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SOIL EROSION CONTROL
IN FARM OPERATION

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Terracing with strip cropping. The corn strip is uniform thruout. The grass strip fills the balance thus avoiding point rows.

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SUMMARY

Soil erosion takes place in almost every agricultural region.

Soil erosion cannot be stopped entirely, but it can be so controlled that damage will be very slight.

Cultivation of land tends to increase many fold the rate of erosion. Certain common farming practices are among the leading causes of soil erosion. Prevention of erosion, therefore, may be greatly aided by avoiding these practices which include removing the forest or sod cover from steep slopes; shallow tillage; cultivating up or down the slope; unwise location of dead furrows, cattle runs, and field roads; and crop rotations that fail to maintain plenty of organic matter in the soil. In large part, control may be effected by the same means as prevention.

Permanent control of **gullies** demands the adoption of well-established engineering methods for checking head erosion, systematic planting of willows and other fast-growing trees, the use of check dams, and the installation of soil-saving dams.

Tho gullying is the most noticeable type of erosion and causes greater interference with farming operations, sheet erosion is actually the most harmful and deceptive type, steadily carrying away the rich top soil but doing this so slowly as often to pass unnoticed.

For permanent and adequate control of sheet erosion, terracing of sloping fields is necessary, along with cover-cropping and contour cultivation.

Terraces save the top soil and by conserving the moisture help prevent drouth damage. The best type of terrace for general use is the standard, variable grade, Mangum terrace.

Running crop rows diagonally across terraces is unwise because it greatly increases upkeep costs and often causes the terraces to fail. Contour planting and cultivation, parallel to the terraces, protects and maintains them and **is an effective aid in sheet erosion control.**

One-fourth inch of soil washed away in a single year may seem negligible, but one-fourth inch each year for 40 years in many cases amounts to all of the top soil.

INTRODUCTION

Many simple practices in farm operation that the farmer may apply without outside help will be of great aid in controlling erosion on the farm. Likewise there are many other common practices that he should avoid because they further erosion. To present these practices for the farmer's consideration and guidance is the purpose of this bulletin. **In a large way, however, solving the soil erosion problem requires the application of engineering practices and in most cases will demand the services of a trained agricultural engineer.** These special engineering phases are presented in Special Bulletin 171, "Soil Erosion Control By Engineering Methods." This publication is available on request to the Bulletin Office, University Farm, St. Paul, Minnesota.

NATURAL CAUSES OF SOIL EROSION

Soil erosion control is an important problem in Minnesota—too important to be ignored by any farmer who operates sloping land. The primary causes of soil erosion are the direct action of rain beating upon the bare soil and the rapid run-off of the water. Soil erosion is most severe in the heavier and more uniform soils and on steep slopes. It is increased by freezing and thawing action in the spring, since, at that time, the top soil is usually saturated, has little cohesion, and contains fewer roots.

When the flow of water is speeded up, the eroding or cutting power increases many times faster than the rate of movement. For example, if the speed is doubled, the eroding power is multiplied over 30 times. This explains why steep slopes erode faster than gentle slopes. Gullies are caused primarily by water collecting in channels or shallow depressions down which it flows swiftly enough to carry away soil particles. Burrows, such as made by gophers, often cause gullies on steep unprotected slopes because they furnish smooth channels for water flowing under pressure.

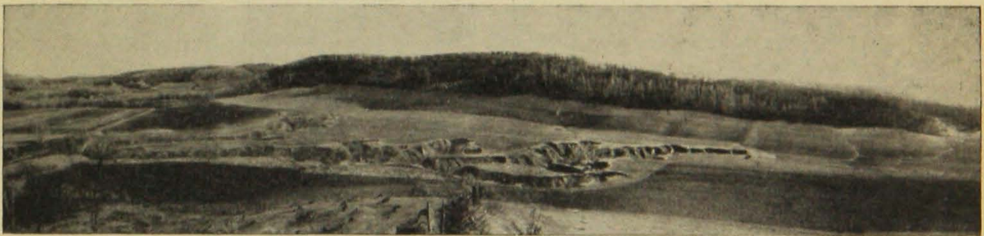

Fig. 1. A gully 20 feet deep and 150 feet wide with several branches, that, through 40 years has eaten its way across an 80-acre unit of a rich valley farm in Goodhue County.

Altho not the most serious type of erosion, gullying is the more widely recognized type because its damage to fields is so easily seen. (See Figs. 1 to 4.) Some other harmful effects of gullies are not so apparent; for example, the danger they present to livestock. In the early stages, gullies are comparatively easy to stop, but many farmers pay little attention until they have become so large as to interfere seriously with farming operations, and are almost impossible to control. (For example, see Fig. 1.) Gullies frequently are only an advanced stage accompanying or following heavy, uncontrolled sheet erosion.

Fig. 2. Rich black loam in the Root River Valley, Houston County, buried 4 feet deep by sand washed in a single season from a large gully through the higher land.

Fig. 3. Left. A gully on a central Winona County farm making its way steadily toward the buildings on the farmstead.

Fig. 4. Right. A gully 100 feet long, 10 feet wide, and 6 feet deep, developed during a single heavy rainstorm from a dead furrow plowed in the direction of the slope. The quality of the land below it is impaired for years to come by the coarse sand and gravel from the gully.

