Utah Surface Irrigation Water Optimization Opportunities and Barriers

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Highlights

- A Utah State University (USU) survey of 126 surface irrigators showed diverse farm sizes and management practices, with most irrigators relying on traditional methods like open ditches.
- Most farmers schedule irrigation based on soil feel and crop condition or a schedule set by the water supplier or cropping practices, with fewer using more advanced tools like soil moisture sensors or evapotranspiration data.
- Precision land leveling was the most common optimization practice (27%), but high costs, fear of reduced yields, and lack of information remain major barriers to adoption of this and other optimization practices in surface irrigation.
- Many producers rely on neighboring farmers and university Extension services for guidance. Cost-sharing programs and accessible education are key to increasing conservation efforts.

Surface irrigation is the oldest form of irrigation and can be practiced in many forms (e.g., basin, border, furrow, graded furrow, wild flood) and is known by many terms (e.g., gravity, flood). Surface irrigation systems are increasingly being replaced with pressurized irrigation systems. Since 1970, land irrigated using surface irrigation in Utah has decreased from over 750,000 acres to around 500,000 (Barker et al., 2023). The trends in Utah are similar to those in several other states in the West. The reasons for this change vary, but the primary drivers are the diminishing availability and increasing costs of farm labor. Pressurized systems can significantly reduce farm labor and, in some cases, can improve irrigation uniformity and crop yield. Furthermore, surface irrigation is sometimes considered less water efficient than pressurized systems (Rajwade et al., 2018), which often leads to more economic incentives, tax breaks, and government support for pressurized systems. However, surface systems often have less consumptive water use than pressurized systems and provide many unique benefits to irrigators (e.g., salinity control, rodent control, beneficial runoff) and the environment (e.g., groundwater recharge, wildlife habitat) (Crookston et al., 2022). Thus, these systems are important for the health of many watersheds, and caution is warranted when replacing large amounts of surface irrigation with other irrigation methods, such as sprinklers.

Surface irrigation systems are still the predominant system used in some parts of Utah and represent nearly half of the irrigated area in the state and the region. Understanding the barriers to water optimization and opportunities for improvement in surface irrigation systems will help ensure their viability. This article presents the results of a survey of surface irrigators in Utah.

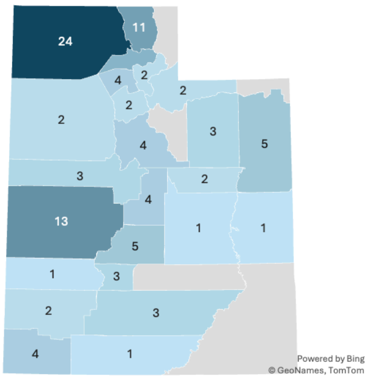
Survey Methods and Demographics

USU partnered with researchers from other states to survey surface irrigators. A total of 126 Utah irrigators completed the survey in 2020 and 2021. We describe some of the respondents' key demographics and irrigation management practices below.

- Responses were obtained from 26 of Utah's 29 counties with the most frequent responses from areas with more surface-irrigated land, specifically Box Elder (22%), Cache (12%), and Millard counties (10%) (Figure 1).
- The average surface-irrigated area was 210 acres, with a range of 1 to 2,200 acres per response.
- Crop types were not requested in this survey, but most respondents were likely raising forage (alfalfa, grass hay, corn silage, small grain forage) and grain crops (corn, wheat).
- The respondents ranged in age from 27 to 87 years old.
- The average time spent on irrigation was 4.5 hours each day during the irrigation season.
- The most common irrigation methods used were borders/basins with lined or unlined open ditches (50%) and every furrow irrigated with unlined open ditches (25%) compared to poly-pipe, underground pipe, alternating furrow irrigation, and aboveground pipe (11%).

- Most surface irrigation occurred on medium-textured soil (loam or silt loam, 48%), followed by heavy soil (clay loam, 39%) and light soil (sandy loam, 14%).
- Most respondents (82%) primarily irrigated with only surface water, a few only used groundwater (6%), and 12% used a combination of the two.

Figure 1.*Count of Survey Respondents by County in Utah*



Note. Sixteen of the 126 respondents did not indicate the county where they irrigate.

These demographics indicate that the survey responses represent small, medium, and large farms, with managers of various ages and a good representation of soil and surface irrigation conditions across Utah. They also include a concentration of responses in areas in northern and central Utah, where most surface irrigation occurs.

