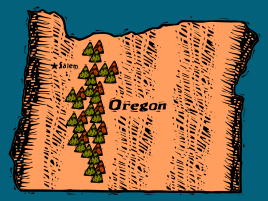
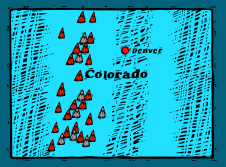
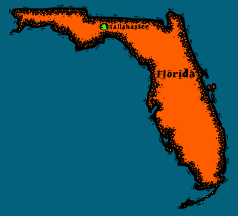
Nursery Production Technologies for Enhancing Water Quality Protection and Water Conservation

-A FNRI Team Research Effort-







Principal Investigators

Jim Owen

Bill Bauerle

Ted Bilderback

Sarah White

Chris Wilson
Tom Yeager
Joseph Albano

National Programs
Sally Schneider
Gail Wisler

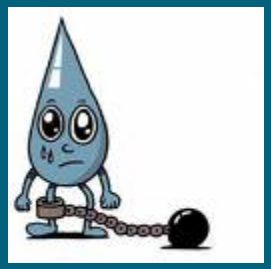
U.S. Hort Research Lab
Calvin Arnold, Lab Dir.
Ed Stover, Res. Leader

Marc Teffeau

Technical Information about the Project

Go Gators!

Problem Facing Industry
-Water Availability and Water Quality-



- Droughts and water restrictions

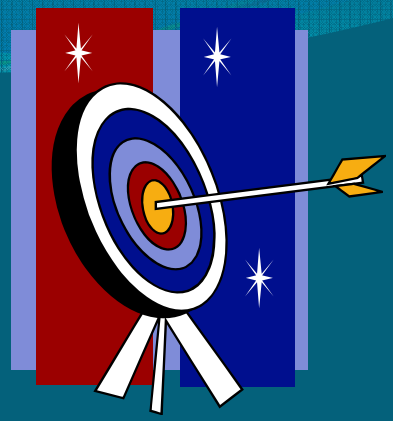
- Use of alternative water sources

- Production cost and energy consumption

- Runoff and regulatory and environmental issues

Project Goals

-What we aim to achieve-



- Conserve more water
- Reduce runoff volume and contamination
- Improve influent and effluent water quality
- Engage in only economically feasible technologies
- Improve plant production and plant quality
- Harmony between horticulture production and the environment
- Increase profits!

Whole Systems Approach

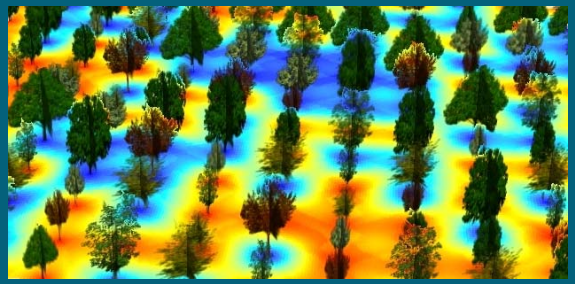
- from the fertilizer that leaves the grower's hand -

- to runoff that leaves the nursery -

Research Areas

Production Inputs - *Prevention*

- Prevent inefficient and wasteful use of water and nutrients



Production Systems - *Containment*

- Improve water and nutrient use efficiency at the container-level

Production Outputs - *Remediation*

- Remediate runoff

Research Area 1
-Prevention-

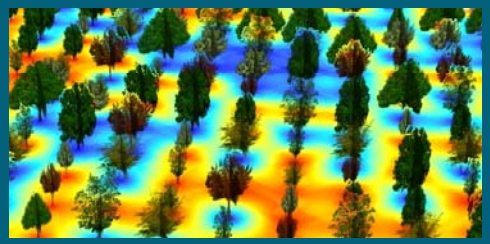
Two projects are engaged in research in this area

Development of a web-based simulation tool (CCROP) for managing resources in the container nursery

