Jesse Kruthaupt
Upper Gunnison Project Manager

June 26, 2024

Nora Flynn
Colorado Water Conservation Board
1313 Sherman St, Rm. 712
Denver, CO 80203

Re: Final Report POGG1,PDAA,202000000009.

Dear Mrs, Flynn,

Please review the following summary report for Trout Unlimited's (TU), Innovative Irrigation Efficiency for Mountain Meadows Project. TU was awarded this grant in July of 2019 and continues to work with producers to develop innovative methods to improve flood irrigation efficiency through automated scheduling and remote sensing.

Background

TU developed this project in coordination with several producers, the Upper Gunnison River Water Conservancy District (UGRWCD), and Colorado State University to evaluate opportunities to improve efficiency of wild flood irrigation practices. This work is relevant to approximately 600,000 acres of pasture and hay on Colorado's western slope where flood irrigation is used. Flood irrigation is simple and less costly than sprinkler or other pressurized irrigation practices, however it requires more water be diverted from the river of supply and can be labor intensive relative to other types of irrigation. Unmanaged, flood irrigation can result in water being over or under applied to crops, which in turn can negatively impact crop production, soil health, and water availability during low supply periods. Water managers in many mountain valleys have long realized that flood irrigation provides habitat for waterfowl, wildlife and supports groundwater recharge in these headwater landscapes. Further, many mountain community leaders are concerned that changing historic flood irrigation practices to more efficient methods like sprinkler will negatively impact springs, seeps, and wells, and change surface water reuse on down gradient fields. Therefore, the focus of this project was to develop strategies to maintain the benefits provided by flood irrigation practices while improving efficiency through automation and remote monitoring. During this grant period, TU shifted focus and funding to Task 1 (Automated Irrigation Scheduling), Task 3 (LoRaWan Network), and Task 4 (LoRaWan Automation) because those concepts showed to be the most practical and attractive alternatives for local producers. Task 2, (Ditch sealant trial) was of less interest to partners.

Task 1: Automated Irrigation Scheduling

During the last 4 years Trout Unlimited (TU) worked with five ranches in the Upper Gunnison basin and one ranch in the San Luis Valley to test prototypes of a timer-latch assembly, nicknamed the the Auto-Tarp. The Auto-Tarp unit is designed to mount on a typical board-stack

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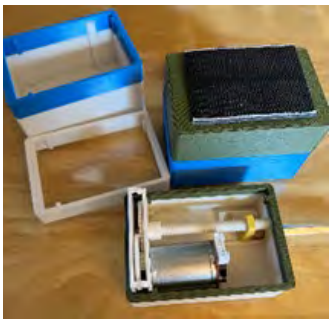
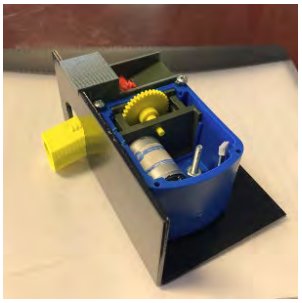
structure for water control - often installed with NRCS cost share assistance. Each season the Auto-tarp unit has transformed to become more compact and reliable. TU continues to use a model built from low-cost parts purchased online and has deployed 30 of these units at the participating properties. This model has provided a proof of concept, allowed irrigators to experiment with the approach, and has inspired tech savvy entrepreneurs to develop versions and circuit boards programable with BLE, WIFI, and LoRaWan radio. These prototypes continue to evolve to simplify installation, reduce costs, and improve reliability. The goal is to make the unit compact, low cost, with a user-friendly programable interface. As of June of 2024, there is not an Auto-tarp unit ready for mass production.

Below is a sequence of photos and videos showing the auto-trap unit development.

Video 2021
Video (2022)
Video (2023)
Setting Timer



2023 version



2022 Version

2021 version

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Trial Locations

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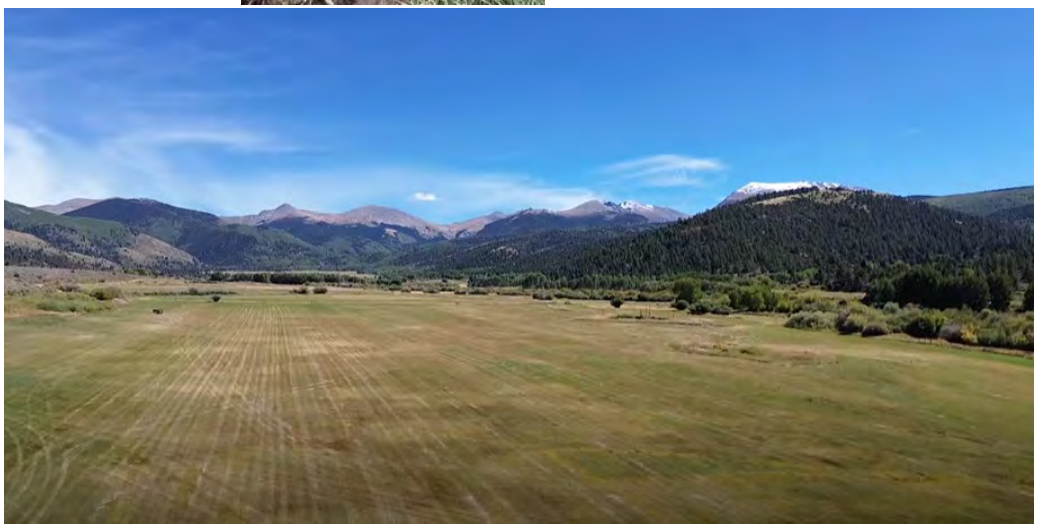

SLV site (7 structures)



Cranor Site (6 structures)

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Razor Creek site (7 structures)

Trampe Site (15 structures)

Elk Creek Site (4 structures)

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In 2022 TU was awarded a NRCS Conservation Innovation On-Farm-Trials Grant. This grant has been used to test the technology and quantify yield, labor impacts producers experience.

