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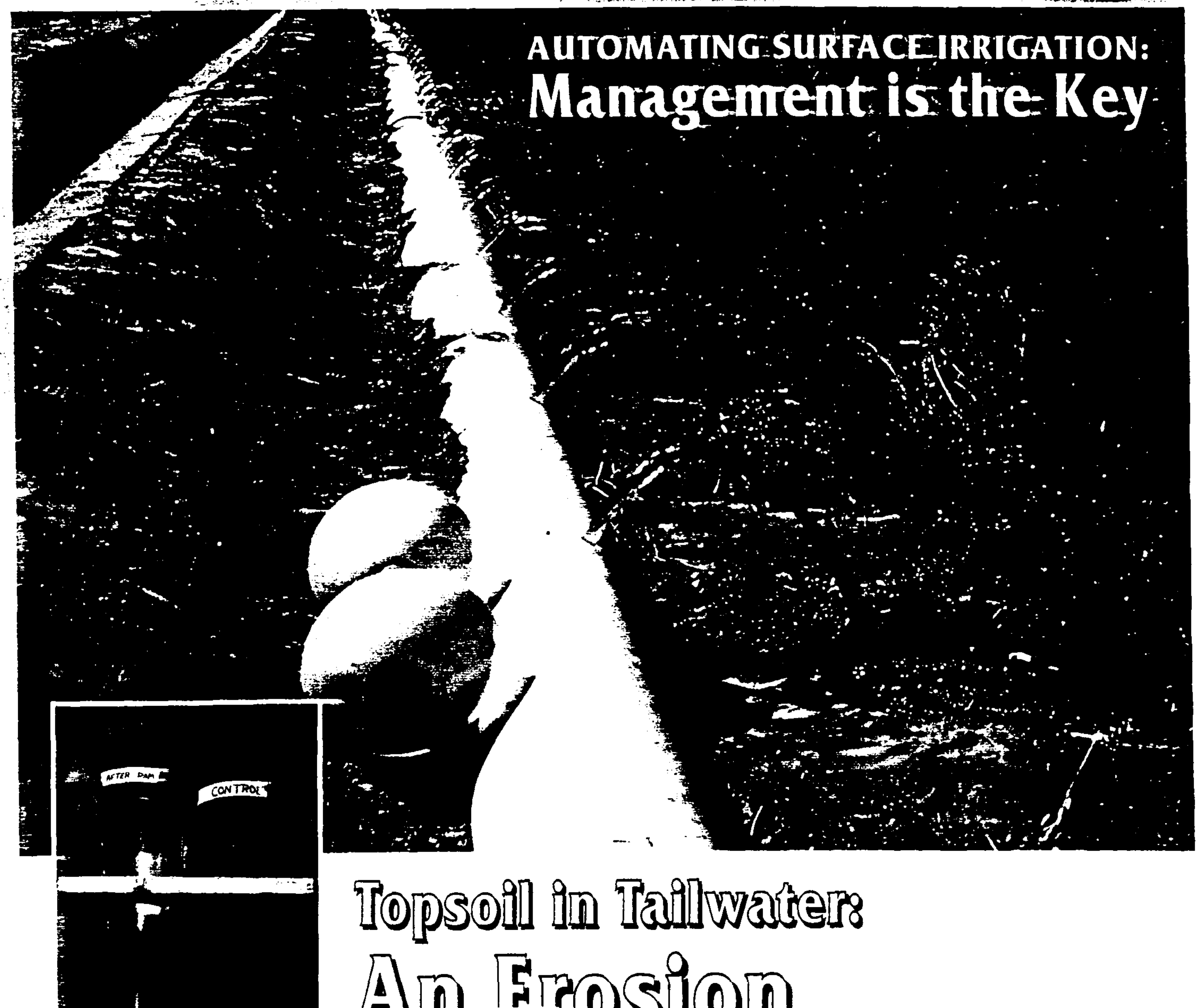

AUTOMATING SURFACE IRRIGATION:
Management is the Key

Topsoil in Tailwater:
An Erosion
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Irrigation-Induced Soil Erosion Reduces Yields and Muddies Rivers

An aerial view of several Magic Valley fields shows white areas where the topsoil has eroded away. The upper 1/3 of fields have little topsoil remaining after 80 years of furrow irrigation. Photos courtesy: USDA-ARS Soil and Water Management Research Unit, Kimberly, ID.

By Tom Trout, Dave Carter and Bob Sojka

The Snake River plain in southern Idaho was a desert until ambitious and far-sighted men built dams and canals early in this century. The result was green oases with names like Magic Valley and Treasure Valley, and world famous Idaho Potatoes. Nearly four million acres are now irrigated in southern Idaho producing a wide variety of crops.