Irrigation Scheduling Methods

Scheduling irrigation properly helps promote optimal crop growth and prevent unnecessary irrigation, which can lead to increased water charges, nutrient loss in the soil, and unintended environmental impacts. There are numerous methods for determining irrigation schedules.

Soil feel and crop condition. The survey showed that most farmers base their irrigation schedules on the soil feel and condition of crops, or on a schedule determined by the water supplier (Figure 2). The soil feel and crop condition methods are much easier and less expensive than some others but can be less effective than more precise data-driven methods. If choosing to use this method, understanding the principles of soil water reserve, available water holding capacity, and how soil and crop types affect water needs can help farmers to know when they should irrigate. A helpful guide is available from the Natural Resources Conservation Service for estimating soil moisture by feel and appearance depending on soil types (USDA-NRCS, 1998).

Water supplier or preset schedule. Preset schedules are another very commonly used method for irrigation scheduling. Most (82%) of the respondents reported using an irrigation schedule determined by a water supplier. Hay cutting schedules or other cropping practices were also a common factor (87% of respondents) for scheduling irrigation. These methods constrain flexibility for irrigation scheduling in surface irrigation, but opportunity may still exist on some operations to refine irrigation management by skipping irrigations when soil moisture is sufficient or adjusting timing by swapping with other users.

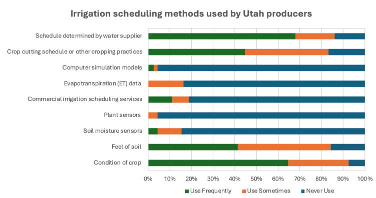
Moisture sensors. It was notable that 15% of the respondents reported using soil moisture sensors for surface irrigation (Figure 2). Soil moisture sensors can be beneficial as they provide information on how much water is present in the soil and help determine irrigation timing and amounts. However, producers may encounter a learning curve in understanding how to interpret and use sensor data to improve irrigation scheduling efficiency (Shortridge & Porter, 2021). Plant sensors are another tool for scheduling irrigation in some crops. Only a few respondents (4%) reported using plant sensors to schedule irrigation (Figure 2). This may be related to the types of crops produced under surface irrigation, as this technology is typically used in orchards and vineyards, while most surface irrigation in Utah is used for forage and grain production.

Weather station data. Evapotranspiration data (mainly from weather stations or other tools that access weather data) is an easily accessible tool and method familiar to some farmers, and weather stations across the state have available data (Utah Climate Center). Around 16% of producers surveyed stated that they have used evapotranspiration data for irrigation scheduling (Figure 2). Using evapotranspiration data with the water-balance approach to estimating soil water is a simple way to use scientific data to determine irrigation without incurring the expenses of individual sensors for each field (Sharma, 2023). For example, the Irrigation Scheduler web app from Washington State University incorporates evapotranspiration for many Utah locations.

Computer models. Computer simulation models are another option for irrigation scheduling, though most producers surveyed were not familiar with the technology, and only 5 out of 116, or about 4% of the producers surveyed reported using this method (Figure 2). Though not commonly used, these programs can be beneficial as they provide real-time irrigation scheduling based on many factors.

Collectively, the results indicate that the surveyed Utah surface irrigators mainly rely on simple, low-cost irrigation scheduling methods like assessing soil feel and crop condition. Only a small portion of farmers use advanced technologies such as soil moisture sensors (15%), plant sensors (4%), evapotranspiration data (16%), or computer models (4%) due to factors like cost, crop type, or unfamiliarity. Further, many follow preset schedules from water suppliers (82%) or base irrigation timing on cropping practices (87%), highlighting restraints to scheduling from a water supplier and/or possible preferences for familiar, accessible methods over more technical solutions.

Figure 2.
Frequency of Irrigation Scheduling Methods Used by 126 Utah Surface Irrigators Who Completed a 2020–2021 Survey



Water Optimization Practices Used in Surface Irrigation

Respondents were asked about 10 practices they might use for water conservation (termed "optimization" in this article) in surface irrigation (Table 1). The four practices respondents used most frequently (18%–27%) from greatest to least included:

1. Precision land leveling,
2. Limiting irrigation set times,
3. Reducing/eliminating irrigation runoff by diking ends of fields, and
4. Limiting the number of irrigations.

