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## EC741 Inexpensive Methods of Gully Control

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Extension Circular 741

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**Inexpensive Methods of**  
**Gully Control**  
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NEBRASKA HAS 25,000 SQUARE MILES OR 16,000,000 ACRES OF LAND  
SUBJECT TO EROSION DAMAGE.

The University of Nebraska Agricultural College Extension Service  
and United States Department of Agriculture Cooperating  
W. H. Brokaw, Director, Lincoln

# Inexpensive Methods of Gully Control

BY IVAN D. WOOD

A hilly farm in southeastern Nebraska was broken from the prairie sod some sixty years ago. Thru one corner ran a clear stream with sloping, grassy banks. A rather wide ravine grown to high grass known as "Bluestem" furnished an outlet for most of the water which ran from the hillsides in periods of heavy rainfall. Torrents rushed thru the ravine and flattened out the grass after a downpour but little or no soil was removed.

## THIS STORY OF TWO DITCHES

In the thousands of years past, Nature had built up over all the land, at least 7 inches of black, top soil, rich in nitrogen. It absorbed water rapidly and grew abundant crops of corn, oats, and wheat. As the years went by the hills became yellowish in color from erosion and removal of the humus by constant farming in grain crops. The soil no longer absorbed the rain and floods ran down the slopes to the ravine.

Each rain scooped a quantity of soil from the bottom of the ravine and each year the farmer plowed in the sides and away it went with the next rain. If one of the Indians, who once made this section his home, could view the scene today what a different sight would meet his eye. The once green hills are yellow and a hundred ditches 12 to 24 inches deep have furrowed their sides. And what of the big, grassy ravine where antelope once grazed? It is a gully now 60 feet wide at the top and 15 to 20 feet deep. What of the clear stream once filled with fish? It is a sluggish little trickle choked with mud and logs.

In the loess soils of northeastern Nebraska a farm was homesteaded some years later by a careful farmer who preserved the soil fertility by planting clovers and other legumes. He used the straw as bedding and hauled out manure upon the fields. The land was not too rolling and for many years there was not much trouble with ditches. One day while walking thru the alfalfa the son of the former homesteader noticed that a gully 8 feet deep, as shown in Figure No. 28, was forming where water from a 20-acre field poured over the bank of a creek after coming down a ravine. Evidently willow roots had prevented the erosion before.

Now this 8-foot waterfall was eating its way thru a good field of alfalfa. On it came 8 to 10 rods each year, cutting as clean as a giant's knife, and did not stop until it had reached a point well up on the hillsides beyond. As the years went by a hundred smaller waterfalls spilled over its sides and ate their way back into the fields until at least 20 acres of once smooth land was set aside for pasture and poor pasture at that.

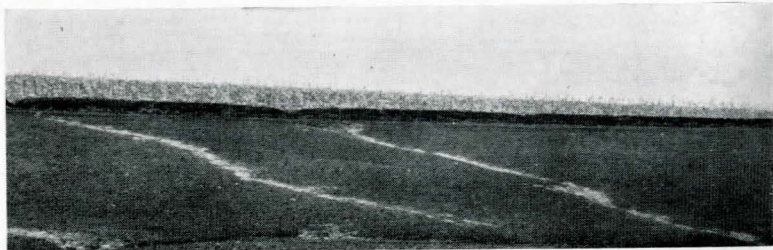


FIG. 1.—Ditches filled with straw or coarse manure before plowing in the sides.



These instances serve to show how gully erosion takes place in two types of soil common to Nebraska. Ditches are started in many other ways. Even a wheel track down a steep, plowed slope or the careless dragging of a plow may result in damage which it takes years to repair. Water running from lister rows at the headland or following a fence row to some one spot may eventually form a ditch too deep to be crossed.

### EARLY CONTROL IMPORTANT

Methods of erosion control vary greatly, depending on soil conditions, location in the state, rainfall, topography, and the stage which the damage has reached. One of the first and most important steps in any program of erosion control consists of building up and maintaining the organic matter content of the soil by the use of legumes, manure, straw, and cornstalks.

