Monitoring soil moisture

For more efficient irrigation

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Advanced Integrated Water Resources Management course

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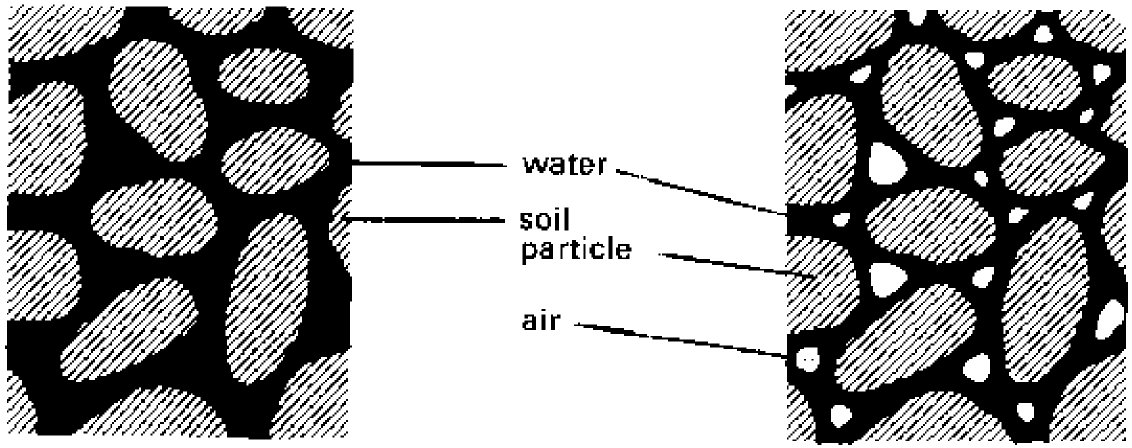
Past drought adaptations in Canada included:

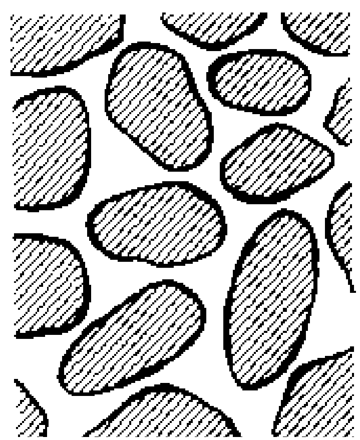
- Increasing irrigation, but in times of low water, or no water, not always viable since irrigation needs often exceed supply
- Planting native grasses for fodder
- Planting drought resistant crops, such as lentils
- Diversification of farm systems
- Implementing conservation tillage to keep soil moisture
- More efficient irrigation, such as scheduling irrigation according to soil moisture

