Erosion Control Progress in the HUA

L. R. Huter, R. L. Mahler, L. E. Brooks and B.A. Lolley

The Idaho Snake-Payette Rivers Hydrologic Unit Water Quality Project (HUA) was one of 74 projects funded nationally by United States Department of Agriculture (U.S.D.A.) designed to improve water quality. The purpose of these 8-year, federally funded projects was to accelerate the transfer of technology necessary to protect ground and surface water quality while maintaining farm profitability. This project had three phases: (1) the determination of surface and groundwater problems in the study area; (2) the development of best management practices (BMPs) to deal with observed problems; and (3) the implementation of developed BMPs on farms in the study area to improve surface and groundwater quality. ***BMPs are management strategies that protect water quality without adversely impacting the profitability of farms.*** Three USDA agencies provided leadership for this project: the Natural Resource Conservation Service (NRCS; formerly the Soil Conservation Service), the University of Idaho Extension System (ES), and Farm Services Agency (FSA; formerly the ASCS).

The Idaho Snake-Payette Rivers Hydrologic Unit Area (HUA) Water Quality Project comprised more than 840,000 acres in Canyon, Gem, Payette, and Washington counties in southwestern Idaho (Figure 1). Within this geographic area are more than 3,400 farms covering more than 500,000 acres. Virtually all of the highly productive farmland within the project area is irrigated. The type of agriculture practiced is diverse, as more than 40 different crops are grown. The largest acreages include: alfalfa (76,000 acres), wheat (52,400 acres), sugarbeets (39,100 acres), barley (25,100 acres), corn (20,800 acres), beans (12,100 acres), orchards (12,090 acres), peppermint (11,000 acres), oats (9,800 acres), seed crops (8,800 acres), onions (7,700 acres), potatoes (5,000 acres), hops (2,600 acres), and spearmint (2,000 acres).

A competitive USDA grant awarded to the NRCS, FSA, and University of Idaho Cooperative Extension System allowed the HUA project to hire staff located in a centrally located office in Payette, Idaho. NRCS personnel provided the technical assistance necessary for BMP implementation. The FSA provided the cost-share assistance for BMP implementation while the University of Idaho Cooperative Extension System provided educational and technical BMP information to individual growers.

This geographic area was chosen for federal funding because there was a concern that agrichemicals (nutrients and pesticides) are a threat to groundwater quality and that agriculture runoff has an adverse impact on surface water quality. Both federal and state agencies have accumulated data that show sediments and agrichemicals have a negative impact on the surface waters (rivers) in the HUA.

A major way of improving surface water quality within the HUA used in

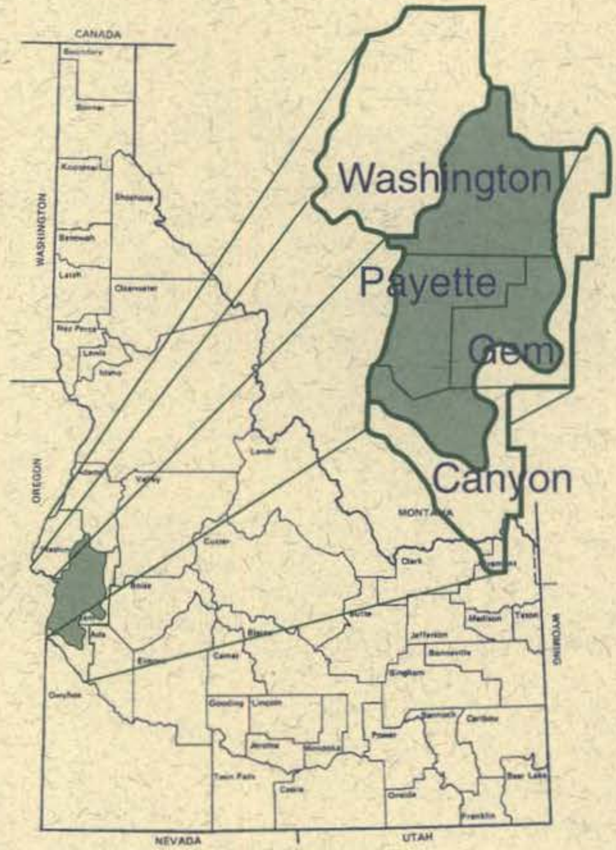

Figure 1. Map of the Snake-Payette Rivers HUA Water Quality Project encompassing Canyon, Gem, Payette, and Washington counties in southwestern Idaho.

