Irrigation Management in the HUA

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The Idaho Snake-Payette Rivers Hydrologic Unit Area (HUA) Water Quality Project was one of 74 projects funded nationally by the United States Department of Agriculture (USDA) 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 quality problems in the study area; (2) the development of best management practices (BMPs) to solve identified problems; and (3) the implementation of state-of-the-art 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 (HUA) Water Quality Project includes 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 is irrigated and the type of agriculture practiced is diverse, as more than 40 different crops are grown. The largest acreage crops 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 Extension System allowed the HUA project to hire staff in a centrally located office. 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 Extension System provided educational and technical BMP information to individual growers. This geographic area was chosen for federal funding because of the serious concern that agrichemicals (nutrients and pesticides) are a threat to groundwater quality and that sediments, nutrients, and pesticides have adversely impacted surface water quality. The Idaho Division of Environmental Quality (DEQ) identified the Payette and Boise river aquifers (both found in the HUA) in southwestern Idaho as particularly vulnerable aquifers because of associated human activities. Both federal and state agencies have accumulated data that indicate

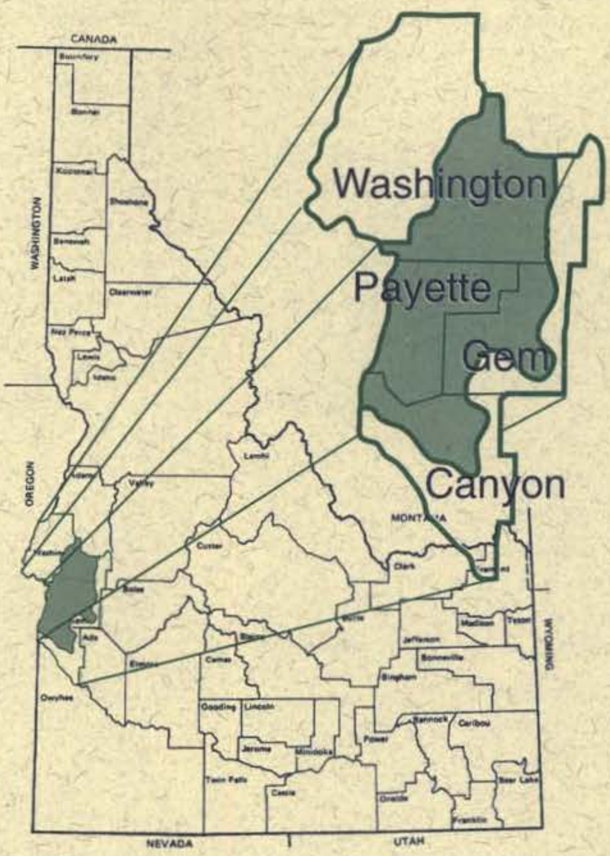


Figure 1. Map of the Snake-Payette Rivers HUA Water Quality Project encompassing Canyon, Gem, Payette and Washington counties in southwestern Idaho.

sediments, nutrients, and pesticides have had a negative impact on the surface waters (rivers) in the HUA during the last 50 years.

Water Management-Link to Agrichemical Management.

Water management, pesticide management, and nutrient management must be linked together to provide effective surface and groundwater quality protection. Overwatering can negate proper nitrogen management. Likewise, judicious pesticide use is ineffective if excess irrigation results in leaching and eventual groundwater contamination. In the past, water, nutrient, and pesticide management were often treated as independent practices. However, recent data has shown that the three must be linked. For instance, a recent study conducted by the Idaho Department of Agriculture found that excessive water use was the major cause of groundwater contamination rather than improper chemical application rates. Extended durations of irrigation sets are common with furrow irrigation, and often result in excessive water percolation below the soil's crop root zone. Such percolation may cause agrichemicals to move beyond the root zone and eventually contaminate the groundwater; thus, chemical management and water management must be linked. Without sound irrigation management, even the most diligent nutrient and pesticide applications can lead to contamination of surface and groundwater supplies. Through educational programs and the use of water management BMPs in the HUA project area, agriculture can lead the way to enhanced surface and groundwater quality for residents who depend on groundwater for drinking and surface water sources for their livelihood and quality of life. Rivers and streams will see the benefits of enhanced irrigation management by reduced sediment and nutrient loading.