It is well recognized, that early attention to small ditches will often prevent a bad gully from forming and that proper farming methods such as planting rows on the contour or "around the hill" will prevent future trouble. It has been demonstrated that a properly designed terrace system will carry the flood water from hillsides or cause it to soak into the soil so that little trouble from gullies need be expected. On the other hand, the fact remains that thousands of farms have ditches which cannot be crossed. Terraces are out of the reach of the average tenant unless he has a long-time lease, or can secure the co-operation of his landlord, and many troublesome ditches have their origin on neighboring land. Often most of the watershed may be on an adjoining farm while the main part of the gully extends across other farms, the owners of which must resort to dams and baffles, seeding to protective grasses and even to large soil saving dams of earth or concrete, as a means of control.

### DITCHES ARE EXPENSIVE

The costliness of gullies is really appreciated when fields are cut into several pieces which must be plowed, seeded, and harvested separately. The actual land consumed by erosion may be only a fraction of an acre but the real expense comes with farming small areas, especially when tractor drawn machinery is used. There is always sure to be a certain amount of unnecessary breakage of implements when ditches are crossed.

### METHODS OF DITCH CONTROL

Following is a brief discussion of methods which have been used with more or less success to permanently fill ditch channels with soil again. A more complete description of the construction of brush dams and other types of baffles will be found elsewhere in this bulletin.

1. **Plowing in and Seeding.**—Filling the channel with straw and plowing down the banks may be successful if the amount of flood water carried in the channel is not too great. Protective crops are planted on the fill.
2. **Baffles.**—Brush dams and other baffles made of concrete, plank, or rock are extensively used. A series of such dams in a ditch slows down the water velocity and causes suspended silt to settle out and the particles rolling on the bottom of the channel are caught. A silt fill from one dam to another soon results. Then protective crops may be planted.



FIG. 2.—A series of brush dams spaced 100 feet apart using a single row of posts successfully controlled erosion in this ditch.

3. **Terraces.**—The construction of terrace ridges across the slope carries flood water to areas which do not erode or cause it to soak into the soil. The side hill ditches which have formed may now be plowed in, since little or no run-off reaches them.
4. **Soil Saving Dams.**—Soil saving dams of earth or concrete provided with proper spillway tubes slow down the water velocity and cause silt to settle and fill the channel.

#### BAFFLES MUST BE WELL MADE

Baffles used in erosion control work must be well made. Poor construction has been responsible for innumerable failures which have resulted in the loss of much time, labor, and materials. There are four essential features used in construction.

1. The dam must be so anchored that water cannot slide it along the bottom of the channel or float it away.



FIG. 3.—The ditch shown in Figure 2 was filled in one year. It may now be seeded down to bromus grass or sweet clover.



2. It must be low in the center to permit water to pour over at that point and not run around it on the banks except under extreme conditions.
3. There must be a spill apron of some sort on the down-stream side to break the fall of the water as it comes over the crest to avoid cutting a deep hole which will eventually cause the structure to fail.
4. There must not be any opportunity for undercutting.

#### HOW A DITCH IS CONTROLLED BY THE USE OF BAFFLES

Suppose a ditch  $4\frac{1}{2}$  feet deep, 12 feet wide and 600 feet long has developed thru a field by the advance of an overfall. The fall in the bottom of the channel is, say  $2\frac{1}{2}$  feet per 100 feet. How could brush dams be used so that in one season no difficulty would be experienced in crossing with machinery?

A single brush dam near the lower end might fill a short section of it, say for 100 feet, but until a series of dams correctly spaced for the slope are constructed, the entire ditch cannot be filled.

It is a self-evident fact that some channel will be necessary to carry water so the dams are left lower in the center than the banks as shown in Figure No. 12. The side banks of the gully may be plowed in after about six dams, spaced 100 feet apart, have been properly constructed. The new fill now can be maintained until protective crops are planted. If more time is available the channel may be allowed to fill from silt which comes in with the flood water and the protective crops planted later. It is also a self-evident fact that in time the brush dams will rot away and the ditch will form again unless a cover of vegetation is left in the channel.

