rain water.

CONSERVATION OF MOISTURE.

Unfortunately, the benefits of terracing have been considered mainly from the standpoint of soil erosion, whereas the drouth of the past two years has demonstrated that splendid results came from holding the water on the land where it fell. On many fields the crop yield was doubled, due to terracing, by holding and uniformly distributing the rain water; and on many places a small crop was raised on terraced fields, whereas on similar adjoining hilly fields not terraced the crop was practically a complete failure.

In a great portion of West Central Texas the average annual rainfall is 20 to 25 inches. The precipitation in this section is very erratic. The rainfall is usually intense and falls in heavy downpours of short duration. The result is a heavy run-off and very destructive erosion on the steep slopes; consequently, much of the rain water is lost to the fields. The seasonal distribution of moisture is also bad in this section. Long drouths often follow these intense downpours with the result that the soil compacts and prevents the land from absorbing the water as it should. The conservation of this moisture would be worth several million dollars to West Texas annually, and this may be done to a greater or less extent on nearly every farm in the semi-arid section of the State by building terraces and small levees at a cost ranging from one to three dollars per acre.

COST OF TERRACING.

Six mules on a V-drag, two mules on a plow and two men can build from one-third to one-half mile (1760 to 2640) of terraces, or an average of five-twelfth miles (2200 feet) a day. The cost of this equipment at present prices is probably about $19 a day. The cost of 100 feet is therefore about 45 cents. By reference to the terracing table on page 19 it will be seen that about 75

per cent. of the land in need of terracing requires from 400 to 500 feet of terraces per acre. The cost at 45 cents per 100 feet will, therefore, range from $1.80 to $2.25 an acre. In some cases it may range up to $5.00 an acre and in others may be below $1.00 an acre.

SUGGESTIONS BEFORE TERRACING.

The best time to do terracing work is in the late summer and fall, after the crops have been harvested. Work done then will be well established before the

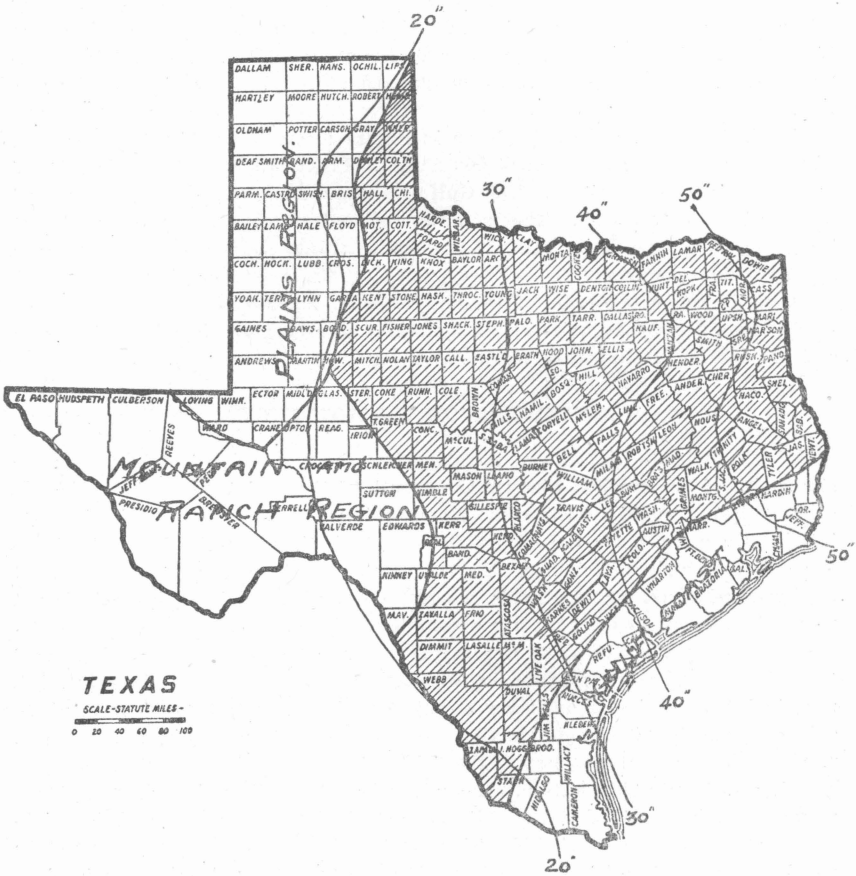


Fig. 1.—Shaded area especially affected by erosion. The figures indicate the rainfall in inches.

spring operations begin, and will also protect the land against heavy fall and winter rains. The expense of building terraces at this time is usually not as great as at other seasons, and by selecting a period for the work when the land is considered too dry to plow, a large acreage may be terraced in a day.

When possible it is advisable to sow the field to small grain preparatory to terracing.

It is better not to flat break or use the middle buster on land until after the

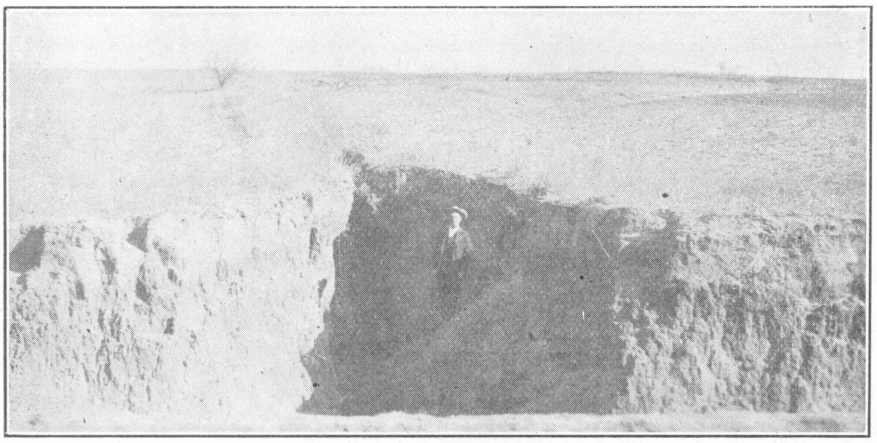


Fig. 2.—Gullying of the water fall type in Eastland County shows how the water undermines the surface soil when it is more resistant to washing than the soil below. Soil saving dams of concrete, tile or wood will often solve the problem economically.

Fig. 3.—The combination of sheet erosion and gullying shown in the above cut has practically ruined part of this field. The surface soil is devoid of humus or other water holding material, and the soil is baked so hard that most of the water is lost as run-off. Kaufman, Texas.

terraces are located or built, because the plowing should be done with the terraces. This will help to fill up the washes, and the fact that the plowing is with the contour of the hill will also aid the terraces materially by protecting them and making the water go into the ground. Also, that part of the field represented by the terraces is plowed. Always flat-break and never use a middle buster on the terraces. The rows should be laid off on the terraces with a cultivator in such manner as to make them come out even with the middle buster rows between the terraces.

Kill all the Johnson grass and Bermuda grass on a cultivated hillside before terracing, because it is more difficult to kill it on the terrace.

