COOPERATIVE EXTENSION WORK
IN
AGRICULTURE AND HOME ECONOMICS
STATE OF OKLAHOMA
D. P. TRENT, Director

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE AND UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING

EXTENSION SERVICE
COUNTY AGENT WORK
STILLWATER, OKLAHOMA

Distributed in Furtherance of the Acts of Congress of May 8 and June 30, 1914

Reclaiming and Controlling Gullies and Ditches

A GULLY LIKE THIS ONE, NINE FEET DEEP, ADDS TO THE FARMER'S BURDEN

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Circular No. 219—Revised, 1929. General Series 57, 1925

Tulsa World, May 12, 1929.—Mr. and Mrs. Laramore, with their two children, were rescued yesterday after spending seven hours in a tree top when their home near Council Grove had been washed into a ravine by the recent heavy rains.

RECLAIMING AND CONTROLLING GULLIES AND DITCHES

Gullies and ditches are so common in the farming area of Oklahoma that the problem of reclaiming them, or at least controlling them, deserves the attention of the owners of the land upon which they occur. Erosion control by terraces on cultivated areas is rapidly being adopted by farmers in this and neighboring states with much direct profit in the way of increased returns. The control of hillside ditches and gullies offers opportunity for improving farm land valuations, as well as for decreasing the cost of farming operations by reducing the time required to go around such gullies in farming between them. Various other good results from gully control will readily occur to the mind of the thinking farmer.

Oklahoma soils, especially the light sands and red loams, erode very readily. Gullies and ditches form quickly with a consequent loss of good top soil and plant food. Gullies also have a distinct effect upon soil moisture, draining as they do the free water from the soil on both sides of the channel, generally down to the full depth of the cut. The ease with which our soil moves is one factor favoring the work of control. The rains of one season, following proper treatment of the gully, may result in almost complete reclamation or at least in sufficient control to make terracing possible at a lower labor cost.

Reclamation Methods suggested here are offered as supplements to terracing, not as substitutes for terracing. It often happens that terracing and gully control must be undertaken on the same field at the same time. Where the gullies are too large to be filled in with earth and the terraces carried across them, more gradual methods of reclaiming them must be employed and gully control should be sought before terracing work is started.

Under a recent Act of Congress, the U. S. Department of Agriculture is setting up research studies of erosion control in different parts of the United States. One project started in January, 1929, is located near Guthrie, Oklahoma, on 160 acres of red sandy loam, having slopes of from two to eight or more feet in one hundred feet. The place had been in cultivation for years and presented many problems in gully control for solution. See front cover page, which shows land lost to cultivation because of a gully nine feet deep,—Guthrie project. Some of the work already undertaken is described herein. Since the methods employed at Guthrie apply particularly to our soil and conditions, Oklahoma visitors to this project will be well repaid for the time spent. The College at Stillwaater is in close touch with the work at Guthrie, and the Extension Division of the College invites groups of farmers when visiting the College to extend their visit to the Guthrie project. An effort will be made to have an official of the service accompany such groups ot visitors so that a thorough understanding of the work of the project may be gained.

