Surface Irrigation Monitoring and Cellular Communication System to Implement Inflow Cutoff Strategy

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2007 U.S. Census of Agriculture (USDA)\(^1\)

Agricultural water usage accounts for nearly 80% of nation’s water demand, 90% in western states

[Aillery. 2004].

Surface Irrigation accounts for 58% of all methods used (approximately 39 million acres) [USGS. 2000].

2007 California Census of Agriculture\(^1\)

Surface irrigation accounts for nearly 50% of all methods used in state (approximately 4 million acres).

- Agricultural sector is under severe scrutiny to reduce tail discharge and increase water use efficiencies.
- In very dry years such as 2014, water availability is itself a serious issue!

\(^1\) Latest installment of respective census.
Alfalfa is a major crop in the Western United States [Putnam. 1996]
- Grown on nearly 1 million acres in California.
- It accounts for 20% to 27% of irrigation water usage.

Border check or flood irrigation is predominant type of irrigation system utilized in alfalfa production.
- Used for its simplicity and low capital costs.
- Subject to large inefficiencies such as surface runoff or deep percolation
  - Around 60% water use efficiency, lowest among irrigation methods [FAO. 1989].
- Proper cutoff strategy can reduce runoff and other water losses to as little as 2% of applied water [Bali. 2001]
To Develop a wetting front monitoring system for check or bordered irrigated alfalfa,

To interface the monitoring system to a communication system to alert the irrigators to enhance irrigation efficiency.

To Demonstrate the system to end users.
Project Developments

- Early development: Development of a wireless network of sensors in early 2003-04 indicated that “Communication range” was an issue and network of transmitters installed in the field may hinder harvesting operations (Oliveira, 2006)!
A monitoring system consisting of buried sensors and cellular communication system was developed in 2010. The system was successfully tested on the UC Davis campus. This system could be used to reduce tail water discharge and improve irrigation efficiency [Saha et al., 2011]
However, growers surveyed indicated a preference for the wireless system. So a new wireless network was developed and demonstrated on UC Davis campus during Alfalfa field day.
The Current System

Wetting-Front Advance Monitoring System I: A simple system that uses a single sensor per check and relies on the expertise of the irrigator.

- Uses one sensor per check placed at a certain distance from the tail ditch based on irrigators' knowledge of the field.
- Upon sensing the wetting front, the unit wirelessly transmits the information to a central module.
- The central module can receive information from up to 256 units, identify them, and generate a cell phone text message to alert the irrigator.
Field setup

Central Module

Wetting front advance monitor and transmitter
Contact sensor and transmitter

Sensor identification

Irrigation Water Arrival Sensor
Sensor Number: 7
Serial Number: 1306782

Contact sensor

Installation
Central Module

Module  Battery

Events
Sensors
Contacts
Central Module

<table>
<thead>
<tr>
<th>Time</th>
<th>ID</th>
<th>GRP</th>
<th>MSG</th>
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<tbody>
<tr>
<td>13:46</td>
<td>0007</td>
<td>00</td>
<td>Wet/Lost/Low Battery</td>
</tr>
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</table>

Sensor Assignment

Sensor 2
Assignment 3083391

Contact Details
Shrini
15302200664
Text When Wet/Lost/Low Battery
Cell Phone Text

Irrigation Monitor AT&T: Water arrived at sensor 7 at 01:58 PM 01/03/2012
Sent: 1:57PM

Irrigation Monitor AT&T: Water arrived at sensor 7 at 02:43 PM 01/03/2012
Sent: 2:43PM

Irrigation Monitor AT&T: Water arrived at sensor 14 at 02:45 PM 01/03/2012
Sent: 2:44PM

Irrigation Monitor AT&T: Water arrived at sensor 1 at 02:45 PM 01/03/2012
Sent: 2:45PM
More Advanced System

Wetting-Front Advance Monitoring System II: A system that uses multiple sensors per check and determines irrigation cut-off time and communicates that information to the irrigator.

- Uses multiple sensors per check placed at known distances from each other to determine wetting front advance time.
- Upon sensing the wetting front, the units wirelessly transmits the information to a central module.
- Sensor poles can also measure surface water depth,
- Uses very first irrigation in the season to estimate inflow
- During subsequent irrigations, system computes the wetting front speed, determines when the irrigation should be cut-off to limit tail drainage to a desirable low level based on a model and transmits that information through a cell phone text message to inform the irrigator.
Field Setup

- Multiple sensors per check
- Central Module
Water Savings
(Arnold, 2013; Upadhyaya2013)

• Proper Cutoff Strategy can save

→ 170 to 200 acre-ft for a typical 300 acre farm (assuming just five irrigations per growing season).

→ System can pay for itself in one season!
Limitations of the System

• Just 0.5 mile range (Distance between the sensor pole and the central unit)

• Most farmers we talked to wanted at least 2 mile range
Commercialization- CERMETEK MICROELECTRONICS

Ag Tech Sustainability Grant

⇒ In Collaboration with Cermetech Microelectronics Range has been increased to 2 miles.

⇒ System is being marketed by this Bay area company
What can a Network of wireless wetting front monitoring and communication system do for you?

- **For you**: Saves time, labor, and money.
- **For the environment**: Reduces tail drainage.
- **For the future**: Conserves a valuable resource.

“We need to produce more food with less water to feed the world in the future”

- One estimate is 21% more food production in 10 years while using 17% less water!

Thank you for your attention!