In stony or stumpy land, when possible, all the stones and stumps should be removed twelve feet each way from the center line of the terrace before building the terrace.

A permanent system of crop rotation should be maintained on the terraced land. Terracing is only the first step in building up a worn-out hillside.

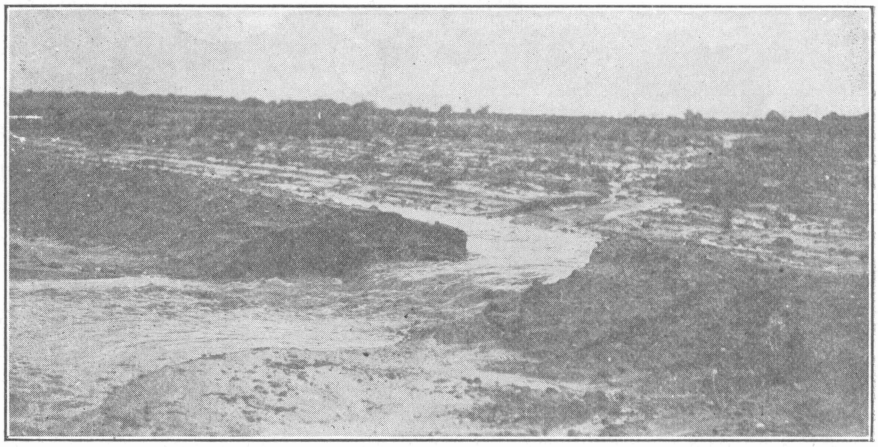


Fig. 4.—The break in this terrace caused by an insufficient outlet occurred 20 feet from the outlet after the water had been carried 1200 feet. The two foot outlet through a hog wire fence should have been 8 to 10 feet wide.

Overloading the top terrace, by giving it too large a drainage area, is one of the common mistakes of the inexperienced in terracing.

Where the drainage from adjacent farms comes through a field which is to be terraced an effort should be made to get the owner of the land to terrace in order to avoid digging a hillside ditch to intercept this water.

In the extreme northwestern part of Texas considerable difficulty in terracing is caused by "gas mounds." When these are located on the terrace line a slip scraper or fresno is used to cut through them. When they are too large to cut through the terrace should be relocated above or below these places.

When it is necessary for a farm road to cross a terrace try to make the road conform to the terracing system by locating the road at the dividing point of the water along the terraces. Should this be impossible the terrace must be built extra large and strong where the crossing occurs. Sometimes culverts are used for crossing the terraces.

It is extremely hard to make an outlet for the terraces in a field where a round knoll projects up in the center. In such cases, where the soil is very

porous, terraces may be located close together on a level and built extra high until a lower elevation is reached which will permit the terrace to empty properly. If the terrace will not be too long, it may sometimes circle from one to one and a half times around the hill before it is emptied.

It is a mistake to attempt to cultivate land where the slope is much over twelve feet per 100 feet. A narrow high terrace should be constructed and the land put in pasture.

Before setting out orchards on a hillside, it should be terraced and the trees set out on the terraces.

TWO CLASSES OF TERRACES.

There are two general classes of terraces. In the first class the terrace is run on a level around the hillside with the purpose of making the land retain

Fig. 5.—A terrace through a pecan grove near Corsicana. Note the trees on the terrace line.

and take up all the water that falls on it. The bench terrace belongs to this class.

In the second class the terrace is given a slight fall, which permits the water that will not soak into the ground to run off at a very low velocity. This is the type that is adapted to the greater part of Texas. The broad terrace and the modifications of the broad terrace come under this class. These are discussed fully in the following pages.

THE BENCH TERRACE.

The level bench terrace—the true terrace—is adapted to Texas conditions to a limited extent. Its use is recommended for deep porous soils which are too steep to permit the use of a cultivated terrace (slopes exceeding 12 to 15 feet per 100 feet).

THE BROAD BASE TERRACE.

The broad base terrace—contouring a field with a light grade to conduct the surplus water away slowly—is the type of terrace to build in most parts of Texas. The graded road is a splendid illustration.

When the terrace is first built and the soil is loose, it should be at least 21 inches high (knee high) in order that it may be 15 to 16 inches high, after settling. From 20 to 30 per cent. should be allowed for settling.

The base width of the terrace for ordinary slopes should not be less than 20 feet. This width is necessary in order to give it sufficient strength to hold the weight of the water above and to make it possible to cultivate six rows of cotton on the terrace satisfactorily. Each year the plowing is started along the crest of the terrace and the base width increased until it is from 25 to 30 feet.

The broad base does not permit the water to cut or denude any part of the

Fig. 6.—One of the thirteen terraces on this slope in Milam County on the farm of J. C. Hardy where the broad base terrace is sown to sorghum the first year.

field. After the ground is fairly well soaked the balance of the water is carried away in a shallow, broad stream, at a low velocity, toward some natural watercourse where the terrace may drain. The terrace gives the water a different course, causing it to move slowly and permits the soil to absorb more moisture. Should the hillside slope 4 feet per 100 feet, which is very common, and the terrace is given 4 inches fall per 100 feet, the water, instead of having 48 inches fall per 100 feet, has only 4 inches fall per 100 feet, after terracing.

The common practice of building terraces ten to twelve feet wide at the base must be corrected. These ridges cannot be expected to withstand even an ordinary rain. They possess many of the bad features of the hillside ditch, and many farmers who have built these small terraces have discouraged others who might have terraced if they had not seen these narrow terraces.

One of the greatest advantages of the broad terrace is that it permits the use of all improved machinery. The gang plow, the section harrow, riding cultivator and grain binder may be used successfully. There is no waste land because the best crop in the field is usually found on the terrace.

MODIFICATION OF THE BROAD TERRACE.

In a few places in Texas a narrow terrace—a modification of the broad terrace—is used quite successfully. Where the soil "melts" down after a heavy rain, making cultivation impracticable, their use is recommended. This type of terrace works very well in blow sand and when located on a level or with fall to meet the conditions, it is very well adapted to pasture land; however, they have many of the disadvantages of the hillside ditch. They are usually built from 18 to 20 inches high and 7 to 8 feet wide.

FARM LEVEL FOR TERRACING.

A simple, efficient and inexpensive farm level, costing from $15 to $25, with telescope, rod and target, is suitable for locating farm terraces. As satisfactory work may be done with these levels, when properly used, as with the more expensive ones. Three or four farmers may use the same level and help each other in locating and building terraces. By cooperating in this manner the cost of terracing is reduced and more satisfactory results are obtained.

Everyone who uses a farm level should know how to adjust and test it because accurate work cannot be done unless the level is in adjustment. This is necessary in the best instruments and requires only a few minutes when the method of performing the work is understood.

ADJUSTING LEVEL WITH A POND OF WATER.

Farm levels may be adjusted with the surface of a small pond of water as accurately as is necessary for terracing purposes.

