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A Buried Drain Erosion and Sediment Loss Control System

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The lower ends of most furrow irrigated fields have become convex shaped, meaning the slope progressively increases from a point 20 to 60 feet from the field end to the tailwater ditch. This increasing slope is the result of maintaining tailwater ditches too deep and keeping them cleaned so runoff from these fields is not restricted. The process of forming a convex field end continues yearly at an increasing rate. With each passing year, the slope at the end of the field becomes greater so that runoff water runs faster and has more energy to erode. Over many years, large quantities of soil have been lost from the lower ends of furrow irrigated fields. Field ends 1.5 to 2.0 feet lower than the furrow elevation 20 to 60 feet upslope are common. Much of the soil loss is from the lower ends of fields.

Observations and measurements of erosion and sediment loss from furrow irrigated fields have shown that erosion is severe along the upper ends of fields where furrow stream sizes are largest. Here, water in the furrows has energy to erode soil and transport sediment. Furrow streams must be large enough to provide sufficient water to irrigate the entire furrow length to meet irrigation purposes, thus requiring these erosive streams at the upper ends. As the water moves downslope, the stream size diminishes as a result of infiltration. The stream no longer erodes soil when its size diminishes to where it no longer has enough energy to erode. Further downslope, the stream becomes too small to transport the sediment it eroded upslope.

At that point, sediment deposition begins, and soil is redistributed downslope. As the stream size diminishes, much of the sediment has settled out, and the furrow stream has become small. This is usually near the lower end of the field. As this small stream increases velocity down the increasing slope of the convex end, its energy increases, and it erodes soil, carrying it into the tailwater ditch. Soil eroded from the end of the field is usually the soil that leaves the field. It is lost and no longer available to the farmer. This process over the long term reduces topsoil depth at the upper ends, increases topsoil depth along middle and lower portions and erodes soil from the lower ends of furrow irrigated fields.

The buried drain erosion and sediment loss control system is comprised of buried pipe along the lower end of a field in place of the tailwater ditch. Runoff water enters the pipe through vertical pipe inlet sections from the surface con-

nected to the buried pipe with tees. The tops of the inlets are set at the desired elevation for the lower end of the field, and the distance between the inlets along the pipe depends upon the slope along the pipe. This distance can vary from 20 feet on slopes of 5 percent or more to 100 feet on slopes less than 1 percent.

When the system is first installed, small earthen dams are placed immediately on the downslope side of each vertical inlet to back-up tailwater until it reaches the elevation to enter the inlet. Small ponds or sediment basins are formed that fill with sediment eroded mostly from the lower portion of the field (Fig. 1). These sediment basins usually fill completely with sediment after a few irrigations, and the shape of the lower end of the field is significantly changed (Fig. 2 and compare Figs. 3 and 4)



Fig. 1. A buried drain erosion and sediment loss control system operating during the first irrigation after installation.

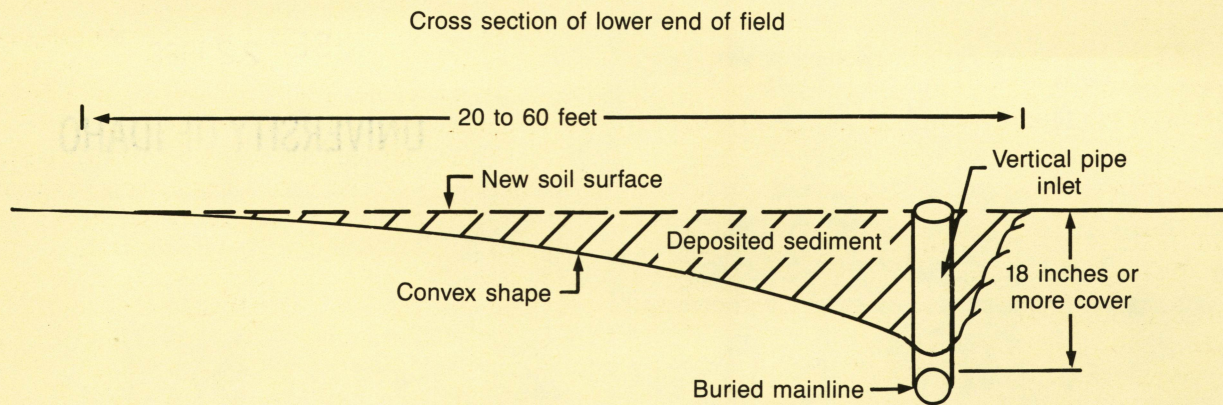


Fig. 2. An illustration of how the buried drain erosion and sediment loss control system corrects the convex end problem. Depth of cover is determined by including the sediment that will collect above the pipe.

