

Evaluating Strategies to Address Water Cuts in the Beryl-Enterprise Groundwater Area

Grant Progress Report - Ngoni Mufute and Matt Yost

Executive Summary

The Beryl-Enterprise groundwater area faces substantial planned reductions in groundwater diversions. This project is evaluating practical strategies that could help irrigators reduce pumping while maintaining productive agriculture, including conversion to low-elevation precision application (LEPA) sprinkler packages, improved measurement and management, and incentive-based approaches such as water buybacks, a water optimization fund, and water spreading as defined in the survey.

Preliminary findings with the greatest relevance to program design

- All 12 valid survey respondents agreed that a water-shortage problem exists, and 9 of 11 respondents (81.8%) viewed the planned water cuts as justified and necessary.
- Producers strongly favored flexibility and incentives: water spreading was rated very or somewhat helpful by 10 of 12 respondents, and a water optimization fund by 11 of 12.
- Measurement and accountability received especially strong support. All 12 respondents rated flow meters as helpful, and all 11 who answered the groundwater-monitoring item rated monitoring and reporting as helpful.
- LEPA is already prominent among respondents and is generally viewed as a water-saving technology, but installation cost, maintenance cost, plugging, runoff/pooling, and management time remain important adoption barriers.
- Producers showed strong interest in monitoring, soil-moisture and weather-informed scheduling, lower-water-use crop varieties, demonstrations, and participation in optimization programs; delayed-start or early-stop partial-season irrigation was much less acceptable.

1. Background and Project Objectives

More than 109,000 acre-feet of groundwater are approved for diversion in the Beryl-Enterprise groundwater area. The adopted groundwater management plan is expected to reduce diversions by more than 50,000 acre-feet (approximately 45%) by 2130, with the first of ten planned reductions - 3,250 acre-feet - scheduled for 2030. Local irrigators are exploring proactive conservation measures that could reduce diversions before the first and second cuts. Proposed approaches include reducing diversions from the allowed 48 inches per acre to 40 inches, providing additional flexibility for conserved water, establishing a conservation or optimization fund supported by water buybacks, upgrading center-pivot sprinklers to LEPA, and expanding flow-meter use. Irrigators asked Utah State University (USU) to help evaluate these strategies and document lessons that may be useful in Beryl-Enterprise and other groundwater areas.

The project has three objectives:

1. Evaluate and compare the effects of LEPA on crop yield, irrigation water use, and evapotranspiration (ET), where data are sufficient, on up to 160 center pivots in the Beryl-Enterprise area.
2. Survey and interview water users to identify barriers and opportunities for proactive water buyback or conservation-fund approaches and assess the feasibility of water spreading and related water-optimization strategies.
3. Develop a practical guide for other groundwater areas on incentive-based water optimization and water-spreading programs, using lessons learned in Beryl-Enterprise.

2. Progress by Objective

Objective 1. Evaluate LEPA effects on water use, ET, and crop performance

USU has received an initial set of irrigator records containing crop-yield information, water-use or flow data, and information for approximately 40 center pivots. The current dataset is not yet complete enough for a defensible comparison of LEPA and MESA systems. Only five pivots in the records are presently identified as converted to LEPA, even though the Objective 2 survey indicates broader LEPA adoption. Conversion dates are also missing for some pivots, which limits the ability to conduct before-and-after analyses.

The research team is continuing to work with irrigators to obtain consistent pivot identifiers, sprinkler-package type, LEPA conversion dates, crop and yield records, and flow-meter data. Climate data and ET information have also been assembled for selected pivots. Once records are sufficiently complete, the analysis will focus on whether LEPA conversion is associated with measurable changes in seasonal pumping, crop yield, and ET while accounting for crop and year-to-year weather differences.

Takeaway: *Objective 1 remains in the data-development phase. The survey results suggest that LEPA is widespread enough to warrant a rigorous analysis, but no causal or quantitative conclusion about LEPA performance should be drawn from the current pivot dataset until sprinkler classifications, conversion dates, and water-use records are completed.*

Objective 2. Water-user survey: barriers, opportunities, and producer preferences

The survey was designed to document irrigator experiences, perceptions, attitudes, suggestions, and future plans related to LEPA/MESA sprinkler packages, water conservation, crop productivity, farm profitability, and strategies for responding to the planned groundwater reductions beginning in 2030. The results provide an early indication of which approaches are most likely to receive producer support and which program-design issues could limit participation.

