Smarter Irrigation Management: Wireless Sensor Systems

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Water Use - Nursery Industry

- Resource intensive – water and nutrients
- Berghage et al., (1999) could exceed 180 kl hectare^{-1} day^{-1}
- Aldrich and Bartok (1994) 18 to 90 kl wastewater hectare^{-1} day^{-1}
- Irrigation Management = Nutrient Management

Irrigation Application Methods

- Overhead

- Micro-irrigation
  - spray stake
  - drip stake

- Sub-irrigation

Horticultural Substrates

- Highly Variable
  - **Physical properties**
    - Very porous
  - Mixes
  - Leach very easily
- Unique challenge for sensor monitoring
  - plant available water
  - calibration

- Peat Moss
- Pine bark
- Shredded Hardwood
- Perlite
- Rockwool
- Sand
- Gravel
- Vermiculite
- Hulls

Pinebark

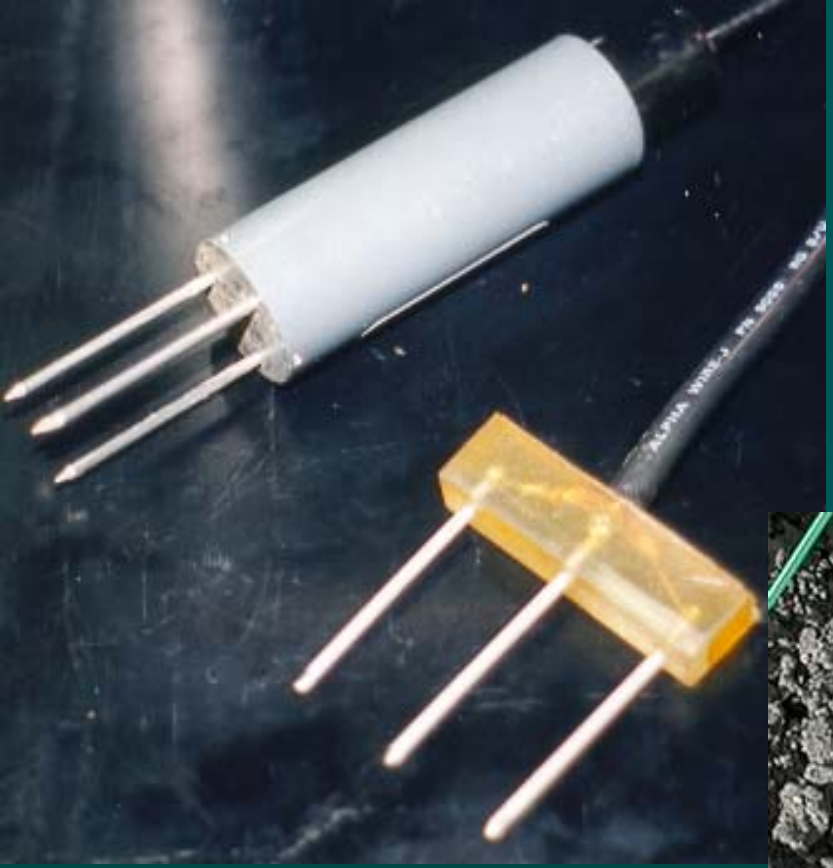
Moisture Sensors

- Gypsum blocks

PDP: Theta Probe ML2

- Low tension tensiometers
- Wave propagation sensors
  - Portable dielectric probes (PDP)
  - Time domain reflectometry (TDR)
  - Capacitance sensors