Available soil moisture



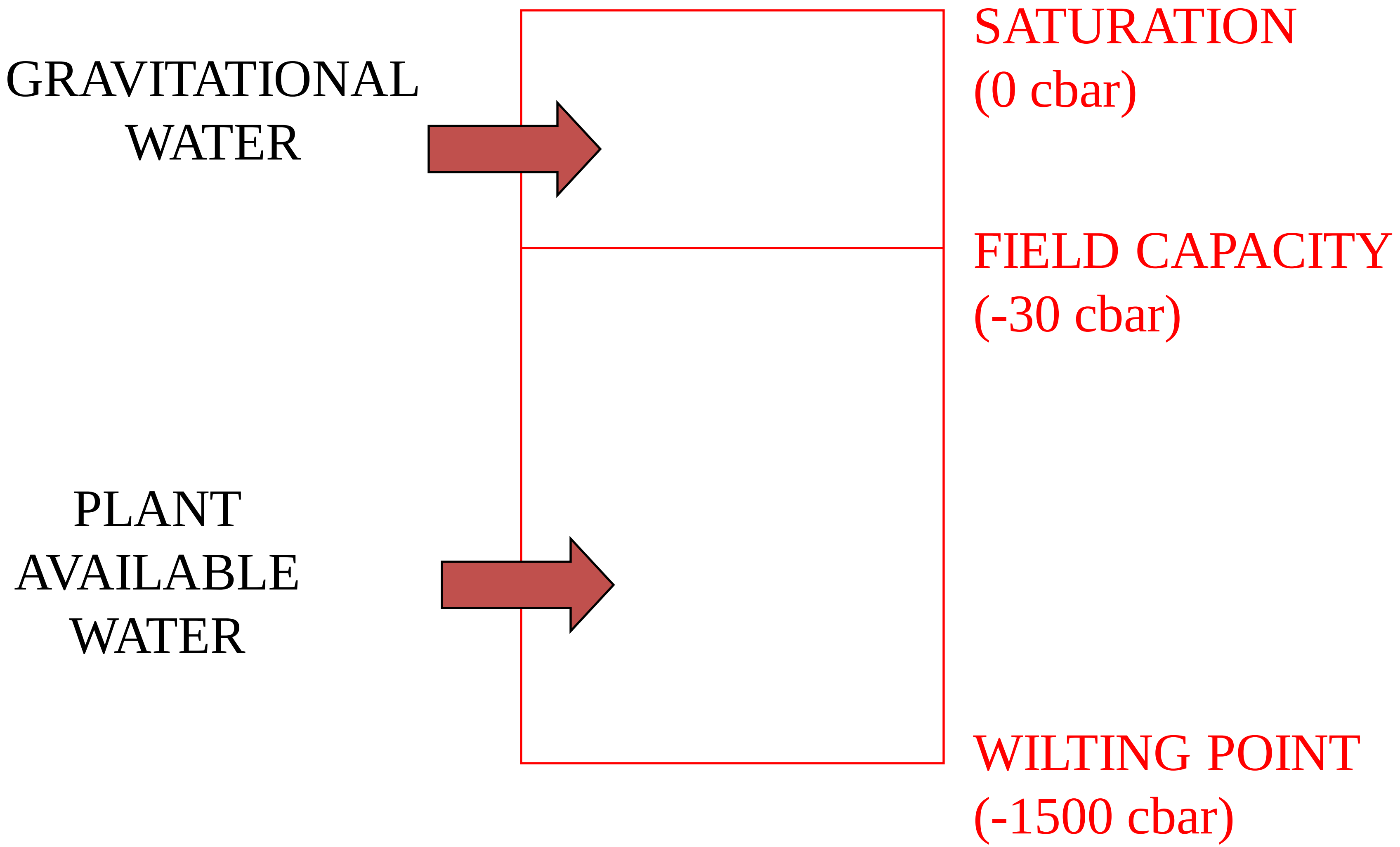
SATURATION

FIELD CAPACITY

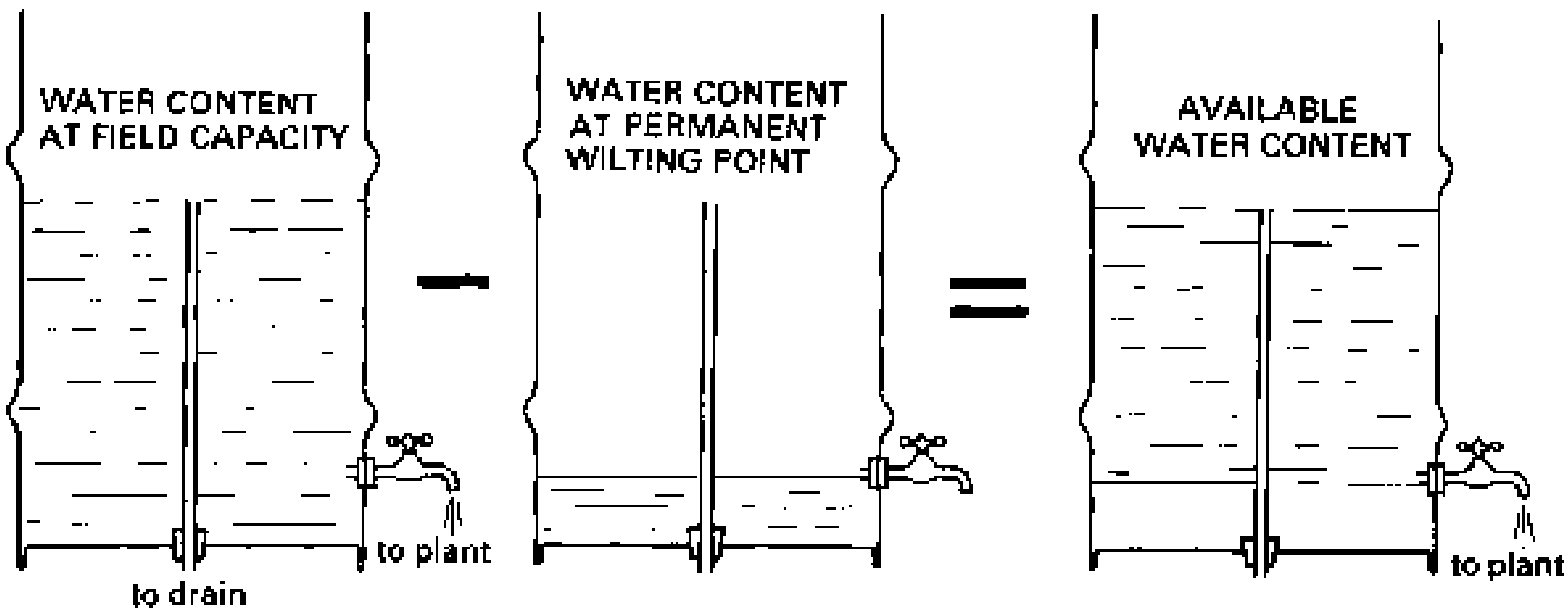


PERMANENT WILTING POINT

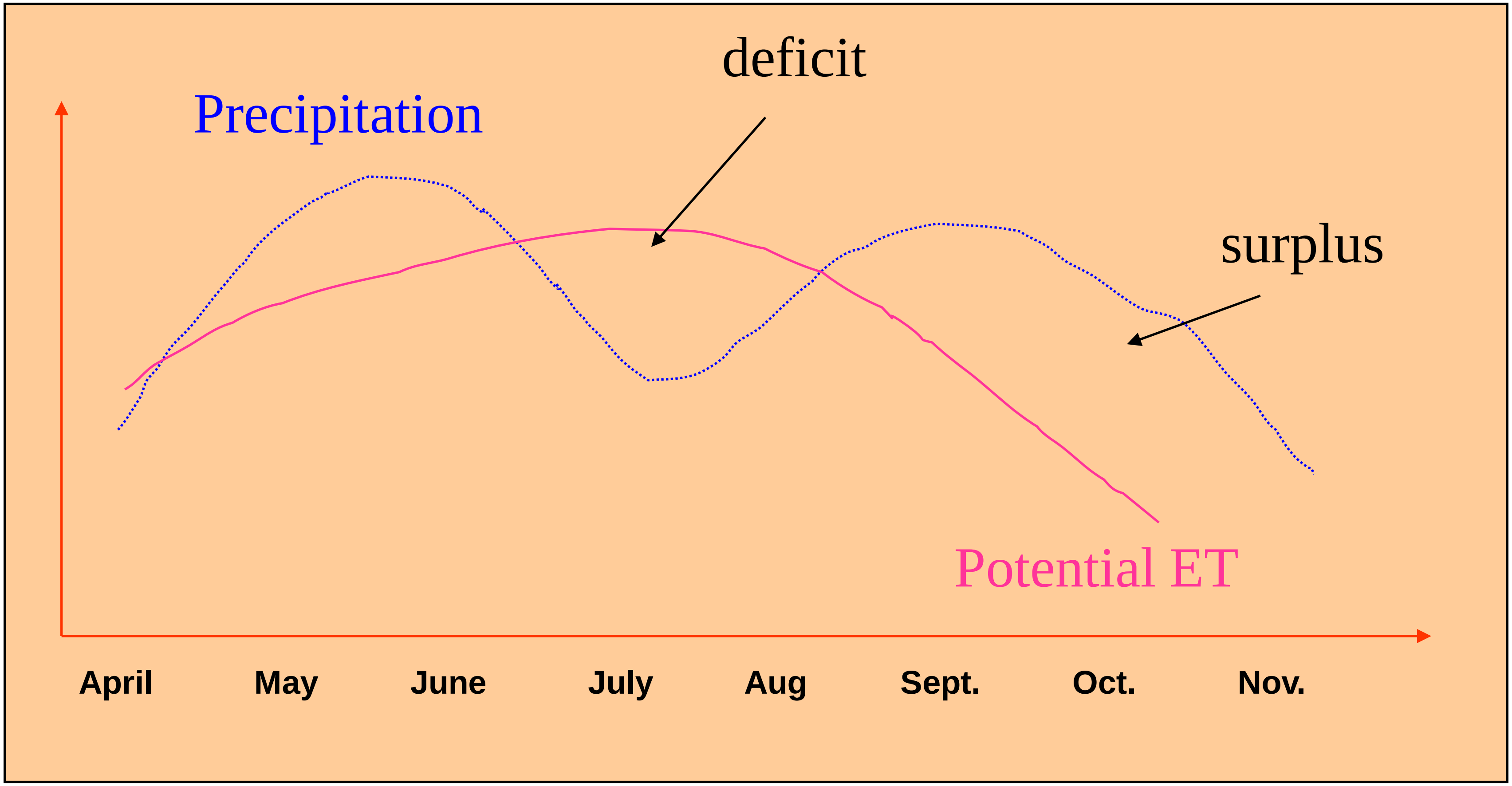
Soil-water conditions



Plant available water



Irrigation needs



Irrigation scheduling

- Irrigation scheduling is deciding when and how much to irrigate based on physical measurements that estimate crop water use and the soil-water status
- The scheduling depends on soil moisture levels and crop evapotranspiration.
- This technique can require investment costs, as technical equipment is sometimes used to monitor soil moisture levels