Improvements in irrigation management were expected to have the greatest impact on surface and groundwater quality within the HUA during this 8-year project. Improved irrigation management results in less leaching of applied fertilizers (nitrogen) and pesticides – thus improving groundwater quality. In addition, improved irrigation management reduces runoff and sediment transport consequently improving surface water quality. The BMPs used in the Snake-Payette Rivers HUA Water Quality Project are presented in this report.

Conditions Prior to the HUA Project

Data collected from southern Idaho in the 1980's and early 1990's indicated irrigation water use efficiency (both deliveries to the field and subsequent crop use) was poor. Researchers at the USDA-ARS (Agricultural Research Service) found by evaluating the network of water supply canals and ditches that deliver water to fields that high seepage losses are common. About 82 percent of the water diverted for agricultural use is lost by poor conveyance, deep percolation, surface runoff, or evaporation. Specific losses include:

1. Conveyance/Regulation losses—45 percent: this is water that leaches through the delivery system canals. These losses are not necessarily wasteful because leaching contributes to groundwater recharge. Lining canals and ditchbanks can increase efficiency.

2. Deep Percolation losses—22 percent: water percolates below the root zones, possibly carrying pesticides and/or nitrates. Between 5 and 8 percent of the wells in the HUA project area exceed EPA's drinking water standard of 10 ppm NO3 –N (compared to the national average of only 2.4 percent). This potential groundwater contamination can be reduced by use of surge, sprinkler, or drip irrigation.

3. Surface Runoff losses—15 percent (up to as high as 40 percent): this is excess water that runs through the furrows

Table 1. The total water applied, crop consumptive water use, and excess water applied for crops commonly grown in the Snake-Payette Rivers HUA Water Quality Project based on a 1991 grower survey.

Crop	Total water applied	Consumptive water use	Excess water
	(inches/acre)		
Alfalfa-hay	40	32.3	7.7
Alfalfa-seed	19	16.4	2.6
Bean-dry	39	18.3	20.7
Corn-field	47	27.5	19.5
Corn-sweet	46	17.9	28.1
Hops	40	19.2	20.8
Mint	52	26.1	25.9
Onions	50	19.6	30.4
Orchards	48	33.3	14.7
Potatoes	49	24.4	24.6
Small grains	39	16.0	23.0
Sugar Beets	56	29.8	26.2

often returning sediments, nutrients, and pesticides back to drainage ditches, local streams, and rivers. These losses can be reduced by land-leveling for more efficient surface irrigation, straw mulching, surge, sprinkler or drip irrigation, and tailwater recovery systems.

4. Evaporation losses—3 percent: these losses are small and primarily confined to sprinkler irrigation.

Because 82 percent of the diverted water is lost, a relatively small percentage of water diverted actually ends up being available for uptake by the plants.

A survey of growers in the HUA project area was conducted in 1991 to: (1) determine the number and duration of irrigations, and the total quantity of irrigation water applied to economically important crops; (2) determine the primary methods used to schedule water application; (3) involve industry and agency personnel who commonly make management decisions with or for growers in the HUA project process; and (4) collect water-use data that would help prioritize HUA programming efforts over the remaining years of the project.

The most significant findings of this survey were:

- Virtually all the land in the HUA is irrigated by either furrow (80 percent) or sprinkler irrigation. Drip and micro irrigation methods are practiced on less than 1 percent of the HUA acreage.

- Depending on the crop, farmers irrigated between 3 and 14 times a growing season (Figure 2).

- More than 900,000 acre-feet of water are annually applied to crops in the HUA. More than 50 percent of the water applied to the 12 major crops is applied to alfalfa and small grains (Figure 3).