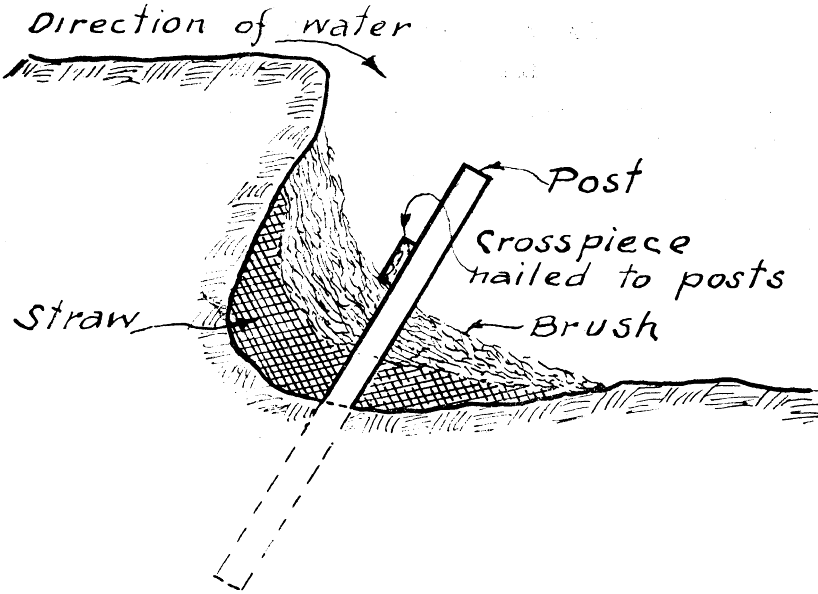


Figure 1

Stopping erosion at the head of a gully is usually the important first step toward control. Where one or more terraces can be carried across the gully head, this first step is well accomplished, the reclamation of the rest of the gully by other means may then be started. Where terraces can not be carried across the head, it is best when possible to divert the water before it enters at the head so as to spread it out thinly over the surrounding ground, or to carry it in a different direction away from the gully.

Brush and Straw Dams. In many counties of this state scrub oaks and other small trees are plentiful and may be used to advantage in gully control work. Head erosion can be checked with brush and straw obstructions properly placed. The method illustrated in Figure 1 shows posts driven deep in the ground close to the gully banks and two or three feet apart across the gully. A layer of straw is placed in the bottom, well packed around the posts and against the undermined banks. A few branches are laid crosswise and interwoven between the posts to hold the straw in place. Brush is packed tightly down over the straw with the butt ends down stream. The brush and straw is held in place by cross pieces nailed to the posts as shown in the figure. Direct pressure of the cross pieces on the brush is depended upon to hold the whole in place and prevent the brush being swept out during heavy rains. Where loose rock is plentiful it can be loaded on top of the brush to maintain the pressure. Occasionally driving the posts holding the cross pieces

Figure 2.—Starting to Reclaim a Gully Washed Down to Bed Rock—Guthrie Project

Figure 3.—Five Brush Dams are Shown in this Gully—Guthrie Project

deeper into the ground will accomplish the desired result of holding the brush in place.

After head erosion is checked, some type of dam is usually depended upon for gully control. Dams built at intervals such that the top of one is on a level with, or slightly higher than the bottom of the one above, may be made of brush and straw, of rock, stone and straw, of poles and straw, or other material, a plentiful supply of which is available. Rock construction is frequently used, the chinks between rocks being filled with stones and straw. Carelessly built dams are not effective. It pays to be thorough in all work done to control the movement of soil and water. Dams should be extended well up in the banks of the gully to prevent end cutting. The waterway through the center of the dam should be as wide and generous as the situation will permit. Figure 2 shows the beginning of a brush dam in a gully which has been cut down to bed rock. The man is boring a hole with a soil auger in the side of the gully for one of the cross poles used to bind the brush in place. Completed dams of this type are shown in Figure 3. The upper ends of the cross poles are tied down with wire to short stakes driven

Figure 4.—Reclaiming a Hillside Field with Brush and Straw Dams.—Guthrie Project.

well into the banks of the gully. The dams shown are from 12 to 15 feet long and are built with butts upstream, having a generous amount of straw, hay or weed trash distributed through the pile. It will be noted in Figure 3 that the dams are lower through the center where the greatest depth of water will occur.

Stake and Wire Brush Dams. Where rock is not encountered in the bottom of a gully, stake and wire brush dams may be built. Rows of stakes are driven in the gully bed and banks until they hold firmly. Number 12 wire is fastened to each stake of the center row with sufficient length of wire left to reach the farthest stake on each side. Hay and brush is then piled between stakes to desired depth and the wire stretched as tightly as possible over the brush to each side stake from the center stake. By driving the stakes a little deeper after the wiring is done, the entire dam will be well anchored and ready to accomplish its purpose. One of these dams is shown in the foreground of Figure 4.