Irrigation scheduling

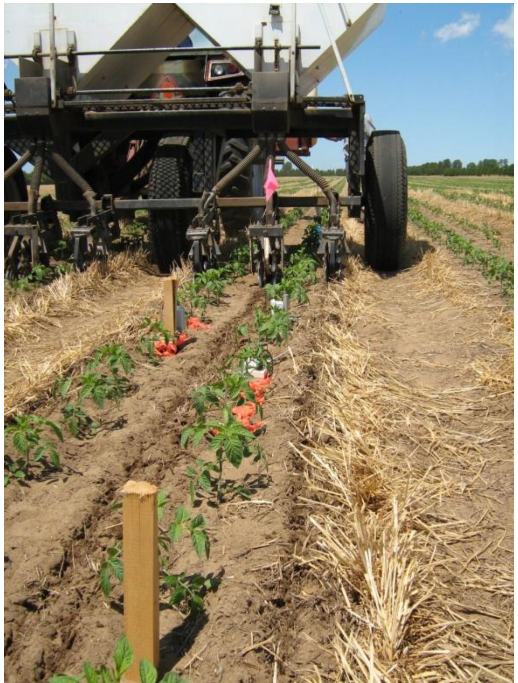
- Irrigation scheduling will not reduce losses on-farm from leaking pipes or equipment. It will however help to conserve water by guiding the grower to apply only the right amount required for optimum crop growth throughout the growing season. The timing of application is closely monitored through soil moisture measuring equipment, either in real-time, or through manually read equipment, or downloadable data onto a computer.