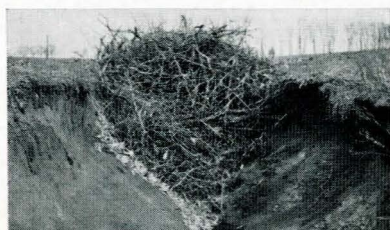


FIG. 4.—A pile of loose brush thrown in a ditch and not anchored is of little value.

#### STRAW PILES, LOOSE BRUSH, AND ROCK

It is common practice to thresh straw stacks or throw large piles of loose brush into gullies. When used in this way neither the straw nor the brush is apt to do much good. In the case of straw piles, the water usually forms a new channel around the stack or flows thru underneath it. Loose brush is picked up bodily and swept downstream to the nearest fence or bridge.

In some cases willow brush growing along the banks of a ravine may be cut and piled in with the butt end upstream. If well staked down and wired a fill of silt will result and in many cases the limbs will sprout, giving rise to a thick growth of young trees.

There are few sections of Nebraska where enough rock can be obtained to build dams. So far, at least the experience with them has not proven very encouraging unless concrete is used in the construction work to form a solid mass of masonry. Even then undercutting and side-cutting is almost sure to result.

#### WOVEN WIRE DAMS

Wire dams made by nailing woven wire to posts set securely across the ditch have given some measure of success, particularly when used in series and spaced very close together. It has been common experi-

ence, however, that when a fill of silt is formed above the wire the only escape for the water is to pour directly over the crest. A hole is then washed below which causes the posts to overturn immediately. This same type of failure occurs when plank and other materials are used and no spill apron is provided for the overflow water.

There are on the market a number of commercial ditch checks of various types which are particularly suited for placing in a small ditch and then being moved to another location when the silt fill is secured.

### PLOWING IN AND SEEDING DOWN

After flood water has removed the loose soil down to a hard surface in the bottom of a ravine, it is said that "scouring" has taken place. It is next to impossible to secure a growth of vegetation in a "scoured" ditch. Ordinarily the sides are plowed down but at the next rain this newly placed earth is washed away and again the hard bottom is revealed.

One common and successful way of attacking these small and newly formed ditches is to fill them with cornstalks, straw, or coarse manure followed by plowing the soil down from the sides and running the tractor wheel on the fill to pack it if motor machinery is used. See Figure No. 1. The fill should be given an opportunity to settle by planting some green crop like oats and sweet clover or some rapid growing crop as cane or sudan grass.

This plowing in method is by no means confined to small ditches. It has been successfully demonstrated by the Extension Service of the Nebraska Agricultural College that gullies 8 feet deep and 16 feet wide can be successfully controlled if the water shed is small as is often the case where the erosion has been caused by an overfall working back from a stream. Large caterpillar tractors and 12-foot blade graders are employed to do the filling and the fresh earth is seeded down to some quick growing crop. Often oats and sweet clover are used.

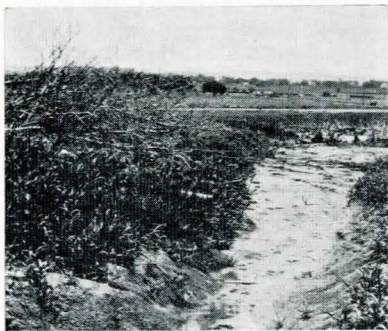


FIG. 5.—A silt fill 150 feet long behind a brush dam 2 months after it was built.

### BRUSH DAMS

Brush dams or baffles are best adapted to ditches which range from 2 to 7 feet in depth. Larger ones may require soil-saving dams of earth or concrete while smaller ones may be eliminated by filling with straw or coarse manure and plowing down the banks.

**Tools Necessary for Construction.**—The following tools are handy to have on hand when brush dam construction is contemplated.

- |                                   |                                   |
|-----------------------------------|-----------------------------------|
| 1 or 2 post hole diggers.         | 1 short fence tool for stretching |
| 1 tamper of 1" gas pipe.          | No. 9 wire.                       |
| 1 spade.                          | 1 16-pound sledge.                |
| 1 round nose shovel.              | 1 claw hammer.                    |
| 1 pair heavy pincers for twisting | 1 sharp axe.                      |
| and cutting No. 9 wire.           |                                   |





FIG. 6.—A ditch  $4\frac{1}{2}$  to 5 feet deep filled in one season with a series of single row post brush dams.