- The primary method for determining irrigation scheduling is experience. Only 17 percent of the growers rely on modern methods of soil moisture monitoring for irrigation scheduling.

- The average amount of water applied significantly exceeds consumptive use for each of the 12 crops surveyed (Table 1). Actual water applications range from 19 to 56 acre-inches depending on the crop (Table 1) and irrigation systems used while the actual consumptive use ranges from 16 to 33 acre-inches (Table 1). Based on water use, onions have the poorest water use efficiency. An average of more than 30 inches of excess water is applied. (Table 1).

Figure 2. Average number of irrigations applied to 12 commonly grown crops in the Snake-Payette Rivers HUA Water Quality Project in Idaho based on a grower survey conducted in 1991.

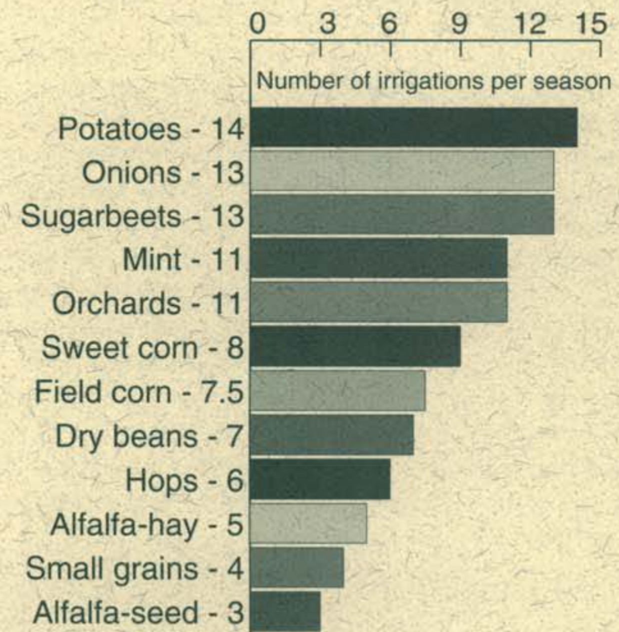
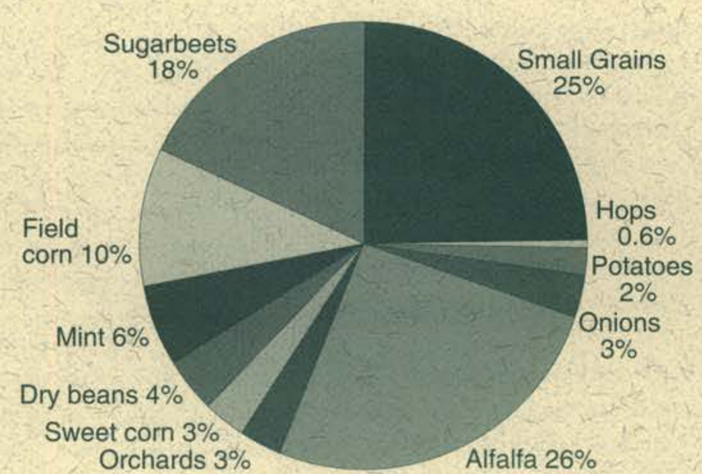


Figure 3. Distribution of water use of the 12 major crops grown in the Snake-Payette Rivers HUA water Quality Project in Idaho.



Improving Water Management

Based on survey results during the initial year of the HUA project, it was apparent irrigation water management could be greatly improved. With improved water management practices, it was expected that surface and groundwater quality would improve in the HUA. Consequently, several programs were established to meet this goal. These programs included: (1) development of a mobile laboratory equipped with modern technology to improve irrigation scheduling; (2) use of field-placed sensors to monitor soil moisture; (3) use of cost-share programs to improve water management; (4) the installation of more efficient irrigation systems and technologies; and (5) tours were organized to demonstrate the newest water management technology available

Mobile Lab for Water Management

The Irrigation Water Management (IWM) team was established in 1994 to assist growers in the HUA project to use their water resources more efficiently, and to evaluate existing conditions and the effectiveness of improvements to their irrigation systems. More than 90 percent of the HUA grower-cooperators received assistance from the IWM team. The IWM team was able to help install soil moisture monitoring devices, measure the amount of sediment leaving the field, evaluate the effectiveness of straw mulching, and help improve current irrigation practices within the HUA.

