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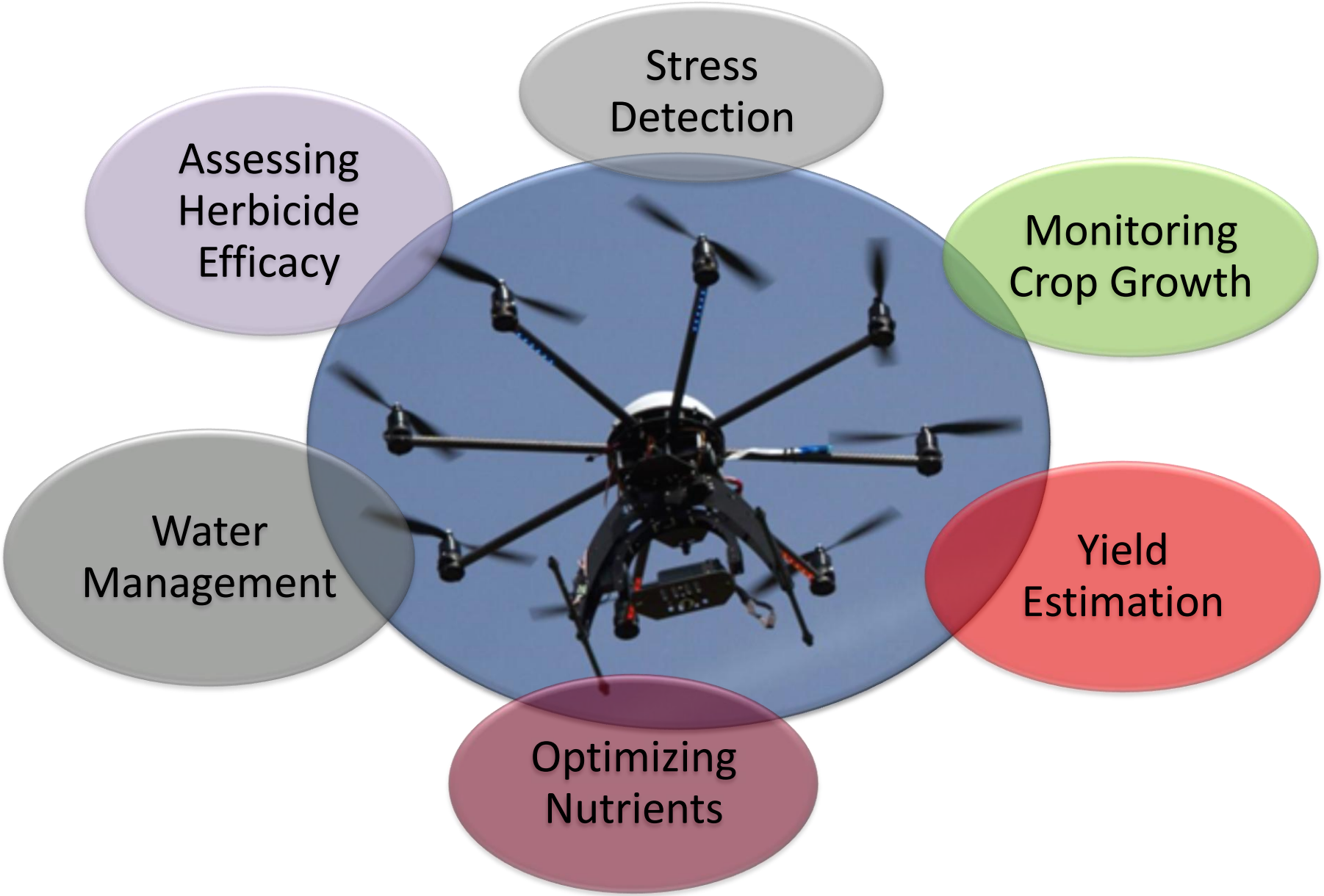
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

