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Furrow Erosion and Topsoil Losses

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Furrow irrigation is an effective means of applying water to a crop. Unfortunately, it can also be effective in removing topsoil.

Annual soil losses on furrow-irrigated fields can average from almost nothing on a nearly level alfalfa field to 30 tons an acre on sugarbeet fields with more than a 2 percent slope. Thirty tons of soil is almost 25 cubic yards.

A 30-ton per acre yearly soil loss adds up to 1 inch of topsoil lost every 5 years. Put another way, erosion can haul away 40 pickup loads of topsoil from each acre in one season.

Furrow erosion is a gradual but persistent process. To see the effects of past erosion, compare a farm's present field surface elevations to noneroded surfaces such as a fence line or the ground surface just above a head or drain ditch. Head and drain ditch undercuttings are examples of severe erosion. Extensive subsoil appearing in a field as "white spots" especially after plowing can also indicate past erosion damage. Use of additional fertilizers can restore crop yields on eroded soils to only about 85 percent of their former levels.

Soil losses are not uniform across a field. They occur primarily at the upper and lower ends. Erosion at the upper end of a field often results in crop yields noticeably lower than yields farther down the furrow where much of the eroded sediment settles out.

Erosion damage may also be visible at the bottom of a field. Deep tail ditches may result in steeply sloping or convex field ends making the bottom edge of a field unsuitable for crop production (Fig. 1). Shallow rooted crops planted on such a convex field end may receive inadequate irrigation where furrows have eroded too deeply for lateral water movement to reach the root zone.

Fig. 1. A rounded or convex field end is a clear sign of soil erosion. This problem needs to be corrected to avoid further damage.

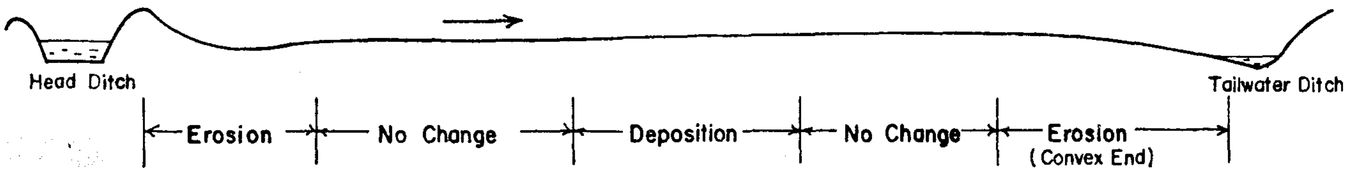


Fig. 2. Erosion in a furrow. The bulk of soil movement occurs at the top and bottom of a field. Furrow stream size and soil conditions have the greatest influence on how much soil movement occurs.

Growers pay the costs of erosion through higher fertilizer costs and nonproductive field ends. Topsoil lost in tailwater also costs downstream water users. Sediment carried in irrigation runoff increases canal and ditch maintenance, causes excessive wear on pumps and sprinkler nozzles and adds nutrients and sediment to downstream reservoirs.

Idaho Agricultural Pollution Abatement Plan

Idaho has adopted a voluntary Agricultural Pollution Abatement Plan to prevent agricultural pollutants — primarily sediment and nutrients — from entering state waters. The plan is part of a total effort to meet national, state and local clean water goals.

Success of the abatement plan relies on the voluntary cooperation of Idaho's farmers and ranchers. To reduce erosion, the surface irrigator must first know how sediment moves within the furrow, how much soil is being lost and what corrective actions can be taken.

Soil Movement Within a Furrow

Soil transported by a furrow stream accounts for most of the soil loss on irrigated land. Fig. 2 shows where erosion and deposition can occur within a furrow. Generally erosion is greatest at the top and bottom of a furrow-irrigated field.

The amount of soil moving in a furrow depends on the furrow stream size and velocity. Water falling onto the soil surface from siphon tubes or gated pipe picks up soil particles and carries them down the furrow. The furrow stream continues to pick up sediment until its energy equals the energy needed to carry the soil particles. Long irrigation runs are especiallv susceptible to excessive erosion at the head of the field because of the large stream sizes generally used (Fig. 3).

A furrow stream's size and velocity decreases as it advances down the furrow. As a furrow stream's energy decreases, so does its ability to carry soil. Most sediment eroded at the head of the field settles out before reaching the end of the furrow. Where slope increases at the end of the field, furrow stream

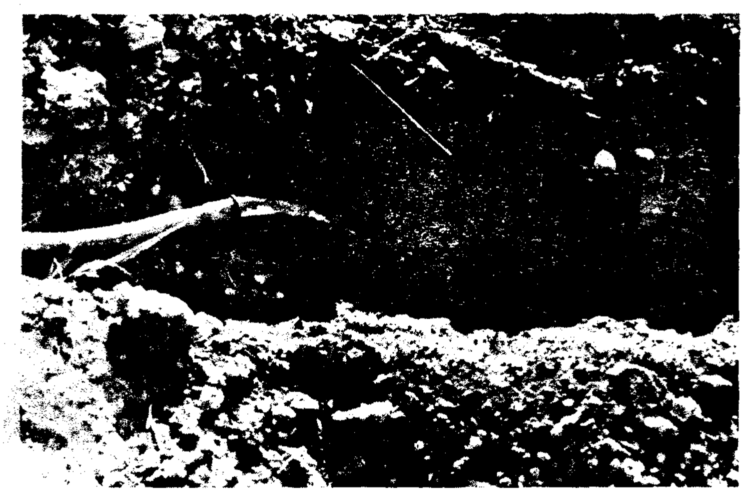


Fig. 3. Water striking the soil surface from a siphon tube causes much of the erosion at the head end of a field.