First Adjustment.—To make the bubble tube perpendicular to the vertical axis. This adjustment is only a matter of convenience and it will not be necessary to "level up" the instrument in sighting in different directions. Turn the telescope over one pair of foot screws and level up the instrument. Then turn the telescope a half turn or 180 degrees about the vertical axis. If the bubble changes its position, raise or lower the adjustable end of the bubble tube until the bubble is brought half way back to its former position. This operation should be repeated until the bubble stays in the center while the telescope is rotated 180 degrees.

Second Adjustment.—To make the bubble tube and the telescope parallel. This adjustment is made with a pond of water. The water must be still and should be at least 200 feet across it. A stake with a smooth top is driven flush with the water surface on one edge of the pond. The level is set up over this stake and the distance from the top of the stake to the center of the telescope is measured. This reading can be taken by sighting through the telescope in the reverse direction. When the target is properly located, it is clamped at that reading and carried to the other side of the pond, where another reading is taken on top of a stake driven flush with the surface of the water. If the cross-hair does not coincide with the center of the target, something is wrong and the telescope must either be raised or lowered with the adjusting screws until this condition is met. The level will then be ready for use.

PRELIMINARY SURVEY OF FARM.

Before attempting to locate any terraces a preliminary survey should be made of the entire farm. Poor forethought and judgment are shown if the

whole farm is not terraced as a unit. It is a mistake to terrace individual slopes without regard to the entire farm. The entire terracing system, including the drainage ditches, on a series of hills on the farm must be made to dovetail and fit together.

The boundary lines of the farm should be located, the slope of the land and the direction the water runs across the fields, should be noted. The drainage from adjacent fields and farms should be determined and controlled, and all the possible outlets for the terraces should be studied, after which the best and necessary ones are selected and used.

There is very little choice in the selection of the outlets when a large acreage drains through the farm from above. In this case, the natural drainage course of this water through the farm should be selected as a ditch and an emptying place for the terraces. This ditch should be made as straight as possible. Usually terraces on the hillsides on either side of this drain may empty into this ditch.

Fig. 7.—This is a very typical condition where there were four ditches on a 30 acre field near West. After the field was terraced only one ditch was left.

As a general rule, the upper terraces are the shortest and often the most difficult to locate with good outlets. It is very often necessary to carry the water from the upper terraces to a fence on one side of the field, and from this point in a small shallow ditch, the water must be carried along the fence down the slope to the main ditch. After the upper two or three terraces are located, the rest of the terraces are easy to locate and usually empty directly into the main ditch where the water can do no damage. They run more or less parallel with the upper terraces. The steeper the land, as a rule, the more nearly parallel they run, and the flatter the land the more irregular they run. On round hillsides that slope two ways it is best to carry the water out to each side of the field if good outlets can be secured. A terrace carrying water 800 feet is an average length terrace. If possible keep the length under 1200 feet. Of course if a terrace empties both ways from the center it may be 2400 feet long. The shorter the terraces, the less water they will have to handle, and the easier they can be maintained. If the area to be terraced is large and several have to be crossed before a good outlet can be secured it may be necessary, in

order not to make the terraces too long, to use one of these depressions as an outlet for terraces from either side, and thus relieve the strain on long irregular terraces. This ditch should be seeded to grass in order to hold the soil together and to check the velocity of the water down the slope, or perhaps, a soil-saving dam, described in circular No. 208, can be installed at a reasonable cost which will prevent the ditch from washing too deep.

In order to give the least possible length, the terraces have to be located so as to empty the water at an angle upstream into the main drainage channels, in a direction more or less opposite to the flow of the ditch, or stream it empties. The water is often carried and emptied into the main channel at an angle of less than 45 degrees upstream with the main channel. If the terraces were run so as to carry the water more or less in the same general direction as the main channels, in most cases the outlets would not be as good and the terraces would be much longer. The fact that the natural drainage channels and creeks, as a rule, have more fall than the terraces, accounts for the difficulty. Of course, terraces cannot be located to carry the water out of its natural course through the neighbor's field, nor should the terrace be located to carry the water out of its natural course and emptied into a public road where it may do damage. The public road is being used too much now as drainage channels. In many cases a house, barnyard, orchard, or garden will prevent running the terraces in the most desirable direction. To properly terrace some farms may affect a neighbor's property, in which case a collective operation in reclaiming land by terracing should be resorted to in much the same way as is required in irrigation and drainage projects.

If the terrace should pass any particular point, such as an orchard or a very irregular place in the field, the starting point should be selected just above or below such points. If there are several large gullies in the field, the location of a terrace just above the sharp breaks in these gullies will often save considerable work and the next lower terrace will usually intersect the gullies at favorable points. Sometimes it is desirable to have the terrace empty at some particular place along the side of the field, and in that case it should be the starting point in locating the terrace. To avoid crossing abrupt knolls in a field, terraces should be located just above and below such places. By avoiding as many of these irregularities as possible, a neat job of terracing may be done while if carelessly done, it would have many ugly twists and turns. In terracing a field it is not necessary to locate the top one first. In fact, it is often better to start half way down the slope where the terraces run more regular and work in the upper and lower ones later. When they are allowed to discharge into a woodland, it often happens that in the future, when it is desired to put that area in cultivation, there will be considerable difficulty in adapting the terracing system to this new land. All the possible future changes should be kept in mind, when locating terraces. A careful inspection of the field and a little forethought in the location of terraces very often results in a better location and reduces the labor of terracing.

LOCATING THE BROAD TERRACE WITH A FARM LEVEL.

After the preliminary survey has been made, a starting point must arbitrarily be selected on the first proposed terrace. Usually the first terrace located is the upper terrace on the hillside. In this case, the level may be set up on a slightly lower elevation about midway between the ends of the terrace line in

a position where the rodman will be within range of at least one end of the terrace line and usually both ends. Sometimes two terraces can be located with one set up of the level. Long sights over 800 feet should be avoided as much as possible. The rodman places his rod at the proposed starting point and the instrument man sights through the telescope at the target, motioning the rodman to move the target up or down until the horizontal cross-hair in the telescope coincides with the middle of the target. Here the target is clamped and a stake driven into the ground to locate the place. Broken corn stalks, weeds or other convenient material may be used for stakes to mark these points on the terrace line. A bundle of light wire stakes 2½ feet long with a red ribbon six inches long tied to a loop at the top of the stake, makes a very distinct mark and may easily be seen 600 feet between high cotton or corn stalks.