TDR Sensor



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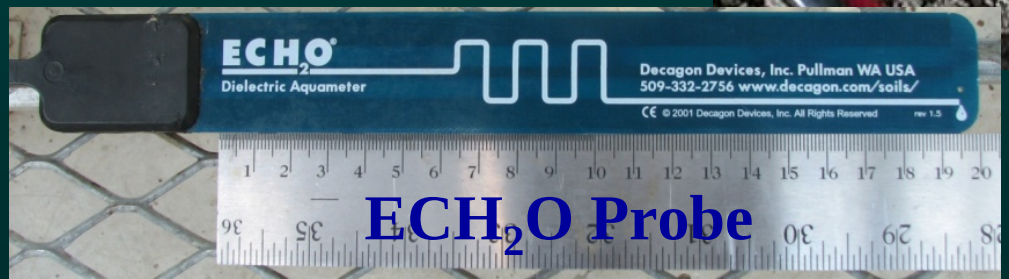
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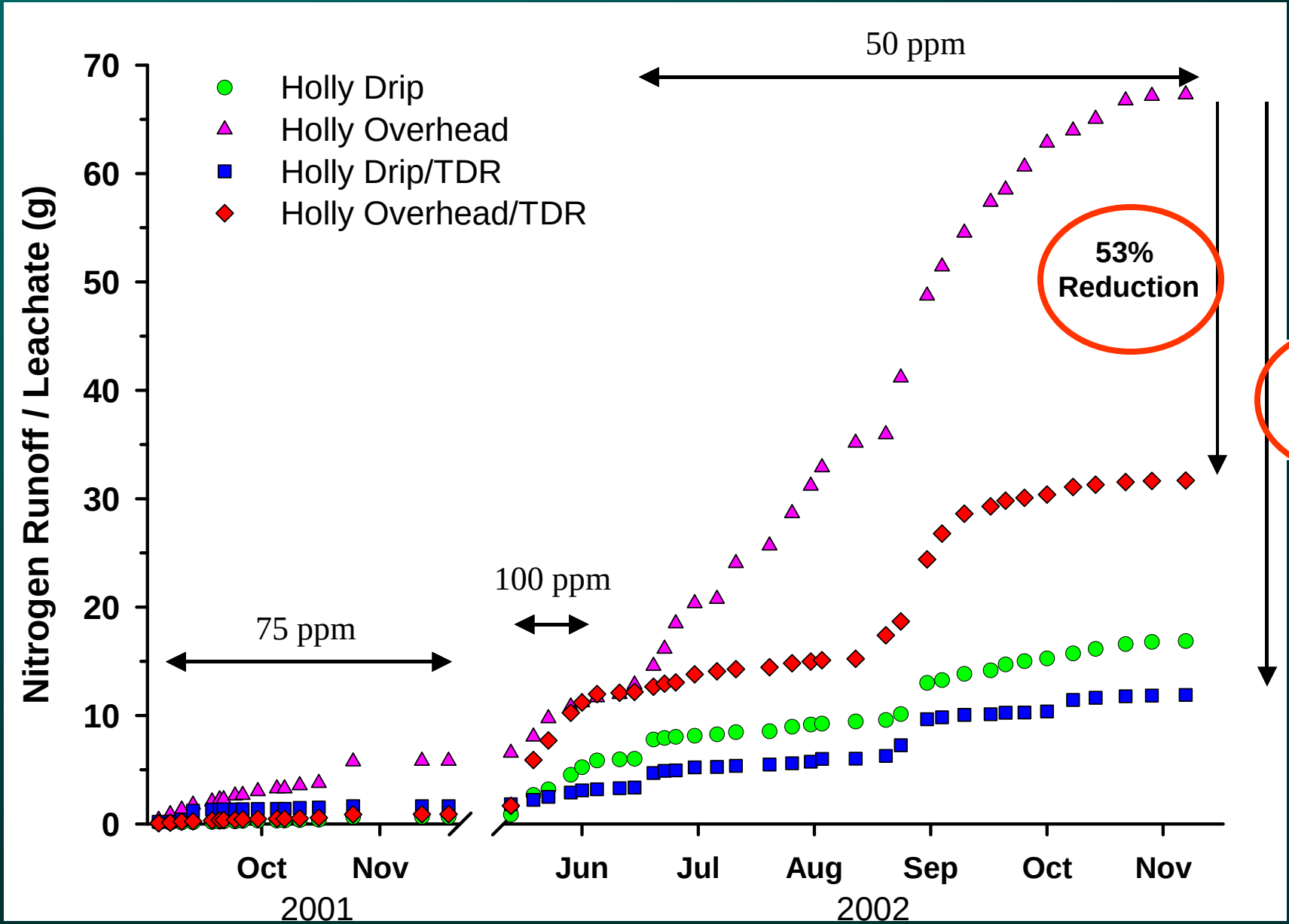
ECH_2O Probe