Survey methods and response

A dual-mode questionnaire was administered online through Qualtrics and in paper form. The online survey was activated in mid-July 2025 and closed at the end of March 2026. Paper surveys were distributed between September 2025 and March 2026 to

addresses in a USU Extension database for Iron County. Participants received information about the study purpose, participating institutions, confidentiality, voluntary participation, and the absence of compensation. Both survey modes were anonymous. The questionnaire was approved by the Utah State University Institutional Review Board (IRB No. 15037).

The study received 25 submissions (18 online and 7 paper). After data cleaning and quality control, 12 valid surveys remained: 5 online and 7 paper. Paper and online responses were combined for analysis. Descriptive statistics were generated in SPSS, and text entered under open-ended or "other" response options was thematically classified. Most results below use n=12; individual tables note when one respondent did not answer an item and the denominator is n=11.

Table 1. Demographic characteristics of valid survey respondents.

Characteristic	Response category	n	%
Education	Some college/technical school	4	33.3
	College degree	4	33.3
	Post-graduate degree	4	33.3
Gender	Male	12	100.0
Birth year	1939-1949	3	27.3*
	1950-1959	0	0.0*
	1960-1969	2	18.2*
	1970-1979	3	27.3*
	1980-1989	2	18.2*
	1990-1999	0	0.0*
	2000-2005	1	9.1*
Gross farm/ranch sales	\$100,000-\$249,999	1	9.1*
	\$250,000-\$499,999	2	18.2*
	\$500,000-\$999,999	2	18.2*
	\$1 million or more	6	54.5*
	Missing	1	-

* Birth-year and reported sales percentages use n=11 because one respondent did not provide the relevant item.

Takeaway: Respondents represent experienced, commercially significant farm operations. Among the 11 respondents reporting years of irrigation experience, 7 had irrigated for 30-50 years and 4 had more than 50 years of experience. More than half of those reporting gross sales (6 of 11) reported \$1 million or more in typical annual farm or ranch sales.

Table 2. Years irrigating crops as a source of income (n=11).

Years	n	%
30-40	4	36.4
41-50	3	27.3
51-60	3	27.3
61-70	0	0.0
71-80	1	9.1

Table 3. Total irrigated acreage reported by respondents (n=11).

Irrigated acreage	n	%
0	0	0.0
1-179 acres	0	0.0
180-499 acres	3	27.3
500-999 acres	2	18.2
1,000-4,999 acres	3	27.3
5,000-9,999 acres	0	0.0
10,000-15,000 acres	3	27.3
Over 15,000 acres	0	0.0

The 11 respondents reported a combined 46,920 irrigated acres.

Takeaway: The survey reflects a substantial share of irrigated production among respondents: total reported irrigated area was 46,920 acres, with respondents ranging from 180 acres to as much as 15,000 acres.

Table 4. Reported irrigated acreage equipped with LEPA (n=11).

LEPA acreage	n	%
0	2	18.2
1-179 acres	2	18.2
180-499 acres	2	18.2
500-999 acres	1	9.1
1,000-4,999 acres	1	9.1
5,000-9,999 acres	0	0.0
10,000-15,000 acres	3	27.3
Over 15,000 acres	0	0.0

Respondents reported 42,485 acres equipped with LEPA, equivalent to approximately 90.6% of the 46,920 total irrigated acres reported by the same 11 respondents.

Table 5. Reported irrigated acreage equipped with MESA (n=11).

MESA acreage	n	%
0	2	18.2
1-179 acres	0	0.0
180-499 acres	5	45.5
500-999 acres	3	27.3
1,000-4,999 acres	1	9.1
5,000-9,999 acres	0	0.0
10,000-15,000 acres	0	0.0
Over 15,000 acres	0	0.0

Respondents reported 4,405 acres equipped with MESA, or approximately 9.4% of total reported irrigated acreage. Wheel-line and hand-move irrigation were uncommon, totaling only 90 and 24 reported acres, respectively.

Takeaway: Among survey respondents, LEPA is already the dominant center-pivot/lateral-move sprinkler package by reported acreage. This does not substitute for Objective 1 field verification, but it indicates that the area has substantial producer experience with LEPA and can provide meaningful operational lessons about both benefits and limitations.

Table 6. Irrigated crops grown by respondents (n=12).