# Harnessing Unmanned Aerial Vehicles in Fruit, Vegetable, and Nut Crops

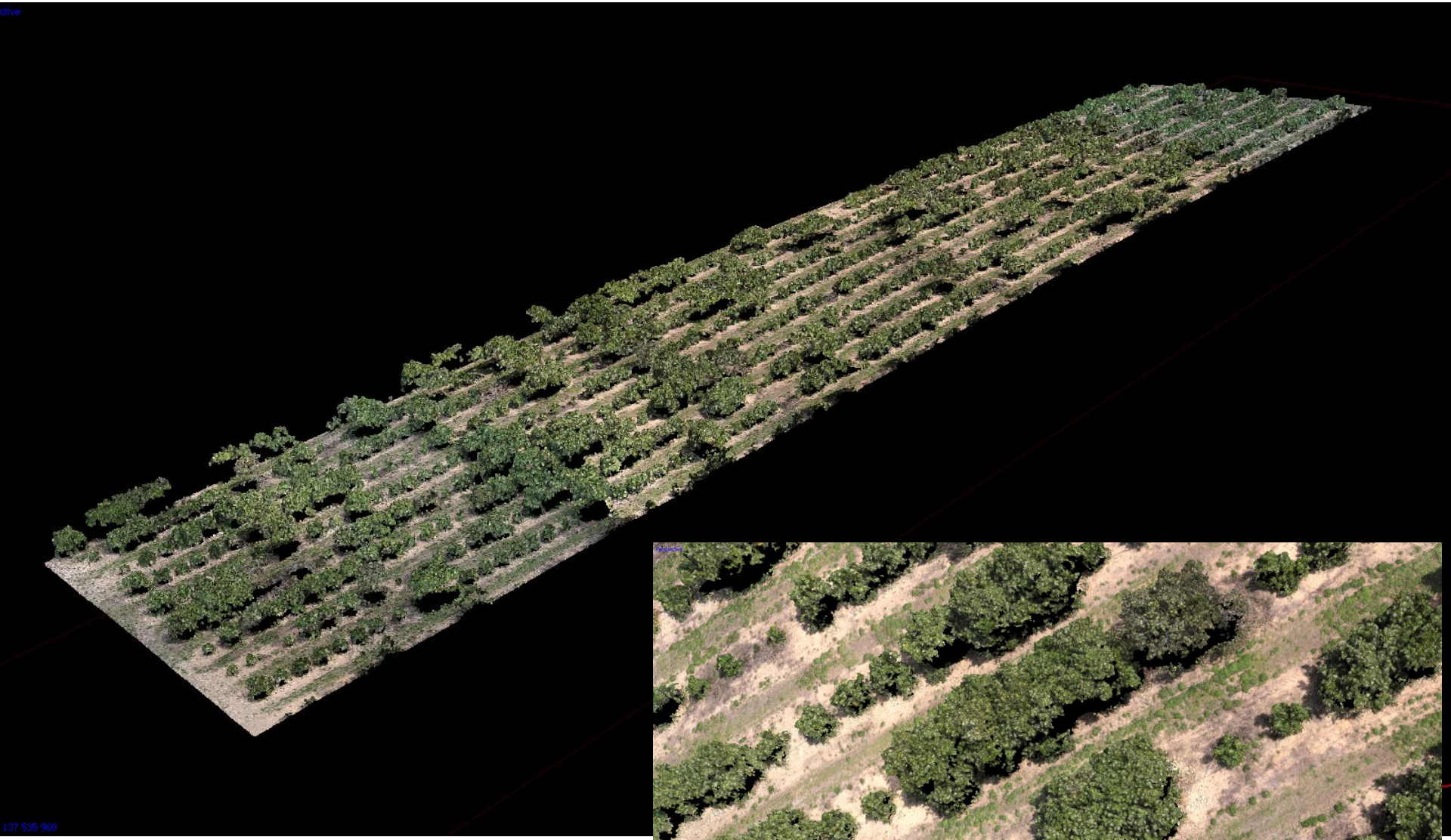
United States Department of Agriculture
National Institute of Food and Agriculture

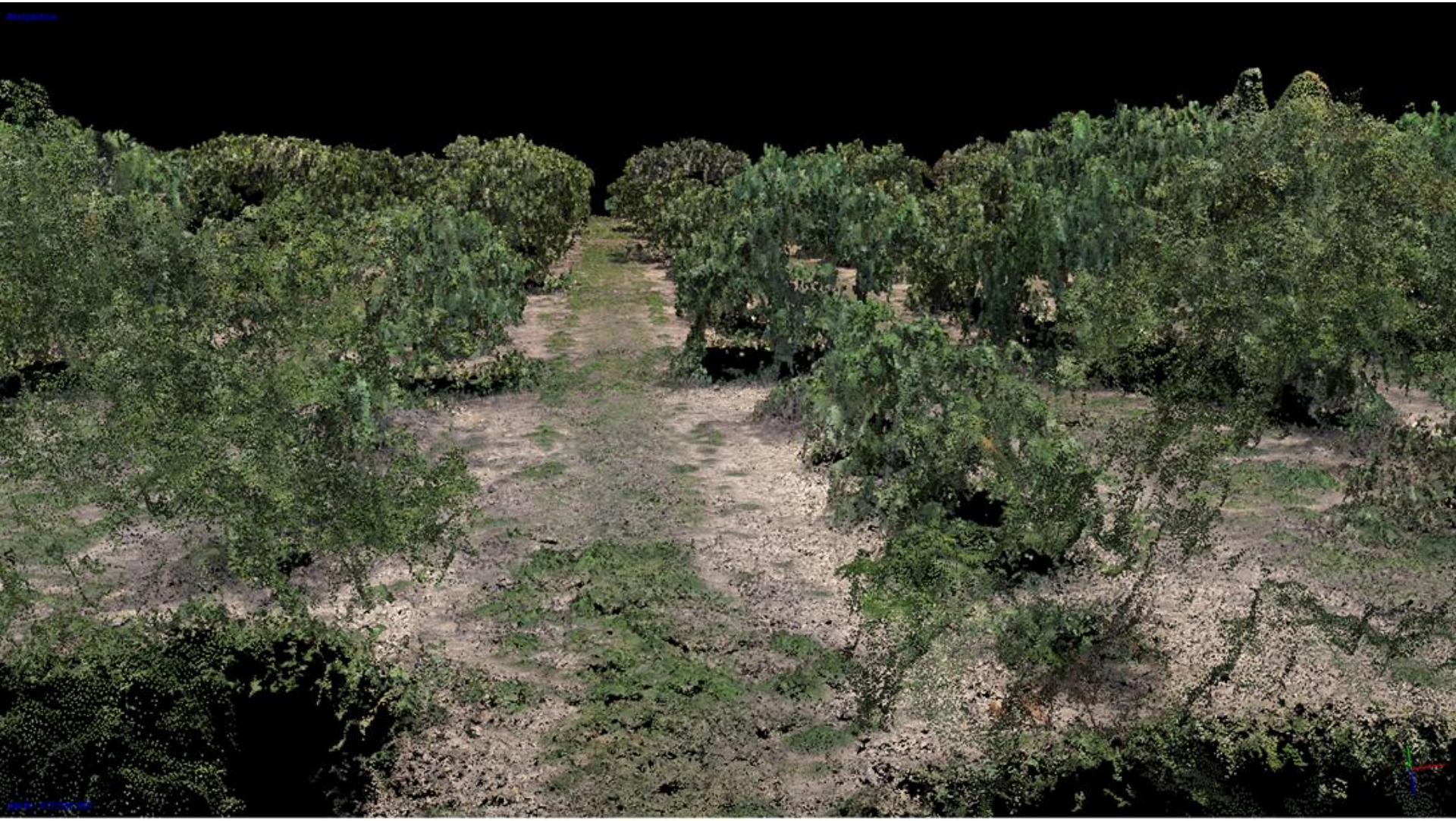
Workshop funded through FY2014 USDA Specialty Crops Research Initiative (SCRI) Planning Grant