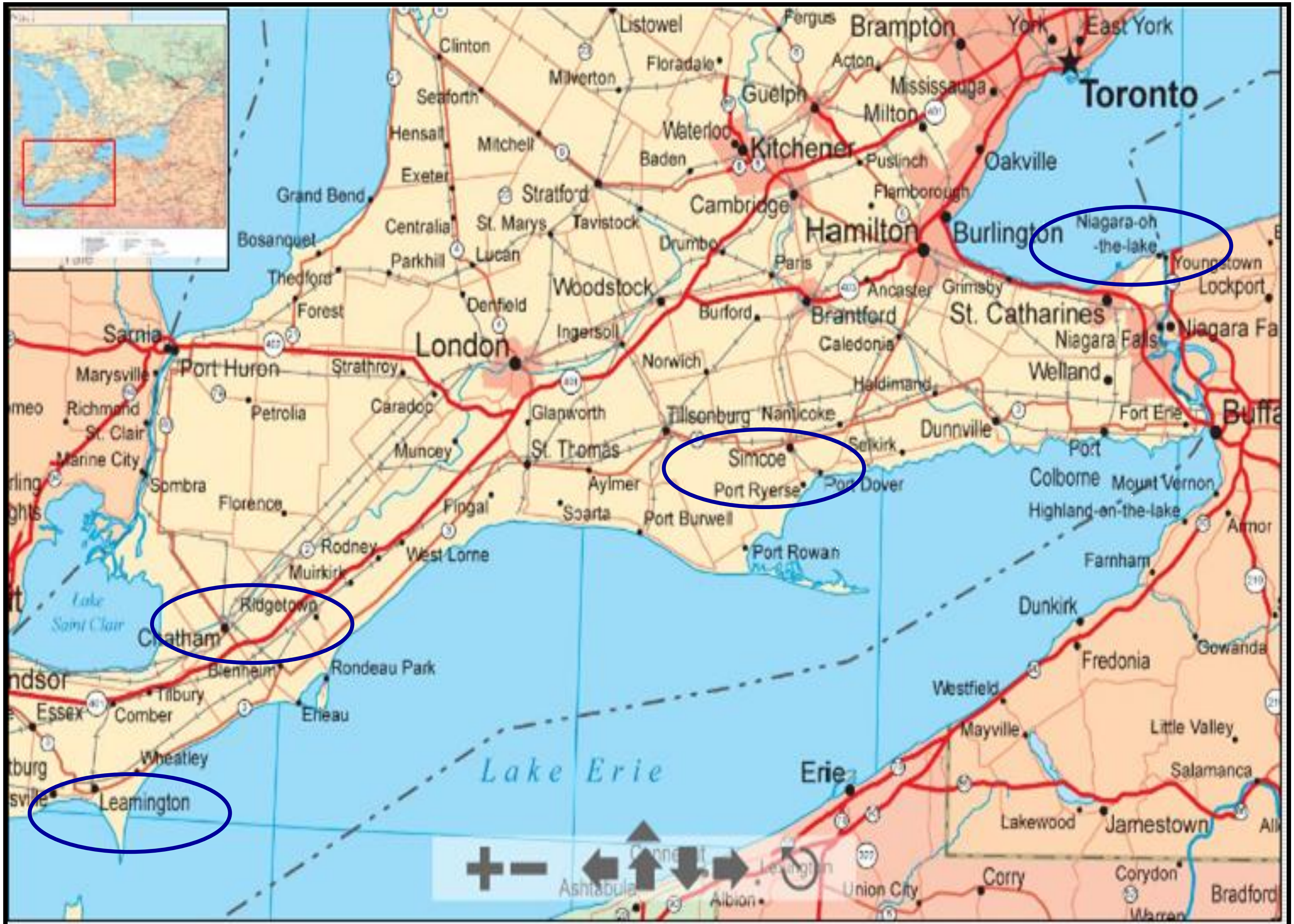
Benefits of irrigation scheduling

Local (farm) benefits	Municipal benefits	Sector (agriculture) benefits
Water savings on farm	Water savings at the municipal level	Water savings in the agricultural sector
Energy savings	Energy savings by reducing the demand on equipment, such as water pumps for example.	Technology transfer and training in the areas of monitoring soil moisture and irrigation scheduling
Higher quality of produce	Improved water quality for the environment by meeting in stream flow requirements for ecosystems	Potential yield increases and crop quality improvement in the horticultural sector
Potential higher crop yields		Potential adaptation strategies to drought and climate change for growers
More timely water application to crops		Increased and advanced knowledge base in water savings
When used with fertigation, can lead to greater nutrient use efficiency by crop, and nutrient application savings		Establish a road map to training and extension materials which will accelerate producer and agri-business uptake of the technology available

Monitoring soil moisture for irrigation needs:
Project objectives

- Provide efficient and timely applications of water to crops
- Provide growers with water management tools
- Test equipment in conjunction with growers
- Obtain grower feedback




Listowel
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Clinton
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Mississauga
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Kitchener
Hensall
Mitchell
Baden
Puslinch
Oakville
Exeter
Stratford
Flamborough
Grand Bend
Cambridge
Centralia
St. Marys
Tavistock
Hamilton
Burlington
Niagara-on-the-lake
Bosanquet
Drumbo
Parkhill
Lucan
Paris
Youngstown
Thedford
Ancaster
Grimsby
Lockport
Forest
Woodstock
Denfield
St. Catharines
Burford
Brantford
Sarnia
Ingersoll
Niagara Falls
London
Caledonia
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Port Huron
Strathroy
Norwich
Marysville
Welland
Haldimand
Caradoc
Richmond
Petrolia
Glanworth
Tillsonburg
Nanticoke
St. Clair
Fort Erie
Dunnville
Marine City
Muncey
St. Thomas
Simcoe
Selkirk
Port
Colborne
Sombra
Aylmer
Port Dover
Mount Vernon
Florence
Port Ryerse
Fingal
Sparta
Port Burwell
Highland-on-the-lake
Rodney
West Lorne
Port Rowan
Farnham
Muirkirk
Lake Saint Clair
Ridgetown
Dunkirk
Chatham
Fredonia
Gowanda
Blenheim
Rondeau Park
Tilbury
Westfield
Essex
Comber
Eriesau
Mayville
Little Valley
Wheatley
Erie
Salamanca
Leamington
Lake Erie
Lakewood
Jamestown
Corry
Corydon
Union City
Albion
Bradford
Warren

Monitoring equipment for soil moisture for irrigation

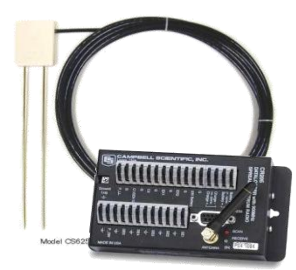
Soil Moisture Sensor	Depths installed (cm)	#Sensors	Data collection	Comments
Fieldscout TDR	20	1	Portable instrument	Data is viewed immediately and recorded
Manual Tensiometers	20, 50	2	Manual read	Read directly in the field
WaterMarks	15, 30, 45	3	Watchdog400 datalogger	Data is downloaded, then viewed on computer
Capacitance probe	15, 30, 50	1 probe, 3 sensors	website	Real-time viewable on web site

TDR, permanent and portable

- TDR: time-domain reflectrometry determines soil volumetric water content. The principal of measurement is based on measuring the travel time of an electromagnetic wave along a waveguide between the two probes. A built in GPS system is able to pin-point the measured sites which is helpful for re-sampling.