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this 8-year project was improved erosion control methods. Erosion control would keep sediments, applied fertilizers (nitrogen and phosphorus), and pesticides out of runoff water from farms–thus improving surface water quality. The technologies used to improve erosion control in the Snake-Payette Rivers HUA Water Quality Project are presented in this report.

The primary objective of the surface water quality protection phase of the HUA project was to reduce sediment coming off fields and entering streams. The rivers targeted for water quality improvement were the Boise, Weiser, Payette, and Snake. By introducing and encouraging implementation of BMPs to control erosion, sediment loading would decrease and result in enhanced surface water quality within the HUA project area.

Baseline Erosion and Surface Water Quality Information 1990

Over a 10-year period, scientists at the USDA Agricultural Research Service (ARS) at Kimberly, Idaho, collected soil loss data at more than 200 different sites within Idaho to construct a model for predicting soil erosion rates on surface irrigated croplands. This research resulted in the Surface Irrigation Soils Loss (SISL) model that estimates the amount of sediment that leaves the bottom of a surface irrigated field in tons/acre/year. This model can be applied to fields in the HUA to determine approximate annual erosion losses. Factors used in the SISL model include base soil loss (BSL), adjusted soil erodibility (KA), prior crop (PC), and support practices (CP). A five-year rotation with four crops, (sweet corn, sugarbeets winter wheat, and onions) on a field with a 1 percent slope had an average soil loss of 7.1 tons/acre/year. Sugarbeets had the highest erosion rate at 9.6 tons/acre, while winter wheat the lowest rates at 3.4 tons/acre. When the field slope is 5 percent, the average erosion rate is more than 14 tons/acre/year. Erosion rates under furrow irrigation in the HUA project range from 2 to 91 tons/acre/year depending on the crop grown, soil type and land slope. It is estimated that a sustainable erosion rate for soils in southern Idaho is approximately 5 tons/acre/year.

Based on this sustainable soil loss rate and the erosion data available in 1990, (the initial year of the HUA project) there was a need to establish BMPs to reduce erosion. Depending on the soil and crop grown, erosion rates must be reduced anywhere from less than 1 to 86 tons/acre/year to meet sustainability criteria. Consequently, several programs were established to meet this goal. Programs included BMP practices that use: (1) PAM for erosion control; (2) straw-mulch for erosion control; (3) surge irrigation for erosion control; (4) improved irrigation management; and (5) the conversion of furrow irrigation to surge-systems, sprinklers and/or microsprinkler irrigation systems. This report summarizes the erosion control programs and associated progress attributed to the HUA water quality project.

Erosion Control

PAM for Erosion Control

Use of polyacrylamide, (more commonly known as PAM) is the most recent technology used in the HUA project to reduce erosion by stabilizing soils against water movement. PAM, a long-chained organic polymer synthesized from natural gas, is traditionally used as a settling agent in drinking water, swimming pools, and food processing protocols. Recently,

Table 1. Technologies used by HUA growers to improve erosion control.