Sheet erosion, or surface washing, does not itself create ditches. As the term suggests, sheet erosion is the removal of a thin sheet of top soil when rainfall moves over the surface. However, the same conditions that cause sheet erosion are generally favorable for the formation

Fig. 5. Stunted corn on Dakota County slopes in 1930 caused by uncontrolled sheet erosion during 60 years of cultivation.

of gullies, since the free run-off of water that causes sheet erosion also means the collection of large amounts of water in furrows and other depressions that are often the starting points of gullies. Therefore, stopping or controlling sheet erosion will in many cases remove the likelihood of gullying. Such control is especially important because the effects of sheet erosion are generally more serious than those of gullying, owing to the fact that sheet erosion takes place all over the field. So gradual is its action that the damage is often unsuspected until the land owner finds almost barren spots showing up in his best fields. (See Fig. 5.) To the experienced eye, however, spots of gravel and yellow clay, and stunted and sparse vegetation on the knolls are unmistakable signs of sheet erosion damage. (See Fig. 5.) Even if they recognize such damage, many farmers consider it unavoidable on cultivated land. Careful studies by federal and state agencies have shown that most of the loss of fertility commonly thought due to continuous cropping is caused, instead, by the action of sheet erosion which removes not only the fertility, but the very soil itself.

Soil erosion is increased by anything that tends to speed up the movement of flowing water or to lessen the ability of the soil to take up water. The practices likely to promote erosion are removing trees, sod, or other vegetation from steep slopes; shallow inadequate tillage; robbing the soil of its organic matter; tillage and planting operations up and down the slope; over-pasturage of hilly or rolling land; and the growing of cultivated crops on slopes too steep for profitable tillage. In southeastern Minnesota, many slopes with a fall of 10 to 15 feet to every hundred are now being farmed in row crops and others as steep

Fig. 6. A 20 per cent slope on a young grain field adjacent to the gully shown in Fig. 1, following a 5-inch rain late in April, 1930. Note the heavy scores 3 to 8 inches deep, out of which all the soil has been washed clear to the plow sole.

as 30 per cent are in hay or small grain. Few of these farms are terraced and little is being done to check erosion.

In some cases the entire surface of the field to the depth of the plow sole has been washed off by a single rainstorm. (See Figs. 6 and 7.) In another generation many fields in this region will have to be abandoned unless steps are taken promptly to check erosion. A dead furrow stretching down the slope often develops rapidly into a deep gully. (See Fig. 4.) The same thing often results from wagon tracks or cattle paths running with the slope.

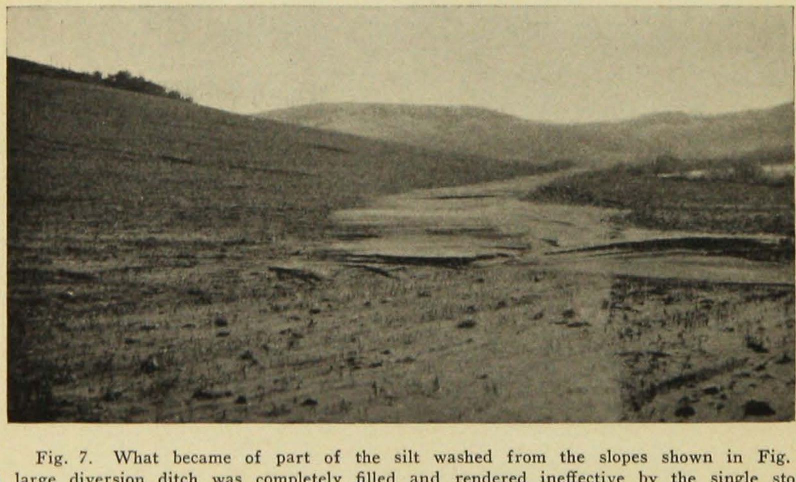

Fig. 7. What became of part of the silt washed from the slopes shown in Fig. 6. A large diversion ditch was completely filled and rendered ineffective by the single storm because there were no other protection works on the slopes above it.

VITAL NEED OF SAVING THE TOP SOIL

Saving the surface soil is especially important on account of its capacity for holding moisture as well as its natural fertility. Not only are nearly all the nitrogen and organic matter contained in the upper foot of soil, but the surface soil has twice the capacity of the subsoil for absorbing water. Moreover, it will absorb this water much more quickly. The erosion damage to farms, therefore, is greatly increased because removing the porous top soil destroys nature's means of catching reserve moisture and holding it until it can soak away into the less pervious subsoil. Most of the rainfall would be absorbed if it could be held on the surface for a time, but on steeper slopes where erosion is not controlled, the water runs off before it has a chance to soak in.

OUTCOME OF UNCONTROLLED SHEET EROSION

In many cases the depth of soil removed yearly, by sheet erosion, from Minnesota fields has not exceeded one-eighth of an inch; in others it has been as much as one-half of an inch, and in a few cases, in seasons of unusual rainfall, the rate has exceeded two inches in a year. On at least one field observed, the rich top soil has been removed to a depth in excess of 30 inches in less than 60 years of cultivation, leaving only a thin layer of sandy and unproductive subsoil over the parent rock. (See Fig. 8.) The removal of one-fourth of an inch of soil in a year, which is probably the more common experience in the southeastern and other more rolling parts of Minnesota, may seem negligible but even one-fourth of an inch a year, extending through the active life of the average farmer, is sufficient to remove all or nearly all of the virgin top soil.

Fig. 8. This Rice County slope was once like that to the right where virgin woods is growing in 30 inches of rich black loam. Through 50 years of tillage of the open field, uncontrolled sheet erosion has removed all the loam and most of the subsoil down to the parent limestone ledge.