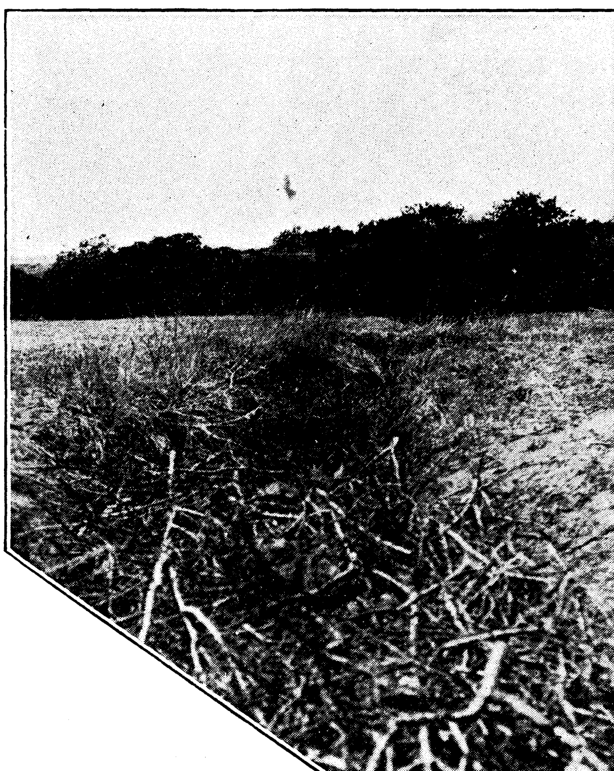


Figure 5.—A Gully Filled with Loose Brush.—Guthrie Project.

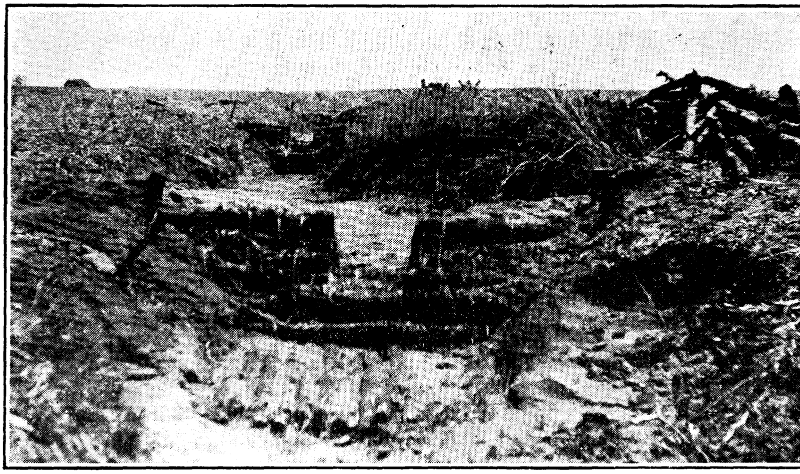


Figure 6.—Two Rains Filled This Gully to the Height of the Notch in the Pole Dams.—Guthrie Project.

Continuous Brush and Straw. It is sometimes advisable to brush-fill a gully throughout its entire length. (See Figure 5.) Care in placing the brush, using hay or straw generously pays good dividends. Some prefer a shingling method of placing, starting at the lower end of the gully. This permits a greater depth of brush at the lower end which may be placed from time to time as the gully fills. If rock or stumps are available they may well be placed on top of the brush to weight it down if their final depth is well below plow depth.

It is surprising to note the effect of brush and straw obstructions to the free passage of water down a gully. One heavy rain will often result in from 12 to 24 inches of soil being caught and held in the gully.

Pole Dams as shown in Figure 6 are an effective method of reclaiming gullies. An apron of poles laid lengthwise of the gully is first put down on a base of straw to break the force of the water falling over the dam. A layer of poles with hay between them is then placed crosswise of the gully. The width of this layer depends upon the final height of the dam desired. Succeeding layers of poles with straw are placed until the height of the notch opening is reached. Each layer will be one pole less in width than the layer immediately beneath. Short pieces of pole are used at each side of the notch opening. These may be spiked and wired to the lower layers to prevent washing out. The notch opening should be generous and dirt should be banked against the upper face of the dam and carried well up on the side walls of the gully to prevent end washing. One advantage of brush dams and pole dams is that when covered with soil they soon rot and offer no obstacle to farm operations. Some of the wire used may possibly be caught by the plow, but will tear loose from its rotted support. The low cost of the materials used is a point in their favor. Building dams between those seen in the picture (Fig. 6) would quickly result in half burying the dams shown, in reclaimed soil.