BMP	Growers	Acres, farms or feet	Cost-share rate percent*
Straw mulch	5	343.6 acres	50
Surge irrigation	3	130 acres	75
Sediment basin	2	3 farms	65
Underground plastic pipeline	32	338,000 feet	55
Concrete ditch or canal lining	7	17,000 feet	55
Trickle irrigation system	2	2 farms	75
Surface and subsurface irrigation system	25	28 farms	55
Pasture and hayland planting/management	27	1600 acres	75
Cover and green manure crops	2	49 acres	75
Conservation tillage	4	267.8 acres	75/50
Land leveling	16	886 acres	65
Sprinklers	17	24 farms	75

* *Cost share rate percentage paid by the government. The grower paid the remainder of the total cost.Figure 1. Map of the Snake-Payette Rivers HUA Water Quality Project encompassing Canyon, Gem, Payette and Washington counties in southwestern Idaho.*

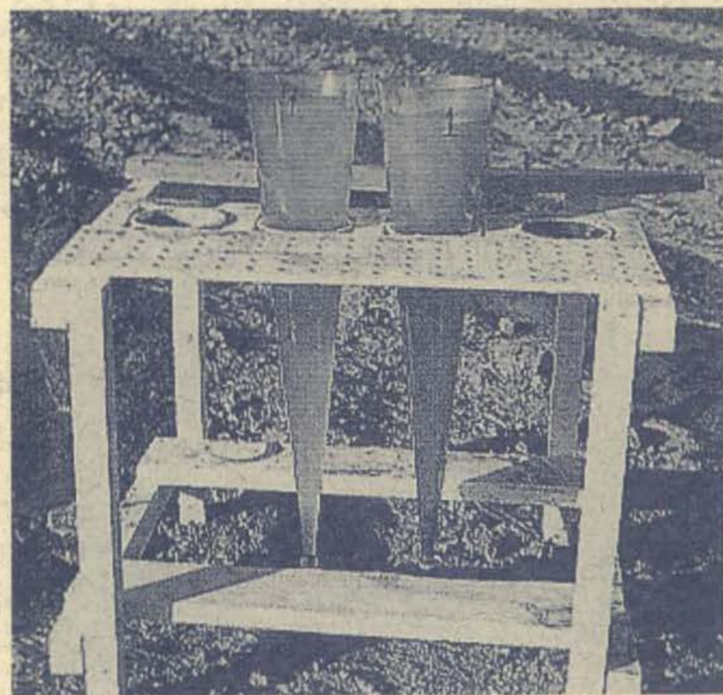

Figure 2. BMP practices such as PAM and straw-mulching resulted in cleaner waste water leaving fields in the HUA. The vial on the left represents water coming off a straw-mulched furrow compared to unprotected soil on the right.

PAM has found its way into modern agricultural systems as an effective soil erosion-control agent.

PAM is applied through irrigation water, most often in furrow (siphon tubes, flood, gated pipe, etc.) irrigation. Once applied in the irrigation water PAM increases soil cohesion and stabilizes soil aggregates. This reduces detachment of soil particles and the subsequent transport of sediment in irrigation runoff water. PAM reduces erosion by acting as a settling agent (flocculent). Fine particles bind together and settle to the bottom of the furrow instead of moving freely in runoff waters. This prevents sediment loss. PAM also helps maintain soil pore structure by preventing the usual reduction in water infiltration rate seen over time in most irrigation systems. Not only is sediment prevented from leaving the field, but pesticides and nutrients attached to soil particles stay in the field.

Erosion control is enhanced and water infiltration increases in soils when 8 to 10 ppm PAM is maintained in the water during the initial advance phase of irrigation. PAM is typically applied at a rate of 1.0 to 1.3 lbs/acre. The optimum concentration of PAM usually varies slightly from field to field depending on soil properties, field conditions, irrigation parameters, and possibly the type of PAM used. PAM does not need to be applied continuously throughout the irrigation set, but only until the water has reached the end of the field. PAM needs to be reapplied periodically during the growing season, particularly after the soil has been disturbed by methods such as cultivation.