**Materials Necessary.**—(a) For single row post dam. For the single row post brush dam in a ditch 3 feet deep and 10 feet wide, the following materials would ordinarily be needed.

- 3 sound posts with 4" tops, 6 feet long.
- 4 stakes 3" diameter, 3 feet long.
- 2 poles, 3" to 4" diameter, 6 feet long.
- 20 staples.
- 15 feet of No. 9 galvanized wire.
- 1 hayrack load of brush not too old and brittle.
- 1 double wagon box full of coarse manure or wet straw from a stack bottom.

**Materials Necessary.**—(b) For double post row dam. The posts for this dam may have to be cut especially for the particular job. Those at the center should be set  $3\frac{1}{2}$  to 4 feet deep and should extend high enough above the ground to reach within 2 to 3 feet of the height of the side banks. Shorter posts may be used on the sides of the ditch. The diameter of posts will vary with conditions from 6 to 8 inches, for those in the center to 4 or 6 inches for the sides.

**Brush:** For this type of dam a large quantity of brush is necessary if the ditch is of considerable size. That for the apron must be long and flexible. Green brush is always preferable to that which is old and brittle.

**Wire:** Figure about  $3\frac{1}{2}$  feet of No. 9, soft, galvanized wire for each foot that the ditch is wide from bank to bank.

**Straw:** Ordinarily  $\frac{1}{2}$  hayrack load of coarse straw, manure, or hay will be used under and above the dam.

**Handling the Brush.**—Brush is awkward material to handle. Ordinarily it is loaded into hay racks with the leafy end up. A quicker and handier method of moving it to the dam is to pile it when cut, tie the bundles together by threading a log chain



FIG. 7.—The ditch shown in Figure 6 three years later. It has been seeded to sweet clover and never broken out.



thru the crotches of the larger limbs and haul it with the truck or tractor. Smaller bundles may be moved rapidly behind a car.

### THE SINGLE ROW POST BRUSH DAM

Complete instructions for building two popular types of brush dams are given in this circular. The construction methods have been developed after years of observation of the effectiveness of many types in common use.

The brush dam made with a single row of posts is adapted to ditches up to the size shown in Figure No. 8. If one or both of the side banks are steep, the cross-section should be dug to about that shown in the cut, and the fresh dirt should not be thrown in the bottom where the posts are to be set.

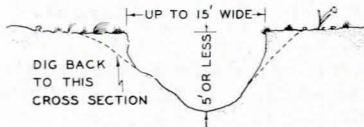


FIG. 8.—For ditches up to this size the single row post dam is well adapted.

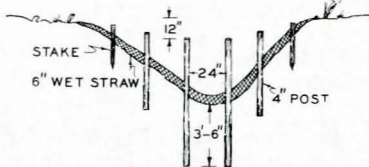


FIG. 9.—After the steep banks are dug down the posts are set and the straw layer placed.

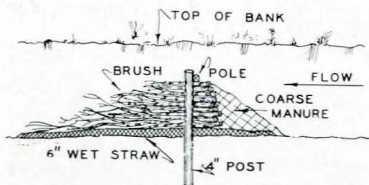


FIG. 10.—The long brush is placed at the bottom to form an apron.

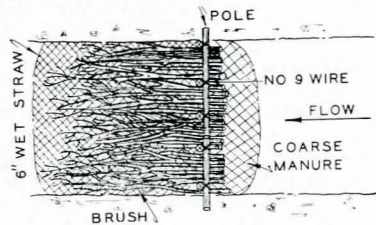


FIG. 11.—Top view of single row dam. Note that brush is carefully piled in and tramped. The butt end is laid between posts.

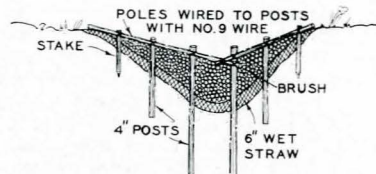


FIG. 12.—A cross-section of the single row post dam showing a 6-inch layer of straw under brush and poles wired to posts to hold brush in position.