TWO FUNDAMENTALS OF SOIL EROSION CONTROL

To be effective, any practice adopted for the purpose of checking or controlling soil erosion must bring about, to the fullest possible extent, one or both of two results; that is, it must increase the capacity of the soil to absorb moisture, and it must check the velocity of the water flowing over the surface. The accomplishing of the first of these results is a problem in soil management wholly within the control of the farmer. **The accomplishing of the second largely involves the use of engineering practices and, in its larger aspects, demands the services of a trained agricultural engineer.**

GULLY PREVENTION

Diversion ditches.—Gullies are frequently started by allowing water from higher land to collect at the top of a field and to flow across it without control. A diversion ditch with a low rate of fall, that will collect the water at the upper side of the field and carry it away slowly to a suitable outlet, will prevent the formation of a gully in such a case. A proper diversion ditch, 2 to 3 feet deep, can be constructed cheaply with a plow and slip scraper, altho a road- or terracer-grader is better. Such a ditch should have a fall of not more than 6 inches in 100 feet in any part of its length and if it is long (1,000 feet and upwards) the rate of fall should be variable, increasing from the upper end toward the outlet as is done with terrace grades. The ditch must be laid out with a level to insure the proper rate of fall.

Strips of sod in natural water courses.—In a natural field depression where considerable water flows during rains, it is a good plan to leave a strip of bluegrass or timothy sod in the bottom of the depression, extending the whole length of the slope. The surface of this sod should be slightly lower than the surface of the land on either side. This strip should be absolutely flat across the direction of flow in order that the water shall move over it only in a thin sheet. The required width of the strip will depend on the rate of fall of the depression and on the area of the watershed for which it serves as an outlet. In general, the narrowest width of such a sod strip should be 20 feet and an additional foot of width should be added for each acre above 20 in the watershed. It is much easier to lift the plow or other tillage implement while crossing this sod strip than it is to have to make frequent turns at the edge of the gully which is very likely to form at such a location if no preventive measure is taken. However, in time, these sod strips tend to build up until they cause the water to flow on either side of them instead of over them. When this occurs the sod strips should be widened on each side sufficiently to include the strips where new channels tend to form. On steep slopes where the water tends to cut in spite of the sod it may be necessary to insert plank strips turned edgewise.

Barriers of sod, and of woven wire and straw.—In small depressions, where there is a tendency to wash, **cross barriers** of sod have been found effective. Strips of bluegrass sod may be put in old feed or fertilizer bags and tamped in tight, end to end, at intervals (4 to 10 feet apart) across the bed of the wash. By the time the bags have rotted away, the sod will be well set. These cross-barriers should be set **level** across the channel and their surface should lie a little below the land surface on either side of the depression. Another effective method is to fill the depression with straw and then lay woven wire over it, fastening it securely with stakes driven almost flush with the surface of the ground. With this type of protection one should be sure that the center is left lower than the edges. Barriers of the kind herein described prevent serious erosion and have the added advantage that they can be crossed with any implement, whereas it is necessary to drive around a dam.

GULLY CONTROL AND ELIMINATION

In gully control there are, as a rule, three essential steps. In order of operation and importance, these are **stopping head erosion, preventing floor scouring and side erosion, and filling or reclaiming of the gully.** However, attention to these, as three separate steps, is usually applicable only to gullies of considerable depth and size.

Straw in gully control.—Very small gullies in open fields with moderate natural slopes may be checked and eliminated by filling them with straw and then plowing in dirt from the sides on the straw and heavily seeding the gully strip with some quick-growing dense grass.

Sod in gully control.—Coarse, fast-growing grass, such as brome grass, red top, or even quack grass, and a little sweet clover to supply nitrogen for the grasses, sown in gullies is effective in checking erosion, caving of slopes, and deeper scouring of the gully floor. **This practice is recommended.**

Tree planting and gully control.—Where there is an abundance of natural soil moisture, willows and other fast-growing trees, planted across the floor and along the slopes of gullies, are an effective agency in the control and elimination of gullies. When set in dense rows across the gully floor at regular intervals, they act much as a series of check dams in retaining eroded material, and when they grow sturdily they also make good anchors for brush dams. When used on the slopes to prevent side erosion and caving, it is best to plant them deep and close together in rows following the contour.

Stopping head erosion.—After a gully is once started its growth is apt to be very rapid, owing to the undermining action of the falling water at its head and the freezing and thawing action along its walls in the spring. In reclaiming a gully of appreciable size, the first need is to stop this head erosion; that is, to prevent the gully from advancing. To do this the scouring and undermining action of the water, and, if possible, its overfall, must be stopped. Wherever possible the best way is to divert the water into some nearby water course before it enters the head of the gully. If this is not possible, in the case of small gullies up to about four feet in depth, the headwash may be stopped by a low dam or obstruction built of posts, wire, and brush tight against the head. This brush mat should be laid close, with butts upstream, underlaid by straw and securely fastened underneath in order to withstand and break the force of the falling water and prevent undermining. The gap behind the dam will quickly fill with soil and the caving away of the headwall will be stopped. In large and deep gullies it is difficult to drop the water to the lower level without serious undermining. In such a case it is usually necessary to construct a plank or galvanized iron flume, a corrugated iron culvert or a concrete or masonry dam provided with a vertical drop and some sort of apron with side or wing walls. Such head control works may cost from $100 to $1,000 or more depending upon the size of the gully and the quantity of water to be carried.

Check dams.—Once the head erosion is cared for, check dams should be built across the floor of the gully at frequent intervals throughout its length.