PAM is commonly applied in granular form by several methods. One way is through a granular applicator (cost about $1,400 dollars) directly into the irrigation water. Another acceptable method is to apply PAM directly into the furrow after irrigation has begun using a hand-held applicator (cost about $20). Depending on the form of PAM purchased, different application methods may be used in order to optimize dissolution into the irrigation water to ensure that the material works effectively. Four manufacturers of PAM have products currently on the market with prices ranging from $3.25 to $3.50 per pound of material.

Field trials conducted throughout the USA have found that PAM can reduce soil loss by up to 90 percent compared to untreated fields. Use of PAM on even the most erodable fields in southwestern Idaho should reduce erosion rates to sustainable levels. Negative effects of PAM have not been observed, even when applied at excessively high application rates.

PAM was not cost-shared in the HUA; however, several field trials were conducted to evaluate this material and to demonstrate its potential effectiveness. Four field trials with PAM were conducted in the summer of 1994. As grower interest increased, field trials were expanded to twelve sites in 1995 and to eighteen sites in 1996. Many of these field trials were highlighted on several field tours attended by as many as 125 growers. It is estimated that 75 percent of row crop growers in the HUA project area are experimenting with, if not widely using PAM today.

The HUA project staff had several farmers remark that before PAM was demonstrated on their fields they had never seen clear runoff water leaving their farms. PAM is currently making a significant, positive impact on erosion control and consequent surface water quality enhancement in southwestern Idaho.

Use of PAM as a component of irrigation water management was strongly encouraged by the HUA. The NRCS also developed an interim Idaho standard for PAM application as a BMP within the HUA boundaries. PAM has since become a cost-shared BMP in several water quality programs across the state, in part based on the field trials conducted by the HUA.

Straw-Mulching for Erosion Control

Straw-mulching was implemented in the HUA as another tool designed to reduce irrigation-induced erosion. The presence of large-sized organic material such as straw in irrigation furrows slows water velocity and reduces the potential erosive force. Straw-mulching in furrows can reduce sediment loss by up to 80 percent. In addition, a significant crop yield response may also occur. In a grower survey conducted in 1993 more than 60 percent of producers using straw-mulch reported higher yields and more than 50 percent reported improved crop quality. Mulched potatoes, onions, and sugarbeets have shown economic improvements of 7 to 23 percent. Straw not only slows water velocity and erosion but also substantially reduces loss of nitrogen and phosphorus. Other benefits from straw-mulching include enhanced water infiltration in soils and a reduction in the number of irrigations each season. In 1993, as a result of straw mulching, 84 percent of HUA producers using the practice reported a decrease in the number of irrigations required.

For maximum erosion control, straw mulch should be applied to soils before the first irrigation. The N.R.C.S.'s Technical Guide recommends a minimum straw application rate of 1 to 1.75 lbs/100 ft of furrow. Straw-mulch spreaders currently on the market typically apply 2 to 4 pounds of straw/100 feet—equivalent to 525 pounds of straw per acre. Chaff and weed free wheat straw that is 8-10 inches long provides the most effective erosion control. Based on field surveys, straw mulching can cost anywhere from \$35 to \$73 per acre depending on straw application rate. To justify this added expense, a typical grower must realize an average yield increase of 7.5 percent for a high value crop. Benefits from straw-mulching increase as the land slope increases (>2 percent incline).

Straw-mulching was demonstrated on a wide variety of crops in the HUA but is probably best suited for higher value row crops. Five HUA cooperators straw-mulched over 340 acres of cropland. Each cooperator was satisfied with the results and planned to continue this erosion control practice in the future. In 1998 approximately 10 percent of the farmers in the HUA were practicing some form of straw-mulching. Straw-mulching will most likely continue to be a more widely used erosion control technology in southwestern Idaho over the next decade. As with the use of PAM, proper straw-mulching should effectively reduce erosion rates to sustainable levels.

Straw mulch is not typically applied to a field until all cultivations are completed. PAM could be used prior to cultivation completion on unprotected soils. PAM has the potential to be used alone for seasonal erosion control or in combination with straw mulch to provide protection until cultivations cease and mulch can be applied.