Precision land leveling was the most common water-optimizing practice respondents used in surface systems (27%). This can be a great tool for improving water distribution across the surface, increasing efficiency, and reducing soil erosion (Dedrick et al., 2007). While highly beneficial, precision land leveling can be time- and cost-intensive when first leveling a field. Later leveling for "touch-up" leveling is often quick and much less expensive. Time and cost explain why nearly three-quarters of respondents had not used this as an optimization measure. This indicates that financial and technical support for land leveling may improve optimization efforts in surface systems. The other reason few use precision land leveling is that much of the surface-irrigated land in Utah was laser-leveled in the past, and additional major leveling is not needed.

The other three practices producers used periodically for optimization in surface systems dealt with irrigation management. Nearly one-fifth of the respondents (18%–21%) adjusted their irrigation set times, reduced runoff at the end of the field, or limited the number of irrigations to optimize water use. This suggests that there is an opportunity to optimize water use with greater use of adjustments in irrigation management, as supported by Schneekloth and others (2009).

Respondents rarely used (6%) the other six options for optimization (recovering water, mulches, zero-grading, shortening rows, wide-spaced beds, and furrowing diking). ***One caution with recovering tailwater is that it can promote movement of alfalfa stem nematode from field to field.*** This concern might be why many respondents were not using tailwater recovery as an optimization method. Further, these results indicate that more research, education, and/or financial support may be needed to advance these options for improving water optimization in surface systems.

Table 1.

Frequency of Water Conservation (Optimization) Practice Use by 126 Surface Irrigation Survey Respondents

Practice	Frequency
Using precision land leveling	27%
Limiting irrigation set times	21%
Reducing/eliminating irrigation runoff by diking end of the field	19%
Limiting number of irrigations	18%
Recovering or reusing irrigation runoff or tailwater recovery system	6%
Applying mulch/other types of row covers	1%
Using furrow diking	5%

Practice	Frequency
Using zero-grading	1%
Shortening border/furrow length	1%
Using wide-spaced beds	1%

Barriers to Water Optimization

USU research indicates that certain water optimization practices can maintain or even ehance yields while using less water.

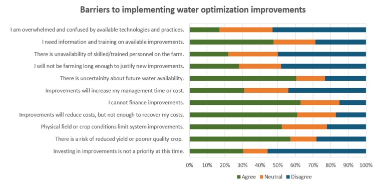
Adopting new irrigation practices or technologies can be challenging due to potential disruptions to farm operations, required equipment changes, and associated costs. The survey identified several key barriers to implementing water optimization in surface irrigation systems, including concerns about crop performance, site limitations, financial costs, uncertainty about future water availability, and lack of technical knowledge.

Crop concerns. One of the most cited concerns was the potential for reduced crop yield or quality, with 57% of respondents indicating that this risk limited their adoption of optimization practices (Figure 3). While this concern is valid in some cases where optimization results in irrigation less than the crop's evapotranspiration demand, USU research indicates that certain water optimization practices, such as improved irrigation scheduling, automation, and surge irrigation, can maintain or even enhance yields while using less water.

Expense hurdles. Cost was another major barrier. About 61% of the respondents agreed that the savings from water conservation would not be enough to cover implementation costs (Figure 3), and 63% cited difficulty in financing improvements as a constraint. This indicates financial concerns may influence nearly two-thirds of surface irrigators in Utah. Much of this constraint is likely related to major changes in irrigation technologies such as piping ditches, automation, and some irrigation scheduling technologies. Government funding has and is available to help support some of these larger changes. In addition, water-saving practices such as modifying tillage, adjusting irrigation timing, rotating crops, or applying mulch can be implemented for a relatively low cost (Nevada Irrigation District, 2025).

Knowledge obstacles. Access to information also emerged as a challenge. Nearly half (48%) of respondents indicated that a lack of knowledge about available optimization options limited their ability to make improvements (Figure 3). Therefore, expanding outreach, technical assistance, and education programs can help irrigators better understand the tools and resources available to support more efficient irrigation.

Figure 3.
Utah Surface Irrigator's Agreement About Barriers to Water Conservation Practices in Surface Irrigation



Opportunities for Water Optimization

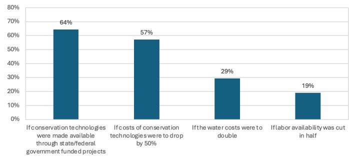
The survey results suggested that some irrigators are willing to implement water conservation measures in surface-irrigated fields during non-drought years. Figure 4 displays some measures that would help many irrigators consider adding these improvements, including:

- State or federally funded projects providing these technologies (64% of respondents).
- Reduction in the costs of these technologies (57%).

Surface irrigation systems are typically not considered the most efficient irrigation system and would greatly benefit from improvements in water optimization, but they can be costly investments for the producers. Therefore, government sponsorship or price reductions might help promote using these water-saving technologies.

