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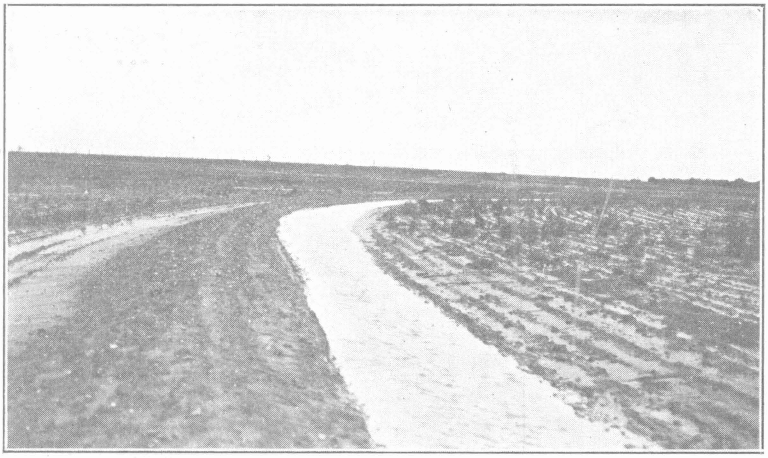
Terracing in Texas



Address

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TERRACING IN TEXAS.

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The importance of soil conservation is being more and more impressed upon the people of Texas by diminishing yields of staple crops on land that once yielded bountifully. In many sections of the state gullied fields and washed-off hillsides are the main features of the landscope. An ignorant man can make a good crop on rich soil, but all that science can do will not produce profitable yields on gullied land from which the soil fertility has been washed by heavy rains.

The extent of losses through soil erosion on the lands of Texas cannot be estimated. In addition, much damage has been done to cities and towns and to railroads through overflows, which could have been prevented by systems of terraces which hold the soil and prevent water running so quickly into creeks and rivers. The moisture thus held and absorbed would be of great benefit to crops during succeeding periods of drouth, and the prevention of erosion would stop the filling up of the beds of streams with silt and be a practicable means of preventing disastrous overflows. It is, however, the loss of the top soil, which contains a large percentage of plant food, with which we are most concerned. The damage caused by overflows is very great, but it is not to be compared with the damage to the soil through loss of fertility. Crops may be replanted, but the vegetable matter in soil cannot be replaced save at heavy expense in time and labor.

Each acre of hill land ruined by erosion usually represents from one-eighth to one-fourth acre of level valley land ruined by overwash and silt. In 1909 the National Conservation Commission reported 11,000,000 acres of abandoned land in the United States, of which 4,000,000 acres were ruined and much of the remainder damaged by erosion. The land abandoned as a result of erosion represents about .2 of the entire area and if saved would form 137,500 farms of 80 acres each. It is estimated that the Mississippi river, which drains about one-third of the United States, is carrying every year into the Gulf of Mexico twice as much soil as was moved in digging the Panama canal.

A PROBLEM OF ALL NATIONS.

The problem of soil erosion confronts every nation in the world. In some European and Oriental countries the cultivation of exceedingly steep hillsides is made possible and profitable by terraces. In China, hillsides that have been in cultivation thousands of years are producing as much per acre as our best lands are producing today. In these countries the hillsides were not cultivated until the density of population required that every available foot of land be made productive. The fact that land has been plentiful and cheap in Texas is very largely responsible for lack of attention to soil erosion. As hillsides washed away our farmers have moved to new and virgin fields. Increase of population and advancing prices of land will soon put an end to that custom. Texas is now face to face with the problem that confronted Georgia, South Carolina, and others of the older Southern states a generation ago, and which has been solved by terracing. In those states, the hill lands, like ours, were permitted to wash before anything was done to save them. In recent years they have been reclaimed with terraces and steep hillsides are again producing large crops.

AGENTS OF EROSION.

The erosion of land is brought about by two agents—wind and rain water. In parts of Texas where high winds are common, the rainfall low, and the country flat, wind erosion is a serious problem. In the greater part of Texas where torrential rains are not infrequent, rain water is the destructive agent that must be controlled.

Soil erosion is the result of sheet washing or gullying. The results of sheet washing may not be as noticeable as where the water runs off in streams, but in many respects it is more detrimental to the land than gullying. Sheet erosion strips the fertile soil off the tops of hills and deposits it on the fertile land below. In that way the fertility of the entire hill may be greatly reduced without causing any material change of appearance. Rows run up and down hill in the direction of the greatest slope are largely responsible for this

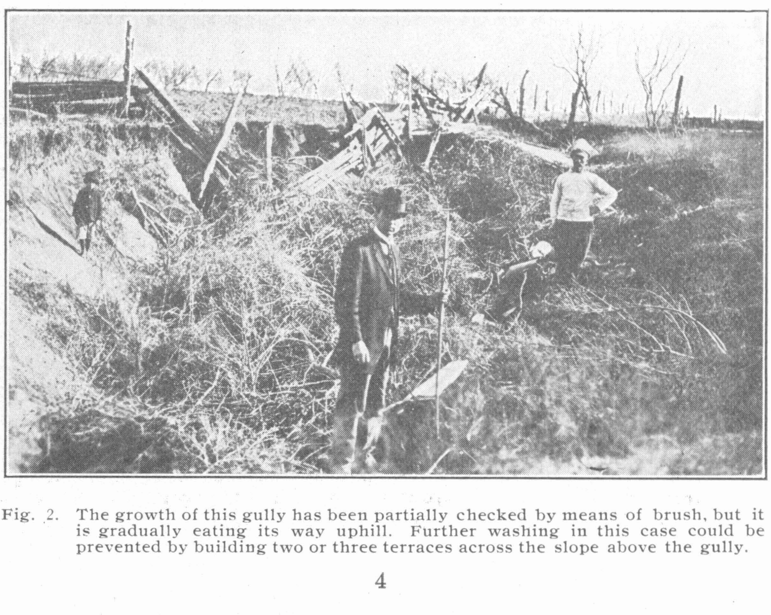

Fig. 2. The growth of this gully has been partially checked by means of brush, but it is gradually eating its way uphill. Further washing in this case could be prevented by building two or three terraces across the slope above the gully.

type of washing. The land at the foot of the hill is usually sandy, while that on the slope shows the clay subsoil exposed, the sand grains and humus having been washed off, leaving the heavy clay behind. Soils of a sandy nature are especially subject to sheet erosion, because the sand grains do not adhere like clay soils.

Clay soils are more subject to gullying than lighter soils. Gullying starts only after water has concentrated in small channels. The wear is rapid and deep gullies with nearly vertical sides soon result. These gullies, which have their source at the brow of the hill, allow the water, the humus, the fertilizer, and the soil to wash away. They grow deeper and wider, and gradually eat out large channels all the way down the hill. They soon grow so large as to interfere with cultivation. Usually the first gullies after developing in size, branch out in many directions, thus hastening the escape of natural and commercial fertilizers, and the destruction of the hill for farming purposes.

CAUSES OF EROSION.

Heavy rains, open winters, the absence of humus or cover crops, a disregard for the laying-off of rows, shallow plowing and poor methods of handling the water are the principal causes of soil erosion. The rainfall often exceeds three or four inches in as many hours. That is much more water than ordinary soils will absorb in that time. The surplus, which must pass off over the surface, washes much of the top soil away unless it is controlled.

The steeper the slope, the less water will sink into the soil. On steep slopes covered with thin, compact soil, unprotected by trees and grasses, a large percentage of the water runs off and carries

Fig. 3. Typical case of erosion in Texas. Terraces cross these gullies at right angles at which points dams will have to be built on the terrace until sediment fills the gullies.

with it much of the original covering. On gentle slopes with deep, porous and grass covered soils, the amount of water that runs off is very small, and therefore erosion is reduced to a minimum. The kind of soil has a marked effect upon the amount of water which will sink into a given volume of it. Usually, sandy soils will take care of more water than the finer clay soils during heavy and destructive rains.

The depth of the soil has an important bearing upon the amount of water which will sink into the ground. When the pores of the soil are full of water, the surplus will flow from the surface in sheets or in streams. A thin soil, therefore, will soon become saturated and its erosion will be more rapid than when the soil is deep and porous.

Vegetation aids the soil in absorbing water by holding it until it has a chance to sink into the ground through the small openings. At the same time, it prevents erosion by holding the particles of soil together and by collecting and holding such soil material as may be brought down from above.