Figure 3. A field that has received straw-mulch in the HUA. Straw mulching demonstrations reduced erosion up to 80 percent and resulted in the adoption by growers on at least 10 percent of the farms in the HUA.

Surge Irrigation for Erosion Control

A surge irrigation system is an easily installed and operated water management tool that has the potential to greatly reduce erosion rates in fields currently under furrow irrigation. A surge irrigation system consists of a solar powered surge valve designed to alternately switch water delivery back and forth between two sets of furrows during several timed intervals until the irrigation is complete. Water is first applied quickly with a uniform shallow application, then applied in shorter cycles to prevent runoff while allowing sufficient time for lateral movement (toward the hills) into soils. Using this method, soil clods partially dissolve and form a silty, slick seal that reduces in-furrow infiltration (decreases in-furrow-leaching potential). Surging can greatly reduce or even eliminate tailwater. This significantly reduces erosion and sediment delivery to surface waters.

In addition to erosion control, surge irrigation has other advantages. The time required for irrigation can be cut in half because surge can irrigate two sets simultaneously instead of watering one set with conventional furrow irrigation. Surge can irrigate much faster because of the silty, slick seal that prevents over

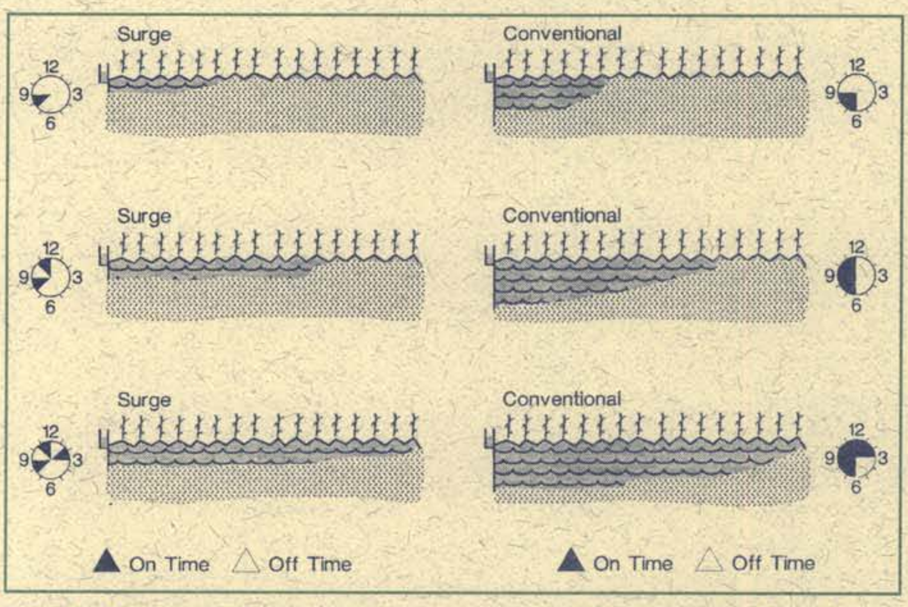

Figure 4. Comparison of surge irrigation with conventional furrow irrigation. Note that water runs only half the time in a surge system. Surge system benefits include lower water useage, more even water distribution, and a lower leaching potential at the top of the field.

infiltration at the top of the field. This water is used more efficiently on the lower portions of the field.

A large surge irrigation system was installed on a HUA cooperator's farm in 1994. Three surge valves on loan to the HUA project were also installed on cooperator fields to demonstrate both erosion control and water saving benefits. About 130 acres were converted to surge irrigation that was cost shared at a rate of 75 percent (up to $17,500 per grower).

