2012

Systems model and prototype development to capture and use rain water run-off from a high tunnel

Raymond S. Hansen
Iowa State University, hansenr@iastate.edu

Linda L. Naeve
Iowa State University, lnaeve@iastate.edu

Shawn C. Shouse
Iowa State University, sshouse@iastate.edu

Systems model and prototype development to capture and use rain water run-off from a high tunnel

Abstract
High tunnels offer opportunities for farmers to increase production of seasonal horticultural crops. Because of the tunnel roof design, rainfall poses challenges of drainage, erosion and runoff. This project investigates a system for catching and collecting the rainwater for future use in irrigation.

Keywords
value Added Agriculture Extension, Fruit and vegetables

Disciplines
Horticulture | Water Resource Management

LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Systems model and prototype development to capture and use rainwater run-off from a high tunnel

Abstract: High tunnels offer opportunities for farmers to increase production of seasonal horticultural crops. Because of the tunnel roof design, rainfall poses challenges of drainage, erosion and runoff. This project investigates a system for catching and collecting the rainwater for future use in irrigation.

Principal Investigator:

Ray Hansen

Co-investigators:
Linda Naeve
ISU Extension and Outreach
Value Added Agriculture Program
Iowa State University

Shawn Shouse
ISU Extension Program Specialist
Lewis

Budget:
$18,959 for year one

Q Can rain water run-off from high tunnels be economically and efficiently captured and reused for drip irrigation?

A The model was built and proven to be efficient and economical, especially in areas where access to water and power are limited.

ECOLOGY

Background

High tunnels are simple, plastic-covered, passive solar-heated structures in which crops are grown in the ground. They are used by fruit and vegetable producers to extend the growing season and enhance production in cold climates. The covered growing area creates a desert-like environment that requiries carefully monitored irrigation practices.

The goal of this project was to design and construct a rainwater collection system in a high tunnel that reduces drainage problems, erosion and crop loss caused by high volumes of rainfall runoff along the sides without altering the soil environment around the high tunnel. Project objectives were:

1. Design a collection, retention and irrigation system to use rainwater runoff from a high tunnel;
2. Develop a prototype of the system on an existing high tunnel; and
3. Develop instructional resources and demonstrate the system through outreach events.

Approach and methods

A system consisting of three components - rainwater catchment, retention, and irrigation system - was designed and installed on an existing high tunnel. Vinyl gutters were attached to capture rain on the 30 x 96-ft. high Quonset-style high tunnel at the ISU Armstrong Research Farm. The gutters were attached to boards affixed to the high tunnel below the existing hip board allowing a 6-inch drop per 100 linear feet to generate adequate flow into the tanks. Two methods were demonstrated to channel the water from the high tunnel cover into the gutters, including attaching an additional strip of plastic to the cover with repair tape (Repair tape is clear duct tape. In this case, a narrow strip of plastic is taped to the existing roof and the loose end of the plastic strip is laid in the gutter thus allowing the water to run from the roof over the additional piece of plastic and directly into the gutter.) Or the plastic strip is attached in the channel with wiggle wire. (Wiggle wire is a standard term for the bend wire that clamps the plastic to the channel iron – in this scenario the extension piece of plastic is locked into place with the wire rather than tape.) The strip of plastic was long enough to reach the inside bottom of the gutters.

The proto-type was installed on the Quonset-style high tunnel at the Armstrong Research and Demonstration Farm

The water was collected in two 500-gallon tanks located on each side of the tunnel, pumped from the tanks and used for irrigating crops in the high tunnel through a drip irrigation system. Electric and battery-powered pumping systems were demonstrated. A 12-volt diaphragm pump was powered by a 12-volt deep cycle storage battery. The battery was charged by a 50-watt solar panel. The solar panel provided ample charge in the battery to run the pump up to 10 continuous hours every three or four days to meet the irrigation needs of a mature crop in the high tunnel using low-pressure, drip irrigation.

Results and discussion

Between July 1 and October 29, 2011, the system with two 550-gallon tanks captured approximately 44 percent of the irrigation needs in the high tunnel. Increasing the storage tank size to collect the first inch of rainfall would capture 60 to 70 percent of the growing season rainfall, or about 14 to 17 inches on the roof area of the high tunnel in Iowa (two 1,000-gallon tanks collect approximately 28,000 gallons per season from a 30' by 96' high tunnel). A water sample was taken from the storage tank in early August and analyzed by the State Hygienic Laboratory at the University of Iowa. Test results showed the presence of coliform and E. coli bacteria. This was anticipated due to the likelihood of bird manure on the high tunnel cover and insects in the gutters and tanks. Because of this risk, rainwater collected from the high tunnel should be used only for drip irrigation and other non-potable needs.