The rate of rainfall, which is the only factor that is not to some extent under the control of man, has an important bearing on this problem. If during a rain of twenty-four hours duration two inches of water falls, the greater part will sink into the ground. If the same amount falls during a storm of two hours, only a small part of it will go beneath the surface.. The movement of water

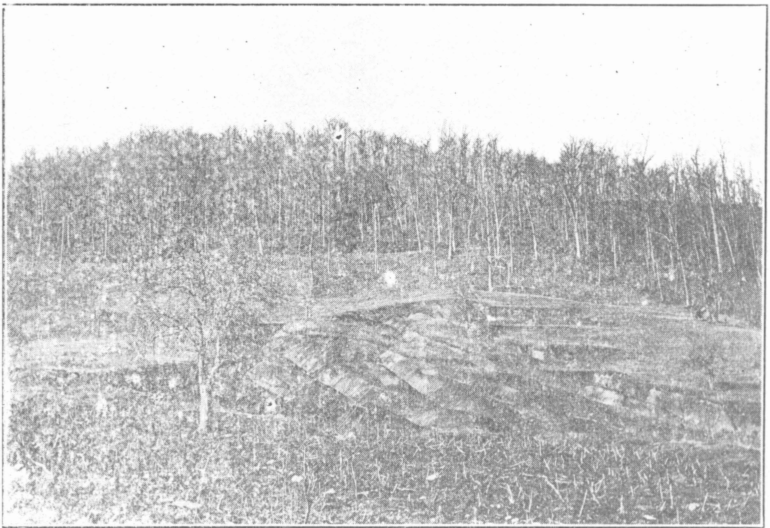

Fig. 4. Hilly land, partly wooded, partly cleared and partly cultivated; illustrating the tendency towards flattening of slopes by destructive erosion attending removal of the natural forest cover. The eroded surface soil is devoid of humus or other water-holding material and the subsoil is baked hard so that most of the rainfall is lost as run-off, leaving the ground too dry for productivity.

underground is slow, and when the surface of the soil becomes saturated, the balance of the rain water cannot enter very fast and so must flow off.

In the Northern states, where the ground freezes two or three feet deep and the precipitation comes in the form of snow, the soil is protected and the loss of soil and plant food is not very great during the winter months. In Texas, where the land is left unprotected from the weather during the winter months, there is a loss of much plant food. Alternate thawing and freezing, especially in the Northern part of the State, causes this soil to heave and crumble very rapidly unless it is protected and when heavy rains come the soil is in condition to be easily carried away. Nature never intended for the soil to be bare during this season. In the woods where the soil is covered with decayed leaves, shrubs, and grasses, the soil loss is very small. It is seldom that we find much evidence of erosion on soil other than that which has been in cultivation.

THE SOIL IN ITS NATURAL STATE.

In its natural state the soil is covered with grass, shrubs and trees which hold it together and prevent its waste. When the soil is covered with native vegetation it is maintained in an open and porous condition. In a forest during a heavy rain, streamlets begin to appear under the humus only after a great quantity of water has fallen. The layer of leaves and litter on the surface of the soil acts as a large sponge and soak up the water. Forest streamlets are very clean and clear, while in an open field with a rolling surface the soil is compacted, preventing the water from soaking in, and the finer materials suspended in the water soon make of it a muddy torrent which is costing the United States millions of dollars annually.

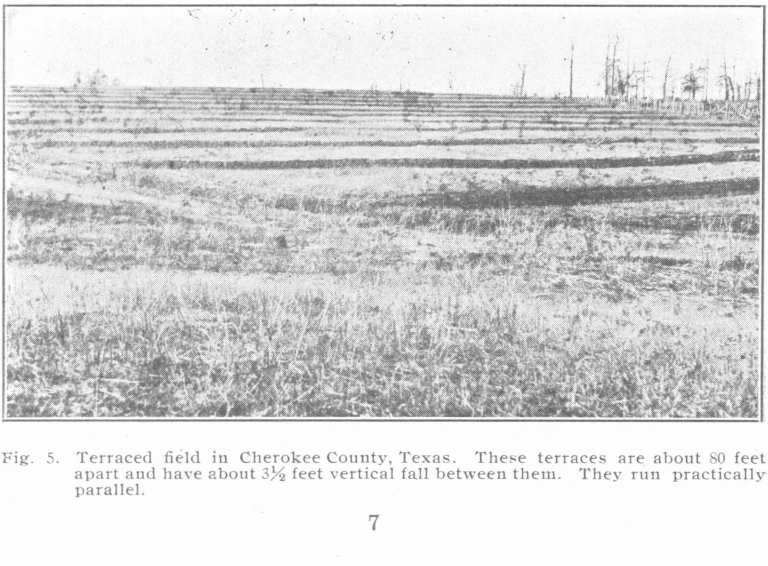

Fig. 5. Terraced field in Cherokee County, Texas. These terraces are about 80 feet apart and have about 3½ feet vertical fall between them. They run practically parallel.

IMPORTANCE OF GOOD TILLAGE.

Many farmers of Texas have not yet learned the importance of good tillage. The direction of plowing, planting, and cultivation is usually determined by convenience regardless of consequences. Very often a dead furrow run up and down hill will become the cause of a large gully. Plowing and cultivating should be done along the contour line and across the slopes. Many men criticise and make sport of circling and crooked rows. They do this in spite of the fact that thousands of fields which have been cultivated in straight rows have been ruined by erosion.

Many of our soils are very deficient in organic matter. These soils compact after a heavy shower, absorb very little water, dry out rapidly and harden and crust very quickly. On these soils leguminous crops, such as cowpeas and clovers should be grown and turned under. Barnyard manure should be turned back to the soil as soon as possible. Weeds, stalks and stubble, so often burned, make very fine humus and should always be turned under. The effect of such treatment loosens the soil, binds the finer soil particles together into granules and crumbs, and aids ventilation; the soil takes up more water, the run-off is reduced and washing diminished.

Hill lands should be plowed deeply at the proper time and terraced. The object is to provide a deeper reservoir to hold the heavy rains and to cause a rapid absorption of water. Land plowed eight inches deep will absorb practically twice as much water during the first few weeks after plowing as land plowed four inches deep.

Fig. 6. Terraced field near Alto, Texas. This field has 86 feet fall in about 3/8 of a mile and twenty terraces cross it. Rows run with the terraces and the best rows in the field are on the terraces. All terraces were built with a plow alone, by re-plowing four or five times.

RESULTS OF EROSION SUMMED UP.

1. Sheet erosion strips the fertile soil off the tops of hills and deposits much of it on the rich bottoms below, where it often does great damage.

2. Gullies formed on the slopes of hills allow water, humus and commercial fertilizer to escape.

3. Cultivation is made more difficult because the texture of the soil is changed, due to the clay subsoil, rocks and sand which are left exposed on the surface.

4. Small streams, rivers and harbors have to be cleaned and deepened at great expense, due to the sediment which has been carried down by the water.

5. Farm land values are lowered.

Hillside erosion is not a simple process. Native vegetation, grass and organic matter in the soil are factors that have marked influence on the amount of water the land will take up and the amount of erosion that will take place. The character of the subsoil, as well as of the surface soil, has a marked effect on the rate of erosion. Two fields of the same slope often show a great difference in erosion.

There are two general classes of terraces. In the first class the terrace is run on a level around the hillside and is intended to make the land retain and take up all the water that falls on it. In the second class, the terrace is given a slight fall which allows the water that will not soak into the ground to run off at a very low velocity. For the greater part of Texas the latter class should be used.

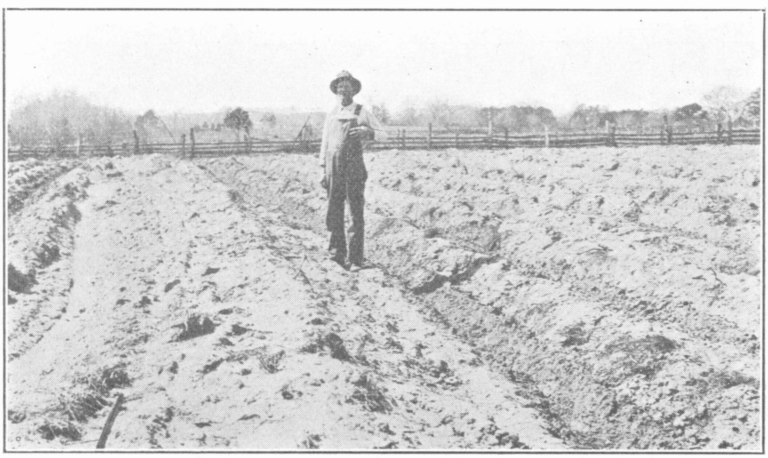

Fig. 7. A small terrace near Gallatin, Texas, in a field that was terraced eight years ago. It illustrates how completely a gully 8 feet deep and 10 or 12 feet wide has been filled. The man in picture is standing over site of the original gully which was filled up in three years.

THE GUIDE-ROW TERRACE.

The guide-row terrace is run on a level. The aim is to hold the water practically where it falls until it soaks into the soil. It is adapted to deep sandy soils, which absorb water quickly and easily, and for hillsides where the slope is less than eight or ten feet to the hundred feet. The terraces are usually located with a vertical fall of three or four feet, and are built about four feet wide and twelve to eighteen inches high. The rows should be run parallel with the terraces. To avoid any waste land, a row may be planted on top of this terrace.