Growers were initially skeptical about surge technology, but their perceptions changed with the results. Surge irrigation reduced erosion and water runoff, but also decreased water usage by up to 70 percent, reduced electricity costs, and required less labor. One grower said he liked surge because "...you use less water (70 percent less) and you reduce erosion in the furrows." Growers using cost-share money to install surge irrigation indicated they would use surge irrigation on other fields on their farms in the future without cost-share money. Several growers who did not have surge installations, but had seen them through HUA demonstrations, were also planning future installations without cost-shares. This is now happening on some HUA farms. Over time conversion of traditional furrow systems to surge systems will have a positive impact on surface water quality in southwestern Idaho. As with PAM and straw mulching, the conversion of traditional furrow irrigation to surge systems can reduce erosion rates to sustainable levels.

Conversion of Furrow to Sprinkler Irrigation

A common way to reduce irrigation-induced erosion is to convert furrow irrigation systems to sprinklers. NRCS data shows that this conversion will often reduce erosion rates to 0 tons of soil/acre/year. This conversion is a difficult task in the HUA project area as conversion to sprinklers in southwestern Idaho lags behind other irrigated areas of the state. Most HUA fields average 25 acres in size and are often oddly shaped causing logistical problems in changing irrigation methods. Other problems include an inexpensive, plentiful supply of water available to most growers and potential plant disease problems associated with overhead sprinkler systems in some crops. Cost and operating expenses of shifting to sprinkler irrigation is also often uneconomical in this era of narrow farm profits. However, many farmers recognize the benefits of converting and are attempting to do so over time.

Black Canyon District is the most viable area in the HUA project to convert from furrow to sprinklers. The Black Canyon area has the highest risk of suffering from a water shortage in years with low mountain snowpacks. This situation encourages growers to look for and adopt water saving irrigation techniques. Sixteen HUA project cooperators converted to sprinkler irrigation systems. A majority of these conversions occurred in orchards. Growers found that water did not run off their fields, thus reducing erosion and water use considerably when compared to furrow irrigation in other orchards.

Other Cost-Share Practices Used to Reduce Erosion

One of the most effective ways of reducing soil erosion was through cost-share incentives. Cost-sharing is a program where both the government and producer share in the cost of implementation of BMPs. The program improves water quality through enhanced erosion control. Many practices in addition to conversion to sprinklers and straw-mulching were cost-shared in the HUA to help reduce irrigation-induced erosion. Most were not new technologies, but rather time-tested techniques that have been used effectively for years. These practices included:

Land leveling—reshaping the surface of irrigated land to planed grades which reduces erosion; cost-shared with sixteen growers on more than 880 acres.

Conservation tillage—leaving at least 30 percent of the previous crop residue on the soil surface; cost-shared with three growers on 270 acres.

Cover and green manure crops—establishing close-growing grasses, legumes, or small grains for seasonal erosion protection; cost-shared with two growers on 49 acres.

Pasture and hayland planting—establishing long-term stands of self-reseeding forage plants for erosion control; cost-shared with twelve growers on 660 acres.

Surface and subsurface irrigation system—installing water control structures necessary to surface apply water; cost-shared with twenty-five growers on twenty-eight farms.

Trickle irrigation system—purchasing and installing equipment to efficiently apply water at low pressure on or below the soil surface; cost-shared with two growers on two farms.

Concrete ditch or canal lining—installing an impervious lining to prevent waterlogging of land, leaching, and erosion; cost-shared with seven growers for a total of 17,000 feet.

Underground plastic pipeline (as opposed to an open ditch)—prevents surface erosion; cost-shared with thirty-two growers and more than 300,000 feet.

Sediment basin—installing a basin to trap sediment-laden runoff water; cost-shared with two growers on three farms.

All practices listed were subsidized through cost share programs. Cost-share rates for each practice are shown in Table 1. More than $900,000 in federal funding was distributed by F.S.A. (formerly the A.S.C.S.) as cost-share monies for HUA contracts to implement these erosion control practices. Actual cost-share rates differed based on their effectiveness for improving water quality.