A key component of the IWM team was the mobile irrigation laboratory equipped with instruments used to improve water management technology on local farms. The mobile lab was capable of measuring water flow rate, linear distance of furrow runs, topographic variability, and soil moisture levels and contained a computer software system that enabled rapid data processing. The IWM mobile unit was staffed with a full-time engineering technician and part-time soil conservation aid. This staff provided grower education and training that resulted in improved evaluations of the performance of individual irrigation systems. Training focused on flow rate, irrigation set area, soil moisture measurement, and the relationships between the three factors. These IWM team services were available free of charge to all growers in the HUA. More than 90 percent of the 52 growers with HUA cost-share contracts used the IWM team's services.

In March 1998, the Payette Soil and Water Conservation District, in cooperation with HUA's Mobile Irrigation Lab, conducted an irrigation water management workshop specifically for Spanish-speaking irrigators. The workshop and materials were presented entirely in Spanish and each participant was provided with a 36-page irrigation guide (Guia Para Administracion de Agua de Reigo). This workshop allowed the project to bridge what can sometimes be a large gap caused by the language barrier between HUA project cooperators and their Spanish speaking irrigators. This is an example of how the HUA has allowed agencies to take a new and more focused approach toward improving irrigation management and water quality in southwestern Idaho.

Watermark Sensors

The HUA survey of water use indicated that less than 17 percent of growers in the HUA project area used soil moisture monitoring devices to determine when to irrigate. When soil moisture monitoring devices are used in conjunction with evapotranspiration data, site-specific crop water use can be adjusted to optimize application efficiency that prevents overwatering. With soil moisture monitoring devices, project staff were able to document the benefits of BMP practices and use the monitoring devices as an educational tool.

As a demonstration, 72 granular matrix sensors (GMS) made by Watermark were purchased and installed in onion, potato, and corn fields in 1992 to determine proper sensor placement and how sensing equipment could be best used to improve water management with minimal risk to the grower. Field trial locations were popular stops for several summer tours and the demonstration plots generated data for grower presentations during the non-cropping season. In 1995, four small grants were awarded to HUA growers for the purchase and installation of additional Watermark sensors. Two of the grants were for apple orchards and alfalfa. The other two grants were awarded to Soil and Water Conservation Districts (SWCD) in the Squaw Creek drainage and Gem County. In addition to these grants, almost one hundred tensiometers (soil moisture measuring devices) were donated to the HUA project by industry to help assist with water management. Sensing equipment was installed in a total of 17 fields during the growing season each for a 30-day period. Data were collected and compiled from these sites. This information was used to modify grower irrigation scheduling to optimize efficiency. In part because of the demonstrations, use of soil moisture monitoring devices has been more widely accepted by growers in the HUA project. This educational process, initiated through the HUA project, is still on-going.

Table 2. Best management practices (BMPs) designed to improve water management and protect water quality which were eligible for cost-sharing in the Idaho Snake-Payette Rivers HUA Water Quality Project.

Cost-share practice	Cost-share Rate*
- conversion of surface irrigation to sprinklers	75 percent
- surge irrigation	75 percent
- irrigation management	75 percent
- irrigation land leveling	65 percent
- water control structures	65 percent
- surface irrigation systems	55 percent
- concrete ditch and canal lining	55 percent
- pipelines to improve irrigation systems	55 percent
- gated pipe	55 percent
- installation of irrigation wells	0 percent

* *Cost share rate percentage paid by the government. The remainder of the total cost was paid by the grower.*

Table 3. Technologies used by HUA growers to improve irrigation management efficiency.