To locate guide-row terraces, select a starting point for the first terrace near the top of the hill; set up the instrument slightly above this point where both ends of the terrace can be seen and locate a line of stakes on the level. After the first reading is taken the target should be clamped and left at the same position on the rod for all readings on this terrace line. For the next lower terrace the target should be raised three or four feet, according to the fall between terraces, and clamped in that position while locating points about 50 feet apart on a level on the second terrace. Two or three terraces can often be located with one set-up of the instrument. After the stakes are all located, the terrace lines should be marked off with a plow. Some one should walk ahead of the team in marking the terrace line in order to make rounding curves rather than sharp corner turns. It is not necessary to follow the stakes exactly, because turns can be made with a gradual curve that will follow the line of stakes closely enough to not materially affect the level of the terrace. After the terrace line is located, the terrace should be constructed by plowing the ground together two or

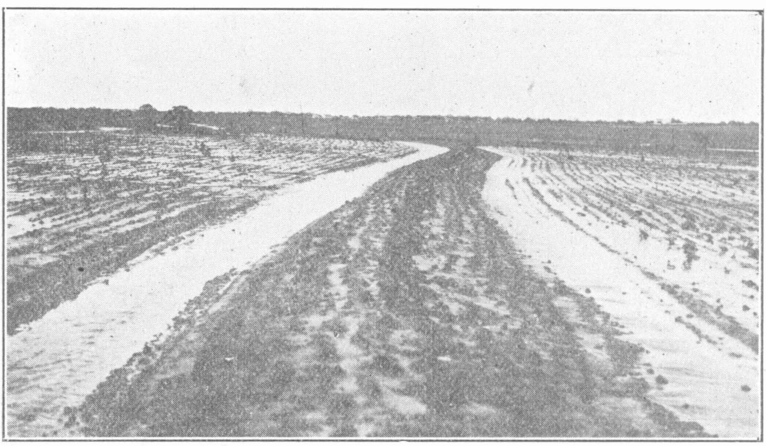

Fig. 8. Terrace carrying water off in a relatively broad and shallow stream and at a low velocity.

three times until it reaches the proper height. If any gullies are crossed they should be filled up with a slip scraper.

If two adjacent terraces are not the same distance apart throughout their entire length, the ground to be cultivated between them will be wider at one end than at the other. In this case begin to lay off the long rows alternately next to the upper and lower terrace, and work out toward the middle till they meet at the narrow end. The short rows will then be in the middle at the wide end. Rows laid off in this way are themselves miniature terraces and are a great aid in holding water. There is some objection to these terraces on the ground that they make the use of improved machinery more difficult, but that is really insignificant when compared with the benefits. When the terraces are not cultivated, which is very generally the case, they present many undesirable features. The use of the land occupied is lost and weeds and shrubs which spring up become harboring places for mice and insects.

THE LEVEL BENCH TERRACE.

The level bench terrace is the true terrace. The land between two terraces becomes a level bench with no fall in any direction. In many places where fields have been terraced by this system, the hillsides appear as though they had natural steps from the top of the hill to the valley below. The level bench terrace is located in the same manner as the guide-row terrace. It is constructed by plowing with a hillside or reversible disc plow which is set to throw the dirt down hill, no matter in what direction the plowing is done. By doing this a few years the land between two terraces becomes a level bench which can be cultivated as land which has never been terraced. It is usually advisable to sow the small incline between the terraces in grass to hold this part of the terrace in place. The

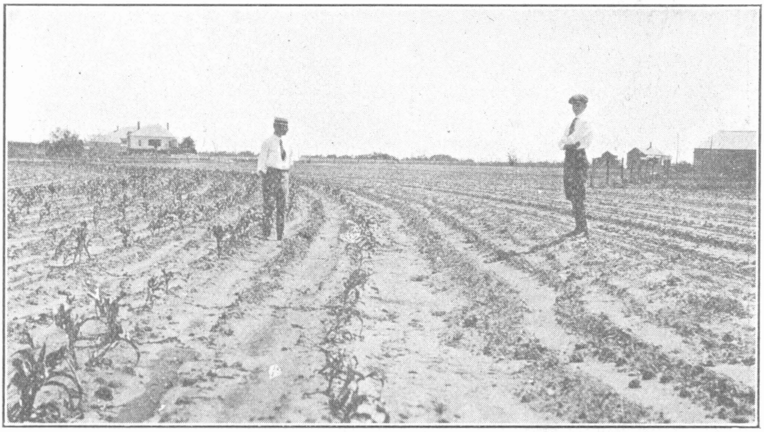

Fig. 9. Circling rows following lines of terrace.

lower side of the terrace, which is about three feet high, should be kept nearly vertical in order to waste as little land as possible. The rows should be laid off as was explained for the guide-row terrace. If the terraces are crossed by teams, plows, wagons, etc., depressions will be formed which will allow the water to break over and start a gully which would probably destroy the terrace. This can be avoided by leaving a sodded place at the end of the field which can be used as a roadway in going from one terrace to another.

HILLSIDE DITCHES.

Hillside ditches, which are commonly used in an attempt to stop washing, are very undesirable. The fall usually given to them is two or three times as much as a terrace should have, and the confinement of the water in a narrow channel and in large volume causes serious washing. One ditch is often required to drain ten acres, which is entirely too much, and they are usually laid off by guess. In a few instances, where a reasonable guess has been made in locating them, they have been of considerable benefit. The space they occupy is a total loss. Weeds on the banks furnish seed enough to infest all adjoining land, besides using the food supply and moisture from the crop, and they also furnish an excellent harbor for mice and other injurious insects. To keep the weeds and grass down requires more time than to cultivate a good crop. Ditches often break, causing great damage and are impassible to machinery. The hillside ditch should be used only when water from adjoining property must be controlled or when it is found necessary to construct a ditch to carry off the water from terraces.

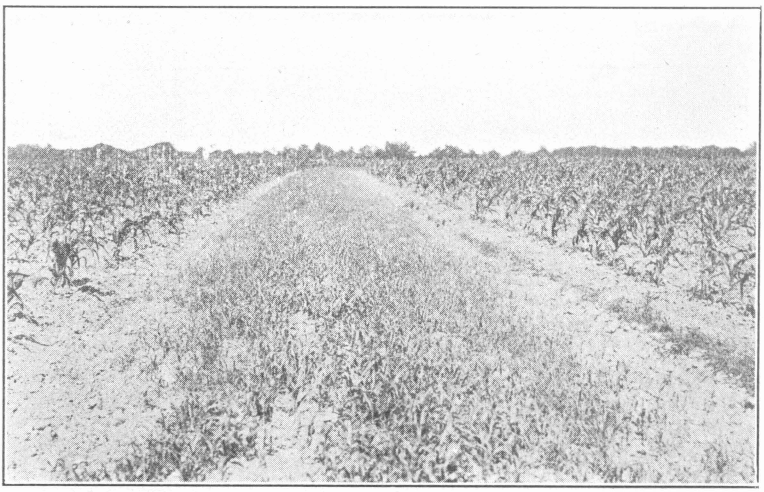

Fig. 10. Terrace showing sorghum growing broadcast first year after building.

If they must be used, it is a good plan to have them seeded to some good soil-binding grass.

ORIGIN OF THE BROAD TERRACE.

The broad terrace which is given a slight fall is the best type of terrace for the greater part of Texas. Its construction is carefully explained on page 20. This terrace as worked out by P. H. Mangum of Wake Forest, North Carolina, in 1885, when properly constructed, admirably meets the requirements for modern machinery equipment. The use of this system of terracing has been so satisfactory that thousands of farmers in North Carolina and adjoining states have adopted it. The water which falls on the fields is handled so well that soil improvement begins at once. Water is not allowed to cut or denude any part of the field. A plow, reaper, rake, mower, or wagon can be driven safely over the field, and the whole cultivated as neatly as the most careful farmer might desire. When these terraces have once shown their worth every owner becomes an enthusiastic advocate of and takes great pride in them. The terrace gives the water a different course, causes it to move very slowly, permits the soil to absorb more moisture, and prevents the water from collecting in depressed areas which would soon break and start washes. This terrace is simple in construction, permanent in character, lends itself to the use of modern labor-saving machinery, and is adapted to practically all types of soil. Any farmer may with a little practice, learn to terrace his own farm.

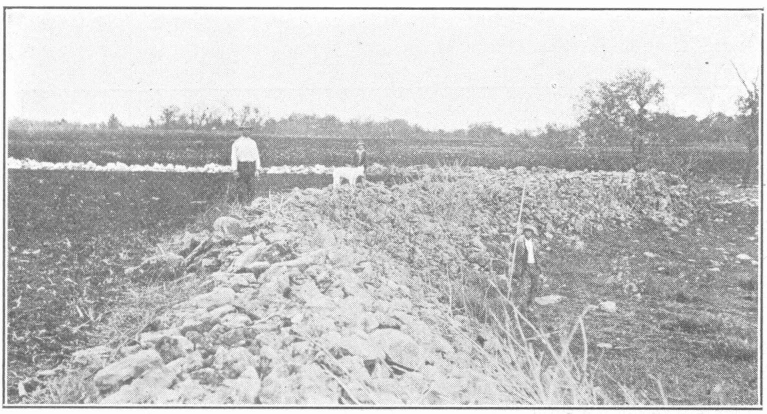

Fig. 11. Stone wall across a wide "draw" near Blanco, Texas. The water as it comes down the steep hillside above is carrying the best soil from 100 acres to the upper side of the dam where it is settling and filling up the "draw." Note the difference of elevation of two men in picture. The dam is now 8 feet high at highest point and the sediment deposited now covers nearly two acres above the wall. When the soil reaches top of wall, the wall is raised by piling on more stones. The owner estimates the value of the wall at more than $500. The hillside above should be terraced to hold the soil.

MODIFICATION OF BROAD TERRACE.

