Open Source Automated Irrigation System for Small Farms, Urban Farms or Specialty Crops

Final report for FNC16-1033

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Grant Recipient: Renegade Acres
Region: North Central
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Project Coordinator:
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Project Information

Description of operation:

Renegade Acres was established on October 15, 2015. Before this, we had been urban farming up to 7 parcels of land in a suburban setting. In 2015 we purchased a house on 7 acres and turned our urban adventure into a small farm. We quickly decided We wanted to drip irrigate the entire farm, but we had no previous experience with this and wanted to make sure it was affordable, easy to set up, and easy to maintain. We knew that irrigating 7 acres would be more difficult than the small 50x50 plots we previously had. We applied for a SARE grant to explore the idea of an automated irrigation system – which already exists – but using consumer-grade lawn irrigation equipment – which was a new concept.

Summary:

Abstract

This project aims to solve multiple issues facing small and urban farmers with regards to crop irrigation. Small and urban farms often employ polyculture cropping systems. Rather than a single, large crop covering multiple acres, small and urban farms will grow several different crops in small areas. Each crop may have its own irrigation requirements – some requiring more frequent irrigation and some requiring less frequent irrigation – which presents a unique challenge that this project aims to solve.

Water conservation is an important part of any farm, big or small. Conserving water is good for the environment, your crops, and your bottom line. When sourcing water from a small body of water – a creek, river, pond or lake – there is a limited amount that can be used. When sourcing water from a municipal supply, there is a significant cost. Excessive irrigation can cause erosion, runoff, high weed pressure, and crop damage. This project aims to provide an easy method for conserving water within the proposed irrigation system.
Southeast Michigan is currently experiencing an Urban Agriculture boom. Abandoned lots in city centers are becoming small farms, families in residential areas are raising chickens and growing their own food, and small farms are popping up in rural, suburban and urban areas. Irrigation is the key to a successful crop, and getting water from its source to the plants is difficult and costly even for a small farm. This project aims to provide an economically viable and ecologically sound solution for small and urban farmers.

Proposed Solution

To solve the unique irrigation challenges of small and urban farms, and to conserve water regardless of the source, we have come up with a solution that utilizes open source hardware and software. This, combined with consumer and professional-grade irrigation components creates an economical, efficient automated irrigation system.

The core component of the system is the OpenSprinkler irrigation controller. Unlike other commercial irrigation controllers, this one is Open Source, meaning the hardware and software are both able to be modified by the user. This allows the system to be customized in any way imaginable. Another key benefit of the OpenSprinkler system is the price. The controller itself retails for $139, which is much more affordable than the commercial systems which can cost thousands.

The second component of the system is consumer-grade solenoid irrigation valves. These valves are typically used for lawn sprinkler systems; however, they can also be utilized for any irrigation method. The OpenSprinkler controller sends signals to the irrigation valve to open or close at specific time intervals. The valves can be located up to 1,500 feet away from the controller, making this an ideal solution for small farms.

The third component of the system is professional-grade drip tape. Drip tape is a plastic hose with small slits or emitters every 8” to 12”. Drip tape is extremely efficient at delivering water directly to the root system of a crop, without wasting water due to overspray, evaporation or runoff.

The combination of the Open Source OpenSprinkler irrigation controller with the consumer and professional grade components will allow small and urban farmers to customize their irrigation based on their needs. The system is affordable and efficient. It will deliver water to a diverse set of crops and can be automated.

Build Process

To make sure the system was installed by our first planting on June 1st, I began work in late April, 2016. I purchased all of the valves, irrigation tubing, piping, irrigation controller, filters, drip tape, and other materials early so I could inventory everything and make sure I was not missing any crucial items. This was the bulk of the expenses and a detailed expense sheet is located on the budget form. I contacted the local land surveying company who originally surveyed our neighbor’s land to get a report and verification of the existing property line. I wanted to make sure that I was installing my water line within my property to prevent any possible future disputes. They provided this at no charge. After verifying the property line, I made sure that the water line was more than 15 feet from the property line for a personal level of comfort. I laid out and marked the proposed waterline path with string, posts and ground-marking spray paint. I submitted a MISS DIG inquiry to verify there were no underground utilities on my proposed path. The various utility companies marked their underground items and none of them conflicted with my proposed path. Next, I contacted a local well drilling company and had them upgrade my well
pump and bladder to support the irrigation requirements for the drip system that I had calculated based on manufacturer information. They also split the main line properly for me to tie in the irrigation system. Upgrading the well was an alternative solution to running electricity 1,300 feet to the back of our property to power a pump and take water from a stream. The cost of running power to the stream was double that of upgrading our well.