Permanent TDR and datalogger

Permanent TDR and Datalogger



Portable TDR with GPS

Tensiometers, manual and automatic

- Tensiometers: are installed permanently at the depth of the root zone. They provide a reading of the soil water suction, or tension, caused by the soil water moving away from the ceramic cup (in a drying soil), or moving towards the ceramic cup (in a wetted soil). The water tension is related to the soil water that is available to plants.

Watermarks (gypsum blocks)

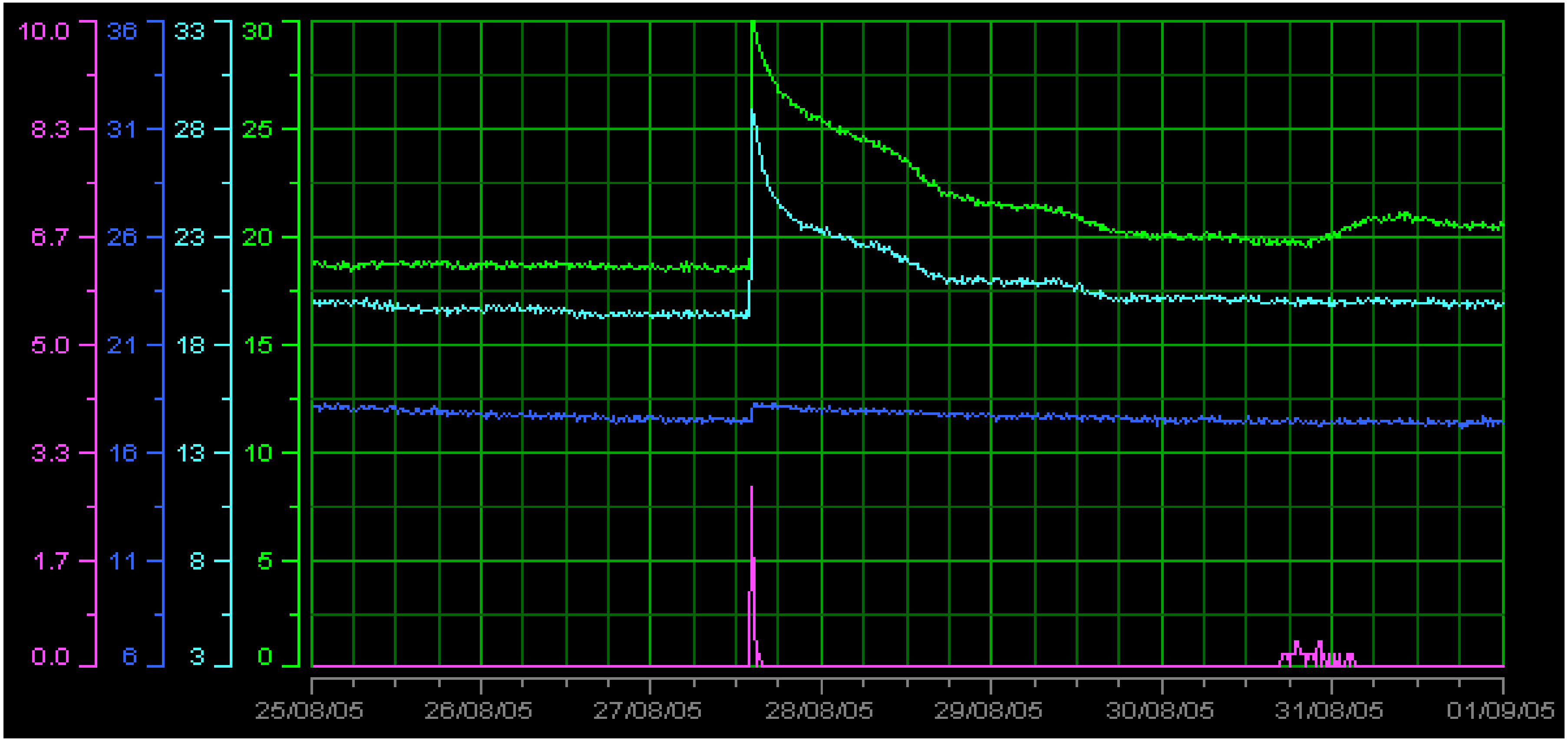
- Watermarks: installed permanently in the soil, and determines volumetric water content which is displayed. It works on the same principal as the tensiometer, it measures the electrical resistance to current flow between electrodes embedded in gypsum; as the gypsum dries the electrical resistance increases between the rods.