The purpose of the check dams is to reduce the rate of fall of the gully floor thus checking the velocity of the water and tending to avoid the deeper scouring of the gully floor and the undermining of its walls. Except at the outlet of the gully, it is usually sufficient to construct the check dams of loose rock, woven wire, or posts and brush. They are cheap and easily built. (See Figs. 10 and 11.) As soon as the first dams are filled to the top with eroded material, new ones should be built. Any ordinary gully can be quickly filled in this manner. (See Fig. 9.)

Fig. 9. A series of properly spaced brush dams that have caused a gully originally about 6 feet deep to fill up. Note the silt deposited behind each dam extending from the top of one to the base of the next one up stream. (Courtesy of C. E. Ramser, U.S.D.A. Bur. of Ag. Engr.)

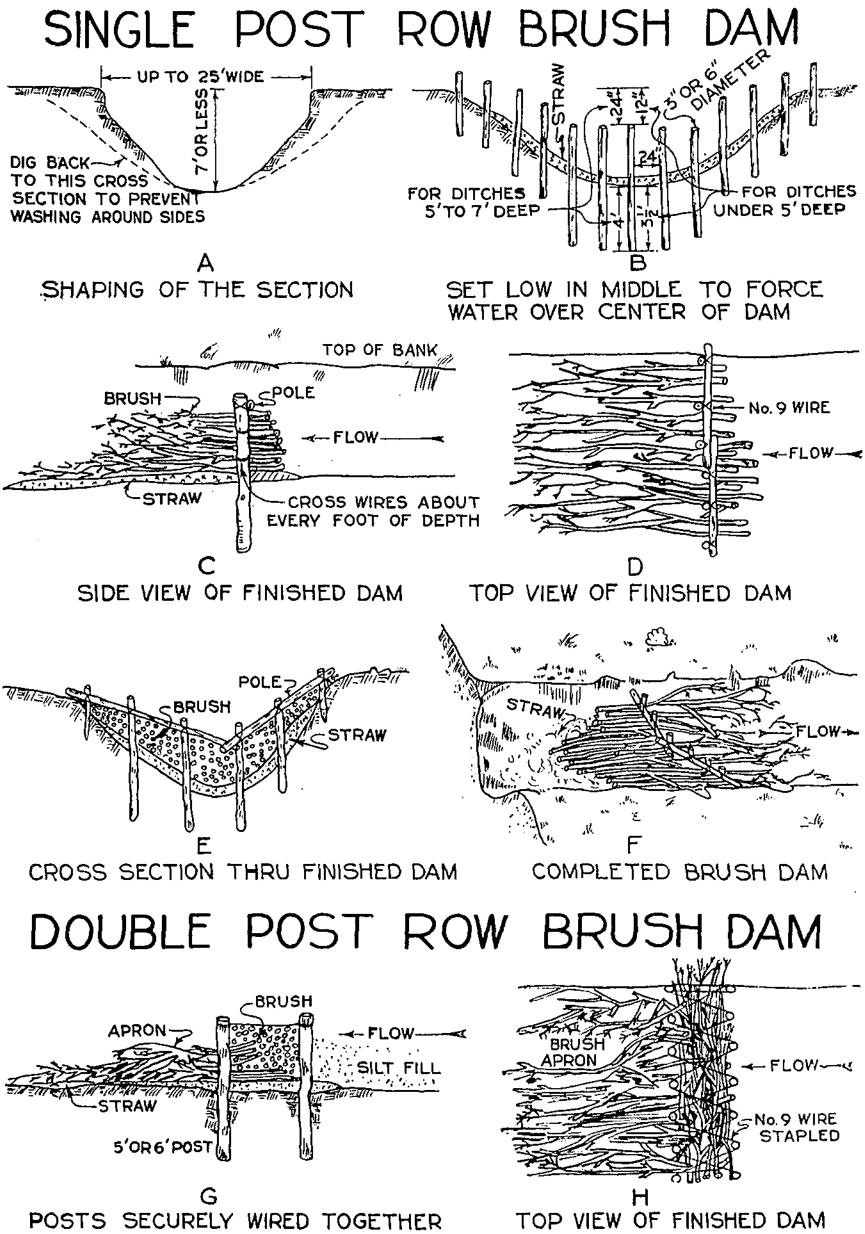

Fig. 10. How to build brush dams. *Note:* The brush must be laid methodically with butts upstream, and be packed by tramping as laid. (Adapted from Univ. of Neb. extension material by I. D. Wood.)

