

PRODUCE SAFETY IN FLORIDA – RESEARCH AND INITIATIVES

● **Michelle D. Danyluk**

North Carolina Fresh Produce Safety Consortium

September 9th, 2010



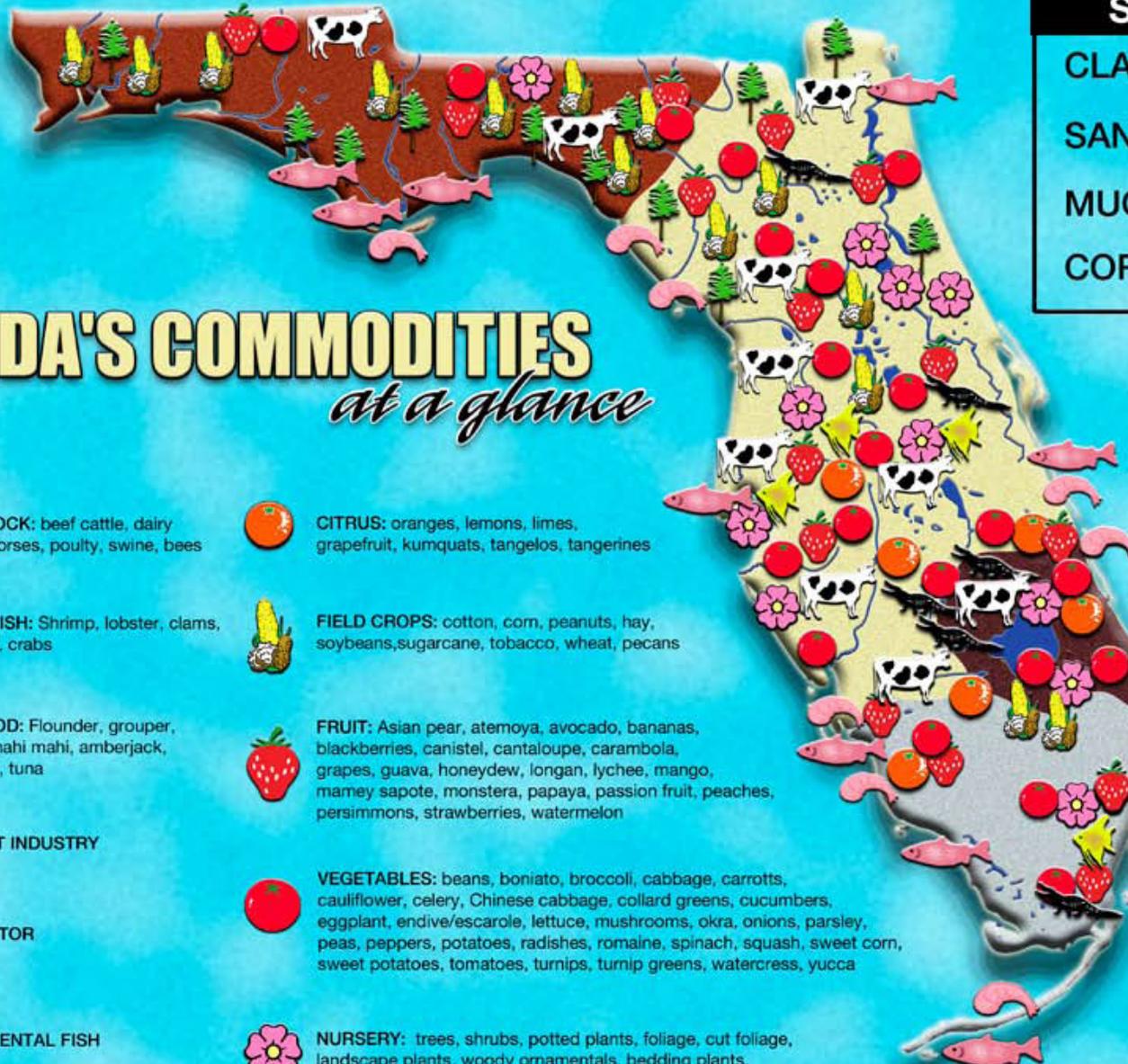
UNIVERSITY OF
FLORIDA

IFAS

OVERVIEW OF FLORIDA AGRICULTURE



- 47,500 Commercial Farms
 - 5,300 Farms with sales exceeding \$100,000
- 9.25 million acres
 - Average farm size of 195 acres
- Ranked first in value production of:
 - Oranges (71%), tangerine(27%), grapefruit (68%), sugar cane for sugar and seed (51%), squash, watermelons (29%), sweet corn (21%), fresh-market snap beans (52%), fresh-market tomatoes (44%), fresh market cucumbers (39%)
- Ranked second in value production of:
 - Strawberries, bell peppers, cucumbers for pickles
- Second in production of specialty crops
 - Behind California
- Seventh in all crops
 - \$6.2 billion in 2007



| SOIL | |
|-------|--|
| CLAY | |
| SAND | |
| MUCK | |
| CORAL | |

FLORIDA'S COMMODITIES

at a glance



LIVESTOCK: beef cattle, dairy cattle, horses, poultry, swine, bees



SHELLFISH: Shrimp, lobster, clams, scallops, crabs



SEAFOOD: Flounder, grouper, cobia, mahi mahi, amberjack, snapper, tuna



FOREST INDUSTRY



ALLIGATOR



ORNAMENTAL FISH



CITRUS: oranges, lemons, limes, grapefruit, kumquats, tangelos, tangerines



FIELD CROPS: cotton, corn, peanuts, hay, soybeans, sugarcane, tobacco, wheat, pecans