Fig. 4. Erosion near the end of a furrow. As the soil erodes, the water fall moves up the furrow.

Table 1. Average annual soil losses from furrow-irrigated cropland in the Boise and Magic Valley areas.

Crop	Slope 0 to 1%	Slope 1 to 2%	Slope over 2%
	(tons per acre annual loss)		
Alfalfa	0.0	0.0	3.0
Wheat	0.5	1.0	4.0
Peas	1.5	4.0	8.0
Beans	2.5	7.0	18.0
Corn	2.5	8.0	20.0
Beets	4.0	12.0	30.0

Table 2. Comparison of soil loss rates.

Soil loss	Soil loss in 1 year	Years to lose 1 inch of soil	Soil loss
(tons/acre/year)	(inches)		(cu yd/acre/year)
2	1/80	80	1.7
5	1/32	32	4.2
10	1/16	16	8.5
20	1/8	8	17.0
40	1/4	4	33.9

(A layer of soil 1 inch thick from 1 acre weighs about 160 tons)

velocity increases and again becomes erosive (Fig. 4). From 40 to 90 percent of soil leaving a field is eroded from the last 30 to 50 feet of each furrow.

Magnitude of Soil Losses

Table 1 lists typical annual soil losses for different crops and slopes. Row crops have a higher soil loss rate than noncultivated crops. The figures in Table 2 illustrate what soil loss rates mean in terms of decreasing topsoil depth.

Muddy tailwater roughly indicates soil loss. The amount of sediment deposited where runoff water slows down gives a better estimate of soil losses. Placing a series of T-slots in a tailwater ditch like the one shown in Fig. 5 will trap sediment in the drain ditch.

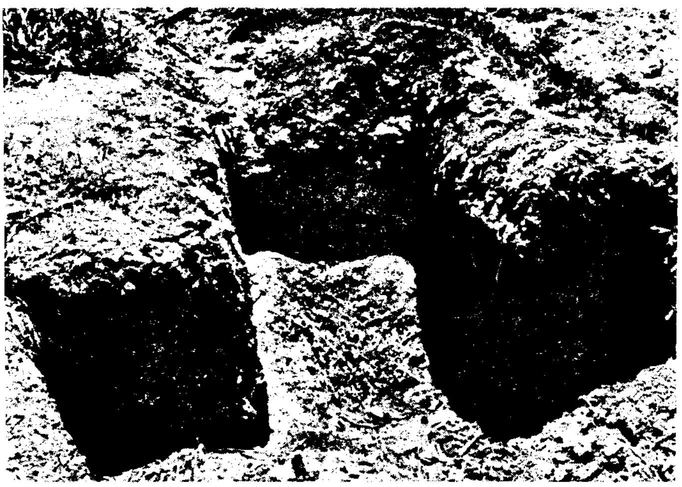
A small sediment basin will give the most accurate measure of soil loss. A properly constructed sediment basin slows tailwater enough to remove up to 95 percent of the sediment running off a field (Fig. 6). Each cubic yard of sediment captured by the basin represents a loss of roughly one and a quarter tons of topsoil. You can estimate the size of sediment basin needed for a season's irrigation by reviewing soil loss figures in Table 1.

Controlling Erosion Losses

Different field and management conditions influence how much soil is lost during an irrigation season. Soil type, length of run and field slope all affect soil losses.

Reducing furrow length will allow you to use a smaller, less erosive stream size. Field slope can be reduced by land leveling or realigning furrows across the slope rather than straight up and down the steepest part. Furrow irrigation is generally unsuitable on slopes of more than 3 percent because of the erosion hazard.

Improving water management also reduces soil losses. Roughly 50 percent of water applied at the head of a field runs off as tailwater. Sediment losses can be cut by reducing furrow stream size, by reducing the number of irrigations during a season or by controlling sediment carried by tailwater. One



ig. 5. A T-slot, dug in the tailditch with a backhoe, operates as a small settling pond to trap sediment washed off a field. T-slots will remove 50 percent of sediment that passes through but become ineffective when filled up.

Fig. 6. This sediment basin is nearly full after collecting sediment from the tailwater from a 5-acre corn field.

study in the Boise Valley showed that three-fourths of total soil loss taking place during an irrigation occurred during the first 30 minutes after runoff began. After 4 hours, no additional soil loss was measured.

Early season irrigations generally cause more erosion than later irrigations after crop roots are established, after plant leaves and stems have fallen into furrows and cultivations have ended. Reducing the number of cultivations or maintaining crop residues on the surface also reduces furrow erosion. Ten times as much soil may be lost during the first irrigation after a cultivation than during later irrigations.

Preplant irrigations are of special concern in reducing sediment losses. As much as one-third of the total season's soil loss occurs during a preplant irrigation. Eliminating this irrigation when soil moisture conditions permit would substantially reduce soil losses.

Best Management Practices

Your Soil Conservation District designates practices that effectively reduce soil losses from your fields and cleanup tailwater for downstream uses as "Best Management Practices" (BMPs). Some of these BMPs include:

- Vegetative Filter Strips
- Sediment Basins
- Improved Water Management
- Residue Management
- Minibasins
- Sediment Ponds
- Tailwater Recovery Pumpback
- Buried Drain Runoff Systems
- T-slots

Follow these steps in controlling furrow erosion and topsoil losses:

1. Determine the size and extent of your soil resource losses.
2. Determine what actions you need to take to prevent future losses and provide for clean water downstream.
3. Choose the practice or combination of practices that will most benefit your farming operation.

You can get additional information and assistance on irrigation water management and sediment reducing BMPs through your local Soil Conservation District office or county offices of the University of Idaho Cooperative Extension Service.

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