In an open field, free from vegetation, piles of dirt, made with a hoe, make good marks. Sometimes stakes are not set, but it is not good practice to do such slip-shod work. Even the most experienced men can do much more satis-

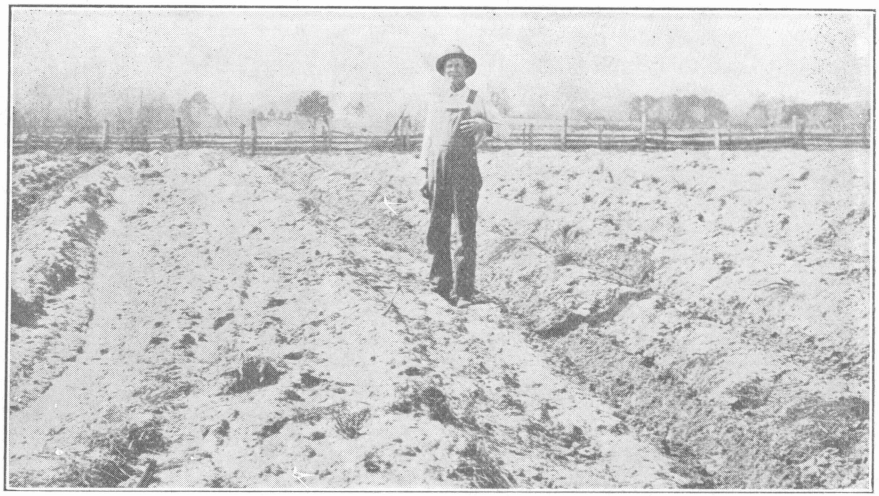


Fig. 8.—This cut illustrates how completely a gully eight feet deep and ten to twelve feet wide has been filled up. This man is standing on the site of the original gully. Gallatin, Texas.

factory work when the line is marked as outlined above. The terraces will be there for a long time, and we should all try to do the work the very best we can. If the stakes are fifty feet apart, and the fall per 100 feet is 4 inches, it will be necessary for the rodman to raise the target two inches at each station in locating the terrace down grade. Seventeen good steps are equivalent to fifty feet, and a variation of three or four feet in distance is not serious. The rodman is motioned up and down the hill by the instrument man, but still keeps approximately fifty feet from the first stake, until the target again coincides with the cross-hair of the instrument. Here another stake is driven and the target again raised for the third position. If the rodman gets out of sight around the hill, or too long a sight is required, it will be necessary to move the instrument to a new position where the terrace may be finished. The first reading with this new set up of the instrument must be taken at the point where the last stake was driven and the target raised or lowered until it coincides

with the cross-hair. After this the target is raised two inches at each station. If the rodman is locating the terrace up grade, the target must be lowered two inches for each reading instead of raising it.

When the fall per 100 feet along the terrace is 5 inches, stakes are usually set 60 feet apart (20 good steps), and the target is raised three inches at each station in locating the terrace down grade, and vice versa in locating up grade.

The vertical drop between terraces is determined as follows:

Take a reading at any one of the stations which have been marked on the last terrace and set the target so as to coincide with the horizontal cross-hair in the level. Suppose the rod reading is 4 feet. If the vertical drop is to be 3 feet between terraces, 3 feet must be added to 4 feet, making a 7-foot rod reading for a lower terrace, and for the next upper terrace 3 feet must be subtracted from 4 feet and the rod reading will be 1 foot. In either case the rodman goes up or down the slopes as the case may be until the target coincides again with the horizontal cross-hair, and the first point on the next terrace is located. From this beginning point the target is now raised or lowered at every station as described in the two preceding paragraphs.

There is more or less variation in the slope of all hills. Very few have uniform slopes. As a general rule, terraced hillsides which have only one general slope have less slope near the outlet of the terraces than at any other place. This is also true to a certain extent with round hillsides. The terraces are, therefore, usually farther apart near the outlet of the terraces than at any other place. They are closer together where the hill is steepest. Therefore, if the proper spacing and vertical fall is taken at the outlet end of the terraces, they may be too close together at the other end and vice versa.

As a general rule, it is better to get the vertical fall and spacing between terraces at some point on the slope which is as representative of the average slope as possible. This position is usually about half way around the terrace.

The upper end of a terrace for short distances (100 to 300 feet) may be run on a level or on a grade up to 8 inches fall per 100 feet safely. Good strong terraces can be located on grades of 3 inches or even 2 inches per 100 feet safely, if their length does not exceed 600 to 700 feet. Sometimes the top terrace may be located with a 5-inch fall, the second one with a 4-inch fall per 100 feet, etc., and vice versa. By taking advantage of these facts the terraces will run more nearly parallel in many instances and lots of point rows will be eliminated.

MARKING THE TERRACE WITH A PLOW.

After staking off the terrace line, the real terrace line is marked off with a plow. The stakes are to be used as guides only because in looking back over the course the stakes will usually show a very broken line. To avoid the irregularities shown by these stakes, it is necessary to miss some of the stakes several feet so as to make easy rounding curves for the terraces. A variation of two feet from the line of stakes on hillsides which slope 4 feet per 100 feet only means a difference of elevation of one inch. Variations of from four to five inches in elevation for short distances can safely be made if additional work is done at the fills and cuts. It is usually best to have a competent man walk ahead of the team in plowing the first furrow in order to lead the way and make these variations. If a riding plow is used to mark the lines, sometimes the driver can stand up on the plow and make these corrections himself. It is not good practice to mark the lines off directly behind the rodman. A little

experience and good judgment are necessary in plowing the first furrow, and especially so if the land is seriously washed and gullied.

LOCATING THE TERRACE OVER A GULLY.

In taking rod readings in rough places average ground should always be selected. Readings should not be taken on ridges, knolls, holes, gullies or washes. If the first rod reading is taken between the rows the succeeding readings should be taken there also. Where elevations or depressions are sharp and the terraces turn and twist considerably, the rod readings should be taken closer together than fifty or sixty feet in order to give the terrace the proper curve. In very rough places where the terrace curves considerably, it is advisable to increase the fall along the terrace slightly. In crossing a gully, stakes should be set on each side in such a way as to make it necessary to grade dirt from the high places to fill in the gully where the terrace crosses. These gullies, of course, need a dam which will be higher at the first than the terrace on either side, because the loose high bank will settle considerably. These banks must also

Fig. 9.—A large terrace in Milam County. The terrace was five feet high across the gully. These terraces were located by County Agent Mr. Geo. Banzhaf. Note how the gully is filling up where he is standing.

stand the strain of the water which concentrates above and softens the bank. These depressions fill up with sediment very rapidly to the grade of the water course of the terrace. Most farmers want to eliminate as many crooks across small draws and large gullies as possible by making extra heavy fills across these places. The amount of variations to make at these points depends entirely on the extent of work the owner is willing to do. Usually it is best to compromise, making a partial fill and curving the terrace line slightly up grade. If the draw is 100 feet or more in width, the curve of the terrace line should be followed pretty closely, because too much work is required to straighten the terraces. In making heavy fills over gullies, if possible, they should be tested with a level or a string which can be stretched clear across the gully to points on top of the completed terrace on either side of the gully which are safe. About 25 per cent. settling should be allowed.

It is also advisable to put in extra fills with a scraper across the gullies half way between the terraces. These places will fill up much faster if this is done.

Sometimes short, small, cross terraces from 100 to 200 feet long with a fall of from 8 to 12 inches per 100 feet, located just above very bad breaks in the hillside between the regular terraces to carry the water to the terrace in the reverse direction, are very helpful.

PRECAUTIONS IN BUILDING TERRACES.