FRUIT: Asian pear, atemoya, avocado, bananas, blackberries, canistel, cantaloupe, carambola, grapes, guava, honeydew, longan, lychee, mango, mamey sapote, monstera, papaya, passion fruit, peaches, persimmons, strawberries, watermelon



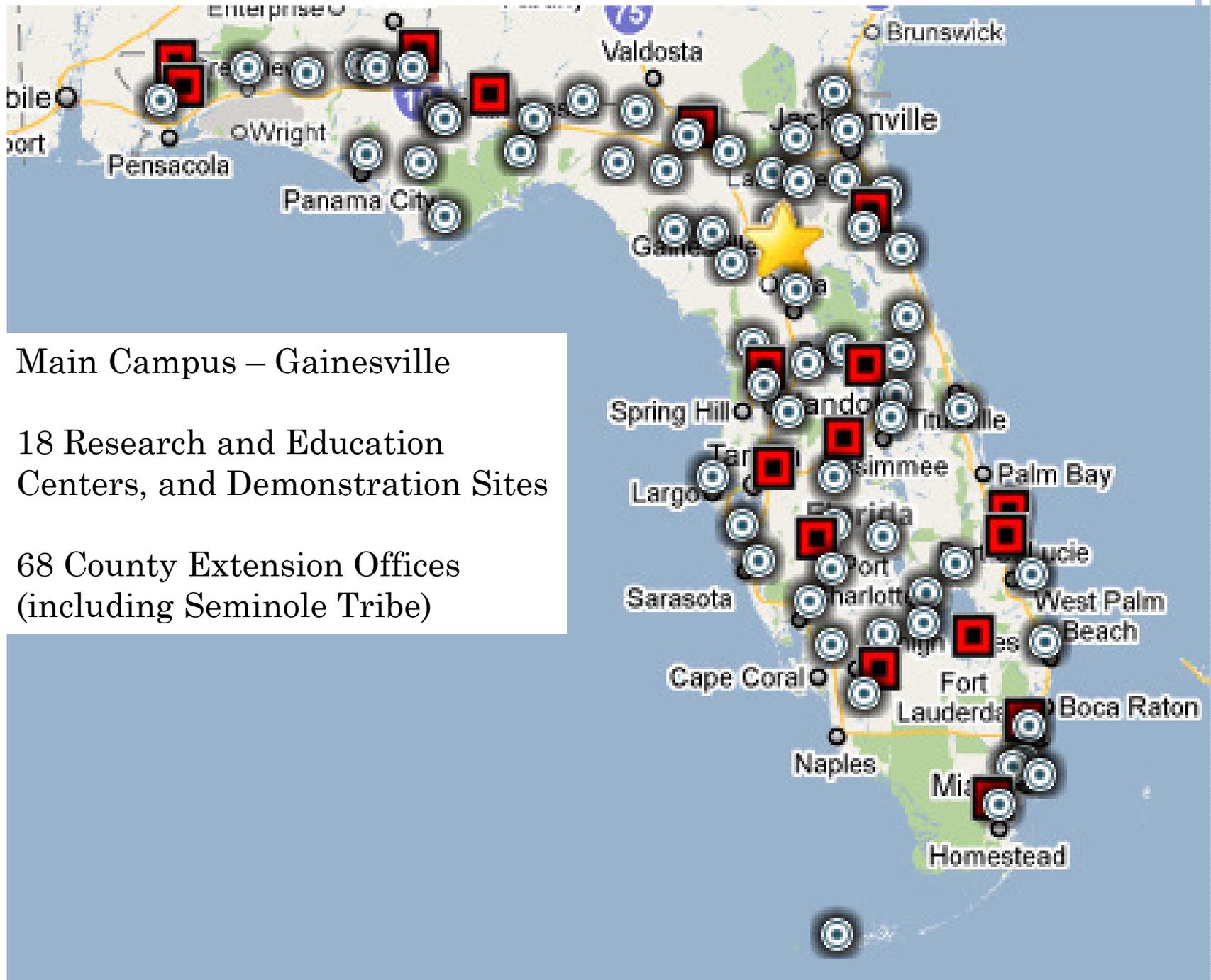
VEGETABLES: beans, boniato, broccoli, cabbage, carrots, cauliflower, celery, Chinese cabbage, collard greens, cucumbers, eggplant, endive/escarole, lettuce, mushrooms, okra, onions, parsley, peas, peppers, potatoes, radishes, romaine, spinach, squash, sweet corn, sweet potatoes, tomatoes, turnips, turnip greens, watercress, yucca



NURSERY: trees, shrubs, potted plants, foliage, cut foliage, landscape plants, woody ornamentals, bedding plants, interior plants, garden centers, turf grass, sod, bulbs, hydroponic plants, mounted plants, plugs, seedlings, topiary trees.