Watchdog 400 with Watermarks

Capacitance probes

- C-probes: is inserted into the ground for the duration of the growing season and consists of capacitance sensors attached to a probe column. It can measure volumetric moisture content at up to 6 depths in the soil. Data is transmitted via radio telemetry every 15 minutes to a base station. The output is in millivolts, soil moisture is interpreted from a graph with the software.

25-Aug-2005

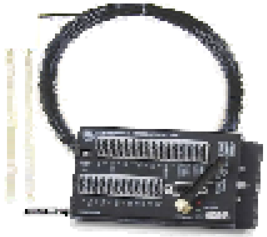


Courtesy of Rufa Doria

Legend:

Color	Name	Last Value
(green)	/OWN 2005/Ridgetown Wireless/23146 Ridgetown Peaches - Irrigated/23146 Ridgetown Peaches - Irrigated/C-Probe 10cm (SFU)	0 SFU at 6-Feb-2006 11:19:05 AM
(cyan)	/OWN 2005/Ridgetown Wireless/23146 Ridgetown Peaches - Irrigated/23146 Ridgetown Peaches - Irrigated/C-Probe 20cm (SFU)	0 SFU at 6-Feb-2006 11:19:05 AM
(blue)	/OWN 2005/Ridgetown Wireless/23146 Ridgetown Peaches - Irrigated/23146 Ridgetown Peaches - Irrigated/C-Probe 40cm (SFU)	0 SFU at 6-Feb-2006 11:19:05 AM
(magenta)	/OWN 2005/Ridgetown Wireless/23146 Ridgetown Peaches - Irrigated/23146 Ridgetown Peaches - Irrigated/Uncovered Irrigation Gauge (mm)	0.0 mm at 6-Feb-2006 11:19:05 AM

Campbell Reflectometers at Cooper's



Permanent TDR and Datalogger

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- Continuous monitoring
- Wireless capability
- Reliability

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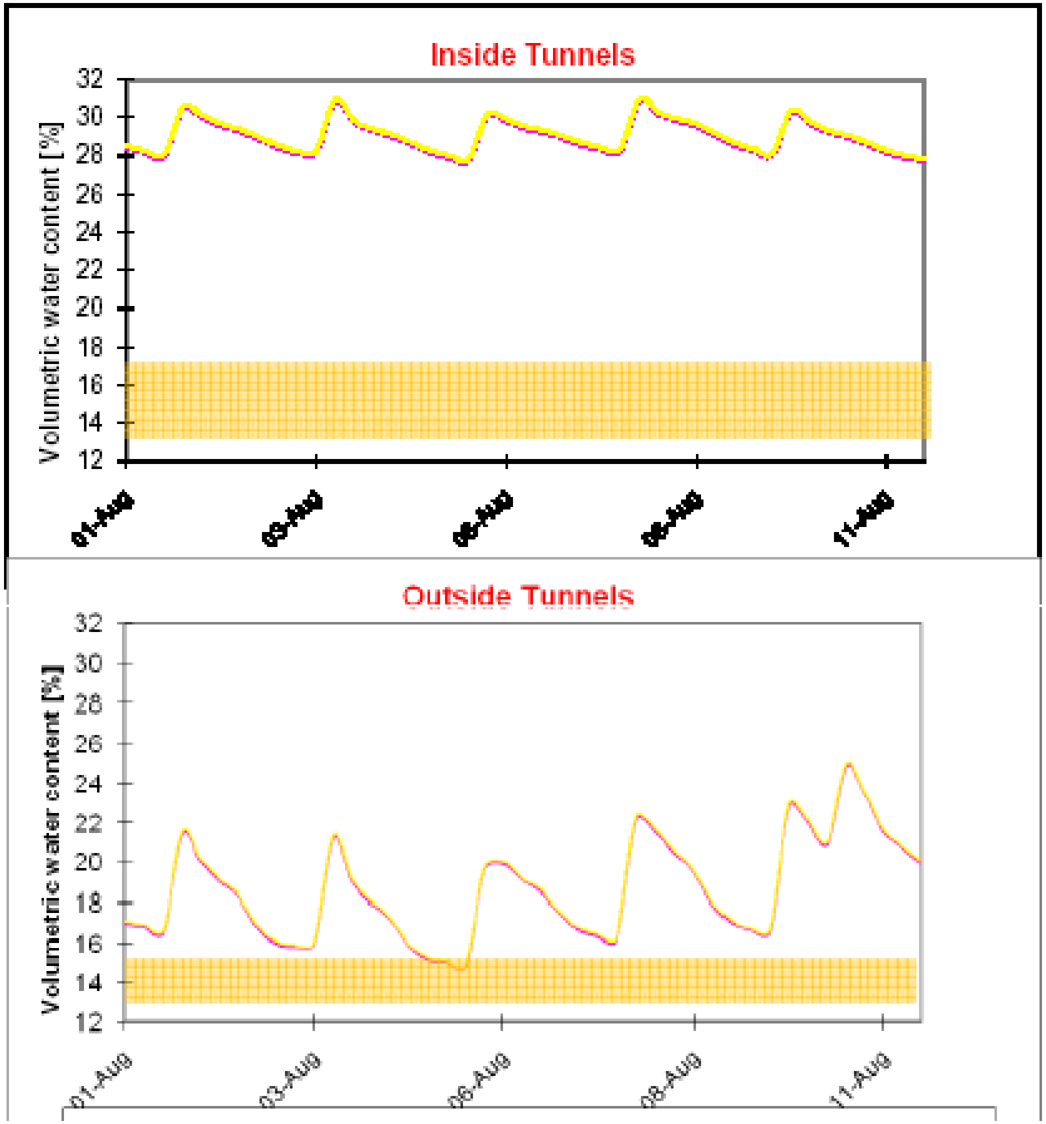
- May need calibration for different soils
- Single point monitoring