# UAVs in Agriculture



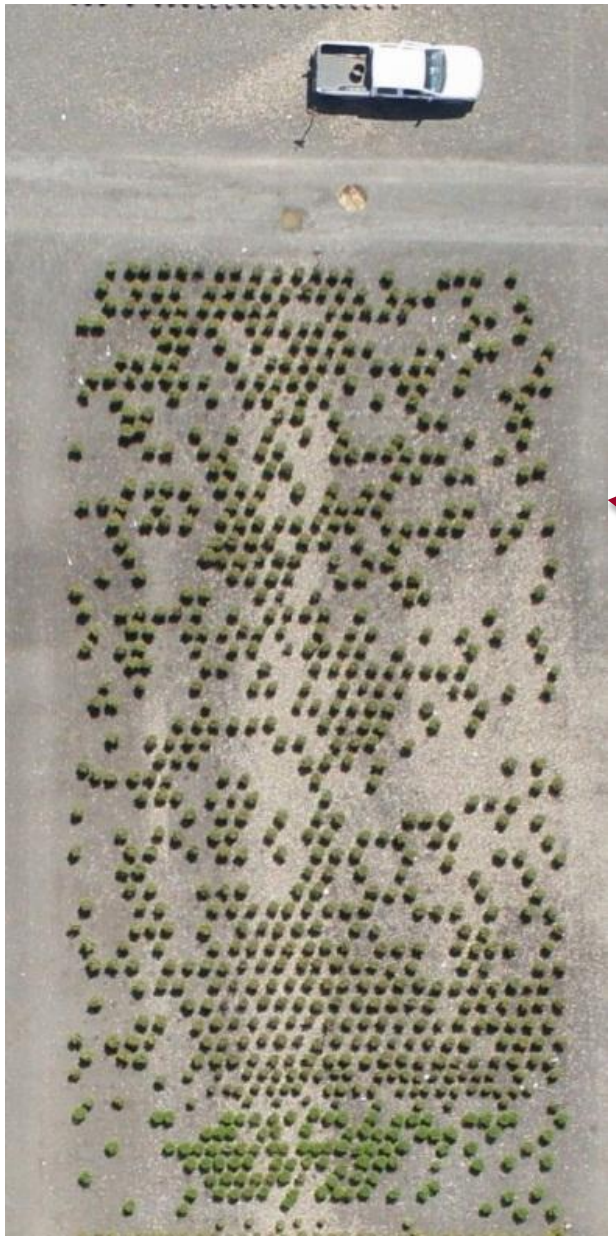
# View from above
# &
# virtual orchard





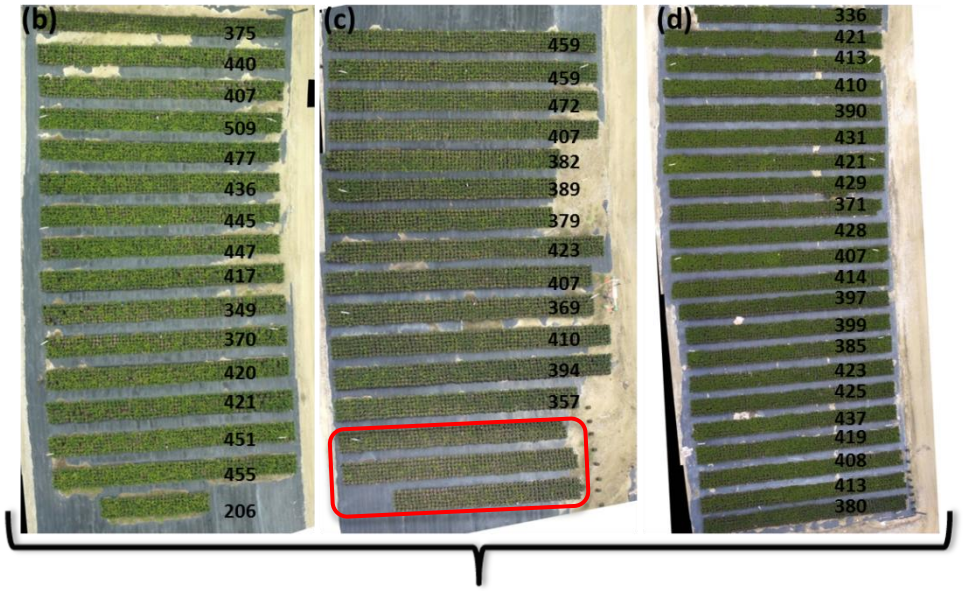
# Inventory management

# Inventory



Counting overlapping plants in containers

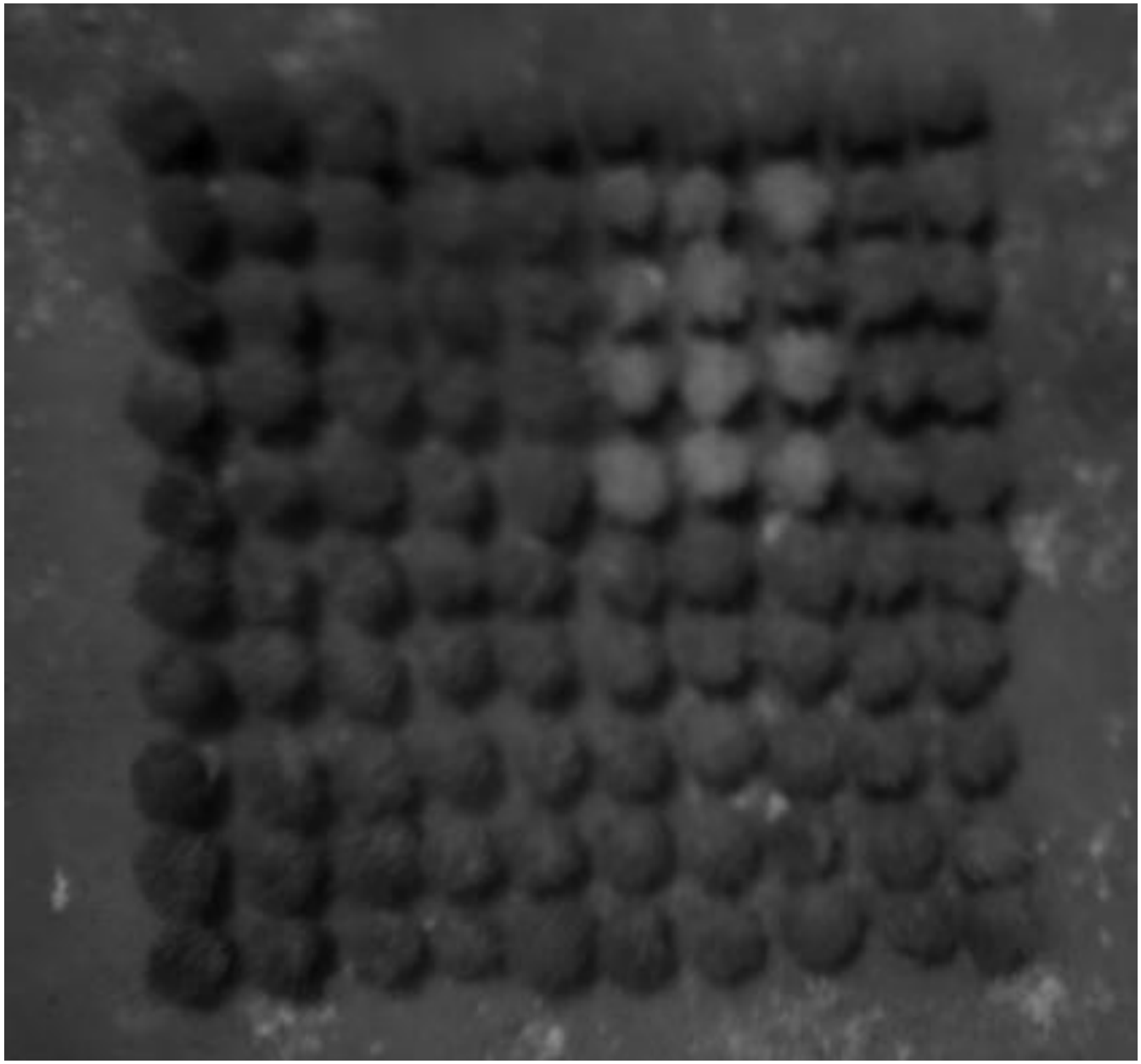
# Counting results




| Row # | Algorithm Count | Manual Count | Error |
|---|---|---|---|
| 99-114 | 495 | 499 | 0.80% |
| 79-97 | 514 | 553 | 7.05% |
| 64-77 | 464 | 425 | 9.18% |
| 49-62 | 429 | 422 | 1.66% |
| 34-47 | 489 | 418 | 16.99% |

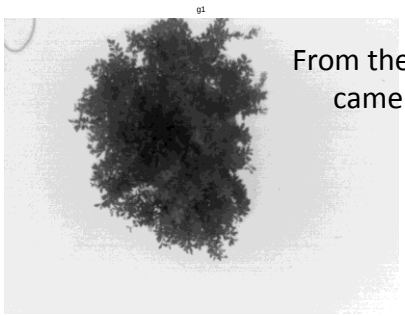
| Algorithm Count | Manual Count | Error |
|---|---|---|
| 20889 | 22000 | 5.05% |