**Setting Posts.**—The next step is the setting of the posts as shown in Figures No. 9 and 13. Only those which are sound and of 3 inches or more top size should be used. They should be set 3 to 3½ feet deep if sufficient strength is to be secured. Many failures have resulted in attempting to use a few stakes driven in the ground instead of setting posts as described. Stakes may be driven high up on the banks at the side.

**Use of Straw and Brush.**—A layer of coarse straw or manure is next placed between the posts and on the ground where the brush is to be laid. This keeps the first flood water from cutting under the brush or around the sides. Figures No. 10, 11, and 14 show the method of using brush. Big limbs are not necessary. They should be cut up into smaller



FIG. 13.—Posts in position for a brush dam in a ditch 3 feet deep.

pieces which can be packed in more closely. The long and slender limbs are placed first, care being used to see that as many as possible are hooked to the posts. The butt end of all brush is placed upstream and the shorter limbs are used near the top of the dam as shown in Figure No. 10. Brush is piled in until the gully is almost level full. One or two men should work on top of the brush at all times to insure a good arrangement and close packing of the limbs.

**Wiring Poles.**—Figures No. 12 and 14 show a cross-section of a completed dam and it will be noticed that the center is low. The low center is obtained by holding the brush down with the two slim poles wired with No. 9 galvanized wire to each post. The weight of one or two men may be necessary on the poles to compress the brush sufficiently when the wiring is done.



FIG. 14.—The brush and wiring poles in position. Straw is placed on the ground below the brush.



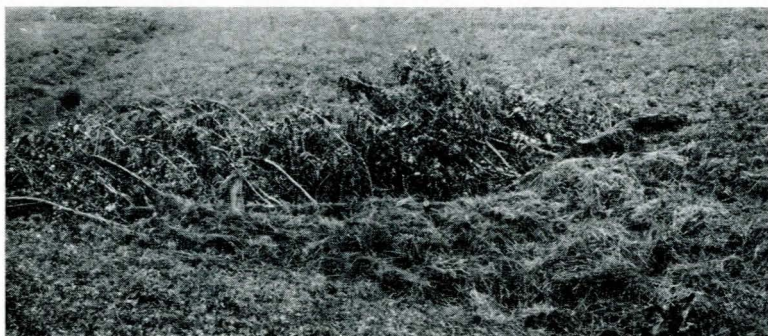


FIG. 15.—The completed dam with straw on upstream side.

After the dam is completed, a few forks full of straw should be thrown on the upstream side and worked in to the butt ends of the brush with a pitch-fork. See Figure No. 15. When care is used in construction, single row post dams will control ditches up to 5 feet deep and 12 to 15 feet wide. Many failures have resulted from a tendency to make brush dams too narrow. Always carry the brush to the top of the banks or beyond and do not neglect to use the coarse straw under and above the dam. The low center has a tendency to force the water over at that point where it will fall on the apron and do no harm.

#### THE DOUBLE ROW POST BRUSH DAM

The double row post brush dam as shown in Figures No. 20, 22, and 23 has proven very substantial and may be used under the most adverse conditions. It has been successfully maintained in ditches 7 to 8 feet deep and 20 or more feet wide with water sheds of more than 100 acres. Figure No. 24 shows a dam of this type just after a 6-inch rain had fallen and filled the gully to the crest of the dam. Note how the brush apron on the lower side protected the bottom of the ditch from eroding as the water poured over the crest.

**Setting the Posts.**—If the banks of the ditch are steep as shown in Figure No. 16, they should be spaded back to a cross-section with side slopes of 45 degrees or less. It has proven very difficult to prevent water from cutting along a steep bank between the brush and the earth. Two rows of posts are set as shown in Figures No. 17, 18, and 21, the larger and longer ones being placed near the center while the smaller diameter and shorter ones are at the sides. The middle posts are set 4 feet or more in the ground but the tops are not as high as the side banks by some distance. This gives a finished dam which is low in the center. The two lines of posts are set 24 to 30 inches apart and the posts are spaced 18 to 24 inches apart in the line. See Figures No. 17 and 18. In cases where the bottom of the ditch is damp thru most of the year from spring water, willow posts are sometimes used. In a short while these will sprout and remain alive, which insures a good anchorage.