In many parts of Texas a narrow terrace, a modification of the broad terrace, is used quite successfully. In some localities where the soil "melts" down after a heavy rain, making cultivation impracticable, their use is recommended. Very few sections of the state, however, are troubled in this way. These terraces have many of the disadvantages of the hillside ditch. They are usually built eighteen or twenty inches high and seven or eight feet wide.

THE BROAD TERRACE.

The broad terrace is adapted to practically all types of soils. It is simply a large bank of earth with sloping sides contouring a field, usually at a grade of four to six inches to the hundred feet. The water is carried away in a thin sheet at a low velocity. If a graded road is kept in mind, a very good idea is obtained of a well-built terrace. The water is carried toward some natural water course which crosses the field and into which the terrace may drain. The fall to give a terrace depends upon the capacity of the soil and subsoil to absorb water, on the rate of rainfall to be expected, and on the slope of the land. Sandy lands need less fall than heavier soils. An open, sandy loam may be so porous that the terrace lines can be run on a level, but on most soils a fall of from four to six inches is desirable. This fall is sufficient to remove the surplus water without erosion.

LOCATING THE TERRACE.

Before locating a terrace, the ground should be gone over very carefully in order that the best location may be made. It often happens that a good outlet will be hard to secure for the upper ter-

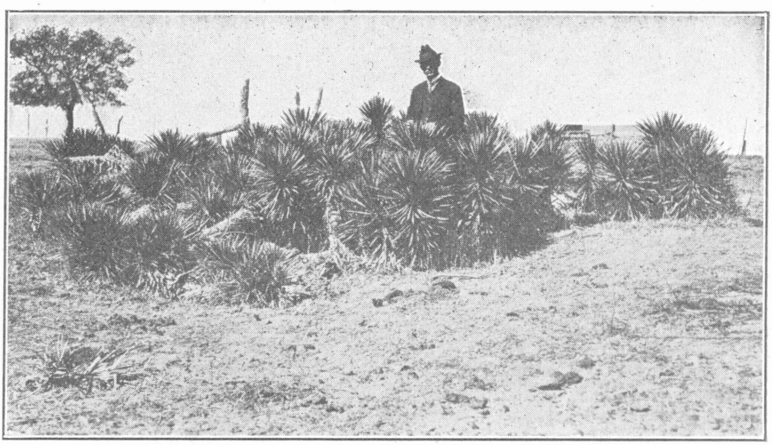

Fig. 12. Bear grass planted in an old gully will soon cause large washes to fill up.

races, and in this case it may be necessary to cut a ditch to take care of the discharge from these terraces. If this ditch shows a tendency to cut a large gully, perhaps a soil-saving dam or concrete drop may solve the problem. Neither are very expensive and an explanation of their construction is given elsewhere in this bulletin. After the upper terraces are located, the lower terraces are very easy to locate. They run practically parallel with the terraces above, and usually their outlets empty directly into the main channel where the water can do no damage. On 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. This will shorten the distance the water must be carried and will lessen the amount to be handled by each terrace. If the area to be terraced is very large and there are several depressions to be crossed before reaching the outlet, it may be necessary to make a ditch in one of these depressions and use it is an emptying point and thus relieve the strain on long, irregular terraces. The ditch should be seeded to grass and partly filled with brush at intervals to check the velocity of the water and prevent it from washing too deep.

If it is desired that the terrace should pass any particular point, tions. When terraces are allowed to discharge into a woodland, it often happens that in the future when the owner desires to put that area in cultivation he will have much difficulty in adapting his terraceing system to this new land. One should always keep possible future changes in mind when locating terraces.

It is often possible, by a careful inspection of the field and a

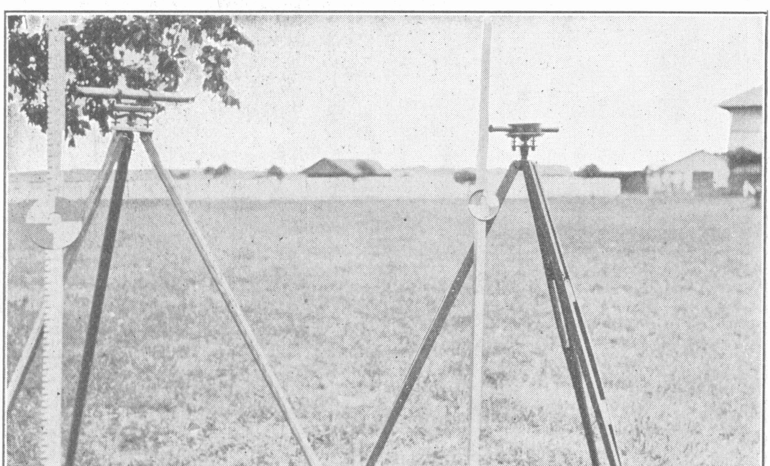

Fig. 13. Two satisfactory types of farmers' levels.

little forethought, to reduce the labor of terracing. If there are several large gullies in a 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 a convenient point. Sometimes it is desirable to have the terrace empty at some particular point along the side of the field, and in that case, that point would be the best starting point for the terrace. To avoid intersecting abrupt knolls in a field, terraces should be located just above and below such places. By avoiding as many of these irregularities as possible, it is often possible to do a neat job of terracing, while, if carelessly done, it would present many ugly twists and turns. In terracing a field it is not necessary to locate the top terrace first. In fact it is often better to start terracing half way down the slope where the terraces run more regularly and work in the upper and lower terraces later.

SOME GENERAL PRINCIPLES.

There are a few general principles which must, if possible, be followed in terracing. First, the general direction in which the country slopes should be noted. This can be determined by noting the direction of the flow of the main streams or drainage channels. As a rule, terraces should be laid off to carry the water upstream or opposite to the direction of flow of these drainage channels. If

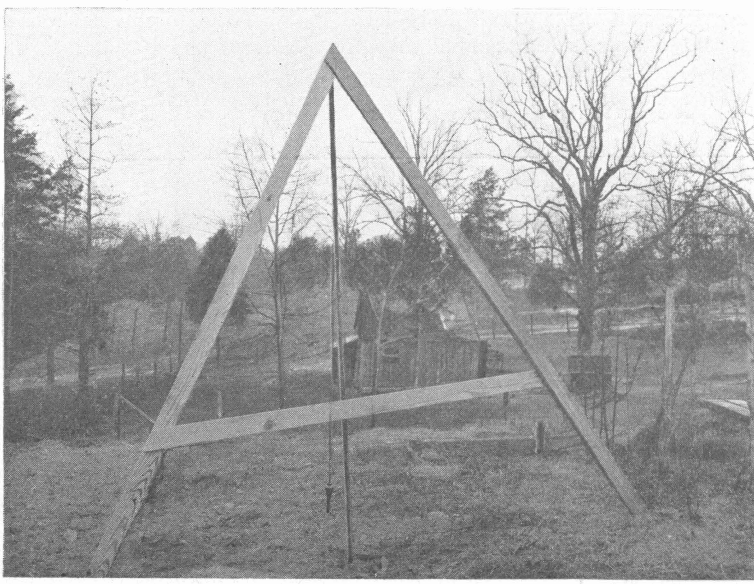

Fig. 14. A-frame with plumb bob for locating terraces. It will not work well on a windy day. A carpenter's spirit level attached to the horizontal board is more satisfactory.

the terraces are run to carry the water in the same general direction as the natural streams, in most cases the outlets will not be as good and the terraces will be longer. The fact that the natural drainage channels and creeks, as a rule, have more fall than the terraces accounts for this difficulty. Of course, the water in the terraces cannot be carried upstream through a neighbor's field, nor should it be emptied into a public road where it will do damage. The natural direction of flow of the water must be considered. Often a house, barnyard, or garden, will prevent running the terrace in the most ideal direction, and in that case, the next best course must be taken. To properly terrace some farms would affect neighbors' property, and in that case, a collective operation in reclaiming land by terracing should be practiced in much the same way as is required in irrigation and drainage projects.

THE FARM LEVEL.

To lay off a terrace, a leveling instrument of some kind is necessary. A simple, inexpensive farm level with a telescope, rod and target, costing about $15.00, is very well suited for terracing work. If reasonable care is taken in using the level and the adjustments are noted from time to time, as satisfactory terracing work can be done with these levels as with the more expensive kind. These levels consist of a tripod, a set of leveling screws, a telescope with crosshairs, and a spirit level. After the instrument is set approximately level by eye, the bubble is brought to the center of the bubble tube by means of the leveling screws. After a little practice it is very easy to level up these instruments. The rod has a movable target, and when the readings are taken with the horizontal hair in the telescope exactly on the center of the target, the height of the level line of sight above the ground at the rod is indicated. Figure 13 shows two of these small farm levels.

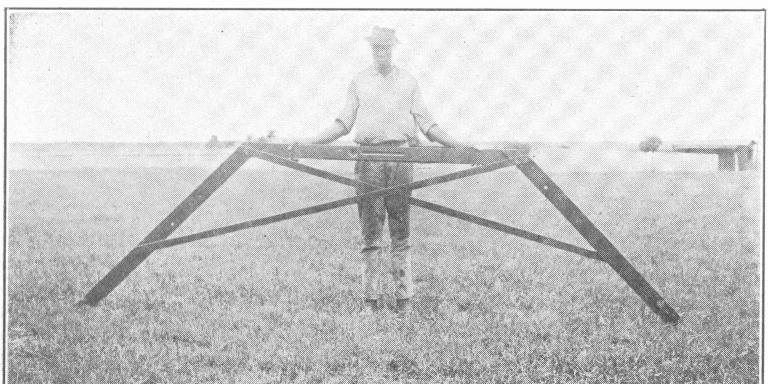

Fig. 15. Home made A-frame with carpenter's spirit level.