Crop	Respondents (n)	%
Alfalfa	12	100.0
Small grains	6	50.0
Other forage crops	9	75.0
Corn	7	58.3

Respondents could report more than one crop; percentages therefore do not sum to 100%.

Takeaway: All respondents grew alfalfa, and most also produced other forage crops, corn, or small grains. Water-reduction strategies therefore need to work within forage-dominated production systems rather than assuming rapid wholesale shifts to different crops.

Perceptions of the groundwater problem and planned cuts

There was broad agreement that groundwater scarcity is a real problem. All 12 respondents somewhat or strongly agreed that a water-shortage problem exists in Beryl-Enterprise. Only 4 of 12 (33.3%) somewhat or strongly agreed that the extent of the shortage has been exaggerated. Half of respondents expected irrigation-water shortages within five years, while one-third disagreed and 2 of 12 were neutral.

Support for the need to act was also substantial. Among the 11 respondents answering the planned-cuts item, 9 (81.8%) somewhat or strongly agreed that the planned cuts are justified and necessary. When asked whether current rates of groundwater use would not worsen future shortages, 7 of 12 (58.3%) disagreed, indicating that a majority believe current pumping rates are likely to worsen future shortages.

The most frequently identified contributors to shortages were increasing **drought and the resulting dependence on groundwater** (10 of 12; 83.3%) and **economic pressure to maximize water use to increase crop yield** (10 of 12; 83.3%). Other commonly cited contributors were unpredictable rainfall and insufficient surface water during critical periods (8 of 12; 66.7%), the inability to bank conserved water for future seasons (7 of 12; 58.3%), and limited flexibility to use saved water for other purposes (6 of 12; 50.0%).

Takeaway: The survey indicates that the central challenge is not convincing irrigators that a groundwater problem exists. The stronger program-design need is to create practical, trusted mechanisms that make conservation economically rational and allow producers to benefit from water they do not pump.

Barriers and opportunities for water optimization

For this survey, a water buyback was defined as purchase by the responsible authority of unused water from an irrigator's seasonal allocation. Water spreading was defined as allowing unused seasonal water to be carried forward for use in future seasons. Water optimization was defined as reducing irrigation water use by making water use more efficient and productive - using less water while maintaining crop output or yield.

The strongest perceived barriers to water optimization were **limited flexibility in the allowed uses of saved water** (8 of 12 strongly agreed), **the use-it-or-lose-it principle** in Utah water law (7 of 12 strongly agreed), **lack of water-spreading programs** (5 of 12 strongly agreed), and **lack of water banks** (4 of 10 strongly agreed). Lack of accountability in irrigation water use and lack of buyback programs were also identified, but less frequently as the strongest barriers.

Respondents viewed several policy and incentive options as potentially useful for coping with planned cuts. **Water spreading** received the strongest support: 8 of 12 rated it very helpful and 2 somewhat helpful. **A water optimization fund** was rated very or somewhat helpful by 11 of 12 respondents, water buybacks by 9 of 12, and water trading among irrigators by 8 of 12.

Table 7. Barriers to proactive water buyback, water-spreading, and water-optimization-fund programs (n=12).

Barrier	n	%
No clear policy for buyback/water-spreading programs	6	50.0
No clear policy for water optimization funds	6	50.0
No clear policy for how optimized water will be used	6	50.0
Water-use concerns / difficulty with change applications	4	33.3
Limited producer cooperation on water spreading	4	33.3
Limited producer cooperation on water buybacks	4	33.3
Limited producer cooperation on optimization fund	6	50.0
Not aware of barriers	2	16.7
Other: lack of State Engineer support	1	8.3

Items are not mutually exclusive; respondents could identify multiple barriers.

Takeaway: *The main institutional barrier is clarity. Half of respondents identified unclear rules for buybacks/spreading, optimization funds, or the disposition of conserved water. This suggests that program participation will depend on simple, transparent rules specifying eligibility, measurement, payment, ownership/control of conserved water, and how savings are credited.*

Preferred conservation practices and accountability measures

Respondents expressed particularly strong support for measurement, monitoring, and targeted investment. All 12 respondents rated installing flow meters on groundwater pumps as very or somewhat helpful. All 11 who answered the groundwater-condition item rated monitoring and reporting groundwater conditions as very or somewhat helpful. Using an optimization fund to upgrade pivot sprinklers to LEPA was rated very or somewhat helpful by 11 of 12 respondents, and using the fund for other irrigator-prioritized optimization activities was rated very or somewhat helpful by 10 of 12.