I installed an underground main shutoff valve for the irrigation system 5 feet from the well. This allows me to shut off the water to the irrigation system directly at the well for maintenance and winterization. I also added a blowout valve for winterization purposes. Rather than running PVC from the well to the field, I opted for polypipe and purchased a grade that was recommended by a local irrigation company. A trench was dug from the well to the back of the field to accommodate the main irrigation line. A few issues arose while digging the trench. The first issue was abandoned non-commercial electrical wires. As soon as the wires were discovered, an electrician friend was consulted to determine if they were live. They were not live so digging was resumed. The second issue was a hidden tree trunk and root system. The trench digger was unable to cut through the massive root so it was hand dug and removed with our tractor. Once the entire trench was dug, the irrigation pipe was laid in the trench and valve stand pipes were installed using a “T” connector. The standpipes were constructed out of PVC and subsequently painted white to increase their UV resistance. Along with the irrigation pipe, irrigation wire was run from our garage and followed the irrigation pipe to the back of the field. Appropriate gauge wire was used to allow for the distance needed.

An irrigation valve was installed at the top of each valve standpipe. Each irrigation valve has its own anti-siphon feature to prevent water from going through the system in reverse. This was important to maintain water safety and prevent any contaminants introduced at the drip line from entering the water supply. A backflow prevention device, as required by code and for Michigan MAEP verification purposes, was installed at the beginning of the system. Each irrigation valve was connected to the irrigation wire using outdoor waterproof splicing nuts. I further waterproofed each wire connection by wrapping it in outdoor electrical tape, enclosing each bundle of wires in a plastic bag and finally we will be installing a white, above ground valve box over each valve and standpipe in the coming year. A filter is attached to the outlet of each valve to catch debris and prevent it from clogging the downstream driptape. From the filter a smaller diameter irrigation piping was connected, also called a “sub main line”, which was then connected to drip tape at the “plot” of land within the field.

All of the vales are wired to the OpenSprinkler Open Source irrigation controller that was installed in my garage. The controller is connected wirelessly to our network and the internet. After connecting each of the irrigation wires to the unit, a test was performed. Each valve was signaled to turn on and I would verify that the valve actually opened and let water through. This system can be activated manually or using a mobile website. I was able to test the valves from my cellphone while I was in the field, between 100 and 1000 feet from the well and the irrigation controller. The commands were instantly sent to the valves each time. Within a few weeks of installing and testing the irrigation controller I had set up irrigation schedules and weather related irrigation delays. The irrigation schedule was based on each plot’s plant types and the water flow as measure at the drip tape itself. I wanted to water as infrequently as possible but still maintain proper soil moisture.

Project Objectives:
1. Develop and test a low cost, automated irrigation system that can be shared with other small and urban farmers

2. Conserve water with the design of the irrigation system to positively impact the environment and save farmers money

3. Improve farmers’ quality of life by saving them time with an automated irrigation system.

Research

Research results and discussion:

Research Approach

The research we did for the efficacy of this system was the amount of water the system used in 2017, compared to the amount of water used in 2016, as well as the number of irrigation events logged between the 2 years.

The graphed data for 2016 is below in Figure 1. In 2016 when the irrigation system ran, it ran for 1 hour per crop, so it is marked on the graph by a single yellow dot. When it rained, we did not track rainfall, so it is marked by a single orange dot. You will notice that we either irrigated or had rainfall nearly every single day.

![Temperature, Rain and Irrigation for 2016 Growing Season](image1)

Figure 1.

In 2017 we decided to use the intelligent irrigation controls. The graph for 2017 is below in Figure 2. You will notice the graph has more detailed information because we tracked rainfall (now displayed as an orange line) and the variable irrigation times (now displayed as a yellow dot representing irrigation time). The difference in the 2017 data over the 2016 data shows less frequent watering and shorter watering periods.
In 2016, it rained 64 out of 153 days in the season (42%). We irrigated the crops 51 times (33%). We used an estimated 101,075 gallons of water. Each irrigation event was manual.

In 2017, it rained 75 out of 153 days in the season (49%). We irrigated the crops 35 times (23%). We used an estimated 42,907 gallons of water. Each irrigation event was automated.