But, all is not well in these productive oases. We're losing our most basic resource—the soil. Over the years, farmers became accustomed to seeing soil wash down their furrows and away through the tail ditches. They have come to consider gradual but continual loss of their rich soil a normal part of irrigating. But after 80 years of washing away 1/8 inch of soil each year from the top ends of their fields, the topsoil is nearly gone.

A flight over the Magic Valley in the spring clearly shows white areas in most fields where the topsoil has been washed away, exposing the white, and much less productive, subsoil. Recent research in the Magic Valley has shown that each inch of rich topsoil that is lost reduces crop yields between 3 and 6 percent, depending on the crop. We estimate that overall yield potential in the area has decreased 25 percent as a result of 80 years of irrigation-induced erosion, and the process is continuing. So far, the only way we found to rebuild the soil to its original production potential is to replace the topsoil.

Six years of drought in the late '80s and early '90s dramatically showed another effect of erosion. The Snake River is nearly filled with sediment in some places, and the nutrients that wash off of fields with the soil are causing lush weed growth in the river. Boating is now difficult in some sections of the river because the propellers continually foul with weeds.

Irrigation-induced erosion is not unique to southern Idaho. The Columbia Basin in eastern Washington has similar silt loam soils and similar erosion rates, and sediment-choked rivers. However, because irrigation there started 40 years later, serious yield decreases are not as evident - yet!

High erosion rates from irrigation furrows have also been measured in Wyoming, Utah, and parts of California, but the real extent of the problem is not really known. A survey now being conducted by the USDA-Soil Conservation Service is aimed at determining the extent and seriousness of the problem throughout the western U.S. A computer model, the Water Erosion Prediction Project, or WEPP, is being developed by the USDA-ARS to predict where and when serious erosion is likely to occur.

Erosion from Irrigation

Soil erodes when water running across the surface breaks down aggregates and carries away small soil particles. Although erosion in hilly, high-rainfall areas has long been recognized, it is generally assumed that "controlled" irrigation water would not cause an erosion problem. But, controlled flows running down closely-spaced irrigation furrows for many hours each summer can result in high soil loss. In southern Idaho, eastern Washington, and two areas in Wyoming, 20 tons per acre (about 1/8 inch of soil) per year are commonly eroded from furrow-irrigated row crop fields with slopes greater than one percent.

Erosion increases with the velocity or "shear" force of the flowing water. Thus, erosion is highest at the head end of furrows where the flow rate is highest, and on steep slopes. Our ability to determine why some soils are more erodible than others is still quite limited, but soils with high silt content tend to erode the easiest. Tillage also increases soil erodibility by breaking apart aggregates.

Erosion can also occur under sprinkler irrigation if the application rate is high and water runs off. This usually happens only under the outer spans of center pivots. Under sprinklers, soil usually erodes from steep slopes and deposits at the bottom of the slope. The best way to combat sprinkler erosion is to prevent runoff by reducing application rates or increasing soil infiltration. Center pivot application rates can be reduced by using large-pattern sprinkler heads or booms to spread out the heads. Reduced tillage and surface residues increase infiltration and protect soil from erosive water flow. Reservoir tillage and deep tillage can also reduce runoff. Reduced runoff from sprinklers also improves irrigation water distribution uniformity and crop yields.

How to Reduce Furrow Erosion

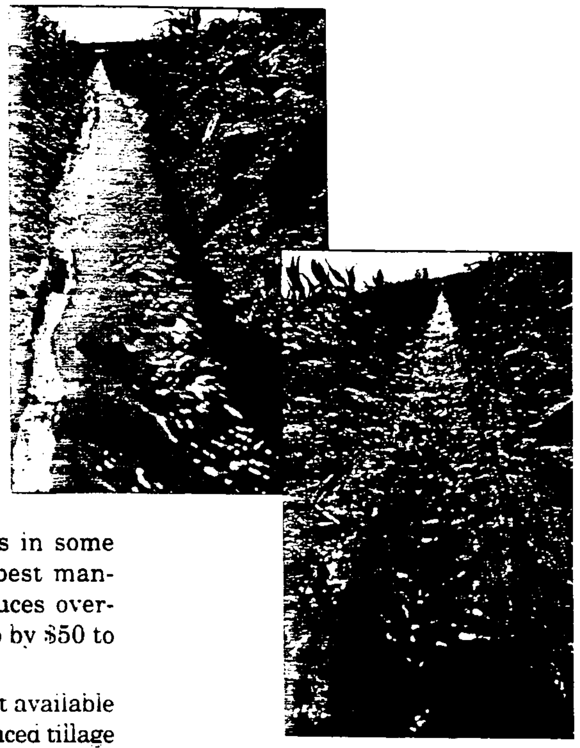
Reducing flow rates or furrow slopes decreases furrow erosion. Carefully setting flow rates to match infiltration and cutting back inflows to minimize runoff are both good irrigation management options that reduce erosion. Shortening furrow lengths by re-organizing fields or with mid-field gated pipe, reduces the required flow rates and reduces erosion at the head end. Furrow slope can sometimes be reduced by land leveling or angling furrows across the predominate field slope. Furrows with cross slopes steeper than the furrow slopes must be managed carefully to prevent water from cutting across furrows.