The survey was conducted before the Utah Agricultural Water Optimization Program was widely available in 2022. This program presently offers grants that support 50%–75% of the cost of upgrading to automated surge irrigation and piping open ditches in surface irrigation systems. If the survey were conducted again, the responses would likely be different and reflect the increased support for improvements in irrigation. In hindsight, this survey highlights and supports the need for the water optimization program to support optimization measures in surface irrigation systems.

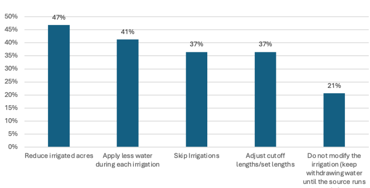
Figure 4.
Percentage of 126 Respondent Feedback for Conditions Encouraging Water Conservation in Surface-Irrigated Fields in a Non-Drought Year



Beyond changes in the cost of technologies or tools, survey respondents were asked about other conditions that would cause them to increase water conservation or optimization practices (Figure 4). Nearly one-third (29%) of the respondents indicated that doubling water costs would cause them to use water optimization measures. Further, 19% indicated that reduced labor availability would lead to increased investment in water optimization. These results indicate that many surface irrigators may be resilient to water prices and labor availability, but these factors do influence, and will continue to influence, water optimization investments and practices.

Producers employ various methods during droughts. The most common method is reducing irrigated acres (47%), while other common options are applying less water during each irrigation (41%), skipping irrigations (37%), and adjusting cutoff lengths and set lengths (37%). Some producers also choose not to modify irrigation or keep withdrawing water until the source runs dry (21%) (Figure 5). Reducing irrigated acres does reduce water use and maintains the quality of fields still being irrigated; however, reducing the amount of irrigation can be another option. Operating at less-than-ideal water amounts can be difficult to make successful, but understanding deficit irrigation methods can help to improve these situations. There are many resources available to understand deficit irrigation, such as this USU Extension fact sheet that discusses pasture irrigation under a deficit.

Figure 5.
Percentage of 126 Survey Respondents Indicating How They Modify Growing Practices During Drought Years



Sources of Information

There are many sources that producers can use for information about how to reduce irrigation costs or optimize water use. A large proportion of respondents turned to university Extension information (58%) or neighboring farmers (60%) for help with their irrigation methods (Table 2). Other options consulted less frequently (21%–42%) by respondents included private irrigation consultants, irrigation equipment dealers, local irrigation authorities, government resources and online sources. Coordinating irrigation support among various sources, building and fostering peer networks of farmers, and strengthening university Extension irrigation programs could greatly improve the success of surface irrigation systems in Utah as well as improve water optimization measures for producers.

Table 2.
Frequency of 126 Survey Respondents Indicating Information Sources Relied on for Guidance in Reducing Irrigation Costs or Conserving Irrigation Water

Source of information	Frequency
Neighboring farmers	60%
University Extension agents, advisors, or specialists	58%
Government specialists from the Natural Resources Conservation Service, local conservation district, Bureau of Reclamation, or federal or state agencies	42%
Irrigation equipment dealers	29%
Local irrigation district employees or specialists hired by the water supplier	29%
Private irrigation specialists or crop consultants hired by the owner or operator	21%
Online or press media reports and information	21%
None	10%

Summary

Surface irrigation remains a vital component of Utah's agricultural landscape despite a gradual shift toward pressurized systems. Nearly half of the state's irrigated land is irrigated with surface systems, with concentrated areas in the Great Salt Lake watershed. Thus, water optimization in surface systems is and will be critical for ensuring a resilient water supply for Utah. Our survey of Utah surface irrigators showed that there is widespread reliance on simple, low-cost irrigation scheduling methods among Utah surface irrigators, with only limited adoption of advanced technologies due to financial, educational, and practical constraints. While many producers are already employing some water optimization practices—such as limiting irrigation or precision land leveling—broader adoption is hindered by concerns about cost, yield impacts, and access to information. However, the survey shows there is interest among producers in implementing water optimization measures, especially if supported by government funding, cost-sharing programs, or educational resources. To ensure the continued viability of surface irrigation systems, especially in the Great Salt Lake Basin, coordinated efforts are needed to improve access to tools, training, and financial support. Strengthening partnerships between irrigators, Extension, the irrigation industry, and water agencies can help bridge knowledge gaps and promote sustainable, efficient irrigation practices that support both agricultural productivity and environmental stewardship.

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