- Tom Yeager, University of Florida

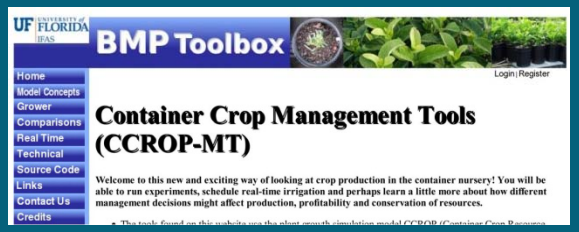
Measurement and modeling plant water use to quantify nursery water requirements

- Bill Bauerle, Colorado State University

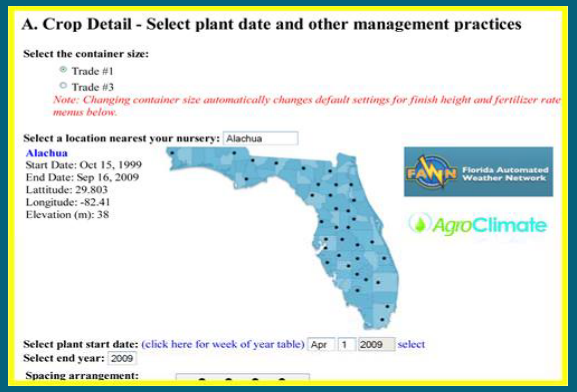


Development of a web-based simulation tool (CCROP) for managing resources in the container nursery

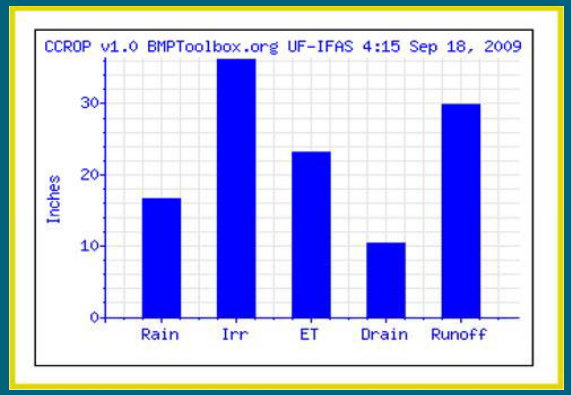
Tom Yeager, University of Florida



Website links to model that will predict plant growth, water needs, and levels of nutrient contamination in runoff.



Comparison tool to compare irrigation and fertilizer inputs for various production simulations.



Measurement and modeling plant water use to quantify nursery water requirements

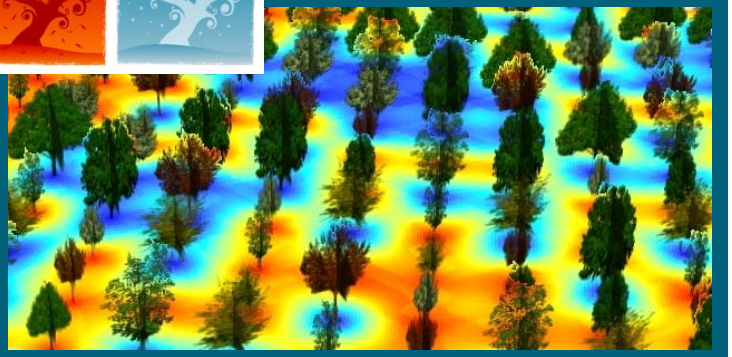
Bill Bauerle, Colorado State University

A process-based approach to predict genotype-specific transpiration of in-ground, field-grown and container deciduous trees and woody shrubs.

Processes used in the model include physiological and morphological responses that allow us to predict transpiration and biomass accumulation.

The model will allow growers to predict plant water use among species/genotypes and across the growing season.

This model utilizes a deployed sensor network that collects environmental data for direct model input.



Research Area 2
-Containment-

Two projects are engaged in research in this area

Irrigation Method and Substrate Composition for Nutrient and Water Use Efficiency in Containerized Crop Production

- Jim Owen, Oregon State University
- Ted Bilderback, North Carolina State University

Use of Wetland Systems (and Container Nursery Crops) to Treat Nursery Runoff

- Bob Polomski, Sarah White, Ted Whitwell, and Steve Klaine; Clemson University

Irrigation Method and Substrate Composition for Nutrient and Water Use Efficiency in Containerized Crop Production

Jim Owen, Oregon State University

Ted Bilderback, North Carolina State University

Engineer pine bark-based soilless substrate with improved water and nutrient use efficiency.