Education

In addition to cost-share programs for implementation, education programs were emphasized to increase adoption of water quality BMPs within the HUA. Meetings, tours, publications, and exhibits at fairs and trade shows were widely used to accomplish the information delivery. During the 8-year duration of the HUA project, more than 200 meetings were conducted by the HUA project staff. These ranged from organizational steering committee meetings to initially organize the HUA goals and logistics, to field tours and local workshops.

Field demonstrations were the most popular hands-on activity for growers in the HUA. Eighteen field tours were conducted during the 8-year period. Tours exhibiting new erosion control BMPs such as PAM, straw mulching, and surge irrigation visited more than 150 fields in the HUA project area. Field tour participation ranged from 12 to 125 people during the HUA project's tenure.

Many HUA growers were most satisfied with the one-on-one educational experiences they received from the HUA project staff. With a USDA grant, both the NRCS and University of Idaho Cooperative Extension System hired staff specifically assigned to the HUA project. NRCS personnel provided the technical assistance necessary for BMP implementation. The FSA provided the cost-share assistance for BMPs, while the University of Idaho Cooperative Extension System provided both educational and technical BMP information to individual growers.

Publications were also an important method for distributing water management information not only to the fifty-two HUA cooperators but also to all the HUA growers (>3,000) as well. The HUA project office issued a quarterly newsletter called *The Farm Planner* with information about water quality BMPs. Circulation of this newsletter exceeded 2,500 per issue. Approximately fifty articles about the HUA and its progress were published in newspapers and magazines that included the *Argus Observer, Capital Press, Independent Enterprise, Idaho Farmer-Stockman,* and *Signal American.*

Erosion Control = Water Quality

The link between erosion control and surface water quality (rivers and lakes) is clear. Data compiled by Idaho's Division of Environmental Quality (DEQ) suggests that more than 900 stream and river segments in the state (8 percent of all segments) do not meet beneficial use water quality standards. In more than 85 percent of these stream segments sediments are the major pollutants. Implementing erosion control BMPs on agricultural, forest, range, and urban lands within the state would result in a significant cleanup of Idaho's rivers. Consequently, erosion control can be equated to improved surface water quality.

SUMMARY

The Idaho Snake-Payette Rivers HUA water quality project successfully accelerated the transfer to local growers of erosion control technologies that were necessary to prevent erosion. Highlights of the projects' accomplishments include:

- Erosion control benefits of PAM were widely demonstrated as erosion rates were reduced by up to 90 percent. Adoption of PAM increased from nearly zero in 1990 to approximately 75 percent of the row crop growers in 1998.
- Straw mulching demonstrations reduced erosion by up to 80 percent and resulted in the adoption by growers on at least 10 percent of the farms in the HUA.
- Demonstrations showed that surge irrigation reduced water use, labor costs and erosion rates. Interest in surge irrigation has increased to the point that a significant number of irrigators installed this BMP over the past five years.
- Conversion from furrow to sprinkler irrigation can virtually reduce erosion to zero. Sixteen HUA cooperators used cost-share monies to install sprinklers.
- Cost-shared erosion control BMP practices installed in the HUA include conservation tillage, planting cover crops, pasture planting, trickle irrigation systems, lining ditches and canals, constructing sediment basins, and land leveling
- More than $900,000 in cost-share money was distributed to fifty-two growers in the HUA for BMP installation.
- Field tours, publications and meetings were educational tools that reached more than 90 percent of the 3,400 farms located in the HUA project area.
- The HUA project accelerated the adoption of technology that improved erosion control and consequently enhanced surface water quality.

About the authors

L.R. Huter is a graduate student in soil science at the University of Idaho.

R.L. Mahler is a professor of soil science in UI's Department of Plant, Soils, and Entomological Sciences, and the Extension Water Quality Coordinator for UI's College of Agriculture.

L.E. Brooks is the Assistant State Conservationist for the USDA Natural Resources Conservation Service in Boise.

B.A. Lolley is a former graduate student in soil science.

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