Objectives

- Identify sensor technology suitable to soilless substrates
- Determine reliability for various substrates
- Implement real-time irrigation monitor / control

TDR / N Runoff Reduction



A Wireless Sensor Network for the Nursery Industry

Using Wireless Networks for Real-time Irrigation Management

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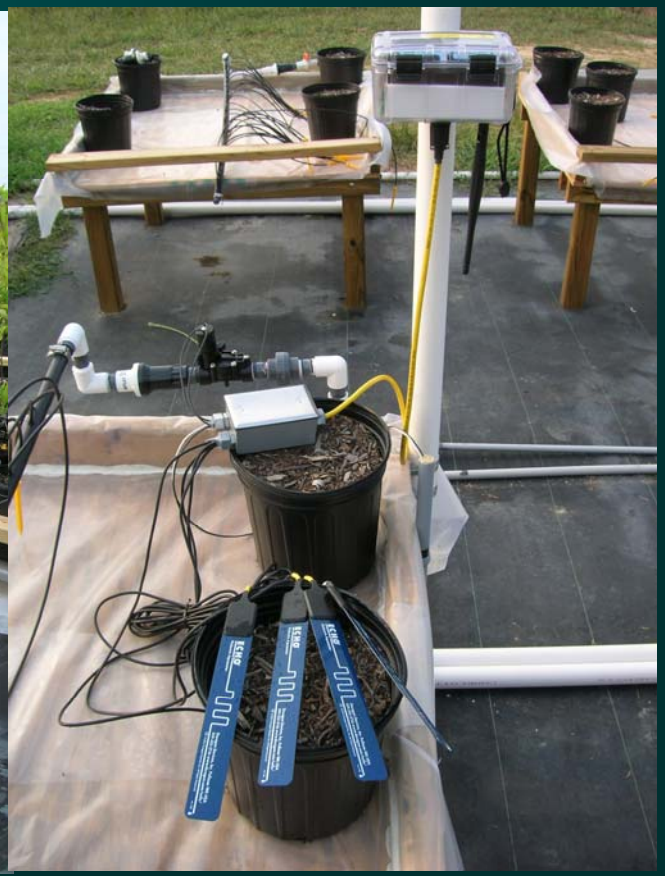

Significance for the Industry

Objective: To create a system to collect and report real-time data over large areas

Desired features:

- low cost
- scaleable
- reliable
- easily deployed
- low power and low maintenance

Concept: Self contained, wireless sensor nodes that form an ad-hoc network to relay data back to a central location