Calcined clays have been extensively studied as an amendment in substitution for sand.

Calcined clay-amended substrates require les water applied and decreases agrichemical leaching, especially phosphorous.

- More recently -

Gravimetric approach for controlling irrigation.

Load cells interfaced with wireless network to provide real-time monitoring substrate water status.

Reduce water application, plant stress, leaching.

Use of Wetland Systems (and Container Nursery Crops) to Treat Nursery Runoff

Bob Polomski, Sarah White, Ted Whitwell, and Steve Klaine

Clemson University

Screened a host of ornamental plants for their ability to accumulate nitrogen and phosphorous.

Plants were aquatic or wetland ornamental plants.

Plants were evaluated for their potential for removing nitrogen and phosphorous in a contained system (i.e. pot) or used in a gravel bed system with sub-surface flow.

Plants have both runoff water nitrogen and phosphorous remediation and commercial value.

Research Area 3
-Remediation-

Three projects are engaged in research in this area

Use of Wetland Systems to Treat Nursery Runoff
- Sarah White, Ted Whitwell, Bob Polomski and Steve Klaine; Clemson University

Water Quality Protection Using Bioremediation Technologies
- Chris Wilson, University of Florida

Integrated Production Systems for Water Quality Protection & Water Conservation
- Joseph Albano and Terence (TJ) Evens, USDA-ARS

Use of Wetland Systems to Treat Nursery Runoff

Sarah White, Ted Whitwell, Bob Polomski, and Steve Klaine

Clemson University

Single deep-cell surface-flow constructed wetland (CW) for nitrogen removal

Subsurface flow cells “gravel beds” lined with clay aggregates at shorter retention time than for CW for phosphorous removal.

- More recently -

Utilizing phosphorous saturated crushed brick as a phosphorous fertilizer supplement.

Water Quality Protection Using Bioremediation Technologies

Chris Wilson, University of Florida

Bacterial-based bioreactor system.

Adapted from aquaculture technology.

Current system removes nitrate from runoff water by exploiting denitrifying bacteria.

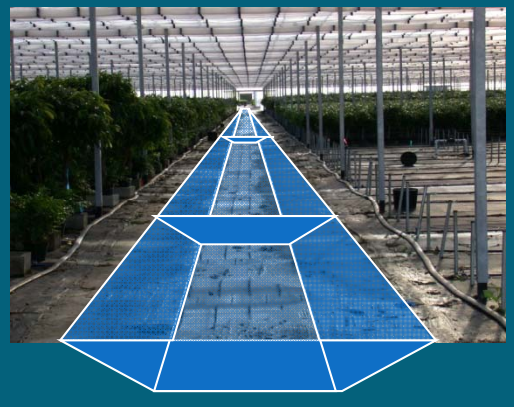
Requires an anaerobic environment and the input of a carbon source.

Conceived that smaller or land-challenged nurseries would benefit from this technology.

- More recently -

Understanding pesticides remediation and influence on the system.

Developing a phosphorous removal modular.



Integrated Production Systems for Water Quality Protection & Water Conservation

Joseph Albano and Terence (TJ) Evens, USDA-ARS

Algal Turf Scrubber (ATS)

Most recent runoff remediation system being research.

ATS systems are gaining attention because of they can be or have the potential to be utilized for:

1. Water remediation
2. Biofuels
3. Substrates
4. Fertilizer

Accomplishments
- Since 2006 FNRI Meeting in Oregon -

Information has been transferred to other researchers and stakeholders through presentations at scientific and stakeholder meetings, peer-reviewed and trade papers, and public-access posting of documents on the web.