In building terraces, the work should begin at the top of the hill on the upper terrace. If the top terrace is not completed before working on the lower terrace, a heavy rain might ruin part of the work already done. The terraces are expected to handle only a small water shed each, and if one of the upper terraces should break, the mud and water will probably clog up and "smash" the terraces directly below and break the terraces all the way down the hill. The crest and the water course of the terrace must both have a uniform grade and a difference, when the soil is settled, of from sixteen to eighteen inches along the entire course.

The first year the terraces should receive careful attention. If the first rains

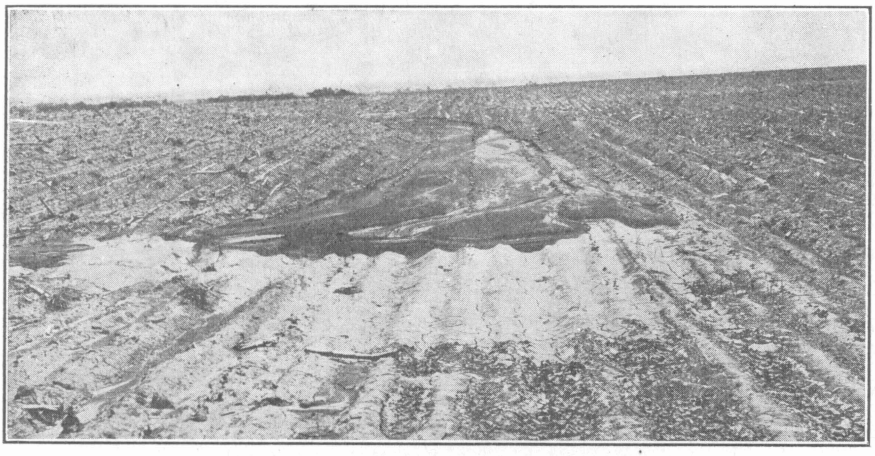


Fig. 10.—Deposit of soil in gully above watercourse of terrace. The water along the terrace is flowing to the foreground. The far end of the terrace shows clearly that the fall was too great.

on the loose, soft terrace are slow, they will probably not cause any trouble; however, should the first rain be very intense and break the terrace, the break should be repaired immediately. After the first year the terraces will need little attention, other than beginning the plowing at the center each year and throwing it toward the center of the terrace each time the land is plowed.

Insufficient outlets often cause the terraces to break and eat back into the field. When the terrace is carrying water to its full capacity, the top width of the stream should be at least eight feet, as a rule, and from eight to ten inches deep. It is a very common occurrence to find the outlet only from two to four feet wide, and of course the water must have double velocity to pass this narrow point and carry the water. If the water piles up too much at this point it will break the terrace a short distance from the outlet. If, at the outlet, the water has a considerable vertical drop, the increased velocity at the outlet will naturally cause the water to eat out a ditch back into the field. In order to eliminate all this difficulty the outlet should be broad so as to spread the water as much as pos-

sible and decrease its velocity. It is also a very good plan to sod the outlet immediately, if there is not already a turf there. Sometimes the outlet ditch can be protected with big flat rocks. These rocks should be placed at the lower end first and laid up grade. The ditch should be slightly rounding and the rocks at the edges should be laid firmly in the ground so that the water cannot eat around them at the edges.

SPACING TERRACES.

Failure in terracing often results from spacing the terraces too far apart. On steep hillsides a vertical drop of less than four feet places them too close together, while on gently sloping land a drop of two feet may place them amply far apart. About 75 per cent. of the hilly land of this State requires from two and one-half to four feet vertical drop between terraces. This places them from 80 to 115 feet apart, giving the terraces as much water as they can handle, while placing them as far apart as is safe to keep the hill from washing. The spacing of terraces depends on the slope of the land; the length, height and regularity of the terraces, and the type of soil. A steep hill, an irregular terrace and a soil which washes easily requires close spacing of terraces. Usually the hillside

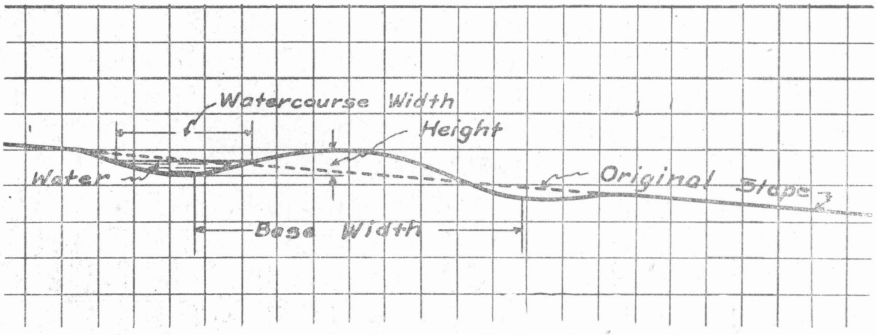


Fig. 11.—Cross section of terrace when completed.

is steeper just below the brow of the hill and flattens out above and below this point; therefore, different vertical falls and distances must be used on the same slope. The vertical drop varies from one to eight feet. The terracing table on page 19 may serve as a guide for directing the work of the inexperienced.

FALL TO GIVE ALONG THE TERRACES.

The fall to give a terrace depends primarily on the slope of the land and the capacity of the surface soil and subsoil to absorb water. As a general rule sandy soils require about 1 inch less fall per 100 feet than heavier soils of the same slope, and the higher the state of cultivation the less fall necessary. Four inches fall per 100 feet for light soils and 5 inches fall per 100 feet for black land and heavy soils in Central and East Texas gives good results. Five inches should be the maximum fall under all conditions. For the steepest slope in West Central Texas 4 inches fall per 100 feet is sufficient fall. See terracing table on page 19.

In West Central Texas many cultivated hillsides have slopes not exceeding 18 to 24 inches per 100 feet. Under these conditions the terrace may be located

on a level to hold all the water where it is so badly needed. Where the slope is less than 15 to 18 inches per 100 feet, the terrace may be located on a level, and in many places some of the run-off water from adjoining pastures may be diverted over the land. This might be termed "Providence Irrigation."

For slopes of 3 to 4 feet per 100 feet a fall of 2 to 3 inches per 100 feet along the terrace is ample fall with a strong terracing system.

TERRACING TABLE.

Vertical Fall between Terraces, Distance between Terraces, and Fall along Terraces for different Soils. Base Width and Height of Terrace, Width of Water Course, and Acres Terraced per Day for various Slopes.