Three or four farmers may use the same level and help each other in locating and building their terraces. Homemade levels, as shown in Figures 15 and 16 are often used for this work, but the farm level is more accurate and faster.

LAYING OFF THE BROAD TERRACE WITH AN INSTRUMENT.

After a starting point and the outlet have been selected for the proposed terrace, the instrument is set up at some point on the hill where the rodman will be within range of the telescope for the greatest distance each way along the terrace. By means of the leveling screws the bubble is now brought to the center of the tube. The rodman places his rod on the proposed terrace line, and the instrument man sights through the telescope at the rod, motioning the rodman to move the target up or down until the horizontal cross-hair in the telescope coincides with the center of the target. Here the target is clamped and a stake driven into the ground to locate the place. Broken cornstalks, weeds or other convenient material can be used for stakes to mark the terrace line. If the stakes are set fifty feet apart, and the fall per 100 feet is six inches, it will be necessary to move the target three inches each time. If the rodman goes toward the outlet of the terrace, the target must be raised three inches each time; if he goes in the opposite direction, he must lower the target three inches every time he walks fifty feet. The rodman now paces off about fifty feet, taking seventeen steps toward the outlet of the terrace, raises the target three inches and clamps it to the rod. The rodman is now motioned up and down the hill, still keeping 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

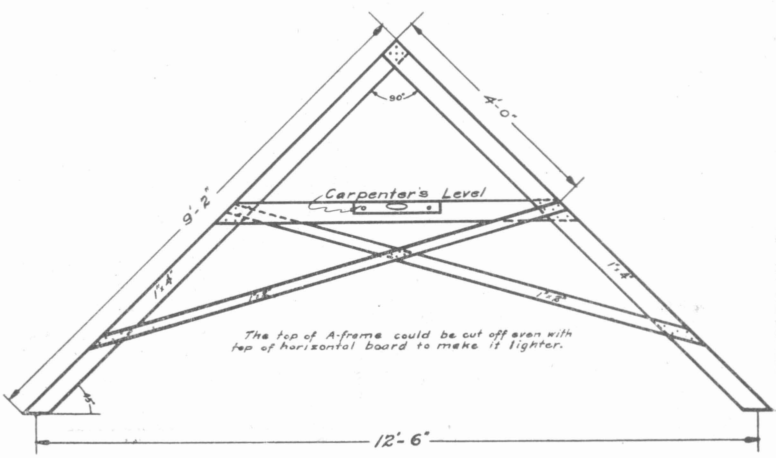

Fig. 16. Drawing showing details of construction of A-frame terracing level.

a hill, or gets too far away for the target to be seen, it will be necessary to move the instrument to a position where the terrace can 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 three inches at each fifty foot station.

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 show a very broken line. The terrace must have easy rounding curves and must avoid irregularities shown by the stakes. It is usually best to have a man walk ahead of the team in running the first furrow, or if a riding plow is at hand, the rider should stand on the plow where he can see ahead. If the land is not seriously gullied, and the man with the team and plow has had some experience in terracing, the terrace line can be marked off directly behind the rodman. The stakes in this case will not be necessary and some time will be saved. Judgement and common sense are necessary in running the first furrow, and especially so if the land is gullied and washed.

LOCATING THE TERRACE OVER A GULLY.

In setting stakes, average ground should always be selected, and where elevations or depressions are sharp, the stakes may have to be set closer together than on even ground. Usually fifty feet

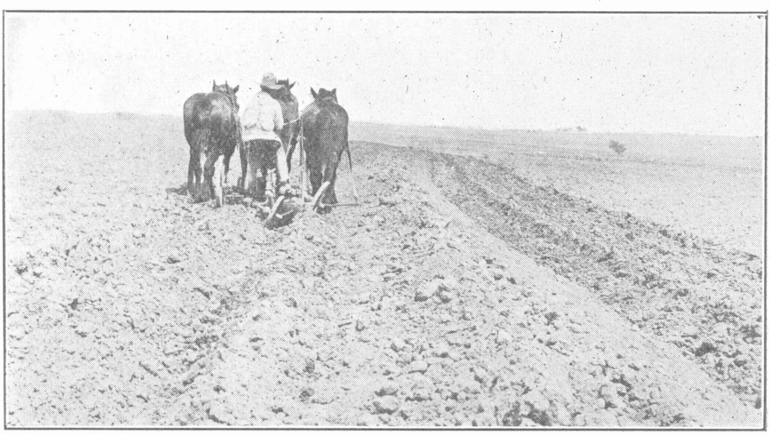

Fig. 17. Building a terrace with plow and V-drag. One round has been made with the drag which shoves one furrow at a time about 4 feet towards the center of the terrace.

is a convenient distance, but on rough land fifty feet may be too far to give the proper course for the terrace. The readings should not be taken in a hole and then on a high place. If the rod readings are taken between the rows the first time, the succeeding reading should be taken there also. In crossing a gully, stakes should be set on each side in such a way as to make it necessary to grade some dirt from each side of it and thus get extra dirt to fill in the gully. The gullies, of course, need a dam which will be higher at first than the banks on either side, because a loose, high bank will settle considerably. Also, the water concentrates at these places and for this reason the banks should be strong. The depressions above the dam will soon fill up to the level of the bottom of the ditch and thus strengthen that part of the terrace.

BUILDING THE TERRACE.

In building terraces, the work should begin at the top of the hill. The upper terrace should be finished before any of the lower terraces are started. This precaution is necessary because a heavy rain might ruin the terraces if the lower ones are built before the upper ones, and if the latter should break, the lower terraces are almost certain to be washed away.

After the first furrow has been run, marking the terrace line, a second furrow is thrown back. In making this back furrow it is a good plan to keep two or three feet from the first furrow, leaving a solid strip in the center of the terrace, which will act as a shoulder for the water. About six furrows should be thrown together. The plow should be run deep and set to take a small furrow

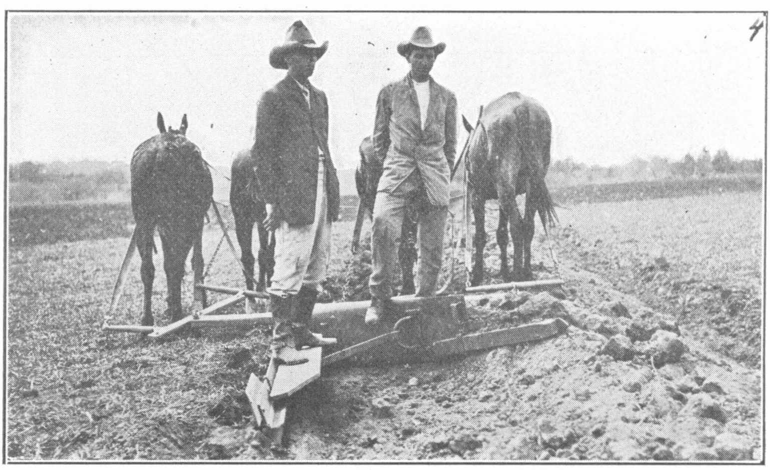

Fig. 18. A small steel ditcher which is very effective in throwing up terraces. It requires 4 to 6 mules to pull it and two men to ride on it. When a plow is used ahead of the ditcher to loosen the dirt, 6 to 12 acres can be terraced in a day.

in order to throw the dirt as high as possible. After these six furrows have been made, a triangular V-drag, Figure 26, which is commonly used for ditching, is very effective and efficient in banking up the dirt for the terrace. After this round, the drag should follow the plow, shoving one furrow at a time about four feet. It usually takes about fifteen rounds with the plow and ten or twelve with V-drag to build a terrace. The drag when used in connection with the plow, under favorable conditions, is probably the best outfit for building terraces. The V drag is made reversible, because on rather steep hillsides it is not practicable to shove dirt uphill very many times. For very steep hillsides the reversible disc plow is probably the bts implement to use.