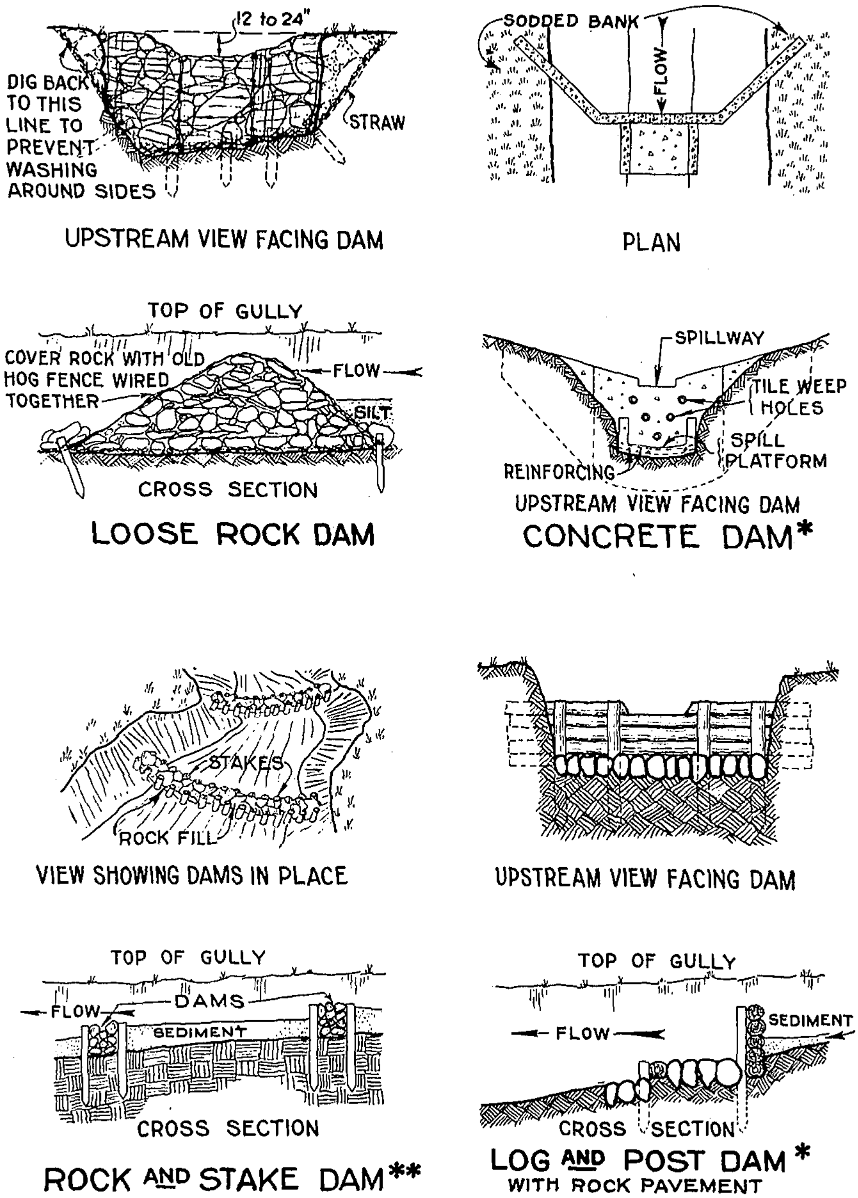

Fig. 11. Various effective types of check dams in common use.

* Adapted from U.S.D.A. Farmers Bull. 1234.

** Adapted from Univ. of Neb. Ext. Circular No. 123.

Check dams should always be made lower at the center than at the edges so the water will not cut around them. Frequent low dams are more economical and less apt to wash out than a few high ones. The dams should be so spaced that the new stabilized gradient between them, when once established, does not exceed 2 per cent. Brush dams give the best satisfaction when built of green brush with the leaves still on and the butts extending up stream. The butts should be well choked with old straw or hay. A loose brush pile in a gully is useless as the silt-laden water will pass through it without depositing any appreciable amount of soil. It is not advisable to put a straw stack in a gully, as the water is likely to cut around the stack and enlarge the gully.

Soil-saving dams.—In any gully of appreciable size there should be one or more soil-saving dams of masonry, concrete or earth so constructed as to retain the silt burden but let the water by. At least one such dam at or near the mouth of the gully is necessary to its control and elimination.

Earth soil-saving dams should always be provided with a concrete or willow mat spillway and apron to prevent washing and undermining. In case of a high dam, a culvert with a vertical drop inlet is required to conduct the water under the dam, which should be at least three feet higher than the inlet to the culvert. (See Fig. 12.) Ordinarily the culvert should be designed with sufficient capacity to carry with safety the largest amount of water that was ever known to discharge through the gully. In addition to the culvert, a spillway should be provided as an emergency measure to take care of exceptional rainstorms. For design and construction of such dams see Special Bulletin 171.

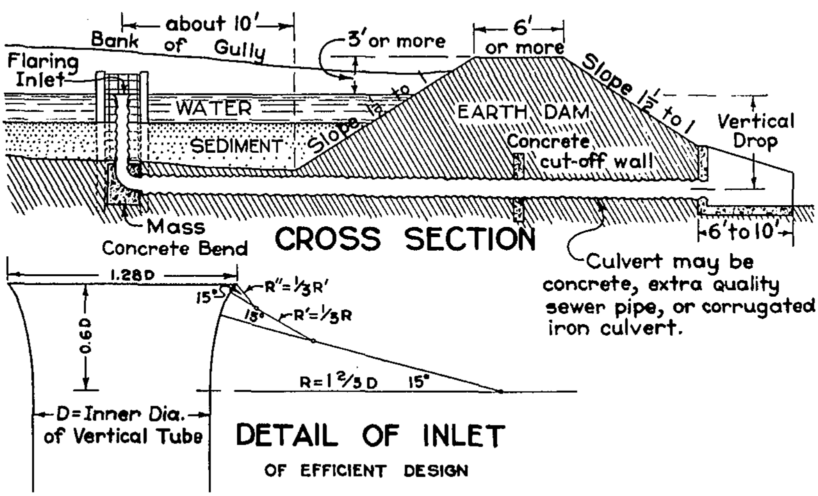

Fig. 12. Earth soil-saving dam and culvert with vertical drop inlet. (Adapted from U.S.D.A. Farmers' Bull. 1234.)

CONTROL OF SHEET EROSION

Soil erosion cannot be completely stopped, but the soil and water losses can be greatly reduced by changing some of our common farming practices. Sheet erosion particularly can be greatly checked by increasing the capacity of the soil to take up water. This may be accomplished by deep tillage, by tile drainage, and by increasing the organic matter through abundant use of barnyard manure. Other good farming practices that aid in controlling erosion are: taking steep slopes out of cultivation, avoiding over-pasturing and burning of pastures and woodlots, contour farming, crop rotations, strip farming, and terracing. The wide differences in soil losses resulting from different uses of farm land are brought out sharply in Figure 13.