	Line	Vertical Fall Between Terraces in Feet.												
		1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7
Distance between terraces for heavy black land and soils with a large per cent of clay	A	200′	165′	135′	115′	100′	94′	88′	83′	78′	74′	70′	67′	65′
Distance between terraces for sandy soils that wash easily	B	185′	140′	115′	95′	89′	84′	80′	76′	72′	68′	65′	62′	60′
Fall per 100′ along the terrace	C	0″-3″	1″-4″	′-4″	3″-4″ 4″-5″	sand for h	y loos eavy	e soil soils.	4″ 5″	for s for s	andy andy	and l and l	oose s oose s	oil. oil.
Base width to build terraces first year	D	22′	22′	22′	21′	21′	20′	20′	19′	19′	18′	18′	17′	16′
Heighth to build terraces above the water course when dirt is loose. Settles 25 per cent	E	15″	16″	18″	20″	21″	21″	22″	22″	23″	23″	23″	24″	24″
Minimum top width of water in water course when water is 9″ deep	F	.....	.....	11′	10′	9′	9′	8′	8′	8′	7′	7′	7′	7′
Lineal feet of terrace per acre for distance between terraces given on line A	G	218′	261′	323′	380′	435′	462′	495′	526′	559′	588′	620′	650′	672′
Acres terraced per day with 4 to 6 mules on V-drag 2 mules on plow	H	8–12	6½–10	5½–8	4½–7	4–6	3½–5½	3½–5½	3½–5	3–4½	3–4½	3–4½	2½–4	2½–3½

See cut on "Cross section of terrace when completed," on Page 18, Fig. 11. It may simplify the use of above table.

RUNNING ROWS WITH THE TERRACES.

The best method of cultivating row crops on a terraced field is to run the rows parallel with the terraces. Practically all the work is then done on level ground. It is very hard on a team to climb up and down a steep hill all day long. If the distance between the terraces varies a great deal, there will be a number of short point rows. The first row should be planted right on top of the terrace. If the terrace is 21 feet wide, and the rows 3½ feet apart, there will be six rows on the terrace. About half of the long rows between two terraces should be located above and below each terrace. To prevent having all the short rows running out together, sometimes it is best to work in two short rows occasionally before locating all the long rows and avoid having too many point rows together, which would concentrate too much water at one point.

Fig. 12.—Cotton rows contoured with terraces in Milam County. Note the two point rows half way between the terraces. The arrows indicate location of terraces.

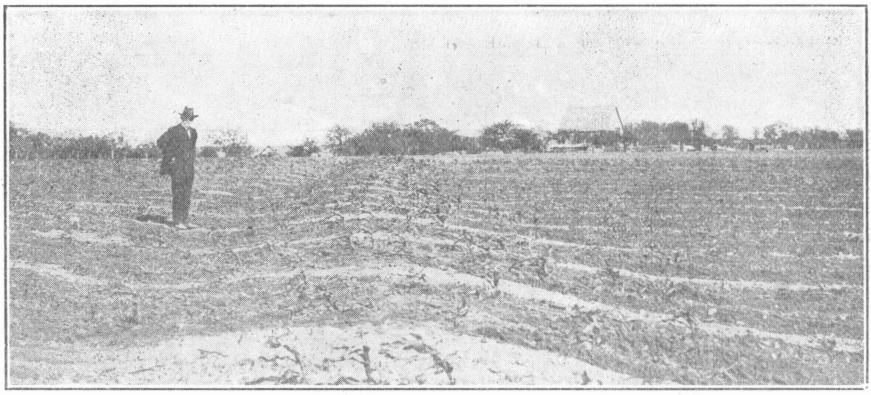


Fig. 13.—Corn rows crossing terraces in Navarro County. If the slope exceeds two and one-half feet per 100 feet this system is usually not successful.

RUNNING ROWS OVER THE TERRACE.

There are a number of farmers in Texas who are running the rows at a slight angle over the terraces successfully, where the slope of the hill does not exceed 2½ feet per 100 feet. A good many farmers are trying to cross the terraces on steeper slopes, but in most cases the terraces give way and cause considerable trouble. If the rows cross over the terraces they should be run in such a direction that the rows will cross the terrace at a small angle. The ideal condition is reached when the rows cross the terrace at such an angle that the rows have the same fall as the terraces in the reverse direction, so that they will carry the water to the terraces opposite to the direction it flows in the terraces. The rows should never be run straight across the terraces. It is useless to waste time trying to cross terraces when a middle buster is used, because they will almost certainly cause trouble. Many farmers expect to lift these plows slightly in crossing the terraces, but it does not work out in practice.

Contouring the rows with every other terrace in some places is an excellent method for slopes of less than 3 feet per 100 feet, and often eliminates many point rows. This is a compromise between crossing and contouring the rows. Where they do cross the terraces they usually do so at a very slight angle. If a hillside has five terraces which run fairly uniform the middle terrace is more representative of the general curve of all the terraces and can sometimes be used as the guide for all the rows on the hillside. On steep slopes the terraces run more regularly than on moderate slopes and the rows should always be contoured with each terrace. If the rows cross the terraces slightly, they should be at least 24 feet wide at the base. A little less time and labor is required in plowing, less difficulty is encountered in turning in the field when the crop is large and farm machinery can be handled a little easier when the point rows are eliminated by this method. Care must be taken to fill up all dead furrows made in plowing as well as tracks made in crossing with other farm implements. If the terraces run nearly parallel it is better to contour the rows with the terraces, because the rows will hold more water and the terraces will be so much easier to maintain.

EQUIPMENT FOR BUILDING TERRACES.

Terraces may be built with a plow alone, a plow and a home-made V-drag, a plow and a steel ditcher, a plow and a road grader, a reversible disc plow, or a combination of the above methods. The home-made V-drag, the steel ditcher, and the road grader should be reversible. Usually two men and from four to eight mules are required for either of these three methods and from sixteen to twenty-four rounds are usually necessary to put up a first class terrace when the soil is in first class condition. (See terracing table on page 19.) When the vertical fall between the terraces is under two and one-half feet the dirt may be shoved toward the center of the terrace from both sides until it is completed. When the vertical fall is from two and one-half to four feet the dirt may be shoved toward the center from both sides of the terrace until it is nearly completed. At the finish three or four rounds should be made by shoving the dirt down hill entirely. This makes a flatter, wider watercourse, which is so necessary for a strong terracing system. When the vertical fall between terraces is from four to six feet, the dirt may be shoved to the center from both sides until it is half built. After this it is more satisfactory to work only from the upper side. For steeper slopes than a six-foot fall between terraces, practically all

the work must be down hill. The dirt is shoved up hill only enough to round off the terraces.

THE HOME-MADE V-DRAG.

The V-drag, shown in Figure 14, when used in connection with a good walking plow, is one of the best implements that is used in building terraces. It is simple, efficient, and may be made in an hour. It is very useful in opening up small ditches, after the soil has been loosened with a plow. It is so constructed as to shove the loosened dirt toward the center of the terrace. When the soil is in fairly good condition, six mules on the V-drag and two mules on a good turning plow can build from one-third to one-half a mile of terrace in a day.