Task 2: Ditch Sealant Trial

TU worked with an irrigator on Ohio Creek to test the effectiveness of a ditch sealant material called SoilFloc. This product is similar to PAM *(Polyacrylamide*). Ten units of the SoilFloc sealant product was applied in the Teachout Mesa Ditch in 2020. TU and the ditch owners decided not to proceed with the ditch liner trials proposed as part of this project. It was determined the longevity of the product and risk of failure outweighed the cost of labor and materials. TU requested moving the remaining funds for this task to task 1 (irrigation scheduling) and task 3 (LoRa technology).

Task 3: LoRaWan Communication Network

In this task, TU demonstrated the use of LoRa-Wan (long range wide area network) for real time monitoring of water deliveries, ground water, soil moisture and stream flows. LoRa is option for wireless communication between a base station (gateway) and variety of sensor nodes. The base station communicates with sensors via unquie radio frequency and transmittes that data to user interface via cell or ethernet. Our vision is this type of network can reduce labor, improve water management, assist with record keeping, and monitoring conservation outcomes.

TU deployed a test LoRa Wan gateway near the town of Gunnison in 2019 that used The Things Network (TTN) protocol for radio communication. TU purchased and tested water level sensor and soil moisture sensor on Trampe Ranch to demonstrate the use of of LoRa networks to monitor water deliveries and demands. Configuing devices and maintaining the supporting interface for data viewing proved time consuming. In 2023, TU contacted with Ethos Connected (previously Paige Wireless) to deploy two LoRa-Wan networks near Gunnison and one near San Luis, CO. The two Gunnison networks consisted of; 2 gateways, 6 water lever sensors in ditch flumes, 3 water level & stream temperature sensors in Tomichi Creek, 1 water level sensor in a well, and 4 soil moisture sensors near the automated irrigation test fields. The San Luis network consists of three water level and temperature sensors in Culebra Creek. Water right owners and local water managers used these networks to manage and monitor irrigation practices and in-stream water quantity and temperature.

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Vega Radar sensor in Cranor flume

Vega Radar on Trampe Lateral

Water level Razor Creek

In 2024, TU and Ethos are working on installing two additional gateways in the Gunnison basin to provide communication with sensors in Quartz Creek and Razor creek. These sensors will include stream temperature, stream water level, and ditch/flume level.

Task 4: LoRa-Wan Automation Trial

TU has not completed the development of a LoRa control node to trigger the close function on an automated check gate. Project partners have integrated the use of Bluetooth communication to program the latch mechanism. During the spring of 2024 a new circuit board water developed with BLE, LoRa and cell radios. LoRaWan has been used to communicate with and program the timer in the lab. TU is working with the programmer and Ethos engineers to configure the radio to communicate thought the LoRa network at Trampe's and Cranor's. Field test of the LoRa radio is expected in July 2024.

Outreach

The demonstration sites using automated irrigation control structures have spurred enormous interest among the local water community and individuals across the western US. In fact, a short clip showing an early version of the auto-tarp received over 14 million views on TU's Instagram and I have received inquiries about the auto-tarp from irrigators on the Snake River near Jackson, WY. Unfortunately, production/manufacturing limitations is the bottleneck to getting more of this equipment on the ground.

The LoRa Wan network examples have also spurred interest and collaboration with watershed partners in Gunnison and San Luis. TU is working with partners to utilize the infrastructure to monitor flows, temperature, and other water quality variables in the greater watershed beyond the on-farm-trial fields.

TU has hosted 5 field tours and presented at 4 agriculture water workshops and directly interacted with 200 agricultural producers discussing this work. In addition to site visits and presentations, several articles have been written about the project including this article in the Denver Post.

May 2022 site visit (Cranor Ranch)

The table below highlights several major outreach events.

Group	**Type**	**Attendees**	**Date**
Colorado Agricultural Water Alliance	Workshop/presentation	25	Nov 2019
NRCS staff	Site visit	6	May 2021
Rio Grande Roundtable	Site visit	18	May 2022
Society For Range Management	Workshop/presentation	60	Oct 2022
Colorado Ag water Alliance	Site visit	12	Oct 2023
Master Irrigator SLV	Presentations	50	Jan, Feb & June 2024
Congreso de las Acequias- March 9, 2024- approx. 50 people	Presentation	50	March 9, 2024
Total		221	

Conclusion

As noted in a previously, TU was awarded a NRCS CIG On-Farm-Trials grant to expand the use of automatic irrigation structures and LoRa radio technology in the Gunnison and Rio Grande Basins. TU has utilized these federal funds during 2023 to install structures at Cranors and the SLV site. Because the experimental nature of the project and delay in deploying the remotely

programable version of the auto-tarp TU plans to wait to purchase the units once further testing is completed. In the meantime, the original version built from on-line parts is deployed at the test sites.

Total expenses billed to this grant are $ 53,712.86. Details on those expenses are include in the attached invoice. A small portion in the amount of $ 335.14 has not been and is not expected to be expended.

TU would like to thank the Colorado Water Conservation Board for their support of this project. Please let me know if you have any questions. I would gladly host a field trip to the sites or discuss specific details over the phone.

Sincerely
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