Reduced tillage decreases furrow erosion. Untilled soil is less erodible than tilled soil, and surface residues slow the water flow and protect the soil from the shear of the flowing water. Many furrow irrigators believe that a clean, uniform furrow is necessary for effective irrigation. But, our research has shown that good furrow irrigation is possible with reduced tillage and even no-till, especially on moderate and steep slopes where erosion is a problem. We have raised no-till corn following alfalfa and wheat, and no-till cereal following alfalfa and corn with no reduction in yield, no increase in water use, and virtually no erosion. Reduced tillage actually resulted in faster furrow stream advance during the first irrigation because tillage increases initial soil infiltration rates. Reduced tillage does require changes in some farming practices such as pest management, but generally reduces overall cost of producing the crop by $50 to $100 per acre.

When surface residue is not available from the previous crop, or reduced tillage is not an option, surface residue can be added to the furrows. Furrow mulching can be targeted to problem areas such as steep furrow sections. Recent research has shown that cheese whey, a byproduct of cheesemaking, sprayed on mulched furrows helps hold both the straw and soil in place, and essentially eliminates erosion, even on steep slopes. Cultivation removes most straw from the furrow, so mulching must be applied, or re-applied, after the last cultivation.

Polyacrylamide, often called PAM, is a material that can stabilize soil and flocculate sediment. It is presently used in the food-processing and wastewater-treatment industries as a flocculent. When some types of PAM are mixed with the irrigation water at very low concentrations (about 1 lb/acre per irrigation), furrow erosion can be nearly eliminated. We are carrying out studies to determine the best PAM formulations and techniques to most economically apply the material. Manufacturers are pursuing registration for PAM use as a soil additive. Polyacrylamide is expected to be a simple and inexpensive method to reduce furrow erosion.

Furrow erosion control not only preserves soil productivity, it also gives the immediate benefit of better crop yields. Erosion and sediment deposition in furrows cause changes in water infiltration and result in uneven water distribution along furrows. Uneven water distribution causes uneven crop yields.



One pound of PAM reduced sediment the furrow tailwater by more than 95 p cent. An untreated furrow (above left) w sediment-laden water compares to the f row (above right) with PAM in the wa and no visible erosion.

Other Control Measures

When, for some reason, it is not p sible to adequately stop erosion on t fields, various types of sediment traps c be constructed to at least keep the er ed sediment on the farm. Vegetat filter strips of small grains or grasses the tail ends of fields slow the runoff a trap part of the sediment. Mini-bas (I slots, T slots, or buried tailwater s tems) in the field tail-ditches can a retain a portion of the sediment. Th techniques are especially useful if the t ditch or tail end of the field has been er ed, resulting in a steep section at the e of the field called a "convex end."

Large sediment ponds construc in drainage ditches also slow the flow a give sediment time to settle. Sedim ponds must be large enough to hold t flow for at least two hours to remove t sediment. Sediment must be remov from the ponds regularly for the por to remain effective. The sediment sho be hauled back to the upper end of t fields from where it was eroded.

A sediment pond coupled with a t water reuse system can eliminate b runoff and sediment loss from the fa With proper design, the tailwater pu can even be used to pump much of t

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Erosion

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sediment, along with the water, back onto the fields, reducing the need for mechanical pond cleaning. Containing irrigation runoff on the farm with tailwater re-use not only saves water, but also means downstream water users, including irrigators, do not have to deal with a farmer's sediment, weed seeds, plant residues, and any ag chemicals, nutrients, or plant diseases that may escape with sediment.

Erosion Control — Voluntary Practices or Regulation?

Although irrigation-induced erosion is not as wide-spread as erosion from wind or rainfall, it is serious in some areas. It is the direct result of farming activities and can be controlled. Erosion control pays in better short-term yields and sustained long-term productivity. If farmers don't control erosion for their own benefit, they will likely be forced to control erosion by downstream water users and environmental interests. Regulated changes are nearly always more expensive than voluntary improvements. No one should be more interested in maintaining good, productive agricultural soils and clean water supplies than irrigation farmers who depend on these two basic resources! ❑

For More Information—	See or Contact:
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Straw mulching machine	Hobson Manufacturing Inc., 3720 Clark Blvd., Ontario, OR 97914 (503-889-5019) Bob Oxnam, Morgan Manufacturing, 525 Morgan Ave., Ontario, OR 97914 (503-889-3950).
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Editor's note: Tom Trout, Dave Carter and Bob Sojka are agriculutural engineers and soil scientists with the USDA - Agricultural Research Service in Kimberly, ID.