Erosion and Sediment Control Benefits

Research evaluations of buried drain erosion and sediment loss control systems have shown that 85 to 95 percent of the sediment in runoff water is deposited along the lower ends of fields during the first season of operation. The amount of sediment deposited ranged from 6 to 15 tons per acre the first season. The sediment removal efficiency during subsequent seasons, after the sediment basins had filled with sediment and the convex end problems were corrected, dropped from the 85 to 95 percent level to about 70 to 75 percent. The quantity of sediment in the runoff water after the convex ends were corrected, however, was generally only a small fraction of the amount before. Therefore, the amount of sediment lost from fields was small.

Correcting the convex end with this system often increases the productive area of fields. This is accomplished by removing the tailwater ditch that often requires about 10 feet along the field end and by eliminating barren strips in row crop fields 10 to 30 feet wide on the steep slopes of convex ends. Also, in many fields the tailwater ditch is too deep to cross,

but correcting the convex end with these systems allows tillage, seeding and harvesting equipment to cross and turn around on a field road beyond the field end. The barren strip with row crops on the steep slope of the convex end results from early season furrow erosion that cuts furrows so deep that water is not absorbed to the shallow roots of small plants, and the small row crop plants die from the lack of water.

The following photos show the effects of the buried drain erosion and sediment loss control system. Fig. 3 shows a tailwater ditch too deep for equipment to cross. Fig. 1 shows the system in operation during the first irrigation after installation. Fig. 4 shows the field end after four irrigations. Notice that the tailwater ditch is eliminated, and subsequent cropping can be done right to the field end.

The initial cost of installing a buried drain erosion and sediment loss control system requires a significant investment. In many areas, however, cost share programs are available, and farmers can install systems using their own equipment to reduce installation costs. The benefit of these systems in 5 to 10 years will usually recover the initial investment



Fig. 3. A tailwater ditch along the lower convex end of a field. This ditch is too deep to cross with farm implements.



Fig. 4. The same tailwater ditch and sediment basin area shown in Figs. 1 and 3, after four irrigations. The tailwater ditch is filled with sediment, and the convex end problem is corrected.

through increased production because more area is put into crop production. Weed control benefits also accrue after the first year because the tailwater ditch is eliminated, and the field end drains about as rapidly as upslope areas. Eliminating the tailwater ditch also facilitates ingress and egress with equipment on one part of the field while another part is being irrigated.

Field Conditions Benefited Most by These Systems

These buried drain systems are most beneficial on fields with slopes between 0.7 and 2.5 percent. Fields with slopes less than 0.7 percent usually do not erode severely, and fields with slopes greater than 2.5 percent often erode so severely that the sediment basins hold only a small portion of the sediment the first season, and erosion along the entire field is usually severe enough that large quantities of sediment from most of the field length reaches the field end. In this latter case, the erosion and sediment loss control efficiency of buried drain systems is low.

Another situation where these systems are highly beneficial is where the tailwater ditch erodes severely. Such problems can be eliminated by a buried drain system. Another situation well suited to a buried drain system is where two fields drain into the same tailwater ditch. The two fields can be combined for tillage operations by this method.

Installation Criteria

A suitable outlet for the buried drain erosion sediment loss control system is required so that the system will drain freely. Usually, systems can be drained into natural open drains or canals. The buried pipe is sometimes at a lower elevation than the tailwater ditch, and its depth must be considered when evaluating the suitability of outlet. Occasionally, the buried pipe can be extended downslope along the side of a field at a gradually decreasing depth to provide an outlet into a shallow drain. The outlet can be submerged provided the slope along the pipe is adequate to force drainage water out the end rapidly enough that sediment does not settle in the pipe.

The slope along the buried pipe should be a minimum of 0.3 percent. Care should be exercised to avoid low spots in the pipe during installation. Often the slope along the tail end of a field is not uniform. This presents no problem because the slope of the pipe need not be uniform. In fact, if upslope portions of a system have steep slopes, downslope portions can be at low slopes, and the system will work well.

The required depth will depend upon the kind of pipe used. Pipe made of materials that have low crushing resistance must be placed deeper than those that resist crushing. Most of the systems that have been installed have been composed of corrugated polyethylene pipe. This material has a high crushing resistance and is flexible so that it does not break under a heavy load or upon impact. Generally, 18 inches of cover over the top of the pipe, including the sediment that will settle in the basins to fill them, is adequate (see Fig. 2); however, 24 inches of cover over the top of the pipe is required to qualify for some cost share programs available. Additional cover may be used with pipe that is less resistant to crushing by heavy loads. The depth of installation can be determined as shown in Fig. 2.

