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Controlling sediment in surface runoff

Irrigators are sometimes criticized for contaminating downstream waters with sediment, nutrients and pesticides contained in surface runoff from irrigation. Research studies have shown that the concentrations of dissolved fertilizer nutrients, pesticides and salts in surface runoff are essentially the same as those in the applied irrigation water. Thus, water passing over the soil surface does not usually pick up additional amounts of these materials.

Significant increases in nutrient or pesticide concentration do occur when these materials are applied by adding them to the irrigation water or when the material falls into the water from spray applications or washed from the plants by rain. When fertigation and herbigation are practiced, runoff water should be retained in a reuse pond and not allowed to leave the farm or flow into natural streams.

Sediment is the greatest single pollutant from irrigation and comes primarily from erosion of irrigated furrows. Research studies show a close relationship between sediment and total phosphorus concentrations in irrigation return flows. Although information on biocide concentrations is limited, results from nonirrigated lands indicate that pesticides are generally absorbed on sediment particles. This appears to be true also for biocides in irrigation surface runoff. Thus, in addition to the sediment itself, surface runoff also carries phosphorus and pesticides which are absorbed on the sediment.

Besides damaging the public image of irrigators, erosion and the resulting sediment in surface runoff is costly to both the farmer and downstream users of sediment-laden water. For example, the Northside and Twin Falls Canal Companies in southern Idaho mechanically remove about 325,000 and 86,000 tons of sediment, respectively, from their canals and drains annually. This is a major operating expense for those and many other canal companies having similar problems.

Erosion and sedimentation losses for nonirrigated agricultural land have been estimated to cost from 1% to 12% of the annual net farm income. Costs for irrigated agricultural land are expected to be similar. Soil losses as high as 12 inches after 10 years of cultivation, even with relatively flat slopes and short lengths of run, have been reported. Soils such as the Portneuf silt loam in southern Idaho are very erodible and erosion-exposed light-colored subsoil is often observed at the upper end of fields and on steep sl[illegible] at the upper end of furrows where the stream size is largest. As water infiltrates into the soil along the length of the furrow, the stream size becomes smaller and its eroding and sediment carrying capabilities decrease. Thus, most of the soil eroded from the upper ends of the furrows is deposited lower in the field. The amount of soil actually leaving the field is directly related, among other things, to the amount of runoff.

A number of studies have been conducted to evaluate the relative contribution of the many variables involved in the erosion process and methods of controlling them. The results of these and more recent studies are summarized by D. L. Carter and J. A. Bondurant in an Environmental Protection Agency publication, "Control of Sediments, Nutrients, and Adsorbed Biocides in Surface Irrigation Return Flows." Copies of this publication may be obtained from the authors located at the Snake River Conservation Research Center, Kimberly, Idaho or from the EPA National Technical Information Service, Springfield, Virginia. Much of the material discussed here is taken from their report.

Controlling factors

Although some erosion is likely to occur whenever water flows over the soil surface, much can be done to minimize the soil loss.

Furrow stream size: One of the most important factors in controlling erosion is furrow stream size. Stream size is closely related to length of run because the stream must be large enough to reach the end of the furrow. Short

Dual purpose sediment retention and storage pond for a farm reuse system.

lengths of run require small streams which erode less. The length of run can be shortened without using cross ditches by using gated pipe or buried distribution laterals to introduce water into the furrows at several places down the field. A field with such a multi-set irrigation system can be managed as one large field for efficient use of farm tillage equipment. Labor for the larger number of irrigation sets can be minimized by using automation.

Slope: Steep land is difficult to irrigate without erosion. Unless soils are erosion resistant or close growing crops such as pasture and alfalfa are grown, consideration should be given to sprinkle irrigating lands with slopes exceeding 1½% to 2% to control erosion. Slopes can often be reduced by placing furrows across the slope more nearly on the contour.

Runoff: Runoff must be controlled to minimize the amount of soil leaving the field or farm. Applying more water than can be absorbed or infiltrated is wasteful of both water and soil. The smallest stream that will irrigate to the end of the furrow will usually add just about as much water to the soil as a stream many times as large. If more water is needed, either the number of furrows or irrigation duration can be increased. Either method is better than increasing the size of stream. A relatively large initial flow is desirable and can be used to reduce the time required to get water through to the end of the furrow. This large initial flow should not be excessive and should be cut back or reduced soon after the entire furrow is wet.

Irrigation method: Basin and border methods of irrigation usually produce small amounts of runoff and sediment. These methods are normally used on fields that are level or have very small slopes.

Cultural practices: Tillage operations loosen the soil and some erosion is inevitable the first irrigation following tillage on many fields. Soil losses during the first irrigation are reported to be as much as 10 or more times greater than during the second irrigation following cultivation. The number of cultivations needed can be minimized by using chemical weed control and good management practices.

Irrigation frequency: Fewer irrigations result in less total erosion. It is usually better to irrigate thoroughly and less often where possible. Shallow rooted crops will require more frequent irrigations. However, light, frequent irrigations with *small streams* are efficient and can be used without producing excessive erosion. The infiltration rate is less for moist furrows and small streams are needed to reach the end of the furrow. Alternate furrow irrigation can be used with soils having good lateral water movement. Only half as much soil surface is in contact with flowing water as with every furrow irrigation.

Tailwater: Severe erosion at the ends of the furrows can be minimized by keeping the drain ditch at the lower end of the field shallow and on a relatively flat slope so that water does not cut the furrows as it flows into the drain. Otherwise, some fields become convex-shaped at the lower end because of the soil loss over a period of time. The field slope is thus increased and furrow erosion is accelerated.

Removing sediment and associated nutrients and biocides from irrigation runoff.

If possible, it is best to irrigate without runoff and erosion. However, steps can be taken to clean the water before it leaves the field so that natural or other streams are not degraded by the sediment and associated nutrients and biocides that leave a field or farm.

Sediment retention basins: One of the most effective ways of reducing the sediment concentration in water leaving a farm is to use sediment retention basins. These can be used strictly for sediment retention or combined with a reuse pond when runoff water is reclaimed for further use on the farm These basins can remove 65 to 80 percent of the sediment from the water which flows through them. Carter and Bondurant report that 55% to 65% of the incoming phosphorus is retained in a basin that removes 65% to 75% of the incoming sediment.

Mini-basins: A similar method of cleaning the runoff utilizes mini-basins. These are formed by constructing dikes in a ditch at the lower end of the furrows. Irrigation tailwater from a small number of furrows flows into each basin and through a grass buffer strip on the lower side of the basin where it is collected by a drainage ditch.

Filters: Grass buffer strips can also be used by themselves to filter sediment from the water as it leaves the lower end of the field. Another technique for cleaning tailwater is to use the water to irrigate alfalfa, pasture, or other close growing crops which filter sediment from the water before it enters natural streams.

In summary, sediments and associated nutrients and biocides in irrigation surface return flows can be controlled by: (1) reducing or eliminating surface runoff, (2) reducing or eliminating soil erosion so that surface runoff contains little or no sediment, and (3) remove sediments and associated nutrients and biocides from irrigation return flows.