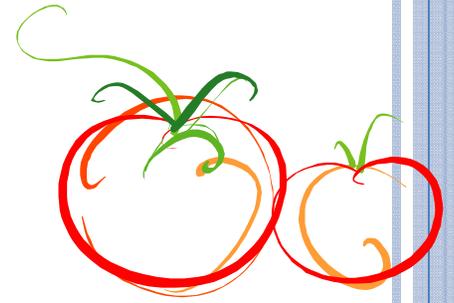
Florida Department of Agriculture and Consumer Services





- ★ Main Campus – Gainesville
- 18 Research and Education Centers, and Demonstration Sites
- 68 County Extension Offices (including Seminole Tribe)

FLORIDA T-GAPS/BMPS



- Commitment to implement Good Agricultural Practices and Best Management Practices for the entire system of tomato handling in Florida, from growing, pre-harvest through packing and retail
- www.floridatomatoes.org/FoodSafety
- Industry Initiative
- Effective July 1, 2008
- Requires annual GAPs training



UNIVERSITY OF FLORIDA - RESEARCH



Michelle Danyluk
Food Science,
Citrus Research
and Education
Center



Anita Wright
Food Science and
Human Nutrition



Keith Schneider
Food Science
and Human
Nutrition

Max Teplitski
Soil and Water
Science,
Genetics
Institute



Jerry Bartz
Plant Pathology



Ariena VanBruggen
Plant Pathology,
Emerging
Pathogens Institute

UNIVERSITY OF FLORIDA - EXTENSION



Michelle Danyluk
Food Science
Citrus Research
and Education
Center

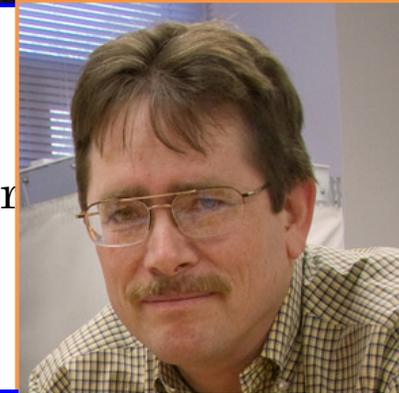


Steve Sargent
Horticultural
Sciences

Keith Schneider
Food Science
and Human
Nutrition



Jeff Brecht
Horticultural
Sciences, Center for
Food Distribution
and Retailing



Renee Goodrich
Food Science and
Human Nutrition



Mark Ritenour
Horticultural
Sciences,
Indian River Research
and Education Center

UNIVERSITY OF FLORIDA - EXTENSION



Amy Simone
Family, Youth
and Community
Sciences

North Florida Research and Education Center, Live Oak



Bob Hochmuth
Multi-County
Extension Agent –
Vegetables

Martha Roberts
Director of
Industry
Relations



Linda Landrum
Multi County
Extension Agent
– Marketing and
Rural
Development



UNIVERSITY OF FLORIDA - SEARCHING

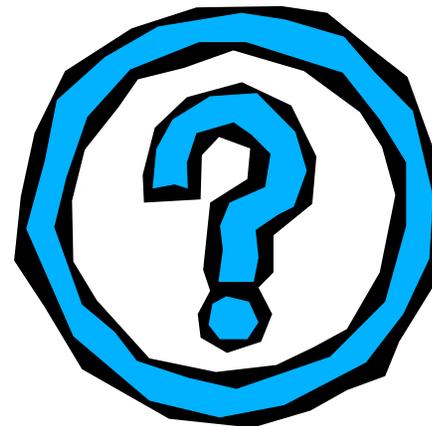
Food Science and Human Nutrition



**Assistant Professor –
Food Safety and
Technology**

25% Teaching
35% Research
40% Extension

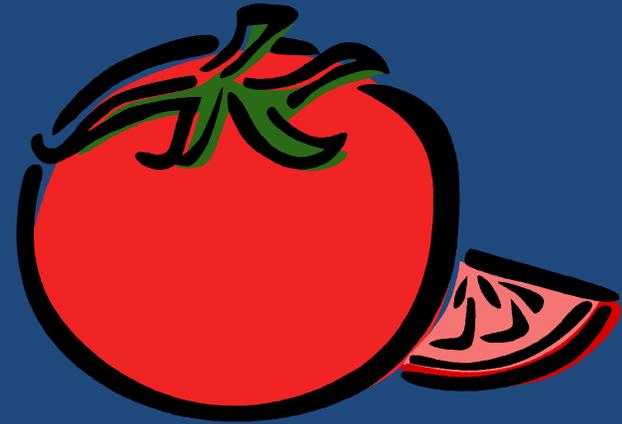
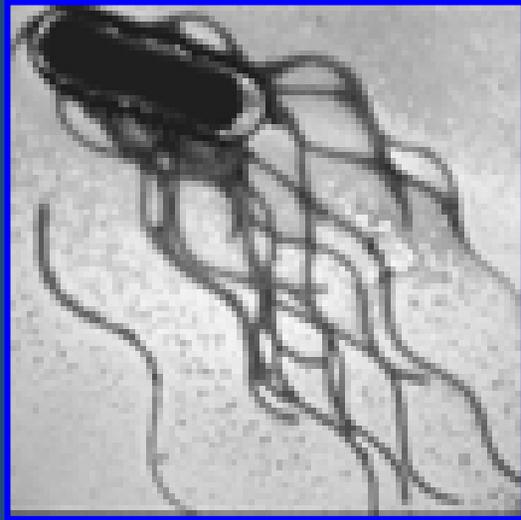
Animal Sciences