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Web-Based User Interface

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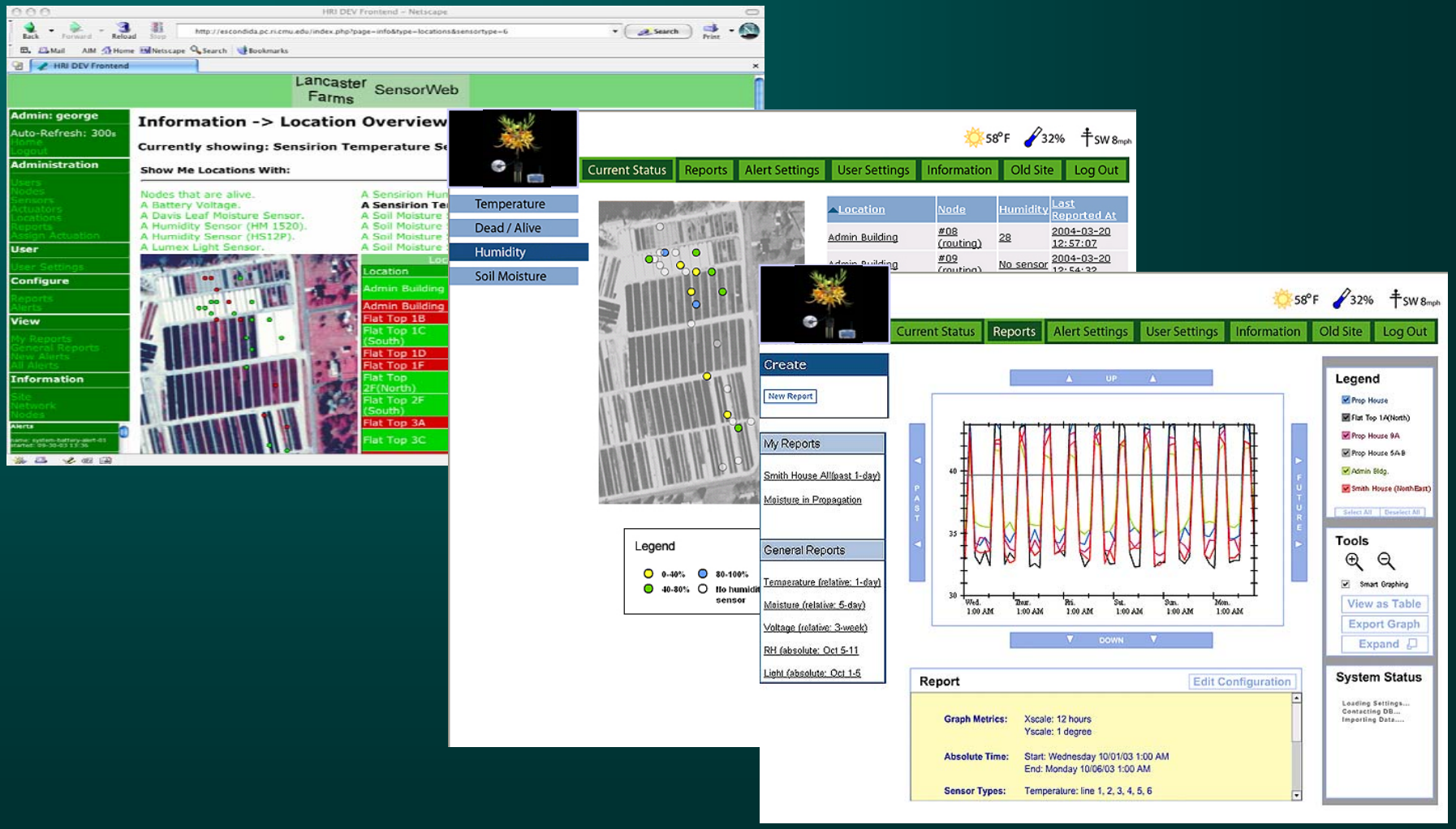
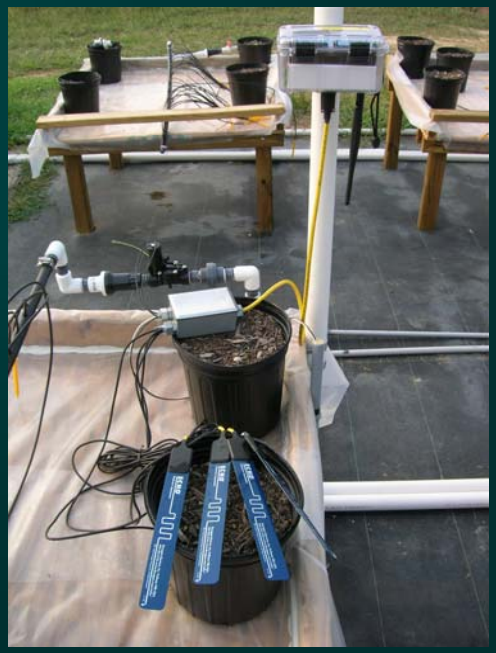


Current Status (2007)

- Up to one year battery life
- Will work with a variety of sensors
- Solenoid actuation capability
- Affordable - parts cost: $100/node (low quantity); manufactured cost (+ software, support) = $400 / node (more than 10 nodes), depending on system complexity