**Use of Straw.**—The ground between the posts and below them for a distance of 10 feet or more is covered with coarse manure or wet straw. This prevents undercutting of the dam. Examinations have shown that

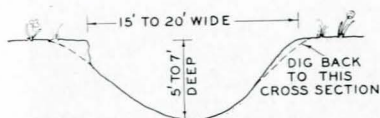


FIG. 16.—The double row post dam as shown in Figures 22 and 23 is adapted to ditches of this size.

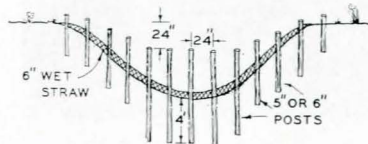


FIG. 17.—The ditch shown in Figure 16 is dug to this cross-section and two rows of posts are set.

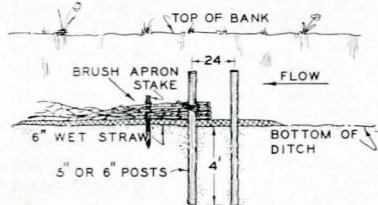


FIG. 18.—After posts are set as shown in Figure 17. The long brush is used to form an apron.

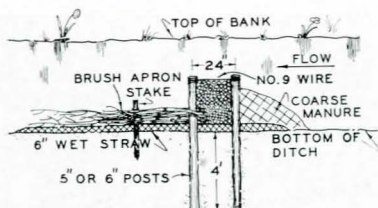


FIG. 19.—When the apron is constructed as shown in Figure 18 the space between lines of posts is filled with brush and wired down.

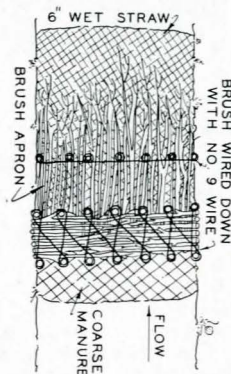


FIG. 20.—Top view of completed double row post brush dam.

after the first rain the silt has lodged in the straw to such an extent that the brush was firmly held down by it. Coarse straw is also placed above the finished dam as shown in Figures No. 19 and 20.



FIG. 21.—Posts in position for large double row post dam in ditch  $7\frac{1}{2}$  feet deep.





FIG. 22.—Completed dam in ditch shown in Figure 21.

**Building the Spill Apron.**—After the straw has been placed on the bottom of the ditch the next step consists in the construction of the brush apron which breaks the fall of the water as it comes over the crest of the dam. As shown in Figure No. 18, long, brushy limbs are hooked on the lower line of posts and allowed to extend downstream for a distance of 10 feet or more. After a thickness of 12 to 18 inches of thickly matted brush has been formed, a number of stakes are driven thru the apron and the limbs are wired down to form a heavy mat.

Next the space between the two lines of posts is filled entirely full with brush laid cross-ways of the ditch as shown in Figures No. 19, 20, and 22. This brush between the posts must be thoroly packed and piled above the top of the posts a distance of a foot or more.

**Use of No. 9 Wire.**—After this space between the posts has been filled, a No. 9 wire is stapled to a post at one end and tightly stretched



FIG. 23.—A good example of double row post dam, in ditch 7 feet deep and 20 feet wide. Note brush apron on lower side.