It is often possible to secure a reversible road grader, requiring six or eight mules to pull it. A reversible grader is best, because often it is not practicable to move dirt up hill. The road grader will usually work better on black, heavy lands than on sandy

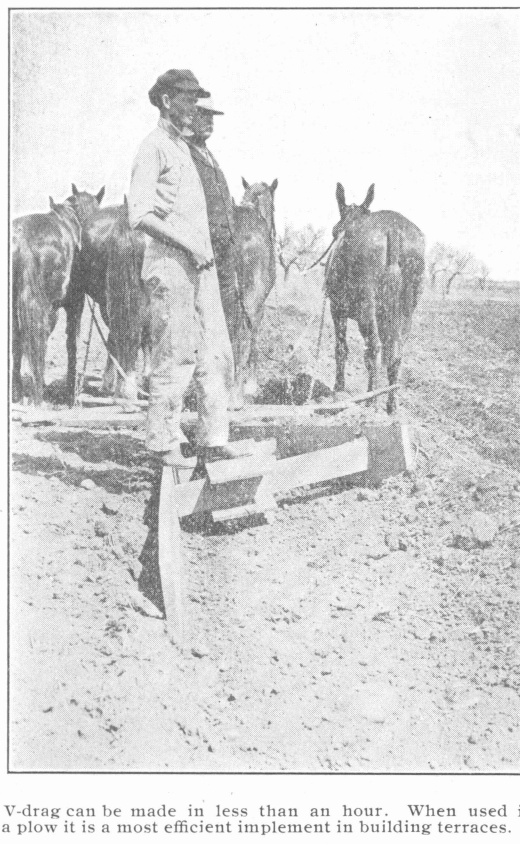

Fig. 19. This V-drag can be made in less than an hour. When used in connection with a plow it is a most efficient implement in building terraces.

lands. In the latter case, the wheels of the grader cut in deeply and make the draft very heavy. For sandy soils the V-drag and plow make a very effective combination.

Terraces are often thrown up with a plow alone, by plowing the ground together four or five times. After the terrace line has been located, a strip of land twenty to twenty-four feet wide is back-furrowed, after which it is replowed, beginning again at the center of the terrace. Four or five such plowings will usually bring the terrace twenty to twenty-four inches high and eighteen to twenty feet wide. The last two plowings can best be done after the preceeding plowing has been settled with a rain.

The terraces on rather steep hillsides can sometimes be built by lapping the furrows together when the plow is throwing the dirt downhill. In this case, only half the time is used in throwing up the terraces, but on returning a furrow is plowed while breaking the land.

To finish a terrace, a slip scraper may be needed to remove the high places in the bottom of the terrace and to fill in the low places on the bank. When finished, the top of the bank and the bottom of the ditch should have a uniform grade. A well built terrace requires considerable team work when made wide enough for five rows of cotton. However, if the land is not too badly washed, two mules on a plow and four mules on a V-drag ought to build terraces

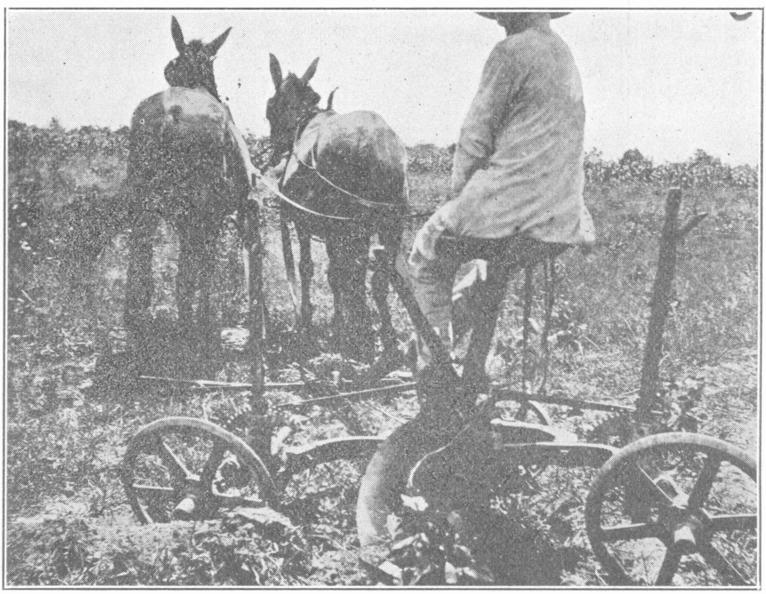

Fig. 20. A reversible disc plow is a useful implement for building terraces.

on from five to fifteen acres a day. It is best to build them strong at first, and especially so if the land is steep and badly gullied.

Terraces require constant attention, and particularly the first year, until the bank has settled. After the first year there should be little trouble from the bank breaking. After each heavy rain, it is a good plan to examine the terraces and remove any obstruction that might be in the ditch and strengthen the weak places.

DISTANCE BETWEEN TERRACES.

The actual distance between terraces must be determined by the lay of the land. On steep hills they must be placed closer together than on nearly level land. On very steep fields a vertical drop less than four feet places them too close, while on gently sloping land a drop of two and one-half to three feet may place them amply far apart. Ordinarily four feet vertical drop will place the terraces from 75 to 100 feet apart and will give them as much water as they will be able to handle. The vertical fall between terraces will vary from 1 1-2 to eight feet. The following table is a good guide to follow, and for the greater part of Texas will be found satisfactory. For West Texas the distance may be a little greater than shown in the table:

Fig. 21. With a road grader and plow from three-fourths to one mile of terrace can be built in a day.

Vertical Fall	Distance Apart
2 feet	125-150
2 1-2 feet	100-125
3 feet	100
3 1-2 feet	95
4 feet	90
4 1-2 feet	85
5 feet	75
5 1-2 feet	70

Usually, the hillside is steeper just below the brow if the hill and flattens considerably near the bottom. In such cases it is necessary to use different vertical spacing on the same field. In fact, good common sense is the best guide. Some soils wash easier than others and the length of the terrace and the height of the bank should also be kept in mind in spacing terraces.

RUN THE ROWS WITH THE TERRACE.

The rows should be run with the terraces. One of the best methods is to plant a few rows just above one terrace and then the same number just below the next higher terrace. By following this method the point rows will come halfway between the terraces. If the distance between the terraces varies a great deal there will be a large number of short point rows. To prevent having all the short rows running out together, 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. The first row should be located on the center

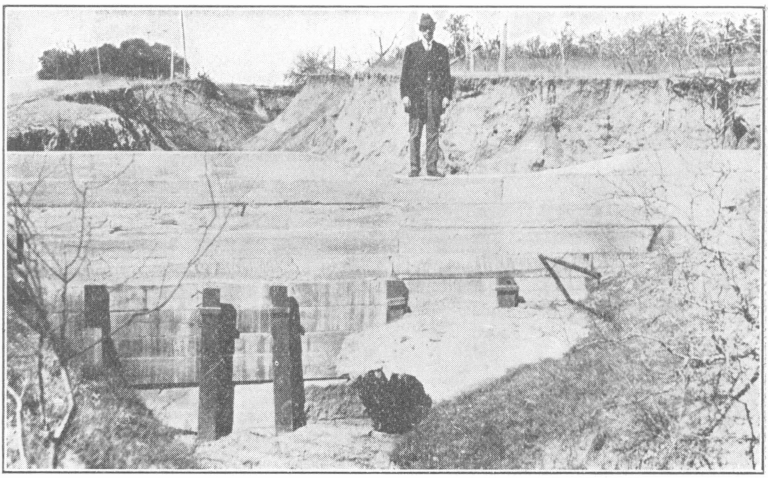

Fig. 22. Concrete wall across gully on public road near Marlin, Texas. The water goes over center of dam and falls on a concrete apron. The gully will gradually fill in above the dam.

of the terrace, and when built 18 to 20 feet wide there will be about six rows on the terrace.

TIME TO BUILD TERRACES.

The best time to do terracing work is in the fall after the crops have been harvested. This is the idle period, and work done then will be well established by spring and will also protect the land against heavy fall and winter rains. The expense of building terraces in the fall is usually not as great as at other seasons, and if a period when the land is considered too dry to plow is selected for this work a large acreage can be terraced in a day.

ADVANTAGES OF BROAD TERRACE.

By building the broad terrace there will be no waste land. The best rows in the field are found on top of the terrace. The crop in the ditch may not be as good the first year, but the second and third years it will produce as well as the rest of the field. Weed rows which are so common on the narrow uncultivated terraces, and which furnish fine harboring places for insects, are avoided by the broad terrace. One of the greatest advantages of the broad terrace is that it permits the use of improved machinery. The gang plow, the section harrow, riding cultivator and grain binder can be used satisfactorily. The terrace is simple in construction, permanent and lends itself to the use of all labor saving machinery.

THE V DRAG FOR BUILDING TERRACES.

The V-drag shown in Figure 19, when used in connection with a good walking plow is one of the best implements that can be used in building terraces. Every farmer who owns a hilly farm should have one of these drags on his place. It is also very useful in opening up small ditches. It is so constructed as to shove the loosened dirt toward the center of the terrace. When the soil is in fairly good condition, four mules on a properly constructed V-drag and two mules on a good turning plow, will usually move

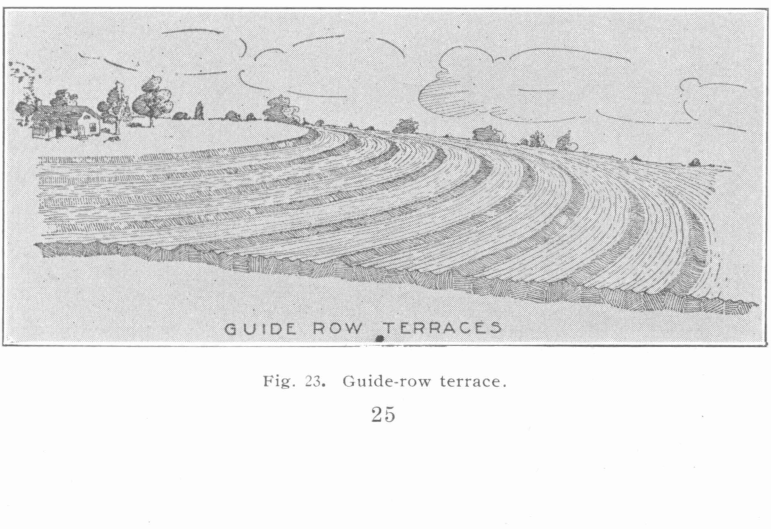

Fig. 23. Guide-row terrace.

more dirt than six mules on a road grader. The V-drag is light, while the road grader requires two mules or more to pull it through the field empty when the wheels get into the soft loose dirt on the terrace. The cost of terracing with a V-drag and plow usually varies from fifty cents to $1.25 per acre.