Outreach

Presentations:	52
Journals and Proceedings:	39
Popular Press:	04
Extension/Tech Transfer:	03
Web site	03
Total:	101

Funds Leveraged: $841,400

Practically, dollar for dollar FNRI funding

Production Practices for an Environmentally Friendly Nursery Industry

Environmental Resource Management Research Group
Floriculture and Nursery Research Initiative
United State Departmental Agriculture Agricultural Research Service
Horticulture Research Institute
SCA #58-6618-2-2027

Contributors
Clemson University
North Carolina State University
University of Florida / IFAS
USDA-ARS Horticultural Research Laboratory

Editors
James S.Owen, Jr. and Sarah A. White

Impact
- Since 2006 FNRI Meeting in Oregon -

A precision irrigation system using predictive models is currently under evaluation at a commercial nursery in Ohio.

A nursery in Georgia has installed two constructed wetlands that were designed based on the information generated from this project

Four bacterial-based bioreactors are operating at two nurseries for real-world assessment of the technology.

It has been demonstrated that clay amended substrates can reduce water application (90,000 gal/acre) and reduce leachate volume (40,000 gal/acre)

Physical and chemical analyses of composted algae from an ATS proves that the organic material is a suitable substrate.

A beta version a web-based production simulator model is currently in testing and proofing under commercial nursery conditions.

Impact
- Since 2006 FNRI Meeting in Oregon -

NCDC216

Water Management & Quality for Ornamental Crop Production & Health

A new multi-state/national program in water quality

- Tom Fernandez, Michigan State University

- Jon Lea-Cox, University of Maryland.

-Two members of our research team sit on the steering committee.

- Nearly all members of the research team are now participating in the project.

Collaborators

Extended Family of the Research Team ≈ 50

USDA-ARS-U.S. Horticultural Research Laboratory, Fort Pierce, Florida

TJ Evens, Stewart Reed, Cindy McKenzie, Scott Adkins, Erin Rosskopf, Nancy Burelle, Kwesi Boateng, USDA-ARS; Tom Yeager, Chris Wilson, University of Florida; Don Merhaut, Julie Newman, University of California, Riverside; Gene Blythe, Mississippi State University, Jeff Leblond, Middle Tennessee State University.

University of Florida

Jeff Million, Claudia Larsen, Joe Ritchie, Craig Warner, University of Florida. (Dave Clark)

Clemson University, Clemson, South Carolina

Steve Klaine, Ted Whitwell, Bob Polomski, Clemson University; Milton Taylor, Insectigen Inc.

Oregon State University, Aurora, Oregon &

North Carolina State University, Raleigh, North Carolina

John Selker, Heather Stoven, Oregon State University; Helen Kraus, Brian Jackson, Mike Benson, Kelly Ivors, North Carolina State University; Stuart Warren, Kansas State University; George Kantor, Carnegie Mellon University; James Altland, Carolyn Scagel, USDA-ARS; Ross Dumdi, Bailey Nursery; Jim Zablocki, Ostara Nutrient Recovery Technologies, Inc.

Colorado State University, Fort Collins, Colorado

S. Anantharamu, University of Arkansas; J.D. Bowden, Stephanie Kampf, Michael Lefsky, Colorado State University; George Kantor, Carnegie Mellon University; John Lea-Cox, Univeristy of Maryland; Y. Wang, R.F. Reynolds, Clemson University; Marc van Iersel, University of Georgia; D.J. Timlin, Ya.A. Pachepsky, USDA-ARS; Tom Demaline, Willoway Nurseries Inc.

Process Information

Go Gators!

Industry-driven Team Research

Challenges & *Opportunities*

Establishing the specific roles that each project will engage in and limiting overlap of efforts.

Maintaining FNRI projects as truly cooperative with USDA-ARS.

How quickly can we get results to industry.

Maintaining momentum.

Funding is temporary

Leverage funds.

Efficient use of funds by sharing resources.

Increased impact and exposure.

Building and strengthen research collaborations.

Long term impact through the support of grad students and their growth into productive independent researchers

Lesson Learned

Do Differently & *Do the Same*

Do a better job about at discussing and defining "mechanics" and process of FNRI projects and funding, including:

SCA
ADODR and ADO roles
Forms and reporting
Budgets

Write into the SOW for a year with an FNRI meeting, that the PI or project representative from each project must participate.

Hold annual team meetings

Recognize a University lead.

Maintain communication with National Programs and stakeholders.