**Assistant/Associate
Professor – Pre-Harvest
Food Safety /Animal
Production**

30% Teaching
70% Research





RESEARCH

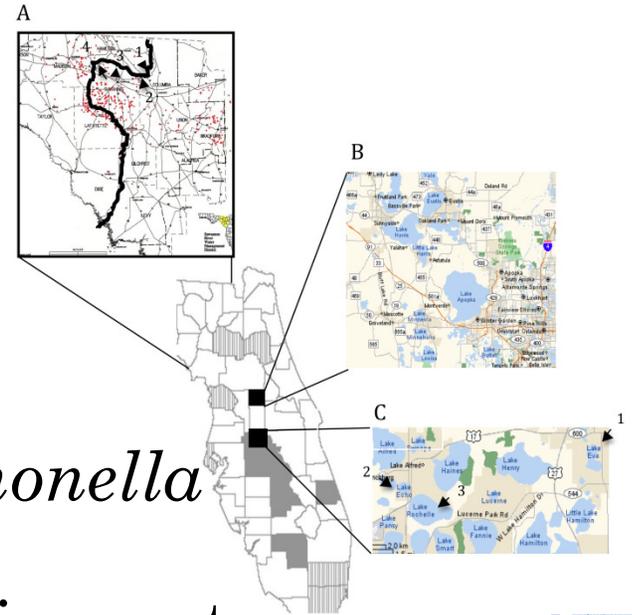
Current Produce Safety Research at the
University of Florida



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Wright Group: *Salmonella* in the North Florida/South Georgia Watershed



- Goals:
 - Examine the distribution of *Salmonella* in this watershed
 - Determine contribution of irrigation water to produce contamination
 - Virulence and genetics of strains collected
- Funding:
 - Florida Fruit and Vegetable Association
 - Pending: UC-Davis Center for Produce Safety
- Collaborators:
 - UF – Michelle Danyluk, Ariena VanBruggen
 - UGA – Paige Adams



Discoveries

- *Salmonella* was frequently isolated from multiple sites on the Suwannee River in north Florida (94%), but was not found in central Florida Lakes and was relatively rare in south/central lakes and irrigation ponds (10%).
- Most (75%) Suwannee River strains (green) were in genotypes that did not contain clinical strains.
- Most (90%) South/central Florida strains (yellow) were in genotypes that were closely related to clinical strains.
- Results suggest that the virulence potential of *Salmonella* strains is variable within different aquifers.
- Proposed studies to investigate *Salmonella* in South Georgia.

| Rep-PCR Genogroup ¹ | Genogroup Distribution based on Strain Source (%) | | | |
|--------------------------------|---|-----------------------|------------------|--|
| | Clinical Library | Environmental strains | | |
| | | Suwannee River | Central FL Lakes | Other |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 0 | 0 |
| 3 | 0 | 2 | 0 | 4 (Orange) |
| 4 | 1 | 0 | 0 | 4 (Orange) |
| 5 | 43 | 8 | 22 | 25 (Orange) 8 (Cantaloupe) 16 (Toad) |
| 6 | 12 | 0 | 0 | 0 |
| 7 | 5 | 3 | 0 | 16 (Orange) |
| 8 | 0 | 2 | 5 | 13 (Orange) |
| 9 | 0 | 3 | 0 | 0 |
| 10 | 0 | 36 | 0 | 0 |
| 11 | 15 | 3 | 68 | 0 |
| 12 | 2 | 7 | 0 | 0 |
| 13 | 0 | 0 | 0 | 16 (Alfalfa) |
| 14 | 1 | 5 | 0 | 16 (Broccoli) |
| 15 | 0 | 32 | 0 | 4 (Tomato) |
| 16 | 4 | 0 | 0 | 24 (Arizonic) |
| N.C. ² | 3 | 5 | 5 | 8 (Water and soil) 4 (Arizona) |
| Total # | 342 | 110 | 19 | 24 |

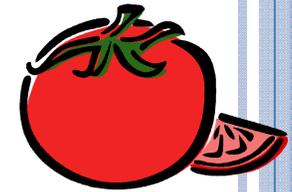
VAN DRUGGEN GROUP:
POTENTIAL TRANSMISSION
OF *SALMONELLA*
VIA TOMATO SEEDS



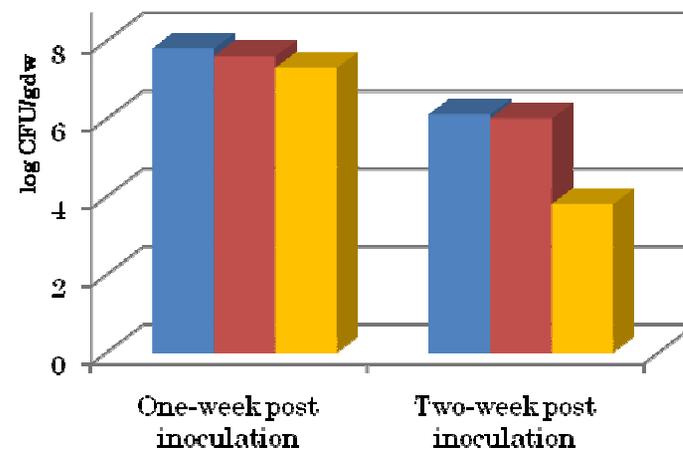
- Goals:
 - Determine if *Salmonella* can enter into tomato plants and internally contaminate tomato seeds
- Funding:
 - University of Florida, Institute of Food and Agricultural Sciences
- Collaborators:
 - UF – Michelle Danyluk