In 2017, we used 58% less water (a savings of 58,168 gallons), we irrigated 16 fewer times, and for shorter periods each time. We also spent considerably less time manually turning on the irrigation system.

A full table of the data can be found at this link: CHRISTIAN-FLICKINGER-Irrigation-Log-2016-2017

**Conclusions**

We set out to develop and test a low cost, automated irrigation system that can be shared with other small and urban farmers, conserve water with the design of the irrigation system to positively impact the environment and save farmers money, and to improve farmers’ quality of life by saving them time with an automated irrigation system.

Our irrigation system design consisted of consumer-grade lawn irrigation valves, professional-grade drip tape, and a consumer-grade open source lawn irrigation controller. These components were easy to purchase off the internet or in big-box home improvement retailers. Repair parts were also easy to find both online and in stores. Ignoring the specific water delivery needs of our property, the system is relatively affordable. The valves, delivery pipes, and controllers are installed once and left in place for the life of the system. The sub-lines from the valves to your various crops can be changed each year - added or removed. We purchased 15-mil thick drip tape which cost more up front, but can be reused for multiple years. We did experience minor leaks in some areas in year 2, but that was easy to repair. Another alternative is to purchase thinner drip tape and replace it each year. We felt that this would have been wasteful, so we recommend the thicker drip tape if you
can disconnect and move it all at the end of the year.

Aside from the inexpensive design, the system also had a positive impact on the environment. Drip irrigation has well known benefits: 90-95% water efficiency, targets crops and not weeds, less erosion, and less water required. We estimated that we had a 58% water savings by using the intelligent irrigation methods of the irrigation controller. It considered weather conditions such as temperature, future forecast, past forecast, humidity, etc. and determined how much to adjust the watering program. In the 1st year we watered everyday it was dry, unless it was raining or rained the previous day. In the 2nd year, we let the intelligent irrigation method take over. This was a huge saving on our water usage, and our crops did not suffer at all.

The intelligent irrigation feature was also the main way that we improved our quality of life. In the 1st year, we had to constantly worry about the irrigation. We manually turned it on every day. We felt like we did not know what we were doing – which we didn’t at the time. We weren’t sure if we were giving the crops too much water, or not enough. In the 2nd year, we let the intelligent irrigation system make changes to our watering programs. It turned the irrigation system on and off, whenever it determined was appropriate. After the first few weeks in 2017, we never touched the irrigation system. It was out of our mind. One less thing to worry about.

The OpenSprinkler irrigation controller was a crucial component of our design. In the 2 years since this grant was proposed and the original system was designed, alternatives have come out on the market. They are not open source, but they are just as affordable, and possibly more flexible. Irrigation controllers such as SkyDrop, Rachio, Spruce, Lono and GreenIQ, to name a few, are doing the same thing that OpenSprinkler has done, but in a cleaner, more consumer-friendly package. They are all compatible with the system we built, and can be interchanged at any time.

Overall, the system has outperformed our expectations. We continue to find value in the original investment, and have yet to purchase new drip tape. The amount of water we saved in year 2 compared to year 1 surprised us. We hope to continue to make improvements and possibly save more water next year.

**Participation Summary**

2 Farmers participating in research

**Educational & Outreach Activities**

**PARTICIPATION SUMMARY:**

Education/outreach description:

**OUTREACH**

We have shared the irrigation project on various social media accounts include Facebook, Instagram, snapchat and through email as well. Our Facebook accounts have a combined audience of 2,500 people, our Instagram account has an audience of 1000 people, and our snapchat has an audience of around 100 people.
We plan to install a page on our blog this February detailing our irrigation project for all to see. We shared our project with various small farmers at Farm Bureau events, and will be speaking about our irrigation project this February at a farming conference in Michigan (Specialty Label Panel, from an organic perspective, at the Michigan Farm Bureau Young Farmer Leader's Conference). We are very excited to share not only the SARE grant process, but also the success of our project specifically.

We also share our irrigation story with anyone who visits the farm. We had around 25 visitors last year who we shared the story with. As the farm becomes more and more established we intend to host groups of people and as part of the tour they will see the irrigation system and how it functions.

Project Outcomes

2 Farmers changed or adopted a practice

Information Products

- Automated, Open Source Irrigation with Christian Flickinger (Multimedia)

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