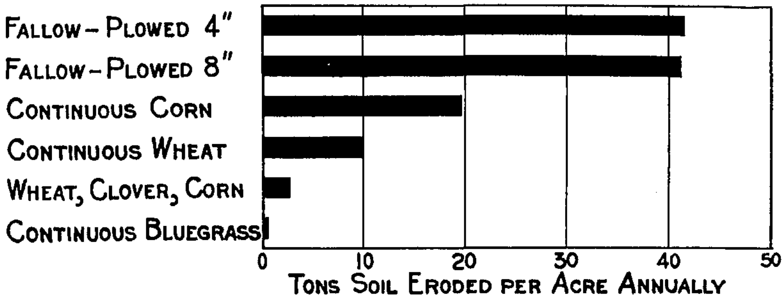

Fig. 13. Soil losses, on a 3.7 per cent slope, resulting from different uses of farm land; no erosion control methods used. (Data from Missouri Research Bulletin 177.)

Take steep slopes out of cultivation.—Bennett, of the Soil Conservation Service, states that, "for some reason man has not resorted very much to the oldest and most effective measure for controlling erosion, that is, thick-growing vegetation, such as trees and grass. The primary effort has been to get trees off the land and to destroy the matted prairie grasses so that cultivated crops might be grown." As a rule, in Minnesota, slopes with a fall of **over 10 or 12 feet in 100 feet** should never be plowed except on the contour. Cultivated slopes steeper than 12 per cent frequently lose 50 to 80 per cent of their virgin fertility largely through erosion, during the first 10 to 20 years of cultivation.

Slopes steeper than 25 per cent should **never** be cultivated, but should be left in permanent hay crop, pasture, or timber. All slopes **steeper than 40 per cent** should be taken out of pasture and reforested.

Avoid over-pasturing and burning of pastures and woodlots.—A bluegrass sod that has been over-pastured—a condition of frequent occurence in Minnesota for several years past—loses most of its effectiveness as a means of controlling rapid run-off and consequent erosion. Not only is the rate of run-off and of erosion greatly increased, but the actual value of the pasture, in pasture days per season, is reduced. On over-pastured sod, the precipitation runs off as on a roof. A few days after the rain, the pasture is as dry and brown as it was before. If the livestock were taken off while there was still a considerable mat of grass left, this would retard the flow of the water long enough for the soil to absorb it, and two or three days after the rain there would be a luxurious new growth. Burning pastures has the same effect as over-pasturing.

The Soil Conservation Service reports during a continuous rainy period in Oklahoma in May 1930, the run-off from a forest area with an accumulation of leaf mold was 250 gallons of **clear** water per acre; while, from a similar area that had been burned over, the run-off was 27,600 gallons of **muddy** water.

Crop rotations.—Erosion may be controlled by planning a proper crop rotation that will offer protection for the land and build up, rather than destroy, its fertility. On gently rolling lands—slopes up to 3 per cent—a good crop rotation, including corn, small grain, and a legume hay crop will greatly reduce the rate of run-off and the rate of erosion over that which would occur by practicing a one-crop system. The great increase in soil loss due to improper farming is forcefully shown by some experiments carried on at the Missouri Experiment Station on a 3.7 per cent slope, which is relatively flat compared to many farms in southeastern Minnesota. (See Fig. 13.)

Contour farming.—On slopes steeper than 3 per cent, a crop rotation alone will not sufficiently control soil erosion. It is necessary, in addition, to farm on the contour or to terrace. The first is a very effective and cheap method of control. It consists in plowing the land and planting all the rows on the level, across the slope rather than with it, as is the usual practice. When farming across the slope each plow or cultivator furrow makes a miniature terrace that will help to hold the water until it is absorbed by the soil; but in farming down the slope these furrows become channels in which the water accumulates and rushes down in a torrent, cutting out gullies from a few inches to over a foot deep between rows.

Nichols, at the Alabama Agricultural Experiment Station, found that, for a one-inch rain in 9 minutes when the rows were **on the contour** there was a very small loss of soil from cultivated fields on slopes up to 10 per cent, while, when the rows were **with the slope**, the soil loss increased from a negligible amount on flat land to nearly a ton per acre from a 10 per cent slope. On steeper slopes running up to 20 per cent, the rate of soil loss resulting from the same rain continued to increase sharply. The soil loss increased from less than a ton to nearly 60 tons per acre when the rows ran with the slope, while the increase was only from 0 to about 30 tons per acre when the rows ran on the contour. This shows that soil losses resulting from our common practices of cultivation are two times greater than the losses when contour farming is practiced. In every case the contoured rows produced greater yields than did rows running with the slope. Nichol's experiments indicate very clearly that slopes steeper than 10 to 12 per cent should not be cultivated in the usual manner, if the soil fertility is to be maintained.

Strip farming.—If a shortage of plow land makes it necessary to plant part of the steep slopes to cultivated crops, **strip farming** should be employed; that is, strips of cover crops should be alternated with strips of cultivated crops, the strips running along the contour. The strips of cultivated land can range in width from 50 to 100 feet, depending upon the steepness of the land. A system of rotations can be worked out among the strips just as well as between fields. Usually, the strips of grain and hay can be made to absorb the irregular width caused by the unevenness of the slope of the land, and the strips of corn (or other cultivated crop) can be made of uniform width. The run-off from the cultivated land will be retarded when it goes through the sod strips and will drop its silt load in the grass instead of carrying it on to the streams. A good example of strip farming is shown in Figure 14.