Figure 26 shows the construction of a very simple and efficient V-drag. The long wing of the V-drag, corresponding to the moldboard of a plow, is 6 feet 6 inches long. For these wings a good grade of 2" by 12" lumber should be used. One face should be planed in order that it may be turned toward the dirt and be used on the wearing side of the V-drag. The spread between the wings for black land should be about three feet ten inches, and for sandy land four feet is satisfactory. To hold the wings rigid, two 2" by 6" braces, as shown, spiked to the 2" by 12" wings and placed three inches from the edge of the wings allows clearance for the drag and makes it reversible. The hitch should be located in the center of the 2" by 12", as shown. Usually an iron 1-4"x2"x2'-6" bent into the form as shown in the cut and bolted to each wing makes a very convenient hitch. Sometimes a 3-5 or 1 inch bolt put through the point of the V-drag ten or twelve inches back answers the purpose very well. A four-horse evener should be hitched to the V-drag by means of a chain 2 1-2 to 4 feet from the point of the drag.

MATERIAL NECESSARY FOR A V-DRAG.

1 Piece 2"x12"x18' (for wings, planed one side.)

1 Piece 2"x 6"x 6' (Rough, for braces.)

1 Piece 1"x 8"x 8' (Rough, to stand on.)

2 Pieces steel 3 or 4"x1-4"x6 1-2' (For the cutting edges of the short wing.)

14 bolts 3-8"x2 1-2" (To fasten steel to short wing. Countersink the bolts.)

Strap of iron 2"x1-4"x2'x6" (For making the hitch for chain.)

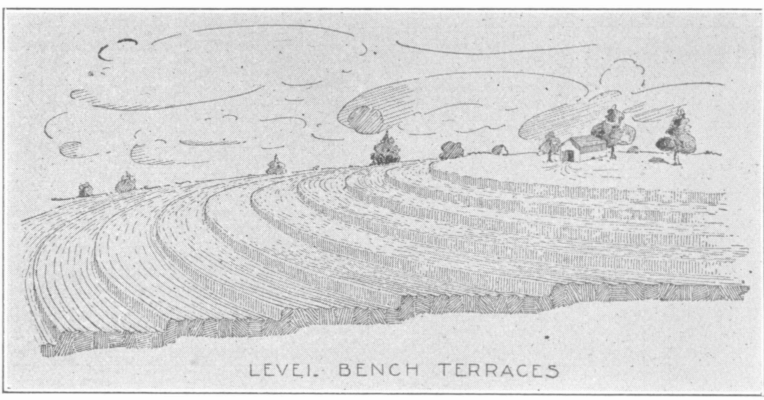

Fig. 24. Level bench terrace.

1 bolt 3-4"x5".

1 Pound 20 penny nails.

1 Log chain and four horse evener.

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 hinged wings can be varied, but usually the drag is not as strong or as rigid. The simpler the drag can be made, the more effective it will be.

With two men riding on the V-drag, four 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 to shed the dirt.

HOMEMADE TERRACING INSTRUMENTS.

A homemade terracing instrument may be made of two pieces 1"x4"x10', two pieces of 1"x2"x10', one piece of 1"x4"x7', and a carpenter's spirit level. The A-shape level in Figure 16 shows its construction. The wood should be light, well seasoned, straight, and free from a tendency to warp. An instrument which spans twelve and a half feet is a very convenient size. The legs should be cut at an angle of forty-five degrees, and be 9' 2" long on the longer side. They are nailed together at right angles at the top of the instrument. A level floor is now selected and the legs are spread exactly 12 1-2 feet. The horizontal board, to which the spirit level is attached, is nailed to each leg the same distance from the floor. Four feet is a convenient height. The level is now fastened to the horizontal board in such a way that it will be exactly level. The 1"x2" braces are often omitted, but they stiffen the instrument considerably. In order to adjust the instrument to give a fall to the terrace, one leg is either shortened a little with a saw, or a small block of wood is nailed under it. In using a level with a 12 1-2 foot span, 8 steps will be needed for 100 feet. If an 8 inch fall per hundred feet is used, the leg will have to be shortened one inch or a one-inch block will be needed. For a four-inch fall, half this adjustment will be required, and for a five inch fall the adjustment will be five-eighths of an inch.

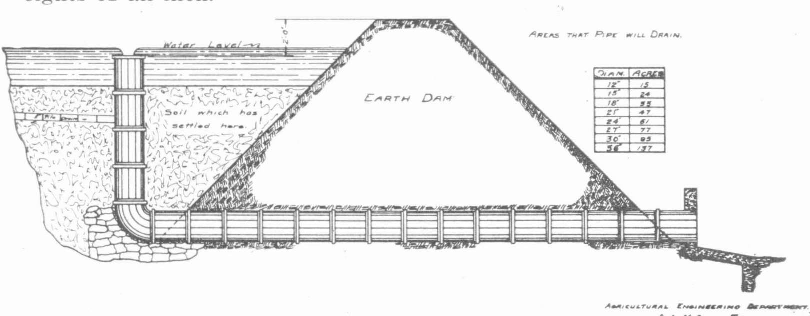

Fig. 25. Soil-saving dam. Lengthwise section of gully showing cross-section of dam and installation of vitrified sewer pipe underflow.

The terrace lines are marked off by walking the instrument around the hill. One leg is placed on the proposed terrace line and the other end is moved up and down the hill until the spirit level shows it to be level. The points where the legs rest should be marked with a stake every few steps, depending on the irregularity of the ground. The instrument is now carried forward so that the back leg is placed where the front leg rested, and the front leg of the instrument is again swung up and down the hill until the instrument is leveled.

In terracing, the first thing to do is to locate the outlet. The long leg of the instrument must then be moved in such a manner that it points in the direction of the outlet of the terrace. After a little experience the operator will be able to locate the starting point and also estimate the fall between terraces by looking at the land.

THE PLUMB-BOB INSTRUMENT.

Another instrument, which is very commonly used, Figure 14, is constructed practically the same as the above instrument, except that a plumb-bob is used in place of the level. The most convenient spread of the legs should be an even aliquot part of 100 feet. A 12 1-2 foot instrument is very satisfactory. The plumb-bob is suspended from the top of the A-frame and allowed to swing freely until it comes to a rest. The cross bar is marked where the plumb line crosses it. The A-frame is now turned end for end on its supports and again marked where the line crosses the cross bar. The point midway between these two points is distinctly marked and called zero. When the ends of the legs are so placed that the plumb-line falls on zero, the points on which they rest are on a level line. If a one inch fall is now given for each step of the instrument, a one-inch block can be placed under one leg and the place where the string crosses is marked on the cross bar. In this way any fall that

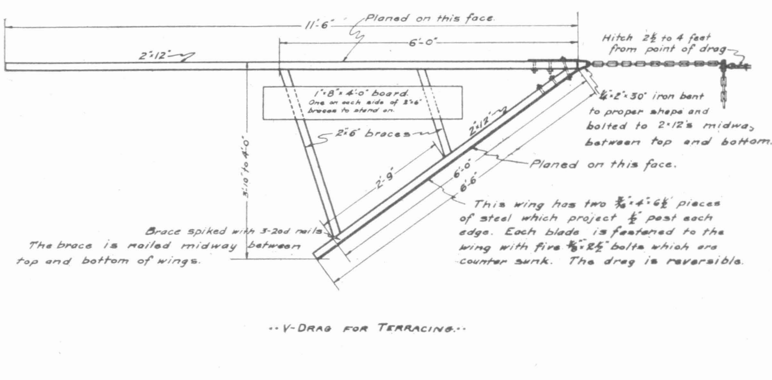

Fig. 26. Drawing showing construction details of V-drag.

may be desired can be marked off on the cross bar. The plumb-bob works very well on a quiet day, but if the wind is blowing it is useless to try to use it. The spirit level attached to the frame is more satisfactory.

Another home-made terracing instrument, the principle of which is the same as the first A-frame described, is made by nailing at right angles 1"x4"x4' legs to each end of a 1"x4" or 1"x5" scantling 16 feet long. The legs are braced with a short piece of 1"x4". A spirit level is nailed in the center of the long scantling.