Rock and Stone Dams. In some localities rock and stone are available in generous quantities for gully control work. This material may be used in much the same way that brush and straw are used, that is, laid continuously throughout the length of the gully or built into dams spaced properly in the gully. The success of rock and stone obstructions depends largely upon filling all spaces between the rocks with stones and straw, hay, or weed trash so that no openings are left to permit the free passage of water and soil. Where water is permitted to flow freely through a rock dam, it results in washing the soil from around and under the rock and a consequent lowering of the whole structure with no saving of soil effected. The top layer of rock must be well below plow depth.

Post and Woven Wire Dams are effective in some situations. They are often used in wide shallow gullies having little drainage area. A common source of failure of this type of dam is insufficient bracing of the posts. These should be set about four feet apart and at least four feet deep. If the gully offers steep side banks the end posts should be set in a niche cut into the banks. All posts should be braced or anchored with stout wire to anchor posts driven eight or ten feet above the line of the dam. If not well braced the weight of the water coming against the dam tends to flatten the entire structure. The lower panels of wire may be bent up stream and buried or a trench may be dug along the upper side of the posts so that the woven wire may be fastened six or more inches below the surface. The trench should be refilled and tamped. Loose brush and straw placed in front of the wire and carried well up on the ends so that the water is forced to pass through the center of the dam, adds to the effectiveness of this type of dam in gully control.

Soil Saving Dams. For wide depressions and large gullies which offer reasonably shallow storage capacity, the earth soil saving dam may be employed. Careful preparation of the dam site should include the removal of any stumps and brush undergrowth. If the surface soil bears any humus forming material, grass sod, etc., it should be plowed up and moved to the front or back line of the dam. The prepared strip should again be plowed so that the loose earth brought in to make the fill will contact with loose earth in place, the whole will key together, forming a compact bond which tends to prevent seepage. What has been said about preparation of the surface applies to the side walls or banks of the gully quite as much as to the bottom. The ends of the dam should extend well into the banks. If any clay is available it should be placed in the center of the dam to form a core wall extending from the base to the top of the dam to resist the percolating or seeping tendency of water to pass through the dam. As shown in cross section, Figure 7, a line of tile with cemented joints extends through the dam for some distance beyond the upstream face. Water from heavy rains causes a pond to form above the dam, the silt settles to the bottom of the gully and the water flows into the vertical inlet pipe through the dam and into the gully below the dam. When the pond is filled with soil to the top of the inlet pipe another section may be added and the filling continued. The top of the inlet pipe should always be two or three feet below the top of the dam and when possible the top of the dam after settlement should be at least one foot higher than the firm ground on the sides of the gully, so that if an unusually heavy rain occurs the water will flow over the firm ground and not over the top of the dam. A foundation of stone or concrete should