Takeaway: A credible conservation program should pair incentives with measurement. The survey supports a model in which verified pumping data and groundwater reporting are not treated as punitive add-ons, but as the accounting foundation that makes incentives, spreading, buybacks, and adaptive management possible.

Producer experience with LEPA

Respondents generally viewed LEPA as a water-saving technology. Eleven of 12 (91.7%) agreed or strongly agreed that LEPA reduces seasonal pumping relative to MESA; 10 of 12 disagreed or strongly disagreed with the opposite statement that LEPA increases pumping. Perceived production and economic benefits were positive but less uniform: 7 of 12 (58.3%) agreed or strongly agreed that LEPA increases farm profitability, and 6 of 12 (50.0%) agreed or strongly agreed that it increases crop yield relative to MESA.

Table 8. Reported challenges or weaknesses of LEPA sprinkler packages (n=12).

Reported challenge	n	%
High installation cost	6	50.0
High maintenance cost	6	50.0
High management/monitoring time	4	33.3
Smaller nozzles susceptible to plugging	2	16.7
Difficult to apply fungicides/insecticides through LEPA	2	16.7
Nozzle size too small for inner spans	1	8.3
Runoff or pooling on uneven ground	1	8.3
Nozzles can become entangled in crop	1	8.3
No major challenge reported	1	8.3

Open-ended responses were thematically classified; a response could contain more than one theme.

Takeaway: Cost is the clearest barrier to additional LEPA adoption, followed by added maintenance and management demands. A conversion program that pays only for hardware but not for design, filtration/nozzle management, operator training, or follow-up troubleshooting may underperform.

Table 9. Benefits respondents reported experiencing with LEPA (n=12).

Reported benefit	n	%
Reduced evaporation loss	4	33.3
Reduced wind drift and associated water loss	2	16.7
Less water applied / less water pumped	2	16.7
Increased crop production or yield	2	16.7
More efficient water use	2	16.7
Water placed below canopy / more soil moisture retained	2	16.7
Fewer nuisance pests/animals	1	8.3

Open-ended responses were thematically classified; a response could contain more than one theme.

Takeaway: The reported benefits are consistent with why irrigators view LEPA favorably for water conservation: reduced evaporative and wind losses, lower pumping, and improved placement of water near the soil surface. Because these are producer-reported experiences, Objective 1 remains important for quantifying the magnitude of water savings and any yield effects.

Table 10. Producer suggestions for improving LEPA performance and water conservation (n=12).

Suggestion/theme	n	%
Use reduced evaporation to run faster/avoid high-loss periods; shut off earlier where appropriate	1	8.3
Check frequently for plugged nozzles	1	8.3
Use sprays rather than bubblers on splash plates	1	8.3
Use group funding to reduce application/reporting burden	1	8.3
Focus accountability on water use rather than land area	1	8.3
Use in-ground soil-water sensors to improve LEPA management	1	8.3
Use LEPA to save water while maintaining yield	2	16.7
Plan for substantial operating and maintenance time	1	8.3
Consider elements of the Roswell plan	1	8.3

These are open-ended suggestions and should be interpreted as examples rather than ranked program preferences.

Table 11. Plans for sprinkler-package changes (n=12).

Question	Yes	Maybe	No	Not sure
Convert more MESA acres to LEPA within 5 years	58.3% (n=7)	25.0% (n=3)	8.3% (n=1)	8.3% (n=1)
Try sprinkler packages other than MESA/LEPA that may save water	66.7% (n=8)	25.0% (n=3)	-	8.3% (n=1)

The source draft does not contain a complete response distribution for the separate question about converting LEPA acres back to MESA; no conclusion from that item is reported here.

Takeaway: Future technology adoption appears likely if cost and operational concerns can be addressed. Ten of 12 respondents said yes or maybe to converting additional MESA acreage to LEPA, and 11 of 12 were willing or potentially willing to try other water-saving sprinkler packages.

Interest in additional water-optimization practices

The most broadly acceptable management options were intensive water-use monitoring, deficit irrigation, and variable-rate irrigation. Drip and subsurface drip had much lower stated willingness, indicating that near-term programs should prioritize practices that can be layered onto existing pivot systems (Table 12).

Table 12. Willingness to use irrigation-management practices (n=12).