The short wing of the V-drag corresponding to the mold board of a plow is 7 feet 6 inches long, and the long wing corresponding to the landslide is 12 feet 6 inches long. For these wings a good grade of 2x12-inch lumber should be used. One side should be planed, turned toward the dirt and used on the wearing side of the V-drag. The spread between the wings for black land should be about four feet, while for sandy land four and a half feet is satisfactory. To hold the wings rigid, two 2x6-inch braces, as shown in illustration, spiked to the 2x12-inch wings three inches from each edge of the wings, allows three inches clearance for the drag and makes it reversible when it is tipped over at the end. The hitch should be located in the center of the 2x12-inch for the same reason as shown in the cut. Usually an iron 3-16x2 inch by 6 feet 6 inches, bent into form as shown in cut and bolted to each wing, makes a very convenient hitch. A six-horse evener should be hitched to the V-drag by means of a chain two and one-half to four feet from the point of the drag. Usually one team is put in the lead. The short wing should be faced with a piece of steel 3 to 4 inches wide by 3-16 to ¼ inch thick, by 7½ feet long. This cutting edge is put on both outer edges of the short wing. It is well to do this if the V-drag is reversed a good deal, but if the dirt is shoved up from both sides three-quarters of the time the cutting edge on both edges is hardly necessary. If only one wing is provided with the cutting edge, it should be put on the V-drag so that the drag will shove the dirt in the same direction as the plow. In sandy land, the wear on the plank wings is very rapid, and it sometimes becomes necessary to place a strip of iron along the long wing too, so as to protect it. The following table gives dimensions for a 2, 3, 4, 6, or 8-horse V-drag:

DIMENSIONS FOR HOME-MADE V-DRAG.

	Number of Horses or Mules.				
	2	3	4	6	8
Length of Short Wing	4½′	5′	6½′	7′	8′
Length of Long Wing	8′	9′	11½′	12½′	14′
Size of Material for Wings	2″ x 8″	2″ x 10″	2″ x 12″	2″ x 12″	2″ x 12″
Spread between Wings for black land (33 degrees)	2½′	3′	3½′	4′	4′ 4″
Spread between Wings for sandy land 3-5 of length of short wing (37 degrees)	2½′	3′	3′ 11″	4′ 6″	4′ 10″

Sometimes the short wing is hinged to the long wing, but there is little advantage in making it that way if the terrace is properly started. The spread between the hinged wings in this case should be varied, but usually the drag is not as strong or rigid. The simpler the drag can be made the more effective it will be.

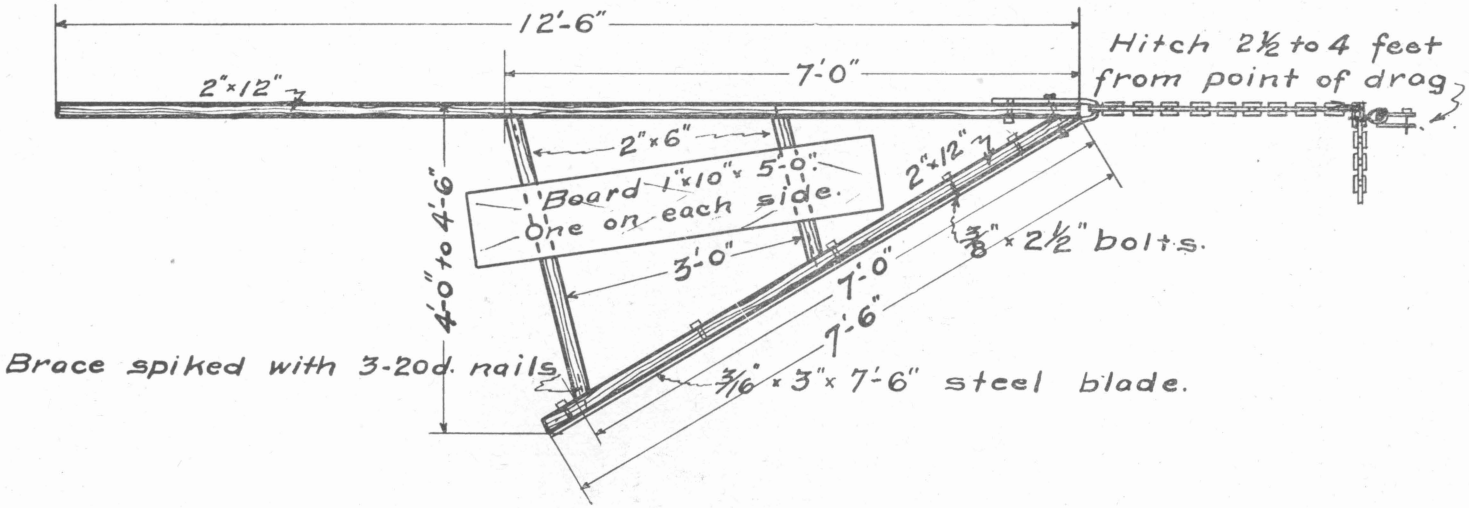


Fig. 14.—The Home-made V-drag for terracing.

MATERIAL FOR V-DRAG.

1 pc. 2″×12″×20′ (for wings planed on one side).
1 pc. 2″×6″×8′ (rough for braces).
1 pc. 1″×10″×10′ (rough to stand on).
1 pc. steel 3″ to 4″×3-16×7½′ (for cutting edge of the short wing).
1 pc. iron 2″×¼″×2′-6″ (for making hitch to chain).
7 bolts ⅜″×2½.″
1 bolt ¾×5.″
1 lb. 20d nails.
1 log chain and 6 horse evener.

With one man riding on the V-drag six good mules will have a full load. By shifting the weight the proper pressure can be put on the wings to hold it in place and cause it to shed the dirt properly.

CONSTRUCTING THE TERRACE WITH A HOME-MADE V-DRAG.

Either a disc plow or a mold board plow may be used with the home-made V-drag in building terraces. After the first furrow has been run, marking the terrace line, a second furrow is plowed three or four feet from and toward the first furrow. This leaves a solid strip for the center of the terrace. Usually four furrows—two from each side—are thrown together before the V-drag is used. The long wing runs in the furrow and acts as the landslide of the plow, while the short wing is the mold board, which shoves the dirt three or four feet

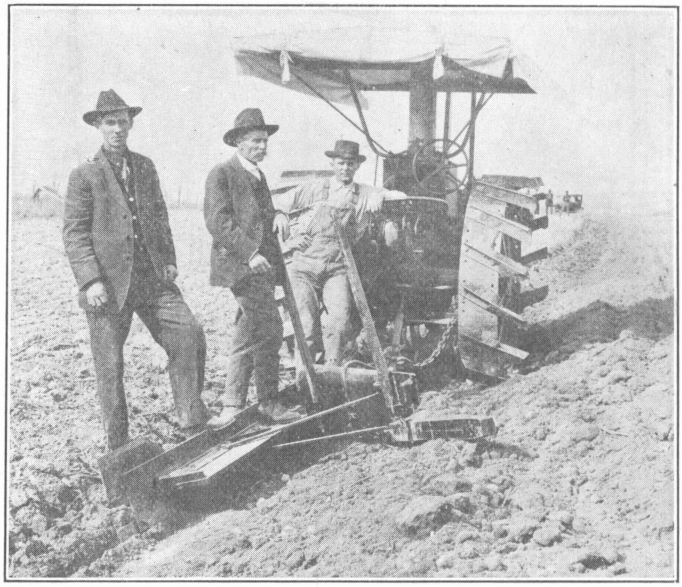


Fig. 15.—Small tractor pulling steel ditcher and four horses on road plow terracing in Bosque County. A half mile of terraces can be built in one day with this equipment.

toward the center of the terrace. From this stage the V-drag follows each plow furrow and the terrace gradually widens out with each round until the proper width has been reached. In order to get the terraces high enough the operation is repeated again by beginning at the center of the terrace as in the beginning. The plowing this time should extend about a foot further to each side, making the base width two feet wider. Sometimes a third and even a fourth operation is necessary to put the terraces up properly. One time over will rarely put it high enough. Two careful operations are generally sufficient. The size of the V-drag, the type and condition of the soil, determine the number of operations necessary. Sometimes a plow with an extra long wing attached to it is used very effectively in putting up terraces.