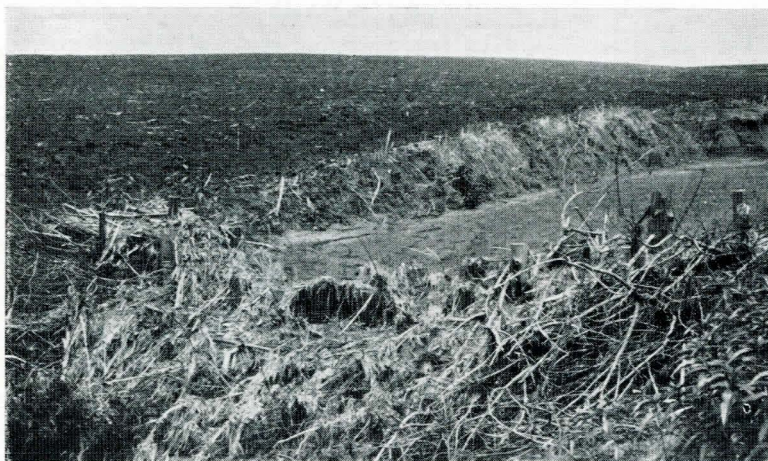


FIG. 24.—A double row post dam after a 6-inch rain had fallen. Note how apron prevented erosion below.

as shown in Figure No. 20. By threading the wire back and forth from post to post the entire mass of brush is held down, forming a solid baffle which no ordinary flood can dislodge. After the wiring process is completed, coarse, wet straw or manure is piled above the dam to insure that the silt coming with the first rain will be caught.

**The Completed Dam.**—When completed this dam is considerably lower in the center than at either edge. It is so solidly anchored that it is impossible for water to push it along the stream channel, nor can it be floated away. Water passing over the center drops on the thick brush apron and does not erode the ditch bottom. A layer of straw underneath successfully prevents undercutting. Observations on many of these dams after a period of years has shown them to be very sturdy and reliable, even when placed in extremely difficult positions. It must be understood, however, that they should be built in a series, one below another if good work is to be done.



FIG. 25.—The dam shown in Figure 24 two years later. The ditch is filled with silt and could be seeded down.



### CONCRETE DAMS

Concrete dams have been used in many parts of the state for the control of erosion in ditches. In many cases results have been far from satisfactory due to poor design and poorer methods of construction. In far too many cases the builder in an effort to keep the cost down has used weak mixtures of concrete and built structures with insufficient strength to withstand the water pressure. Dams which have a height greater than 3 feet should ordinarily be reinforced with steel bars. The following general statements apply to all classes of concrete dams.

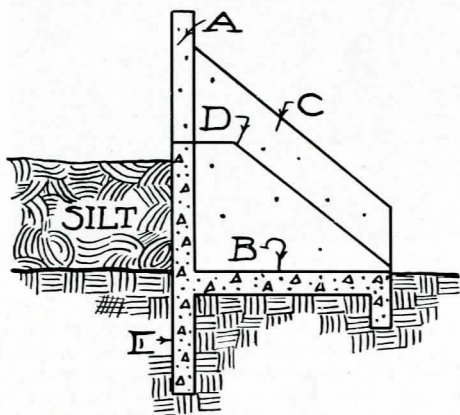


FIG. 26.—The spillway to prevent undermining is an essential part of a concrete dam.

No. 26 and 27) provides a place for the water to strike without causing erosion after rushing over the spillway.

4. A mixture of one part Portland cement and six parts sand-gravel will be found satisfactory for structures of this kind.

5. A dam of more than two or three feet in height must be reinforced with steel bars and often a special design is called for because of local conditions. Larger concrete dams should not be attempted without special advice from a trained engineer.

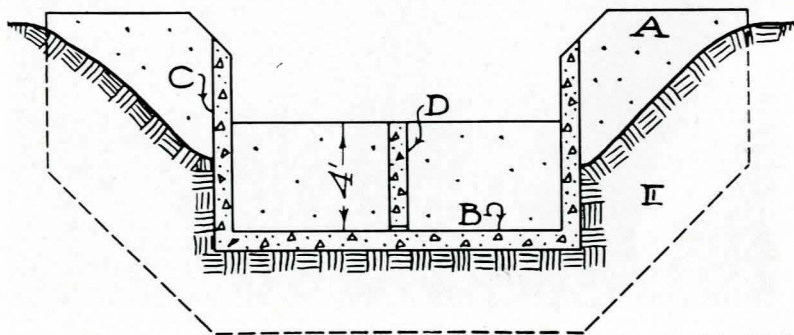


FIG. 27.—The concrete dam to be satisfactory must be carefully designed and installed.

1. The ends of the structure should extend into the sides of the gully a distance of several feet to prevent seepage around the concrete which will result in damage.