Practice	Yes	No	Maybe	Not sure	Using
Intensive monitoring of water use	66.7 (8)	-	25.0 (3)	-	8.3 (1)
Deficit irrigation at less-sensitive crop stages	58.3 (7)	33.3 (4)	8.3 (1)	-	-
Variable-rate irrigation	50.0 (6)	16.7 (2)	8.3 (1)	16.7 (2)	8.3 (1)
Subsurface drip irrigation	33.3 (4)	66.7 (8)	-	-	-
Drip irrigation	33.3 (4)	66.7 (8)	-	-	-

Cell values are percent, with respondent count in parentheses. Blank source categories are shown as "-".

Scheduling tools have unusually broad acceptance. Every respondent either already used, would use, or might use soil-moisture monitoring; the same was true for considering precipitation events or forecasts. These practices are strong candidates for technical-assistance and demonstration programs because they can complement LEPA without requiring a major change in crop or irrigation system (Table 13).

Table 13. Willingness to use irrigation-scheduling practices (n=12).

Practice	Yes	No	Maybe	Not sure	Using
Soil-moisture monitoring for irrigation decisions	58.3 (7)	-	25.0 (3)	-	16.7 (2)
Use precipitation events/forecasts in irrigation decisions	58.3 (7)	-	16.7 (2)	-	25.0 (3)
Night-time irrigation	41.7 (5)	16.7 (2)	8.3 (1)	-	33.3 (4)

Cell values are percent, with respondent count in parentheses.

Broad partial-season shutoff or delayed-start strategies are not currently attractive to most respondents. A program focused primarily on removing entire portions of the irrigation season would likely face more resistance than one based on efficiency, monitoring, targeted deficit irrigation, or flexible incentives (Table 14).

Table 14. Willingness to use partial-season irrigation strategies.

Practice	Yes	No	Maybe	Not sure	Using
Delay irrigation start until June (n=12)	25.0 (3)	66.7 (8)	-	8.3 (1)	-
Delay irrigation start until July (n=12)	25.0 (3)	75.0 (9)	-	-	-
Cease irrigation at end of June (n=11)	27.3 (3)	54.5 (6)	9.1 (1)	-	9.1 (1)
Cease irrigation at end of July (n=12)	25.0 (3)	58.3 (7)	8.3 (1)	-	8.3 (1)

Cell values are percent, with respondent count in parentheses.

Changing varieties appears more acceptable than changing crops. Nine respondents would consider lower-water-use varieties of crops they already grow and two were

already using them. Interest in entirely different lower-water-use crops was more tentative, with half of respondents selecting "maybe." (Table 15).

Table 15. Willingness to use soil and crop management practices (n=12).

Practice	Yes	No	Maybe	Not sure	Using
Conservation tillage	41.7 (5)	-	16.7 (2)	8.3 (1)	33.3 (4)
Lower-water-use varieties of current crops	75.0 (9)	-	8.3 (1)	-	16.7 (2)
Different crops that require less water	33.3 (4)	-	50.0 (6)	-	16.7 (2)
Adjust planting timing to periods of greater natural moisture	33.3 (4)	16.7 (2)	16.7 (2)	8.3 (1)	25.0 (3)

Cell values are percent, with respondent count in parentheses.

Recycled water had substantially greater producer support than transbasin transfers. Although alternative supplies are outside the core scope of this project, the survey indicates that locally available recycled water could merit future feasibility evaluation where water quality, infrastructure, and regulatory conditions allow (Table 16).

Table 16. Support for alternative water sources (n=12).

Alternative	Yes	No	Maybe	Not sure	Using
Transbasin transfers	25.0 (3)	25.0 (3)	33.3 (4)	16.7 (2)	-
Properly recycled water for irrigation	66.7 (8)	8.3 (1)	8.3 (1)	8.3 (1)	8.3 (1)

Cell values are percent, with respondent count in parentheses.

Education and demonstrations are among the most broadly supported enabling strategies: all respondents considered general education/training and demonstration projects helpful, and 11 of 12 considered workshops/seminars helpful. Collective agreements received more mixed responses, suggesting that collaboration should be

built gradually around clear benefits, trusted measurement, and successful demonstrations (Table 17).

Table 17. Perceived usefulness of education and collaborative approaches for reducing water consumption (n=12).