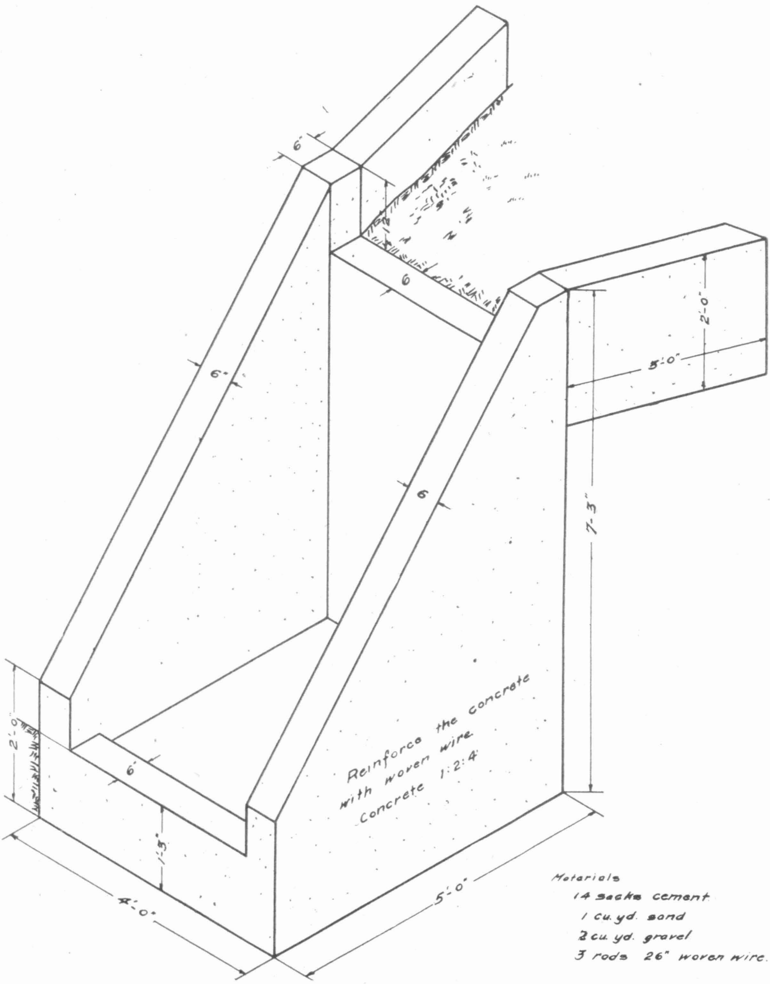

Fig. 27. Drawing showing construction details of concrete drop.

RECLAMATION OF ERODED AND ABANDONED LAND.

When the field is badly gullied, the problem of checking the washing and repairing the damage becomes difficult. No attempt should be made to fill large gullies with a team, plow and scraper unless the gully stretches out into a cultivated field, because such work is not very remunerative and requires too much hard labor. This applies to gullies which a horse would have considerable difficulty in crossing. The improvement of gullied land requires considerable labor and may be considered a long-time investment. A gullied field is generally a poor field which requires time, money and patience to build up. Some soils respond very rapidly to good treatment and often the reclamation of eroded areas prove to be a profitable investment.

In any reclamation work it is essential that the water be controlled first at the brow of the hill where the gullying begins. This headwater must first be stopped and perhaps a ditch must be located to divert this water to some more suitable place. The terrace system should start there and usually three or four terraces located on this smooth land will take care of the water. The upper end of the gullies just below these terraces is the next place to work. Very often large washes can be made to fill themselves in time by building dams at the points where the terrace crosses. Cheap and simple dams of earth, brush, straw, etc., placed in the gullies will soon cause them to fill up. Anything that causes a decrease in velocity of the water results in deposition. Small quick growing trees planted in the gullies check the velocity of the water so that deposits are made behind them, filling the gully. Some gullies may be filled in this way in a few years without further labor being expended on them. The banks of the gully if loosened with a spade and plow will slough off quickly and fill up the gully. In many places gullies ten to fifteen feet deep have been entirely refilled by this method. If the dams can be located at some narrow point in the gully the labor of build-

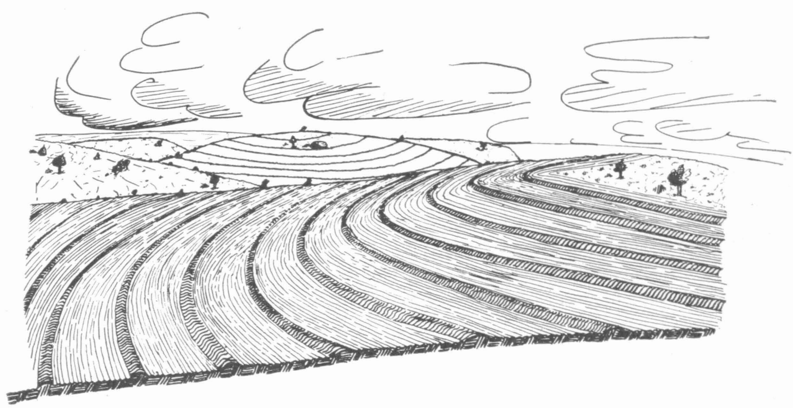

Fig. 28. The broad terrace. Rows follow the terrace.

ing will be reduced considerably. A sharp lookout should be kept for incipient gullies and every means used to prevent their enlargement. Draws should be kept in grass. Any grass which will form a tough sod will answer the purpose. As soon as a gully has filled enough to permit a plow and other machinery to cross, a few loads of manure, straw, etc., will help to prevent washing and improve the soil. After this, sorghum or rye, both poor land crops, should be planted and plowed under before a leguminous crop is planted. A legumininous plant, usually, will not do very well until the soil has been built up.

For filling average sized gullies a plow should be used along each side. If a gully is back furrowed two or three times before terraces are located the terracing can often be done more quickly and satisfactorily.

Cover crops which afford a good covering of vegetation, especially in the fall, winter and spring, should be grown. A rotation should be practiced which permits the land to be put into a pasture or meadow part of the year. Rye, oats, wheat, rape and all the clovers, especially burr clover where it will thrive, are excellent for this purpose.

STEEP HILLS.

The hope of reclaiming eroded land on very steep hillsides lies in the development of stock husbandry in connection with terraces. It is a mistake to attempt to cultivate land where the slope is much over twelve feet per hundred feet where livestock farming is profitable. The steep hillsides should be set in some permanent grass. By raising dairy cattle, beef cattle, sheep and hogs, these hillsides will produce nearly as much and in many cases more than our best level land is returning.

Bermuda grass is probably the best summer grass known in the South for preventing erosion. No other plant has been found as suitable for gullied hillsides. If burr clover can be grown in connection with the Bermuda grass, probably no better combination of grasses can be secured. One lies dormant while the other is growing. The Bermuda grass furnishes summer pasture and the burr clover early spring grazing.

SOIL SAVING DAM.

The soil saving dam, (Figure 25) is a very good means of saving gullied land. A dam of earth is built across some narrow, deep place in the gully and by means of a pipe under the dam with a right angle turn on the upper side the water is allowed to get through, leaving the soil behind. The gully is gradually filled at the expense of the slopes adjoining. The rushing water in the valley above the dam is checked, its sediment is deposited, and the water is carried through a pipe under the dam. The lowest point in the bed of the stream or gully is selected and about thirty feet of vitrified sewer pipe is laid. On the end of the pipe which projects on the upstream side of the dam, a right angle sewer pipe is set in a vertical position. Into the upturned end another pipe is fitted. The dam is built in such a way that every point of the crest is two feet higher than the top of the vertical pipe. During a rain a pond, of course, is formed above the dam. The water rises to the level of the upstanding pipe, pours down through it, under the dam and away, but the greater part of the soil which it originally carried will have settled. After a few hard rains the depression above will be filled and then it will be time to add a few more feet to the height of the dam and place another length of vitrified pipe over the first one. The silt will then settle on the higher level, much broader in expanse, and the process may be continued indefinitely as long as the dam and the pipe are from time to time raised. The vertical pipe should be protected by four posts around which hog wire is wrapped. The wire keeps the rubbish from clogging the pipe. The mouth of the pipe should be protected with a bulkhead of some kind to prevent it from being dislodged. The land above the dam is drained by means of a tile drain. If the fall of the gully is very great, two or three dams may be needed. The size of the dam will depend on the size of the gully and the watershed above.

The soil-saving dam is best adapted to wide, long depressions and large gullies. If the slope is steep and long, several dams will be necessary. The upper dam should be put in first and probably a six to ten foot fall may be taken care of with this dam. The water is caught above the dam, its velocity is checked and it is lowered a step at a time until it reaches a lower level where the fall will not be sufficient to cause it to wash.

CONCRETE DROPS.

Concrete drops, (Figure 27) although somewhat expensive, are very effective for the purpose of taking up excess grades. They are designed to discharge water from one level to a lower level by a vertical drop. It often happens that on hillsides with excessive grades a ditch must be made and used for the outlet of terraces. On such ditches, drops will prevent a large gully from forming. Directly below a drop the cut will be deep, and from this point downhill the depth of the cut decreases until it reaches the surface, at which point a second drop should be inserted. The proper location of drops will depend on the topography. If the slope is uniform, the drops should be spaced at equal intervals and be of equal height. It is a matter of choice between low drops spaced close together and high drops spaced far apart. A series of low drops cost more but require less excavation.

The width as shown in drawing, (Figure 27) is three feet and the difference in levels of the water is five feet. These distances must be varied to suit conditions. The drop should be reinforced with woven wire. This dam has a nine inch water cushion which resists the impact of the falling water.