Type of practice	Description	Number of implementers
Structure	Nonreinforced concrete ditch or canal lining	7
Structure	High and low pressure underground plastic pipeline	33
Structure	Steel pipeline	1
Structure	Rigid gated pipe	13
Structure	Structure for water control	17
Structure	Trickle irrigation system	2
Structure	Sprinkler irrigation	23
Structure	Surface and subsurface irrigation systems	28
Management	Irrigation water management (IWM)	50
Management	Land leveling	16

Cost-Sharing

One of the most effective programs to improve water management is the use of cost-share incentives to install efficient, state-of-the-art BMP technology. Cost-sharing is a program where both the government and grower share the total cost of implementation of practices (BMPs) that improve water quality through efficient water management. Both structural installations and management practices were cost-shared based on their potential to solve both water management and water quality problems within the HUA. These cost-shared practices were placed into four categories, which were assigned government cost share rates of 75 percent, 65 percent, 55 percent, or 0 percent. BMPs deemed to have the most positive impact on both water management and improved water quality were cost shared at 75 percent (75 percent government; 25 percent grower) while those considered to be of minimal benefit were not cost shared. The BMPs that were cost-shared are shown in Table 2.

Cost share funds totaling $921,000 were distributed by the FSA through 65 contracts to 52 growers in the HUA project. The land receiving treatment totaled 7,694 acres. Cost share funds averaged $19,188 per cooperator. Nearly 88 percent of the funds were spent on structural improvements (eg. conversion of irrigation practices, canal, and ditch lining, etc.) for improved water management, while the other 12 percent were used strictly on management technology (eg., record keeping and irrigation management).

Based on a face-to-face survey conducted with each project cooperator, HUA growers were pleased with the cost-share practices. Most agreed that the water management BMPs would not have been adopted on their farms without the help of cost-sharing. Once the practice had been implemented the grower was able to see the results first hand, which in most cases made significant, positive impressions. More than 70 percent of the participating growers said they would implement the cost-shared practices on other areas of their farm in the future without cost-share incentives. Most growers agreed that the long-term benefits of the implemented practices more than paid for themselves, either through increased yields, reduced labor costs, reduction of water use, and/or reduced erosion. One grower saw the HUA project as a benefit for everyone as he remarked "…yes, I had increased production, but the taxpayer received a direct benefit as well. When you use less water there is more water in the streams for recreation and for fish. By doing these programs sediment is not going into the streams and the water is cleaner. To me, that is a benefit for everyone."

Even though only 52 growers received cost-share dollars, these growers had a great impact as the cost-shared sites served as educational resources resulting in adoption of BMP practices by many other growers living in the geographic HUA project area.

State-of-the-Art Water Management Technology

Relatively inexpensive irrigation water has historically resulted in the widespread use of low-cost, low-efficiency furrow irrigation systems within the HUA. Few incentives were available and/or attractive to convert traditional furrow systems to more efficient watering systems. However, the 5-year drought suffered by Idaho growers earlier in the decade produced an increased interest in more efficient irrigation methods. The HUA water quality project provided an avenue for growers to learn about and install new technology to reduce their water consumption. Table 3 lists BMPs implemented to improve water use efficiency (and water quality) using cost-share funds provided by FSA through the HUA project.

Many of the implemented BMP technologies were not new; however, the HUA provided for demonstrations of these time-tested technologies that are considered state-of-the-art. Consequently, grower adoption was escalated. In addition, state-of-the-art BMP technologies such as surge irrigation using rigid gated pipe, and drip and micro-irrigation placed many local growers in the forefront of efficient water management.