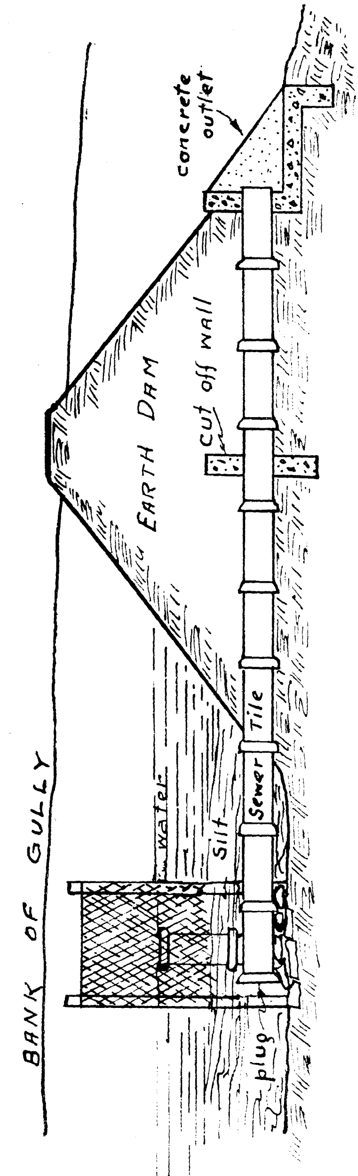

BANK OF GULLY
water
Silt
Sewer Tile
plug
EARTH DAM
cut off wall
concrete outlet

Figure 7

be provided for the tee or elbow of the inlet pipe to rest upon. Unless the inlet it set some distance (about 10 feet) above the dam, floating trash may clog it, and the eddying water around the pipe may cause a break in the dam. Posts set about the inlet and wrapped around with netting or fencing will help to prevent clogging.

Unless the soil forms a close bond with the pipe, seepage of water along the pipe may occur. A concrete cut off wall as shown in Figure 7 tends to prevent seepage. A firm foundation for the pipe is necessary to prevent unequal settlement, and leekage through broken joints. The outlet end of the pipe should be protected by concrete to prevent undermining and eating back through the dam along the pipe.

The size of pipe required for a definite drainage area will depend upon the storage capacity above the dam, the slope and humus content of the land drained, the probable rainfall and other factors. The following table is intended only as a guide to help in estimating the size of pipe required:

Diameter of Tile	Acres Drained
10 inches	3 to 6
12 inches	6 to 10
15 inches	10 to 20
18 inches	20 to 30
20 inches	25 to 50
24 inches	40 to 80
30 inches	60 to 100

Where conditions are right, a series of these earth soil saving dams located at proper intervals such that a layer of soil will be deposited throughout the length of the gully will prove effective in reclaiming gullies that are too wide and large for the economical use of other means.

Methods for Control of Gullies and Ditches may be thought of as differing in their application from methods for reclaiming arable land. Control methods apply in situations where a waterway or channel must be provided for storm waters, which if uncontrolled would result in wasteful erosion, destruction of property and other bad effects. Control measures usually contemplate structures of a more or less permanent character. Terrace outlets sometimes occur at points where a considerable over fall of the discharged water cannot be avoided. Unless control measures are used at such points serious eating back of a ditch along the terrace line will occur. Figure 8 illustrates a concrete drop which will be found useful in controlling terrace outlets and side hill ditches having excessive fall. The center of the dam should always be considerably lower than the ends, although the notch shown in the illustration may not always be desirable. The size and shape of this dam will depend upon the size and shape of the ditch and the amount of water to be handled. (See Figure 9). In a ditch line, the shape of the dams should be such as to reduce the size of the ditch to a safe minimum. In a terrace outlet the wings of the dam should extend well into the banks and bottom of the ditch to prevent washouts through seepage. The height of the center of the dam should be as high as the ditch can be maintained above the dam. Do not over estimate this height or the reasonably free passage of the water will be obstructed and result in trouble.

The small holes below the notch shown in Figure 8 are seep holes. They serve a purpose in cases where a considerable fill above the dam is expected, in relieving the force of the water over the dam and in providing some drainage for the fill as it occurs. The brace walls strengthen the structure and divert the falling water onto the concrete apron which should extend well below the dam to prevent undermining.