DISCOVERIES



- One out of 800 fruits was internally contaminated, and the extracted seeds (HCL extraction) carried the pathogen. The experiment will be repeated this fall and winter.
- Impacts could be very important for the tomato industry and seed companies



Population size of strain 119 of *Salmonella* Typhimurium at the site of inoculation inside the inoculated leaflets. Blue=sand; Red=conventional soil; Yellow=organic soil



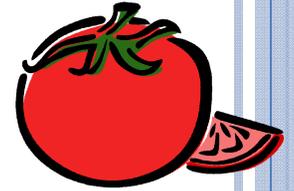
TEPLITSKI GROUP: FUNCTIONAL GENOMICS OF *SALMONELLA*-TOMATO INTERACTIONS



- Goals:
 - Characterize *Salmonella* gene expression within green and ripe tomatoes of commercial cultivars to identify maturity stage and cultivar, which are less susceptible to *Salmonella* contamination at harvest
 - Define the roles of soft-rot plant pathogens in contamination of tomatoes with *Salmonella* pre- and post-harvest
- Funding:
 - UC-Davis Center for Produce Safety, Florida Tomato Committee
 - UC-Davis Center for Produce Safety
 - Pending: UC-Davis Center for Produce Safety
 - Florida Department of Agriculture and Consumer Services
- Collaborators:
 - UF – George Hochmuth, Keith Schneider, Jerry Bartz
 - UC Irvine - Michael McClelland



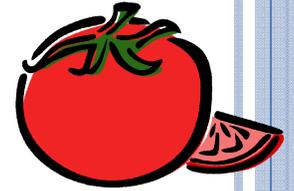
DISCOVERIES



- *Salmonella* proliferates in green tomatoes 10-1,000 times less than in red. This is cultivar dependent
- Some *Salmonella* genes are expressed in all tomato fruits, others are differentially regulated in response to a variety, maturity stage (Noel et al, 2010. PLoS One)
- None of the commercial cultivars is completely “resistant” to *Salmonella*, however 10-500 fold differences in proliferation of the pathogen within fruit exist.
- Soft rots promote significant growth of the pathogen in damaged produce. Quorum sensing is not involved.



SALMONELLA-TOMATO INTERACTIONS AND CONTROL, POSTHARVEST



○ Goals:

- Control of *Salmonella* in the packing house
- Understanding *Salmonella* cross-contamination in the packing house

○ Funding:

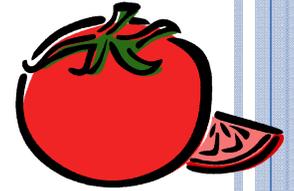
Florida Tomato Committee
Florida Fruit and Vegetable Association
UC-Davis Center for Produce Safety

○ Collaborators:

- UF – Michelle Danyluk, Steve Sargent, Jeff Brecht, Max Teplitski, Jerry Bartz
- UGA – Mark Harrison, Bill Hurst
- USDA ARS – Sunny Luo



DISCOVERIES



- A 5-30 s overhead water spray with brush rollers reduced surface contamination by an average of at least 3.5 log CFU/tomato.
- Few or no uninoculated tomatoes or brush rollers were cross contaminated with *Salmonella* from inoculated tomatoes after the 60 s 200 ppm sodium hypochlorite spray.
- A 3.65-log reduction in *Salmonella* on tomato surfaces was seen after 5 seconds sodium hypochlorite (100 ppm) overhead spray treatment on brush rollers.
- Comparatively, contamination was reduced by only 0.34 logs in the flume under the same time and concentration.
- A 5-log reduction was seen after just a 15 s overhead spray compared to an average of 2.34 log reductions using the flume.



BARTZ GROUP: POSTHARVEST WATER MANAGEMENT ON TOMATOES



○ Goals:

- Packinghouse water management

○ Funding:

Florida Tomato Committee

Florida Fruit and Vegetable Association

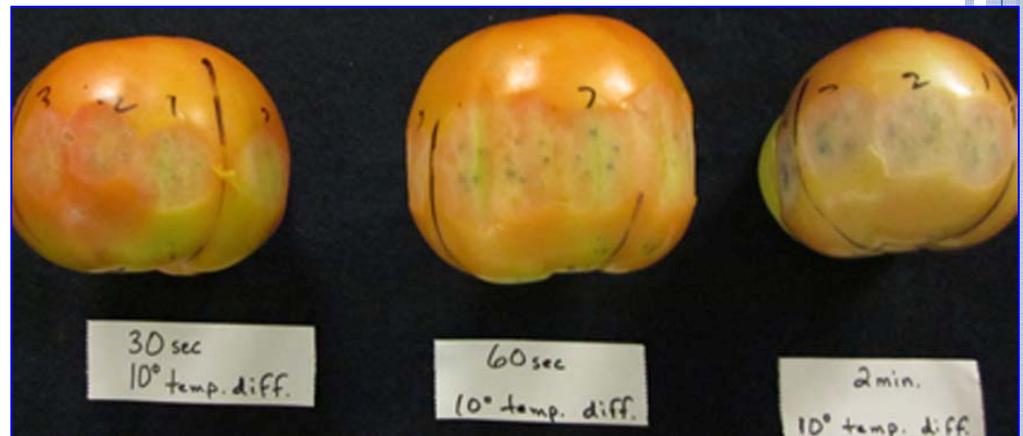
○ Collaborators:

- UF – Steve Sargent, Max Teplitski



DISCOVERIES

- Stem scar water uptake is confounded several factors including freshness and water congestion of stem scar.
- as the dwell time of the fruit in the dye solution increases, the infiltration of tissues beneath the wound increases. These fruit were ca. 10°C degrees warmer than the water. If exposure is limited to 30 sec, uptake is minimal.
- Wounds made just before the immersion treatment took up little dye whereas those made a more realistic (for commercial handling) 3 hr prior to treatment took up the most. Wounds made the day before (fruit held overnight) took up less than the 3-hr wounds except when fruit were stored hot (> 95°F).



DANYLUK GROUP: QUANTIFYING CROSS CONTAMINATION DURING PRODUCE PRODUCTION, HARVESTING, HANDLING, PACKING AND TRANSPORT



Goals:

- Determine *Salmonella* transfer potential during
 - Production of Staked tomatoes
 - Hand harvesting of mature green, round, staked tomatoes
 - Reuse of tomato cartons, tomato dry cleaning and tomato transportation
 - Handling of fresh cut melons and celery
- Impact of berry maturity, handling and packaging on *Salmonella*
- Impact of natural light labeling on *Salmonella* infiltration into tomatoes and citrus
- Impact of mechanical harvesting on citrus surface and juice



DANYLUK GROUP: QUANTIFYING CROSS CONTAMINATION DURING PRODUCE PRODUCTION, HARVESTING, HANDLING, PACKING AND TRANSPORT



- Funding:

USDA NIFSI – Special Emphasis, lead institution Cornell University

USDA NIFSI – Special Emphasis, lead institution Colorado State University

USDA SCRI CAP – lead institution University of California Davis

FDA Fresh Cut

FDA Transportation – lead institution University of Georgia

UC Davis Center for Produce Safety

Florida Tomato Committee

Citrus Research Initiative



DANYLUK GROUP: QUANTIFYING CROSS CONTAMINATION DURING PRODUCE PRODUCTION, HARVESTING, HANDLING, PACKING AND TRANSPORT



○ Collaborators:

- Colorado St – Larry Goodridge
- Cornell – Randy Worobo, Martin Wiedmann
- Michigan St – Suzanne Thornsberry, Elliot Ryser
- Rutgers – Don Schaffner
- Texas Tech – Mindy Brashears
- UC Davis – Linda Harris, Trevor Suslow
- UGA - Mark Harrison, Bill Hurst
- UF – Keith Schneider, Anita Wright, Ariena VanBruggen, Tim Spann, Ed Exteberria



DISCOVERIES



- During handling of tomatoes with gloved hands, under moist conditions up to 44% of *Salmonella* transferred.
 - When handling multiple tomatoes, less than 1% of *Salmonella* transferred beyond touching the 6th tomato, but at least 10 tomatoes were contaminated.
- *Salmonella* transfer to and from used tomato cartons differs from new tomato cartons
- Natural light labeling does not increase infiltration into tomatoes or citrus
- Mechanical Harvesting of citrus does not increase microbial load under most conditions.



DANYLUK GROUP: EVALUATION AND APPLICATION OF PRACTICES FOR CONTROLLING *SALMONELLA* IN NUTS AND NUT PRODUCTS



○ Goals:

- Prevalence and frequency of *Salmonella* on Peanuts and Pecans
- Survival of *Salmonella*, *Listeria* and *E. coli* O157:H7
- *Salmonella* during peanut production

○ Funding:

USDA NIFSI, lead institution UC Davis

National Pecan Shellers Association

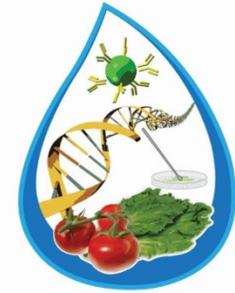
Pending: American Peanut Council, USDA AFRI

○ Collaborators:

- UC Davis – Linda Harris
- UGA – Larry Beuchat



DANYLUK GROUP: *SALMONELLA* IN SOUTH AND CENTRAL FLORIDA SURFACE WATERS



Sampling Methods to Evaluate the Microbial Safety of Fresh Produce

○ Goals:

- Develop a method to concentrate and test large volumes (5 - 10 L) of surface water
- Evaluate rapid methods of *Salmonella* detection (in Florida, *E. coli* O157:H7 as well in other collaborating states)
- Characterize isolated strains

○ Funding:

USDA SCRI CAP, lead institution Colorado St.