Outreach as a team

Be Aware

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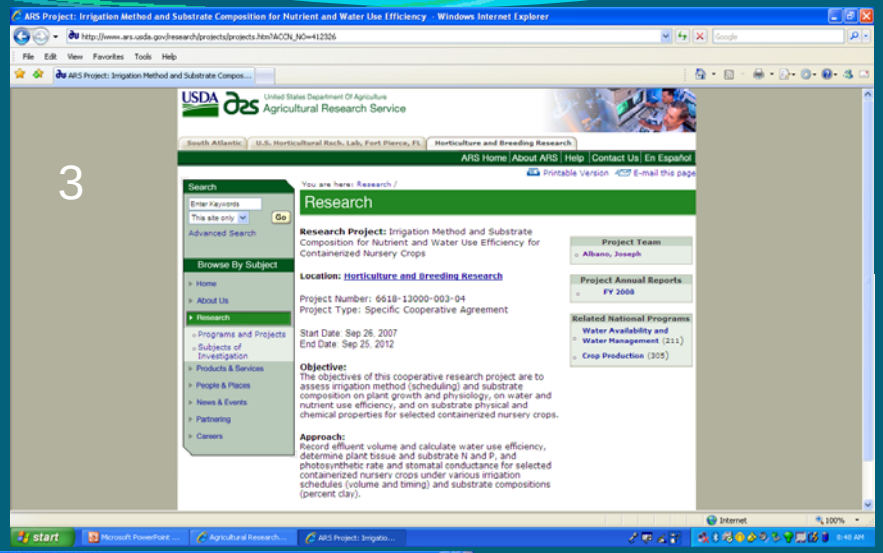

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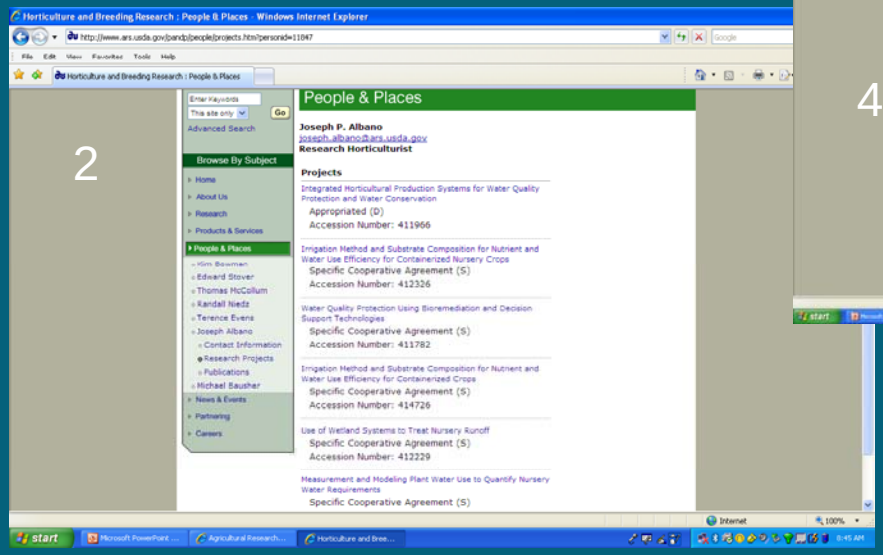

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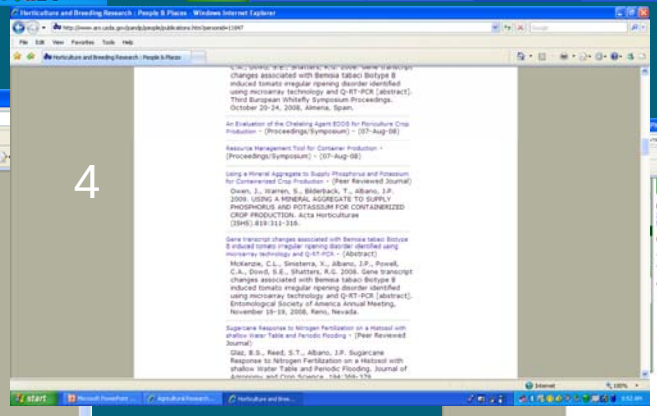

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Questions