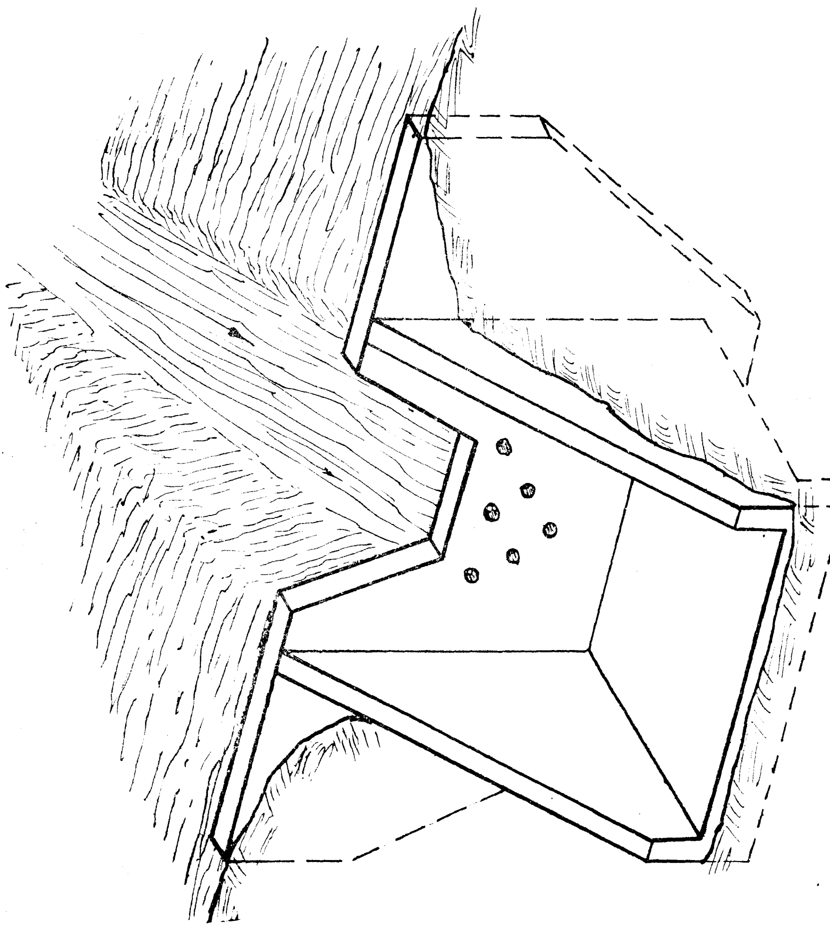


Figure 8

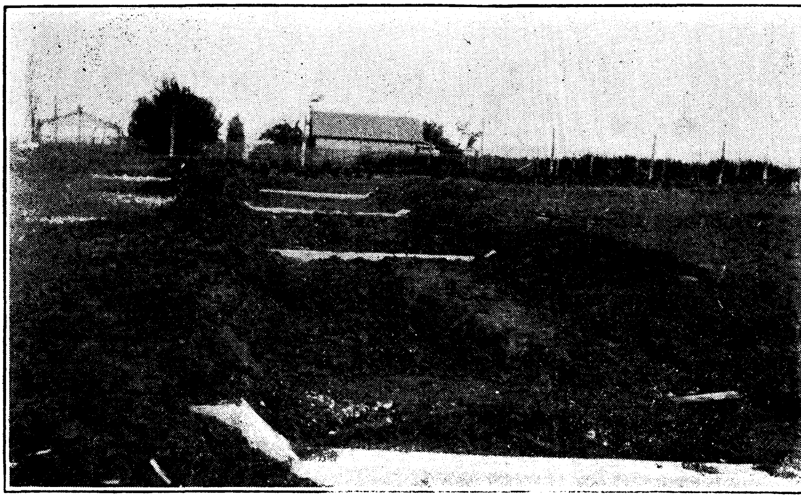


Figure 9.—The Dam Should Maintain the Shape of the Ditch.

As mentioned above, the throat clearance at the center of the dam must be generous whether or not a notch is used.

As stated elsewhere, the amount of water that will drain from a given area, varies; therefore the following table is only an approximate guide to determine notch sizes. In this table it is figured that the run off is one-half inch of water per hour.

Width of Notch Feet	Depth of Water Flowing Through Notch Inches	Area Drained Acres
2	6	5
3	8	10
4	12	25
6	18	70
8	24	140
12	24	235
20	24	375

No standard specifications can well be given for these dams since no two are exactly the same even in the same ditch.