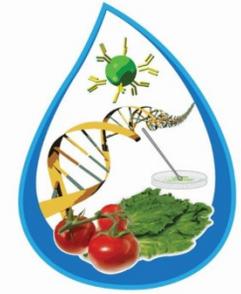
○ Collaborators:

- Colorado St: Larry Goodridge, Kendra Nightingale
- Ohio St: Jeff Lejeune
- Rutgers: Don Schaffner
- UC Davis: Trevor Suslow
- Guelph: Mansel Griffith



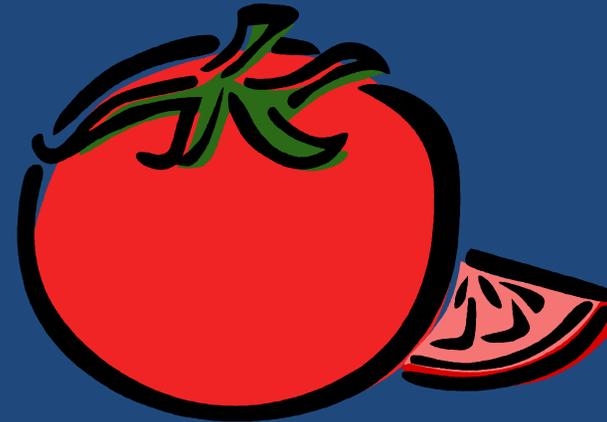
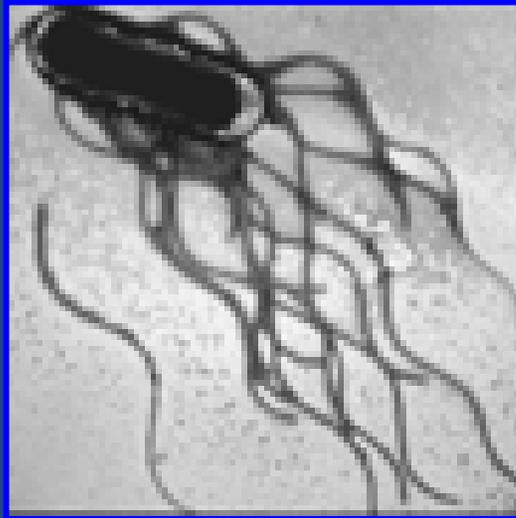
DISCOVERIES

- *Salmonella* Methodology: 10 L, 3 days
 - Detection Limit; 1 CFU/L
- Currently a 12 month survey ongoing of 18 water sites in Central Florida
 - Includes generic *E. coli* MPN testing
- Establishing metrics for Chlorine Dioxide use in flume and dump tank waters



Sampling Methods to Evaluate the
Microbial Safety of Fresh Produce





EXTENSION

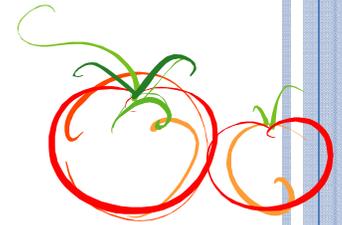
Current Produce Safety Research at the
University of Florida



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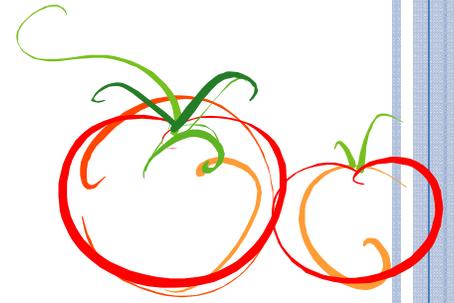
SPECIALTY CROPS BLOCK GRANT PROGRAM: GOOD AGRICULTURAL PRACTICES TRAINING INITIATIVE



- This grant began in late 2007, with funding beginning in 2008.
- Ultimately, this program was to support the efforts of the FDACS and the FTC by providing the necessary training so farmers and packer could comply with the new tomato good agricultural practices (T-GAPs) and tomato best management practices (T-BMPs) program.



OBJECTIVES



- Develop and deliver food safety educational materials and training
- Provide training and materials statewide to producers, field workers, packers and repackers of fresh fruits and vegetables
- Designed a food safety program focusing on those fruits and vegetables associated with the highest risk of foodborne: tomatoes, leafy greens, melons and berries



TRAINING TEAM



Michelle Danyluk
Food Science
Citrus Research
and Education
Center



Steve Sargent
Horticultural
Sciences



Keith Schneider
Food Science
and Human
Nutrition

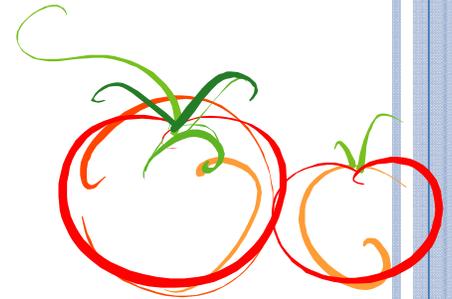


Renee Goodrich
Food Science and
Human Nutrition



- Designed a food safety program focusing on those fruits and vegetables associated with the highest risk of foodborne: tomatoes, leafy greens, melons and berries