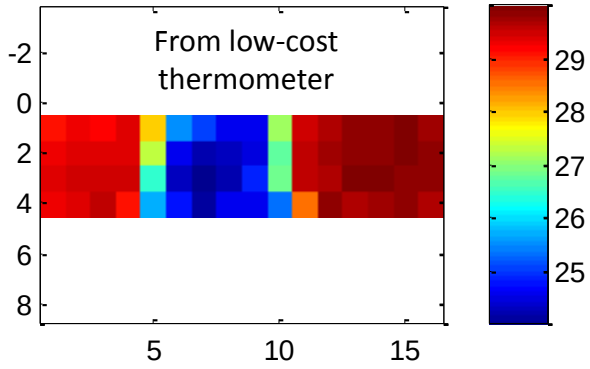
# Disease and stress detection

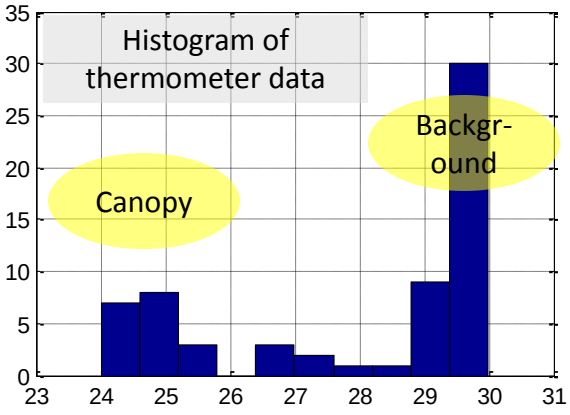


# Indoor Barberry Sensing

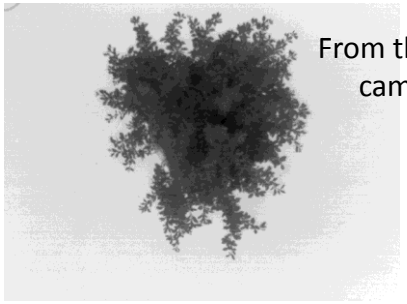
## Non-stressed

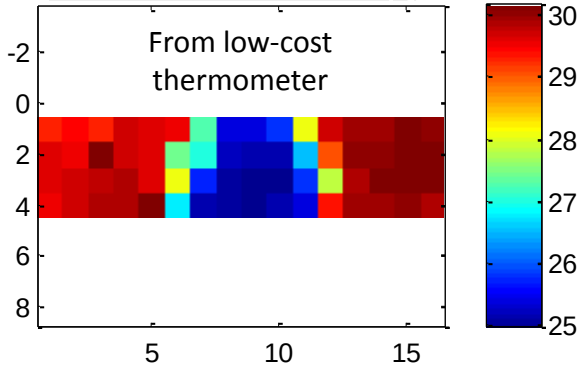


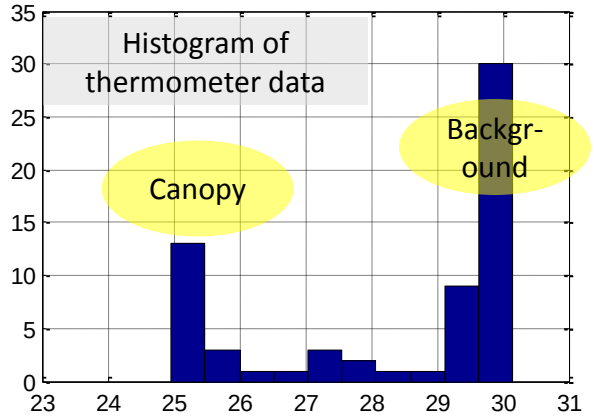



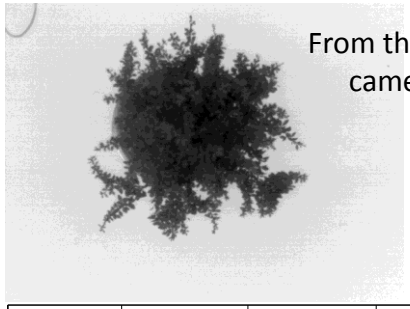

## Medium-stressed

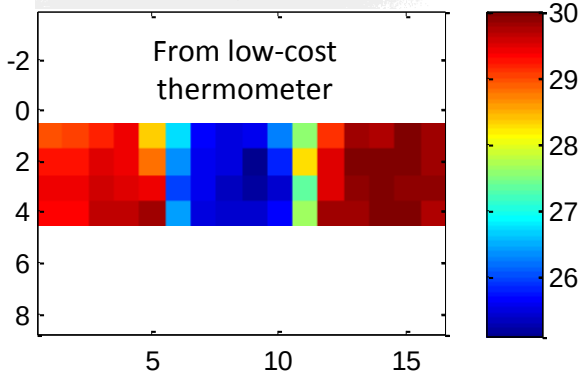