Irrigation target range (65% - 85% of FC);
FC is 17% outside, and 20% inside the tunnel

Depth 1 = 20 cm (8 inches)
Depth 2 = 45 cm (18 inches)



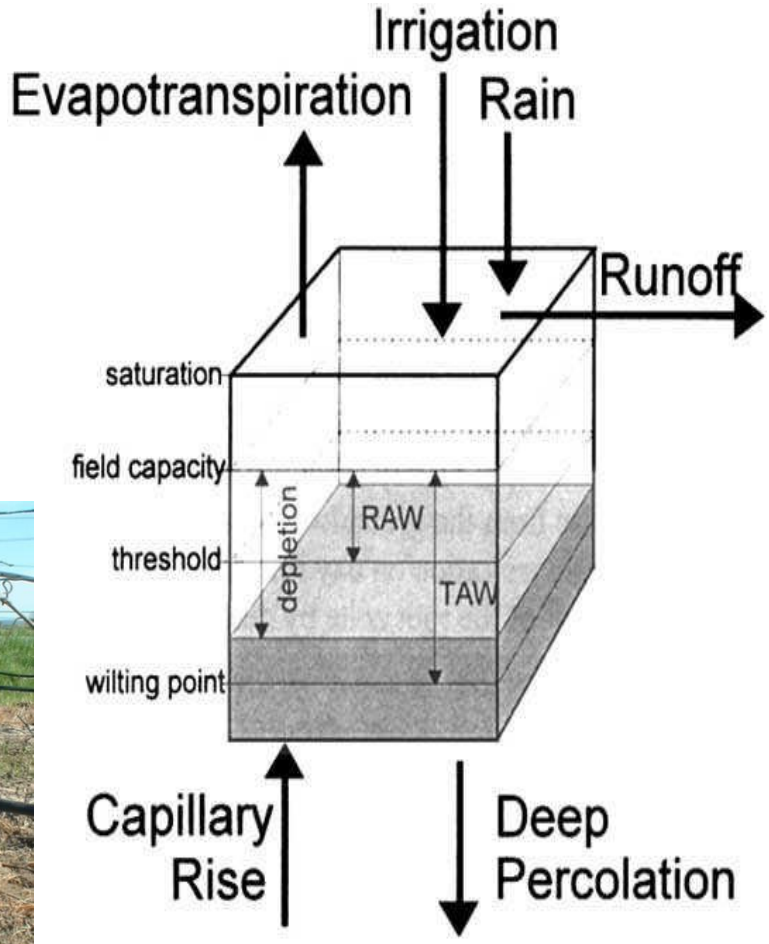
Project to predict irrigation needs

Water Balance Model

I=ET-PPT- RO –P ± ∆SMC

- Part of the project involves using C-probes to monitor soil moisture

- Tools for producers to determine when to irrigate



Doria, 2006