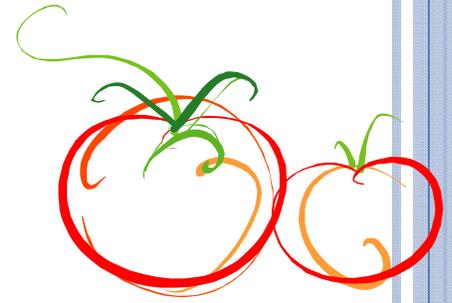
TRAINING MATERIALS



- Tailgate Flipchart (in English, Spanish and now in Creole)
- Food Safety Begins on the Farm: A Growers Self Assessment of Food Safety Risk Manual
- Fruits, Vegetables, and Food Safety: Health and Hygiene on the Farm DVD (in English, Spanish and now in Creole)
- Worker Health and Hygiene Program for the Produce Industry DVD (in English and Spanish)
- Food Safety Posters (in English and Spanish)
- Educational Factsheets
- Audit Documents



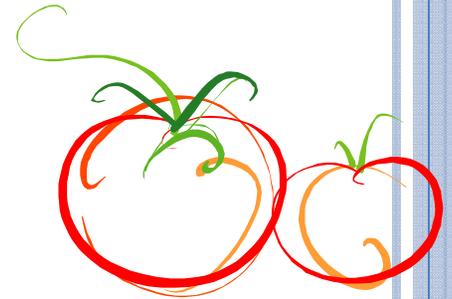
TRAINING MATERIALS



- In all, over 15,000 pieces of food safety material were distributed.
- In addition, all attendees received workbooks and other educational materials



REGIONAL WORKSHOPS

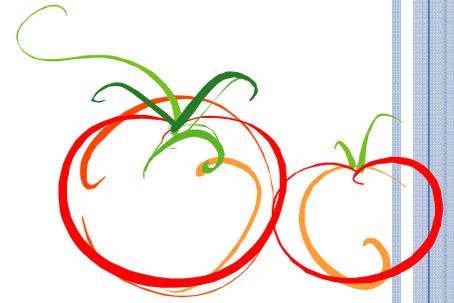


- Since the grant's inception the workshop events have trained 1027 attendees (approx. 700 persons; with some individuals attending two or more workshops). Of the 700 unique individuals, approximately 40 were Florida Extension agents.

AGENT TRAINING

- Two agent specific workshops
 - General GAPs
 - Water



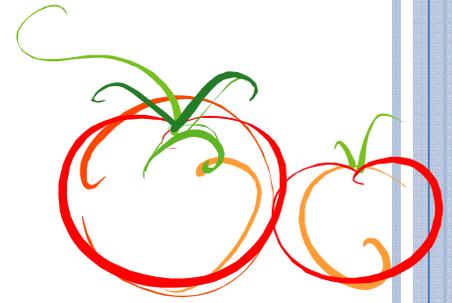


NOW AND IN THE FUTURE

- The success of this program has generated new programs directly from comments received from farmers.
- Extension Agents/Specialists have additional workshops, new programs and grants in the works.
 - Bob Hochmuth and Linda Landrum, North Florida REC
 - Workshop to build Food Safety Programs with Growers
 - Two held to date, more planned



NOW AND IN THE FUTURE



- On-line training
- <https://eces.ifas.ufl.edu>

- All we need to do now is update the course with the new regs and rules.

Tomato School



The Tomato School website has been developed through a grant with the FDACS, USDA and the University of Florida. It is designed to deliver educational material to the Florida produce industry. The site will contain GAPs mini-course all growers will be required to take. The site will also contain helpful materials, designed to make safety a number one priority.

[View Courses](#)

University of Florida IFAS Extension Solutions for Your Life

Extension Continuing Education Solutions

Home Topics Help

If you have an ECES or GatorLink account, log in here:

Username:

Password:

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[First Time User Register](#)

[Forgot Username or Password?](#)

Online Training Courses - Tomato School

Limited Time Offer!! All for-sale items reduced by 50% (applied at checkout).

GAPs Lectures



[View Courses](#)

OTHER EXTENSION PROGRAMS

- Florida Tomato Committee
 - Annual workshop
- Florida Small Farms Conference
 - Annual meeting
- National Mango Board
 - Narrated online power point presentations
- Other commodity/location specific programs
 - Sunbelt Expo
 - Value Added Tropical's, Tropical REC
 - Citrus packing houses personal hygiene



CENTER FOR PRODUCE SAFETY

- Established at UC Davis
- 2010 – First Research Symposium
 - June 2010, UC Davis
- 2011 – Second Research Symposium
 - Late spring, Florida Location



CENTER FOR PRODUCE SAFETY

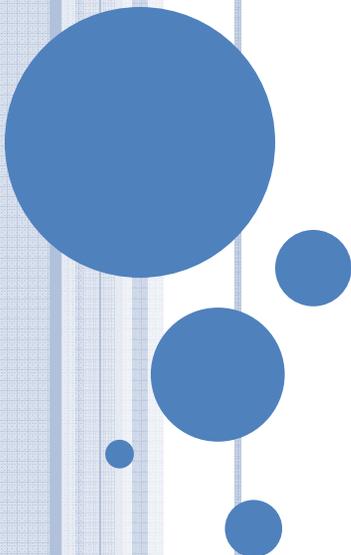
Produce Research Symposium

June 23, 2010 • University of California, Davis





QUESTIONS?



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