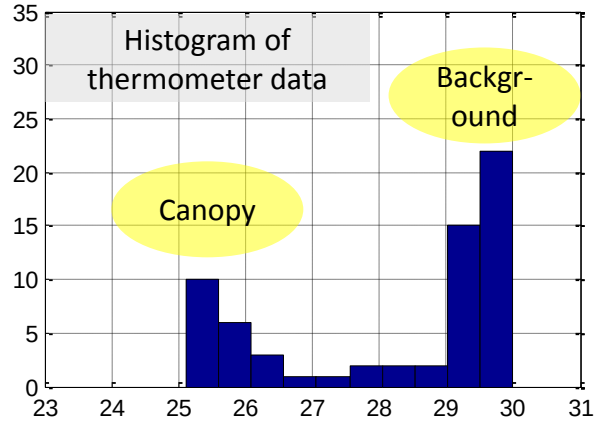




## High-stressed

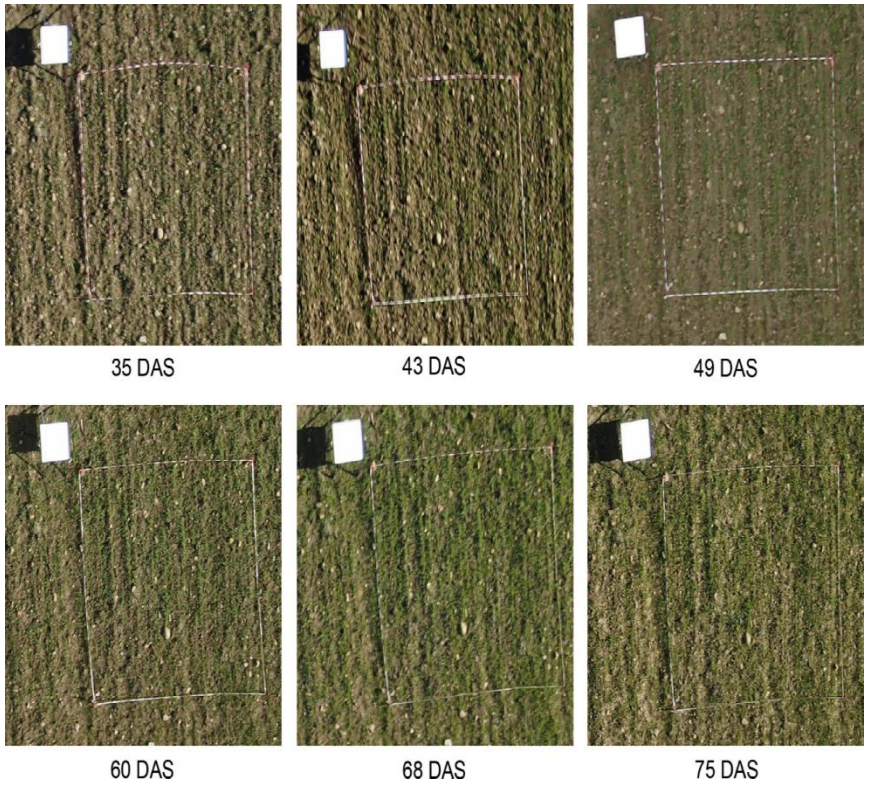


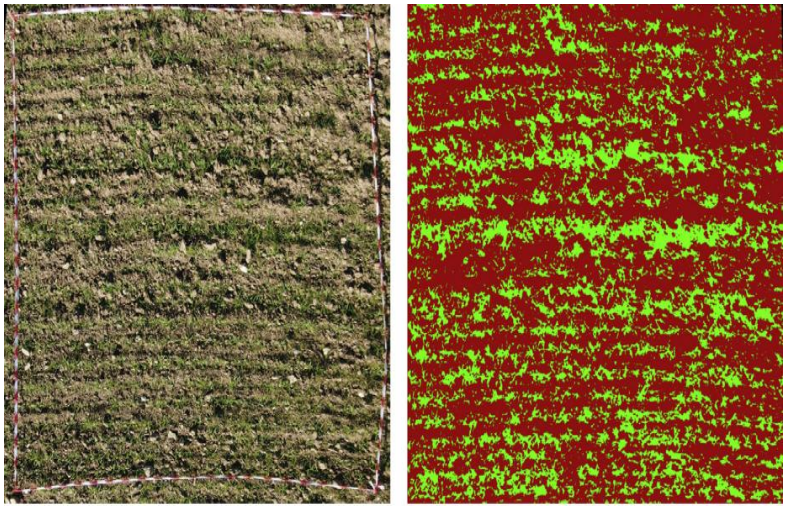



# Applications of UAVs in weed detection

- J. Tórres-Sánchez, J.M. Peña-Barragán, A.I. de Castro and F. López-Granados. (2014). Multi-temporal mapping of vegetation fraction in early-season wheat fields using images from UAV. *Computers and Electronics in Agriculture,* 103, 104–113