Conclusions

Rainwater can be efficiently and effectively captured from a high tunnel and used to supplement the irrigation needs of crops growing in the high tunnel. The amount of water collected for irrigation use depends upon seasonal rainfall, the storage capacity of the water tanks and the frequency of irrigation events.

A substantial amount of rainwater can fall on the cover of a high tunnel even during a small rain event. Capturing the rainwater from the high tunnel eliminates drainage and erosion issues around the high tunnel and the problem of frequently saturated soils along the sides of the tunnel. It also creates a mechanism to use water resources that would otherwise be lost and provide an alternative water source for irrigation.

A simple system installed on a high tunnel effectively captured and contained rainwater for reuse through a drip irrigation system in a high tunnel. Although it is more efficient to install the system at the time the high tunnel is constructed, this project demonstrated that it can be added to an existing high tunnel. A solar-powered pump operated as efficiently as the electrically-powered pump to provide a continuous flow of water for the required time per water event. In 2011, the system captured an average of 43 percent of the water needs in the high tunnel over four months during the period of high water usage in the high tunnel. The cost of the catchment system was approximately $1,200 (an additional $700 for solar-powered) and required approximately 70 hours of labor to install.

A field day at the Armstrong Research and Demonstration Farm led by Shawn Shouse, Extension agricultural engineer.

Impact of results

This project will benefit many farmers with existing and new high tunnels. In response to hearing a lecture and seeing the publication on the construction and operation of the system, a commercial vegetable producer said, "I have been seriously thinking about putting a catchment system on my tunnel, but didn't have the time to determine what I needed to accomplish it. This is the information that I needed to get it done."

State Natural Resources Conservation Service (NRCS) staff forwarded the electronic publication created for this project to all county NRCS units to share with farmers who received NRCS Environmental Quality Incentive Program (EQIP) funding for high tunnels. They felt this project aligned with the goals of EQIP and will help farmers better manage their soil and water resources.

On March 31, 2012, Golden Hills Resource Conservation and Development (RC&D) sponsored a rainwater harvesting workshop in Oakland, Iowa. The water catchment system model was used to install a system on a 20' x 24' high tunnel during the workshop. Bahia Nightengale, local food coordinator at Golden Hills RC&D, reported that they were able to modify the design to retrofit it on an existing Quonset-type high tunnel. The purpose of the rainwater collection system on this high tunnel was to save the rainwater in a 55-gallon drum for evaporative replacement from an aquaculture system. Sixteen farmers with high tunnels attended the workshop and nearly all participants said that they were going to install a similar system on their high tunnels.

Education and outreach

- **Field days:** July 2011, ISU Armstrong Research and Demonstration Farm, 18 participants and Practical Farmers of Iowa at Nature Road Farm, Boone, 65 participants
- **Conferences:** January 2011, Practical Farmers of Iowa, Ames, IA, (poster) and Iowa Fruit and Vegetable Growers Conference, Ankeny, IA, (poster and presentation)
- **Extension Publication:** Naeve, L. and Shouse, S. 2011. PM-3017, Rainwater Catchment from a High Tunnel for Irrigation Use. Iowa State University Extension and Outreach. Available as a downloadable pdf file: https://store.extension.iastate.edu/ItemDetail.aspx?ProductID=13734
- **Videotape:** Rainwater Catchment from a High Tunnel for Irrigation Use. See www.leopold.iastate.edu, www.iowaproduce.org and www.extension.iastate.edu/valueaddedag. A DVD of the videotape makes it convenient to show at workshops, field days, and other events.

Leveraged funds

Two other projects were leveraged as a result of the funding support for this project. The system developed through this project was adapted and constructed on a gothic-style high tunnel in Boone County. The North Central Sustainable Agriculture Research and Education (SARE) program provided the financial support to produce the videotape, "Rainwater Catchment from a High Tunnel for Irrigation Use."

***For more information, contact**:*
Ray Hansen, ISU Extension Value Added Agriculture, 1111 NSRIC Building, Iowa State University, Ames, Iowa 50011; (515) 294-3890, e-mail hansenr@iastate.edu