Almost any kind of pipe can be used in these systems. The cost and the ease of handling are important factors in determining which pipe to use. Corrugated flexible polyethylene pipe is easy to handle. The vertical inlets are flexible and seldom damaged when run over by farm implements. Also, the underground pipe is protected by the flexible vertical sections when inlets are run over by equipment. The tees and connectors are also available at a low cost. Rigid PVC pipe is also easy to install and usually near the same cost as corrugated polyethylene pipe, but the tees are much more expensive than those made of polyethylene. Sometimes the two materials can be combined with the main underground line being PVC and the tees and vertical inlets being polyethylene. These systems drain by gravity flow and need not be sealed against all leaks. Concrete or metal pipe can be used, but tees are not as readily attached to these materials.

The pipe size required depends upon the quantity of runoff expected from each irrigation set and the slope along the pipe. Trench depth can be controlled to some degree to get the desired slope. Keep the pipe as small as possible because pipe costs increase markedly with increase in pipe diameter. Eight-inch I D pipe was used for most of the research installations.

Trenches for installing buried drain erosion and sediment loss control systems can be dug with trenching machines, backhoes, blades or ditchers. Where severe convex ends and deep tailwater ditches are present, you may not have to do any trenching. Under these conditions, smoothing the tailwater ditch and placing the pipe in it may suffice. Sometimes, however, the buried pipe can be placed 2 to 5 feet beyond the tailwater ditch because the ditch is sometimes far enough from the extreme end of the field for ditching implements to clean it.

The buried drain system should be placed at the extreme end to put a maximum of land area into production. In fact, it can be placed beneath the edge of the bank of a subsequent head ditch or elevated field road. Fig. 5 shows a system about to be installed in a trench made by a trenching machine. Fig. 6 shows a system placed in a ditch prepared by using a blade.

Backfilling is important in these installations. The pipe should be covered with adequate material to avoid "floating out" when the small sediment basins fill with water. Puddling to settle the fill material before using the system helps to avoid problems during the first irrigation.

The small earthen dams should be 4 to 6 feet wide on top and about 6 to 8 inches higher than the top of the adjacent inlet. They should extend up into the field far enough that water does not run around them. Dams that are too narrow wash out readily the first time the system is used, particularly where the trench has not been previously settled.

Maintenance

The buried drain erosion and sediment loss control system requires little maintenance. The first season, while the small sediment basins are filling, some work may be required on the earthen dams to prevent washout. Also, some weed control around the small sediment basins is usually desirable. Burning weeds may damage risers of some kinds of pipe. After the basins have filled and corrected the convex

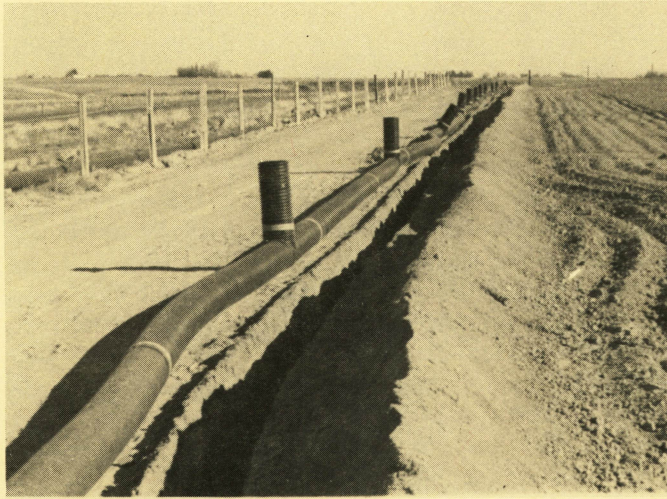


Fig. 5. A pipe with inlets connected ready to be placed in a trench made with a trenching machine.



Fig. 6. A buried drain system assembled in a ditch made with a blade and ready to be covered.

end problem, crops can be planted to the extreme lower end of the field, even over the buried pipe. It is usually not necessary to maintain the earthen dams adjacent to the vertical inlets. On some fields the vertical inlet may be extended the second season to trap more sediment and build up the field end more, and in these cases, the earthen checks would be necessary.

This publication recommends against cleaning the small sediment basins. Once the convex end problem is corrected, the slope near the field end is much less than before,

and the small streams do not gain velocity and develop energy to erode. That portion of the erosion problem on the field has been corrected. The drainage water readily finds its way to a nearby pipe inlet and is carried off the field.

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