Approach	Very helpful	Somewhat helpful	Not sure	Somewhat unhelpful	Not helpful
Education and training	58.3 (7)	41.7 (5)	-	-	-
Workshops/seminars on practices and technology	50.0 (6)	41.7 (5)	-	8.3 (1)	-
Demonstration projects	66.7 (8)	33.3 (4)	-	-	-
Collaborative water management	33.3 (4)	33.3 (4)	33.3 (4)	-	-
Community agreements among neighboring farms	16.7 (2)	33.3 (4)	41.7 (5)	-	8.3 (1)
State/federal water-optimization programs	41.7 (5)	41.7 (5)	16.7 (2)	-	-
Other: fallow program	8.3 (1)	-	-	-	-

Cell values are percent, with respondent count in parentheses.

Objective 3. Draft guide for addressing planned groundwater reductions

Objective 3 is to translate the Beryl-Enterprise experience into a practical framework that other groundwater areas can adapt. The draft guide below is based primarily on the Objective 2 survey findings and should be refined as Objective 1 produces verified water-use, ET, and crop-performance results. It is intended as a program-design guide, not as a legal determination; any water-right, banking, spreading, transfer, or change-application mechanism would require review under the applicable state and local framework.

Draft guide: a producer-centered pathway for managing water cuts

- 1.** Establish a shared, quantified need for action. Begin with transparent reporting of groundwater trends, pumping, and the timing and magnitude of planned reductions. Beryl-Enterprise respondents already broadly recognize the shortage, so communication should focus on the size of the required reduction and the consequences of different response options rather than on debating whether a problem exists.
- 2.** Measure water use consistently. Require or support reliable flow meters on groundwater pumps and establish a simple process for collecting, validating, and reporting seasonal pumping. Measurement should be the basis for crediting conserved water, evaluating investments, and demonstrating basin-level progress.
- 3.** Create clear rules for conserved water before asking producers to reduce pumping. Define how saved water is credited, whether and how it can be carried forward, sold through a buyback, traded, or otherwise used, and what happens to conserved water after an incentive payment. The survey indicates that uncertainty about these rules is a major barrier.
- 4.** Build a flexible water-optimization fund. Use grants, cost-share, loans, or buyback revenues to reduce the upfront cost of practices that measurably reduce pumping. Funding should not be limited to one technology; it should support a menu of eligible practices prioritized locally and tied to measurable water outcomes.
- 5.** Prioritize upgrades that fit existing production systems. In pivot-irrigated areas like Beryl-Enterprise, LEPA conversion is a logical early option because producer experience and acceptance are already high. However, funding should include system design, filtration/nozzle management, maintenance support, and operator training in addition to hardware.
- 6.** Pair hardware with irrigation management. Support soil-moisture monitoring, weather- and precipitation-informed scheduling, intensive water-use monitoring, and carefully designed deficit-irrigation strategies. These options received stronger producer interest than delayed-start or early-stop partial-season irrigation and can be implemented without abandoning existing crops or irrigation infrastructure.
- 7.** Use crop and soil management as complementary tools. Encourage lower-water-use varieties of crops already grown, conservation tillage where appropriate, and evaluation of alternative crops where economics and markets are favorable. The survey suggests that producers are more ready to change varieties or management than to make immediate wholesale crop changes.

8. Use demonstrations and technical assistance to reduce risk. Establish local demonstration pivots or farms, publish water-use and yield results, and provide practical training on equipment operation, maintenance, irrigation scheduling, and interpretation of soil-moisture and weather information. Demonstrations were rated helpful by every survey respondent.
9. Pilot before scaling. Begin with a voluntary group of producers, test payment rates and accounting procedures, document administrative burden, and evaluate both water savings and farm impacts. Refine program rules before expanding basin-wide.
10. Evaluate performance using water outcomes, not adoption alone. Track verified reductions in seasonal pumping, cost per acre-foot conserved, crop yield and revenue where available, producer participation and retention, equipment reliability, and changes in groundwater conditions. Technology installation is a means to an outcome rather than the outcome itself.

Table 1. Recommended components of an incentive-based groundwater optimization program.

Program component	Beryl-Enterprise evidence	Recommended design response
Water measurement and reporting	Flow meters and groundwater monitoring received near-unanimous support.	Meter pumping, standardize reporting, and use measured water as the accounting basis.
Saved-water flexibility	Limited flexibility and inability to bank/save water were major barriers.	Define conserved-water credit, carryover/spreading, buyback, and trading rules before enrollment.
Optimization fund	11 of 12 rated a fund very or somewhat helpful.	Use grants/cost-share/loans for locally prioritized, verifiable conservation investments.
LEPA/pivot upgrades	LEPA widely used and 11 of 12 agreed it reduces pumping; cost and maintenance are barriers.	Fund equipment plus design, training, maintenance, and verification; do not assume uniform savings.
Scheduling and monitoring	Strong willingness to use soil-moisture, precipitation, and water-use monitoring.	Bundle sensors, weather information, decision support, and Extension/technical assistance.