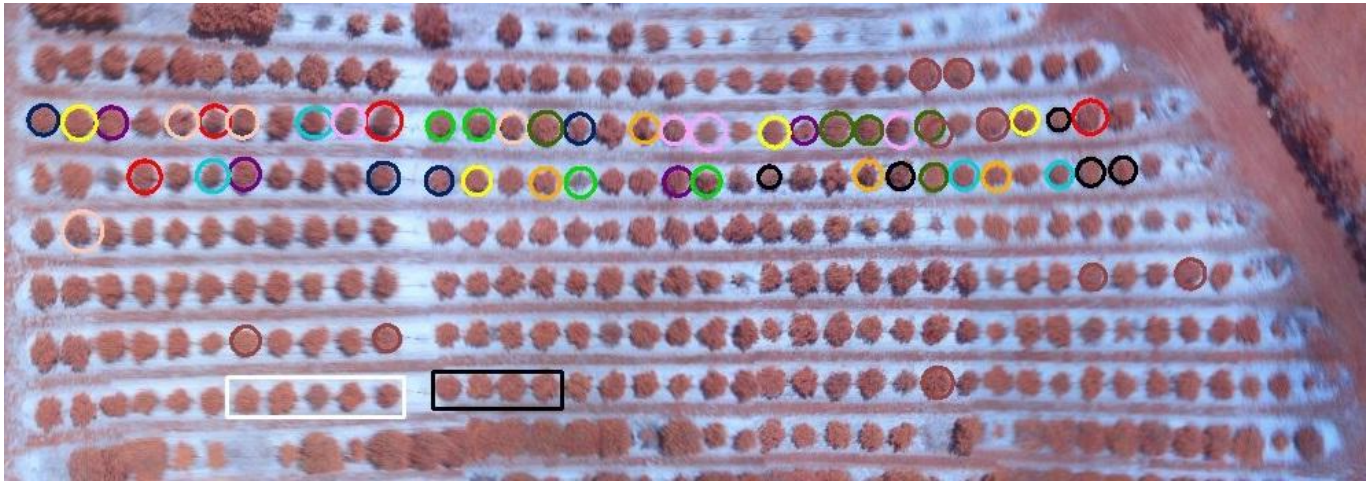



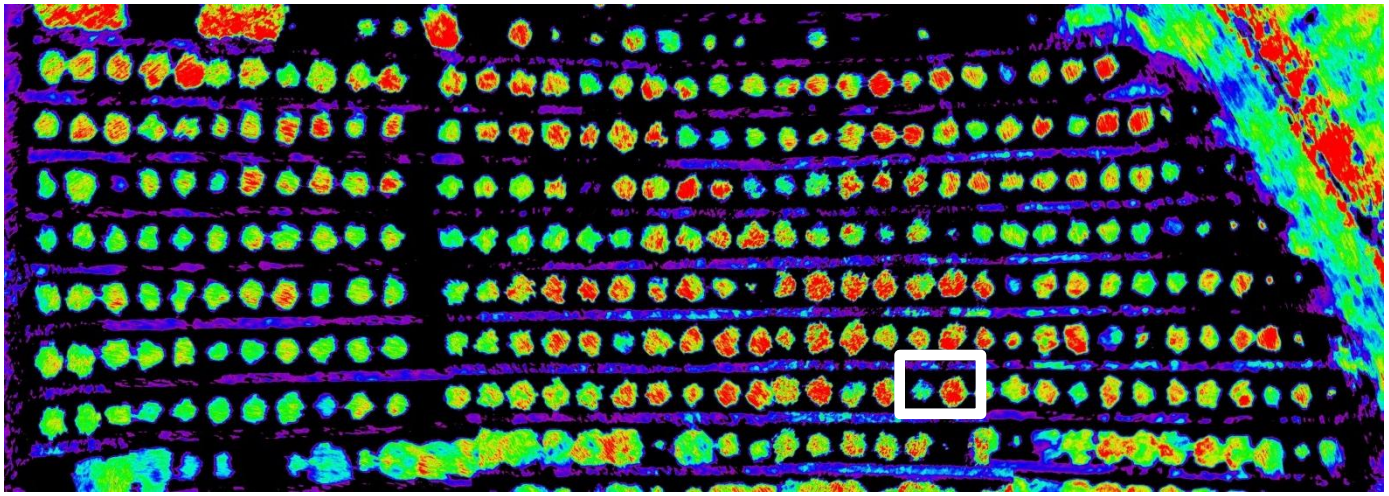
# On-farm research

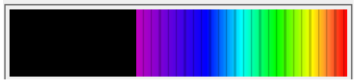
courtesy of Dvorlai

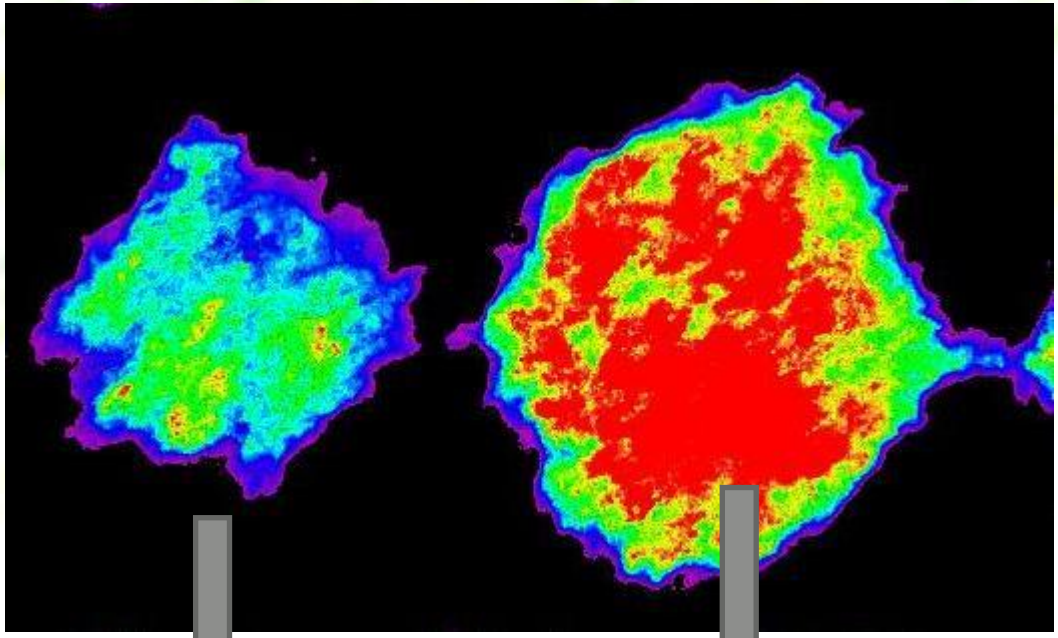
The effect of different experimental treatments in an apple orchard