Terracing.—Terracing is the ultimate and most effective method of controlling erosion on cultivated fields. It serves a double purpose, as it checks washing of the soil by preventing the rapid movement of water over the surface and it helps to protect against drouth by holding

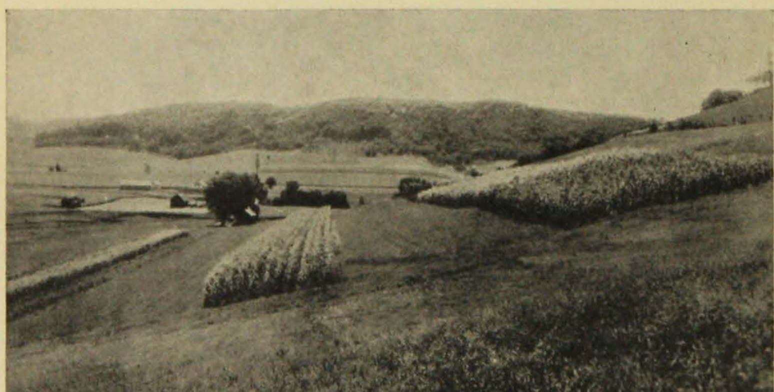

Fig. 14. Strip farming on a slope in the northern Mississippi Valley. (Courtesy of the Soil Conservation Service, U.S.D.A.)

the water on the slopes, thus giving the soil a chance to absorb more of it. Consequently there is a substantial increase in crop yields on terraced lands. A combination of terracing and contour or strip farming reduces the soil losses to a negligible amount. (See cover page.)

Run-off and soil losses from terraced and unterraced land.—At the ten government soil erosion experiment stations, fairly well distributed over the United States, results obtained on the relative losses of soil and water from terraced and unterraced lands demonstrate conclusively the great value of terraces as conservers of soil and water. At Guthrie, Oklahoma,—the station with the longest record—the average annual soil loss from **unterraced** 5 per cent slopes was 64.12 tons per acre. From similar **terraced** slopes the loss was only 2.21 tons per acre, or only 3.4 per cent of that from unterraced land. At LaCrosse, Wisconsin, where the local conditions of soil type, slope, and rainfall are most nearly comparable with those of Minnesota, the loss from fields of a 13 per cent slope was 31.7 tons for unterraced land as compared with only 2.2 tons for terraced land. Inspection of Table 1 shows that this great contrast between the loss of soil on unterraced and terraced land is the quite general experience the country over. By similar studies it has also been shown that the water run-off from terraced land is, as a rule, appreciably less than from unterraced land under similar conditions of slope and rainfall.

Table 1

Average Annual Soil Losses from Terraced Land as Compared with Those from Similar Unterraced Land at Five of the Soil Erosion Experiment Stations*

Experiment Station	Annual rainfall, inches	Period	Annual soil losses in tons per acre†		Average slope of land in ft. per 100 ft.	
			Terraced	Unterraced	Terraced	Unterraced
Guthrie, Okla. ...	31.3	1931-33	2.2	64.1	5.2	5.1
Tyler, Texas	45.7	1933	4.6	41.0	5.8	7.5
LaCrosse, Wis. ..	26.8	1933	2.2	31.7	12.7	13.1
Bethany, Mo.	31.7	1933	3.2	27.1	8.3	6.7
Pullman, Wash. ..	26.6	1932-33	3.2	16.9	20.0	20.0

* Data by C. E. Ramser, "Agricultural Engineering" 15:382, November, 1934.
† 40 tons of soil per acre means, on the average, ¼ inch of depth.

Best types of terraces.—There are many types of terraces but the Mangum terrace, named after the man who originated it, is best suited to Minnesota conditions. It consists of a broad ridge of earth

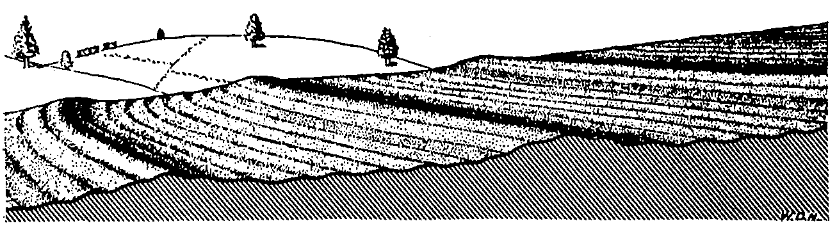

Fig. 15. Mangum terraces on a fairly steep slope showing how one blends into the other next below it, making the field a succession of terraces. (From U.S.D.A. Farmers' Bull. 1669.)

15 to 24 inches high, thrown up across the slope approximately along the contour (see Fig. 15) but having, in the direction of its length, a varying rate of fall sufficient to carry the water **slowly** to an outlet channel at the end.

TERRACING PRACTICE

The laying out of terraces, however, is a job requiring considerable training and technical skill. A field level and the knowledge of how to use it are absolutely necessary.

The construction of terraces is a job that, for best and most economical results, requires some experience in handling grading machinery. It is, therefore, recommended that the farmer, before starting terracing first seek technical counsel and aid. Special Bulletin 171, pages 3 to 17, presents a complete discussion of good terracing and terrace outlet practice, including surveying, construction, and the best types of equipment for this work. A copy of Special Bulletin 171 may be had from the Bulletin Office, University Farm, St. Paul, or from county agents, who also will be glad to discuss with farmers their individual problems.