Through the implementation of practices shown in Table 3, producers found that their water use dropped by as much as 50 to 70 percent. Other advantages of using these practices included: improved irrigation uniformity (soil uniformly wet), reduction in water runoff, easier application of pesticides and fertilizers in irrigation systems, reduction in weeds (fewer seeds in irrigation water), and reduced soil erosion. By installing a surge irrigation system one farmer said he could use 70 percent less water and significantly reduce erosion in the furrows. Growers found they could reduce their labor costs, save and protect water quality by switching to a computer operated system that automatically shifted irrigation from one sector of a field to another. Crop yield and crop quality benefits were also seen by several HUA growers for various crops. Producers were most pleased with the BMPs that reduced labor costs.

The most popular new practices implemented were surge and micro-sprinkler irrigation systems. Based on grower interviews, surge irrigation reduced water-use, labor, and power costs by 50 percent or more. Economic benefits associated with the use of micro sprinklers in orchards had the greatest impact of all implemented BMPs. One satisfied grower had this to say about his new microsprinkler system and its advantage over traditional furrow irrigation, "...there's no comparison. It not only protected it [water] but also conserved it [water]. The design is such that the efficiency went from 30 percent (with furrow) to 90 percent." Most interviewed HUA growers intended to expand the use of these BMP technologies to the rest of their farms in the future not only for the above mentioned benefits but also for the perceived increase in property value resulting from the BMP improvements.

Educational Efforts

In addition to cost-share programs for implementation, education programs were emphasized to increase the adoption of water management BMPs within the HUA project area. Meetings, tours, publications, and exhibitions at fairs and trade shows were used to accomplish this educational objective. During the 8-year duration of the HUA project, more than 200 meetings were conducted by the HUA project staff. These meetings ranged from organizational steering committee meetings to outline the HUA goals and deal with project logistics, to field tours and local workshops.

Field demonstrations were the most popular hands-on activity for growers in the HUA project area. Eighteen major field tours were conducted during the eight-year period. The best attended tours exhibited new practices such as buried tape drip irrigation systems, automatic surge valves, micro-sprinklers, gated pipe enhanced systems and soil moisture monitoring devices. Field tour participation ranged from 12 to 125 people during the HUA project's tenure. More than 176 field sites were visited on these tours.

Publications also were an important method for distributing water management information to the 52 HUA cooperators but also to all HUA growers (>3,400 farms). The HUA project office issued a quarterly newsletter called The Farm Planner which focused on water quality BMPs. Circulation of this newsletter exceeded 2,500 per issue. Approximately 50 articles about the HUA and its progress were published in newspapers and magazines such as Argus Observer, Capital Press, Idaho Farmer-Stockman, Independent Enterprise, and Signal American.

Summary

The Idaho Snake-Payette Rivers HUA Water Quality Project successfully accelerated the transfer of water management technology BMPs to local growers to protect both ground and surface water quality. Highlights of the project's accomplishments include:

- The Irrigation Water Management (IWM) mobile lab provided direct assistance to over 90 percent of the 52 HUA grower cooperators, and to an additional 20 area farms
- Soil moisture sensors were installed in fields within the HUA project area to demonstrate improved irrigation scheduling. The demonstrations resulted in increased grower adoption.
- More than $900,000 in cost-share incentives were used to install irrigation BMPs on HUA farms.
- Conversion of traditional surface irrigation systems to surge, sprinkler and/or micro-sprinkler irrigation systems reduced water use by 50 to 70 percent. This is expected to translate into enhanced surface and groundwater quality over the next decade
- Field tours, publications and meetings reached over 90 percent of the 3,400 farms located in the HUA project area.
- Educational programs emphasized the link between water management, nutrient management and pesticide management in protecting surface and groundwater quality.
- The HUA project accelerated adoption of BMPs that improved water management and enhanced surface and groundwater quality.
- More than 80 percent of the growers enrolled in cost-share programs for improved water management indicated that the HUA project was either the best or one of the best federal programs in which they had ever been involved.
- More than 70 percent of HUA grower cooperators indicated they would use BMPs in the future without cost-share incentives.

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