Program component	Beryl-Enterprise evidence	Recommended design response
Partial-season irrigation	Most respondents opposed delayed starts or early shutoff.	Use selectively where crop economics and agronomy support it; do not make it the default strategy.
Crop adaptation	High interest in lower-water-use varieties; more tentative interest in different crops.	Emphasize within-crop adaptation first; evaluate crop shifts case by case.
Education/demonstration	All respondents rated demonstrations and general education helpful.	Use local demonstration farms and peer learning to show verified water and production outcomes.
Collective governance	Community agreements received mixed support and uncertainty.	Build collaboration gradually with clear rules, transparent accounting, and voluntary pilots.

Implementation Sequence

- Phase 1 - **Baseline and governance**: inventory wells/pivots, install or verify flow meters, establish baseline pumping, define program authority and saved-water accounting, and agree on transparent reporting.
- Phase 2 - **Voluntary pilot**: enroll a manageable group of producers, offer a menu of eligible investments and management practices, provide technical assistance, and document implementation costs and administrative burden.
- Phase 3 - **Verification and learning**: compare measured pumping with baseline/expected use, document yield and economic outcomes where possible, identify operational problems, and publish demonstration results.
- Phase 4 - **Adaptive scaling**: revise incentive rates and rules based on verified cost per acre-foot conserved, expand successful practices, and add or remove practices based on performance rather than assumptions.
- Phase 5 - **Long-term basin management**: combine verified on-farm savings with groundwater-condition monitoring to assess whether cumulative actions are sufficient to meet scheduled reductions and adjust the program as conditions change.

Performance indicators

Table 2. Example indicators for evaluating a water-optimization program.

Outcome area	Example indicator
Water conservation	Acre-feet of pumping reduced relative to an agreed baseline or comparison method
Cost effectiveness	Public/private program cost per acre-foot of verified water conserved
Agricultural performance	Yield, revenue, or profit maintained per unit of water pumped, where data are available
Technology performance	System reliability, plugging/maintenance events, and operator time requirements
Participation	Number/acreage enrolled, repeat participation, and completion rate
Producer acceptance	Satisfaction with rules, payments, reporting burden, and technical assistance
Groundwater response	Trends in groundwater levels/conditions using the best available basin monitoring data

Overall Takeaways

Takeaway summary

Objective 1:

The pivot-level dataset is not yet complete enough to quantify LEPA impacts. Completing sprinkler classifications, conversion dates, flow-meter records, crop information, and yield data is the highest priority before making performance claims.

Objective 2:

- Producers clearly recognize the groundwater challenge and generally accept the need for reductions, but they want conservation to be paired with flexibility, incentives, clear rules, and credible measurement.
- Water spreading/saved-water flexibility, an optimization fund, flow meters, groundwater monitoring, LEPA upgrades, and irrigation-management tools received the strongest support. These findings point toward a measured, incentive-based approach rather than a strategy centered on abrupt partial-season irrigation cuts.
- LEPA is viewed positively for reducing pumping, but high installation and maintenance costs and management demands are significant barriers. Program support should therefore address implementation quality and ongoing operation, not only equipment purchase.

- Demonstrations, training, soil-moisture and weather-informed scheduling, and lower-water-use varieties offer practical pathways to broaden conservation beyond sprinkler hardware.

Objective 3:

A transferable program model should combine transparent groundwater accounting, clear treatment of conserved water, flexible incentives, locally appropriate technology and management choices, technical assistance, voluntary pilots, and verification of actual pumping reductions.

Next Steps

We plan to complete Objective 1 data collection and analysis and use the combined Objective 1 and Objective 2 findings to refine the Objective 3 guide. The final guide will be structured so that other groundwater areas can adapt the framework to their own hydrology, crops, irrigation systems, legal constraints, producer preferences, and reduction targets while retaining the central principle demonstrated by the Beryl-Enterprise case study. Effective water conservation is most likely when producers have a clear reason to conserve, a measurable way to document savings, and a practical benefit from using less water.