THE STEEL DITCHER.

The steel ditcher is one of the best machines that can be secured for building terraces. It is usually necessary to plow ahead of the ditcher in the same manner as for the home-made V-drag. In sandy or loose land only about one-half as much plowing is necessary. For terracing, the small to medium-sized should be used, and it requires from six to eight mules to handle them efficiently. In terracing a large acreage it will pay any farmer to buy one of these machines. They are also very fine for cutting small ditches from two to two and a half feet deep.

THE ROAD GRADER.

The road grader is used considerably to put up terraces. If the soil is in good condition they work splendidly, and when eight good mules are hitched to a small reversible road grader probably no better outfit can be secured for putting up terraces. A plow is often needed to loosen the dirt ahead of the grader.

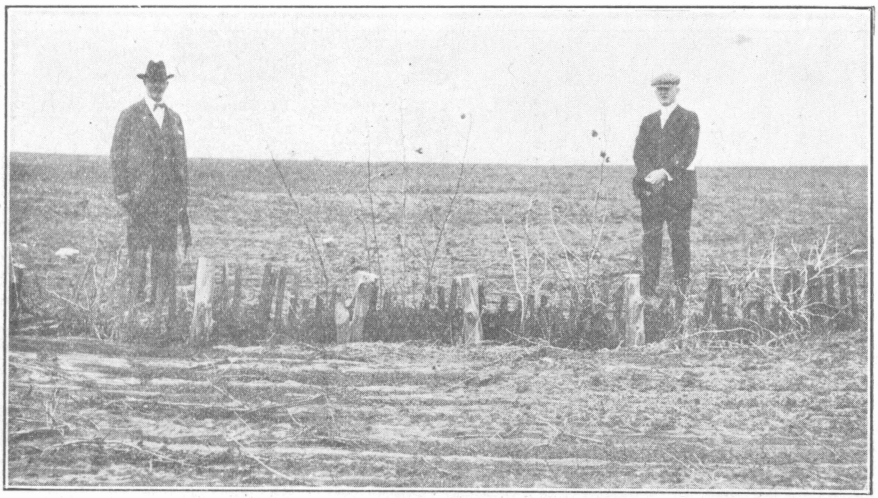


Fig. 16.—A good way to stop and fill up gullies especially along fence lines. Rocks, if they can be secured, are permanent and much more satisfactory. The wall of rocks should be level so the water may filter through and over evenly all along the line.

USING THE PLOW ONLY FOR BUILDING TERRACES.

Some of the best terraces in the State of Texas were built by using no other implement than a plow. This system simply requires replowing a sufficient number of times to bring the terrace to the required height and width. The double disc plow is especially fine. The size of the plow, the condition and type of soil, the depth of plowing, the kind of plow and the speed of the plowman determine the number of plowings necessary to put up a good terrace. The terrace line is used as a center line and the furrows are thrown toward this center line from both sides until a land 20 feet wide is plowed. The center line of the terrace is again used as a beginning point and the land is replowed in this manner about half a dozen times or until a terrace of the required height and strength is built. The ground, after the second or third plowing, may be very loose and in that case farmers sometimes wait and allow a rain to settle

the terrace. This is quite risky because a heavy rain may not only settle the terrace, but may injure and undo some of the work which required a lot of hard labor. Either of the previously described methods of building terraces is better.

THE FRESNO AND SLIP SCRAPER.

For making fills at the gullies the fresno is the best implement to use. A slip scraper is often used, but it is a slow, hard and tedious way to finish the terrace at the high and low places. The fresno is easy to fill, dump and handle, and the four-horse fresno will move about three times as much dirt as the ordinary scraper.

FILLING GULLIES IN ADVANCED STAGES OF EROSION.

For filling gullies in advanced stages of erosion the soil-saving dam and the concrete, stone or wooden drop are effective means for checking and filling them

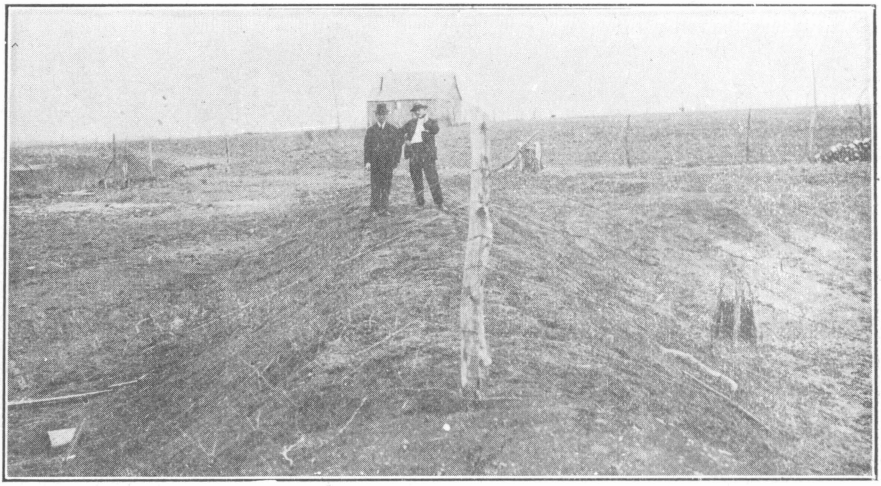


Fig. 17.—Soil saving dam at Bruceville, Texas. The inlet end is shown on the right and the outlet end on the left.

up. Both take up the excess grade and fill the gully at the expense of the adjoining upper slopes. The rushing water is checked above, its sediment deposited and the water is carried through the pipe of the soil-saving dam or over the concrete, stone or wooden drop.

The table on page 27 gives the approximate number of acres a soil-saving dam will drain. If the storage above the dam is large, slightly smaller pipes may be used, and if the storage is small it may be necessary to increase the size of the pipe.

For filling gullies three to five feet deep the banks should be plowed down just before terracing. Sometimes five or six rounds will fill it up half full and make it possible to cross with farm machinery.

NUMBER OF ACRES DRAINED BY SOIL-SAVING DAM.

Fall in Feet.	Diameter of Tile in Inches.							
	10	12	15	18	20	22	24	30
5	3	4½	7	13	17	25	31	53
6	3	4½	7½	14½	18½	17½	34	58
7	3½	5	8½	15½	20	29½	36½	62½
8	3½	5½	10	17	25	31½	39	67
9	4	6	11	18	27	33½	41½	71
10	4	6	11½	18½	28	35	43½	75