2. A spillway built in the center of the structure will provide a ready means of escape for flood waters but the sides near the banks of the gully must be as high or higher than the banks. See "A", Figures No. 26 and 27.

3. A spill apron below the dam (see "B", Figures



FIG. 28.—Many ditches are formed by the advance of overfalls as shown here.

place them rather closer together on steeper slopes than where the gradient was less.

When a baffle is constructed silt begins to accumulate above it. As soon as the bottom of the ditch no longer scours, vegetation begins to grow on the silt fill. Other particles coming down are lodged among the vegetation and in consequence one dam may fill a considerable portion of the original ditch channel. Observations have been made showing that the fill 100 feet behind the dam was 18 inches higher than the crest of the dam itself. Some farmers follow the practice of building a baffle at the lower end of the ditch and allow the channel to fill as far as possible. Then a second dam is constructed and so on until the entire gully has been disposed of. Generally speaking a spacing of 75 to 100 feet under ordinary conditions will be sufficient. On slopes as steep as 10 or 12 per cent it may be necessary to reduce the spacing to 25 feet or less.

### CONTROL OF OVERFALLS

As stated in the beginning of this circular, many ditches, particularly in the loess soils, are formed by the advance of an overfall. In other words, flood water plunging over a small waterfall causes it to advance up a ravine by eating away the soil.

Permanent methods of control consist of putting in soil-saving dams or a series of heavy baffles below the overfall. Better yet, divert the water away from it with a system of terraces or by changing the flow to another ditch.

It appears, however, that it is not always possible to divert flood water, install terraces or construct dams. Yet it may be extremely important to prevent the overfall from advancing in otherwise level fields. Figure No. 28 shows a typical overfall in the loess soils advancing up a ravine in a cultivated field. These overfalls may advance at the rate of 8 to 10 rods or more per year,

6. Buttresses help to support the structure when properly designed and placed. (See "C" and "D", Figures No. 26 and 27.)

7. A dam placed in a gully, the bed of which is underlain with gravel or sand will often be undermined and fail unless special provisions are made to cut off seepage beneath it with sheet piling or by extending the foundation down to impervious material.

### SPACING BRUSH DAMS AND OTHER BAFFLES

It is very difficult to give any hard and fast rules governing the spacing of brush dams. It has, of course, been found necessary to

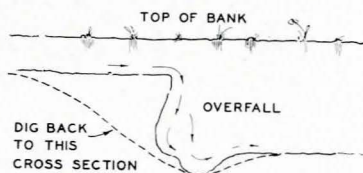


FIG. 29.—The overfall shown in Figure 28 would appear like this if viewed in section.



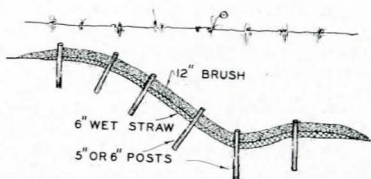


FIG. 30.—A temporary means of control in cutting the abrupt fall to this slope and covering the surface with a layer of straw over which brush is placed and anchored to posts with No. 9 wire.

30. The entire surface is covered with 6 inches of coarse manure or wet straw from the stack bottom. Over the straw is laid a blanket of brush, approximately 12 to 18 inches thick. The brush is laid with the butt ends upstream and must be closely packed. It is held in position by means of wiring poles or No. 9 wire stretched tightly between posts and stapled.

Another means of control consists of covering the area with wet straw and then putting on a thin layer of fine brush 6 inches thick and over this putting strips of heavy, woven wire stapled to stakes driven into the sloping surface. In some instances the advance of large overfalls has been arrested as shown in Figure No. 31, by the use of flumes which take the water from the higher to the lower level and thus prevent erosion. These flumes have been successfully constructed of galvanized metal, wood, concrete, and brick. It is very essential that no undercutting occur at the top of the flume or the whole structure will be destroyed.

Additional bulletins dealing with terracing and the construction of the large soil-saving dams of earth and concrete can be had by writing to the Extension Service, College of Agriculture, Lincoln, Nebraska.



FIG. 31.—A galvanized iron flume used to carry flood water down an overfall without erosive action.