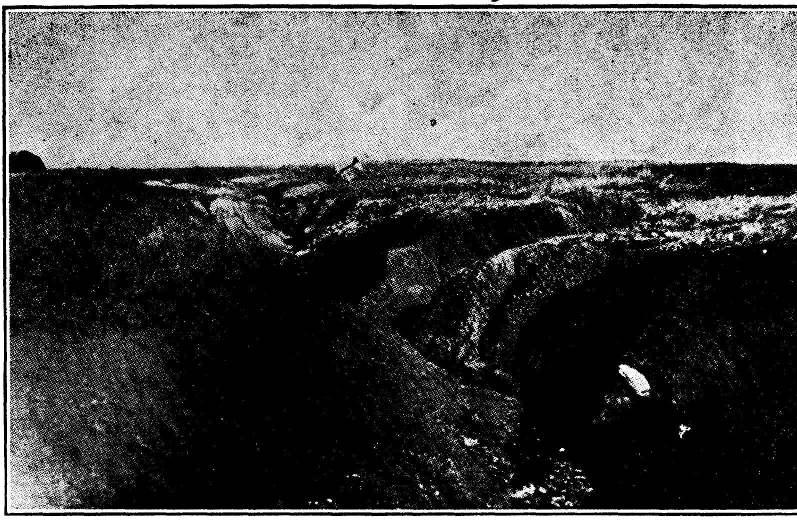
Rusty wire should not be used for reinforcing concrete since the cement will stick to the rust and form no bond with the steel. For the same reason it will pay to wash the sand and stone used unless it is known to be quite clean. By washing a small amount of the sand or stone in a bucket its relative cleanliness can be determined. If clay or other foreign matter coats the particles, the cement can not come into direct contact with the sand or stone, therefore good conrete cannot result from its use.

Farmers' Bulletin No. 1279, "Plain Concrete," gives much practical advice regarding this material. Copies may be secured from your county agent, from the College at Stillwater, or direct from Washington, D. C.

Figure 10.—Let Us Avoid Mistakes Like This.

Figure 10 shows the result of too little clearance at the throat. The ends of the dam were not carried high enough or far enough into the bank and the washout has resulted. If good hard rock is available, rock dams may be used in place of concrete with good success. A porous rock, such as loose sand stone, will weather and crumble when exposed to frost, rain and sun and would make only a short lived dam. Figure 11 shows two rock dams in a hillside ditch in Wagoner county. These dams were built five years ago. A

Figure 11.—Highly Effective Ditch Control



study of the picture shows how thoroughly erosion has been controlled in this instance. The ditch is completely filled and sodded with plant growth, and the buildings, etc. are no longer endangered by caving banks.

Methods Employed for Larger Structures. Where an attempt is to be made to control large deep cuts such as the Payne county gully shown in Figure 12, careful thought should be given to the methods used. Sometimes an earth soil saving dam with a concrete core wall and a concrete spill tube will insure the right working of the structure. The high cost of the larger sized clay tile may make the concrete spill tube as used in Nebraska more economical. These tubes are made rectangular in shape, are cast in place and reinforced throughout. The following table applying to concrete spill tubes is taken from University of Nebraska Extension Circular 123.

Acres Drained	Size Tube Rectangular	Acres Drained	Size Tube Rectangular
10	1' 5" x 1' 5"	70	3' 3" x 3' 6"
15	2' 0" x 2' 0"	80	3' 3" x 4' 0"
20	2' 0" x 2' 5"	100	3' 9" x 4' 0"
30	2' 6" x 2' 6"	120	4' 0" x 4' 3"
45	2' 6" x 3' 0"	140	4' 0" x 5' 0"
50	3' 0" x 3' 0"	160	4' 3" x 5' 0"
60	3' 0" x 3' 6"	200	5' 0" x 5' 0"

The tube is installed with a vertical inlet the same as the sewer tile shown in Figure 7. The reinforcing is carried up beyond the top of the inlet opening so that when the height of the inlet is increased, the reinforcing will be in place to key the new work to the old.

Work done in reclaiming small gullies such as those shown on the cover page and Figures 2, 3, and 4, will lead to the development of methods suitable for larger undertakings. If we start now on the small gullies we can prevent them ever getting big and certainly prevention of erosion is better than cure.