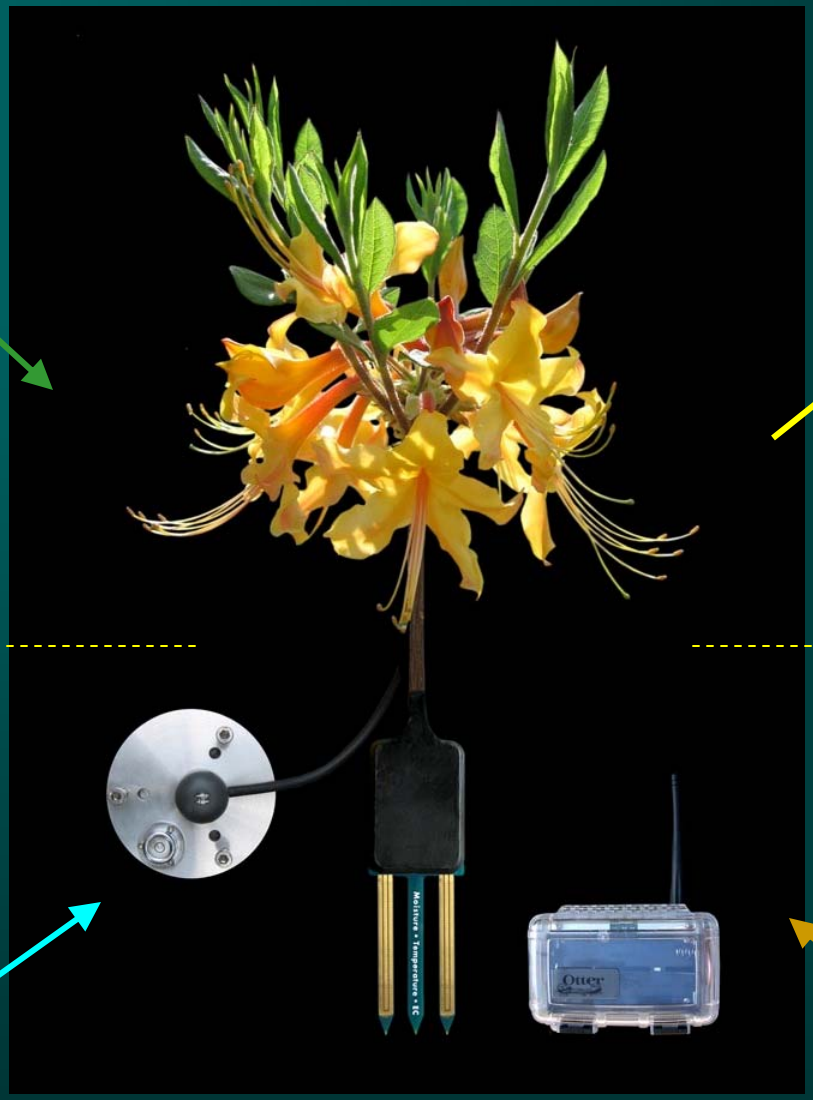


Sensing the Aerial Environment

Increased Efficiency, Profitability and Reduced Environmental Impact

Real-Time Data

Relating Temporal Dynamics



Overcoming Spatial Dynamics

Real-Time Data

Precision Management of Water and Nutrients

Web-enabled Management Systems

Sensing the Root Environment

Questions ?

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Ornamental Nursery Industry

2002 USDA Ag Census – Crop Production Data

Crop	Oilseed and Grain	Vegetables and Melon	Fruit and Tree Nuts	Other (Sugar, Tobacco, Hay)	Nursery and Greenhouse
Land Area (Million acres)	242.22	11.22	11.53	118.33	4.82
Market Value of Goods (Billion US$)	0.47	13.25	13.56	16.11	15.09
Gross Return ($/acre)	167	1181	1176	136	3128
Net Return ($/acre)	32.57	362.23	260.56	13.54	946.59