TILLAGE OF TERRACED FIELDS

Soil erosion can be reduced by proper crop rotations, by contour farming, or by terracing, but the greatest reduction in the rate of erosion comes when all three of these methods are applied at the same time. When the rows cross the terraces, the water running down the cultivator furrows between the rows carries considerable silt. When the velocity of this water is reduced at the terrace, the silt load is dropped, thus filling the terrace. If the rain is intense enough or continues long enough, the terrace will be filled with silt and will overflow. Also when the tillage implements go over the terrace, they "dig in" deeper than on the natural slope, consequently the effective height of the ridge is reduced. The maintenance cost is greatly reduced by having the rows run with terraces instead of across them.

The recommended practice is to run the rows along each terrace, permitting the point rows to come between the terraces. All point rows should be run parallel to the terrace above them. (See Fig. 16.) By farming on the contour, not only is the cost of maintenance of the terraces reduced, but also the yield of crops is materially increased.

Since it is impossible to plant corn by check row when farming on the contour or parallel to terraces, weeds may become a problem. Under these circumstances the weeds can be better controlled by planting row crops in shallow furrows made by furrow openers attached to the planter.

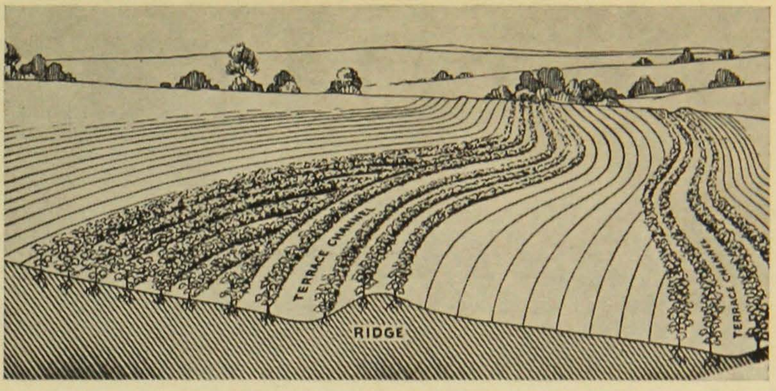

Fig. 16. Planting parallel to terraces. See arrangement of the short or point rows. (Courtesy of the Caterpillar Tractor Company.)

COST OF EROSION CONTROL

Cost of gully control.—Owing to the fact that gullies differ widely in size and general character, and, hence, require a great variety of methods of control, it is not possible to given even a range of costs of gully control that will be a reliable guide. The prices of construction materials can be had readily from local dealers and further counsel may frequently be obtained from the county engineer.

Cost of terracing.—The cost of building terraces is influenced by several variable factors. Terraces cost much more to construct in wet soils than in dry soils, and more in heavy soils than in light soils. Roots, rocks, sprouts, and stumps, as well as gullies in a field, add materially to the cost of terracing. Terrace-building by an inexperienced operator is likely to cost much more than terrace-building by an experienced one. The cost per acre will be greater on steep slopes and on short terraces than on flat slopes and on long terraces. Terracing by the regular farm forces during periods when farm work is slack is a recommended economy in terracing-labor cost.

Recent experience has shown that a good job of terracing with suitable heavy equipment can be done for from $1.75 to $3.50 per acre. In general it may be said that a normal cost is about the same as that of a good job of ploughing. With smaller or horsedrawn equipment the cost will usually be several times the price just named.

MAINTENANCE OF TERRACES

One of the most effective methods of maintaining the terrace ridge is to plow a backfurrow around each ridge. If additional capacity of terrace is necessary, a deadfurrow may be made in the terrace gutter. (See Fig 17.) In case this additional capacity is not needed and it is desirable to shift the position of the deadfurrow from year to year, this may be done by making the backfurrow around any given terrace wider or narrower than it was the previous year.

Since the terrace lines are not parallel, that is, the lines are close together on steep slopes and become farther apart as the slope becomes more gentle, the lands will not be the same width across the field, thus forming point lands that will have to be plowed out by intermediate turns. To avoid turning on the plowed land, the plow should be turned across the approaching point end when the land is reduced to a width of 10 to 12 feet. When the unplowed land has been reduced to a width of 10 to 12 feet for the full length of the field, it can, of course, then be plowed without making any intermediate turns.

Farming across the terraces is not recommended, but when the rows do run across the terraces, the channel must be cleaned out at least once a year and usually more often. This can be done with a light terracer or road grader.

Terraces should be inspected after each rain to see that all "breaks" are repaired and that all "fills" are cleaned out.

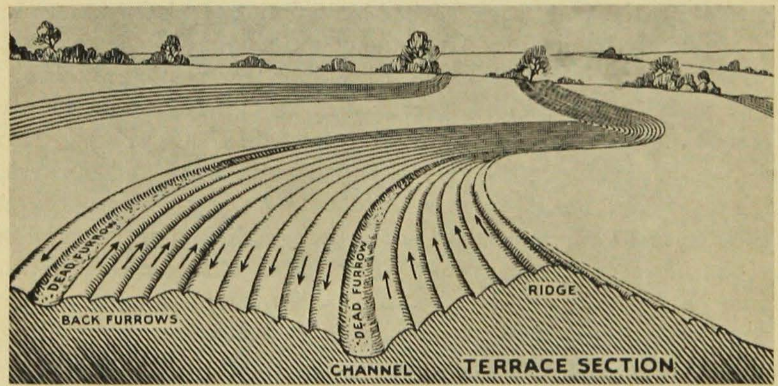

Fig. 17. Method of maintaining terraces while plowing. Arrows indicate direction in which furrows are made. (Courtesy Caterpillar Tractor Company.)

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