# Aerial Imaging to Assess Heat Treatment

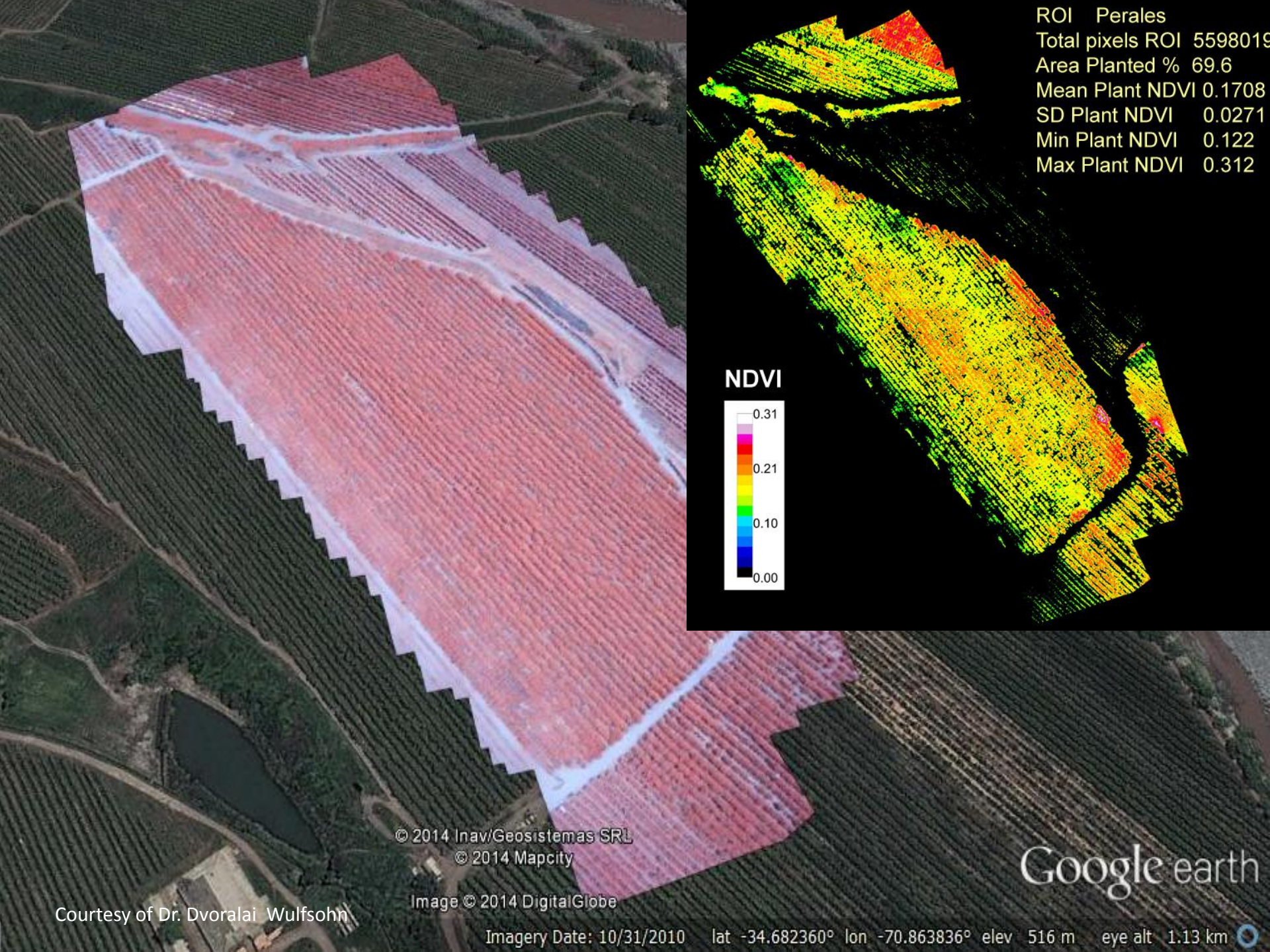








# Yield estimation




Courtesy of Dr. Dvoralai Wulfsohn

Period Calculator
4 iteraciones
INPUT VALUES:
Etapa Nombre
WANTED VALUES APROX
Sample size
Periodo
CALCULATED VALUES
Hilera
Planta
Rama
Segm1
Por Hilera
Por Planta
Por Rama
120
85
15
10
36
12
24
35.4
SAMSUNG
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Courtesy of Dr. Dvoralai Wulfsohn
Fechas de imágenes: 1/6/2013

Courtesy of Dr. Dvoralai Wulfsohn

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# Premise

The high value and labor- and decision-intensive nature of fruit, vegetable, and nut crops provides an environment ripe for novel uses of UAVs to support diverse management tasks that go beyond the traditional remote sensing applications for which UAVs are predominantly used in agronomic crops

# Surveillance

- Identification of stressed or diseased plants on large scale
- Scouting of individual plants for pests and diseases
- Weed detection
- Monitoring field workers

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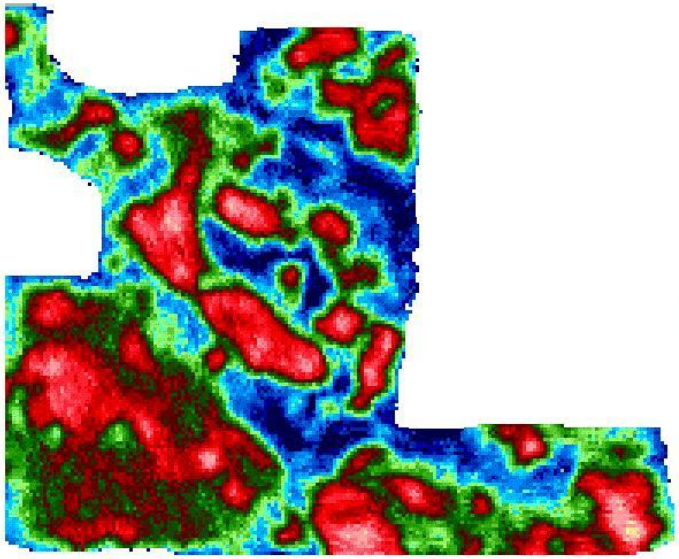
# Interventions

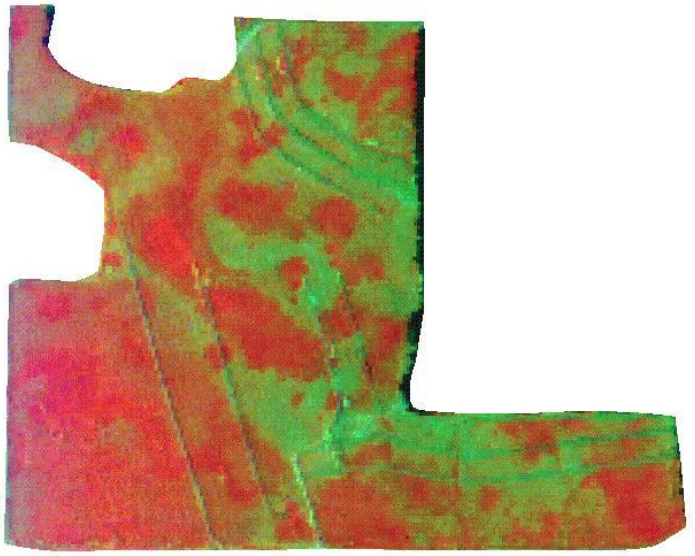
- Repelling large pests such as birds and feral hogs
- Application of pesticides
- Application of pollen or biocontrol materials

# Data Analysis

- Yield estimation
- Crop maturity estimation



Actual yield measurements



Predicted yield measurements

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# Swarming Robotics

- 10 to 100 or 1,000 robots per acre
- Cost of each robot - $1-$2
- Not all robots have same sensor payload
- Very close up view of each plant or tree
- Data collection
  - Land on leaf or plant to collect data
  - Land on soil to take measurements
  - Pathogen detection

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# Extreme Data Collection

- Sub-mm accuracy for each plant
- Develop 4D model of plant or tree
- Collect and integrate data over entire life cycle of plant/tree
  - Rate of growth of plant and fruit
  - Location of blooms that lead to fruit for yield estimation and harvesting
  - Tree architecture for trimming and pruning
  - Multi-sensor approach

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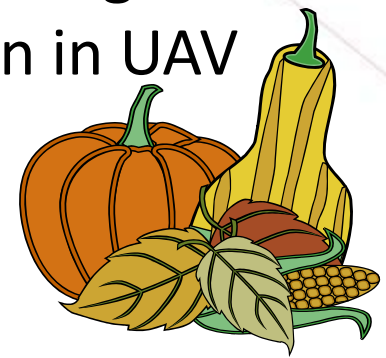
# Planning Grant Goals

- Critically evaluate the state-of-the-art of agricultural UAV technologies as well as needs and opportunities for their use in specialty crops
- Build an interdisciplinary network of scientists, engineers, and stakeholder to address these opportunities
- Develop a Roadmap to enable applications of UAV technologies in these crops in the short to medium term
- Utilize the Roadmap to guide regional and national grant-writing efforts to support research and extension in UAV technologies for specialty crops



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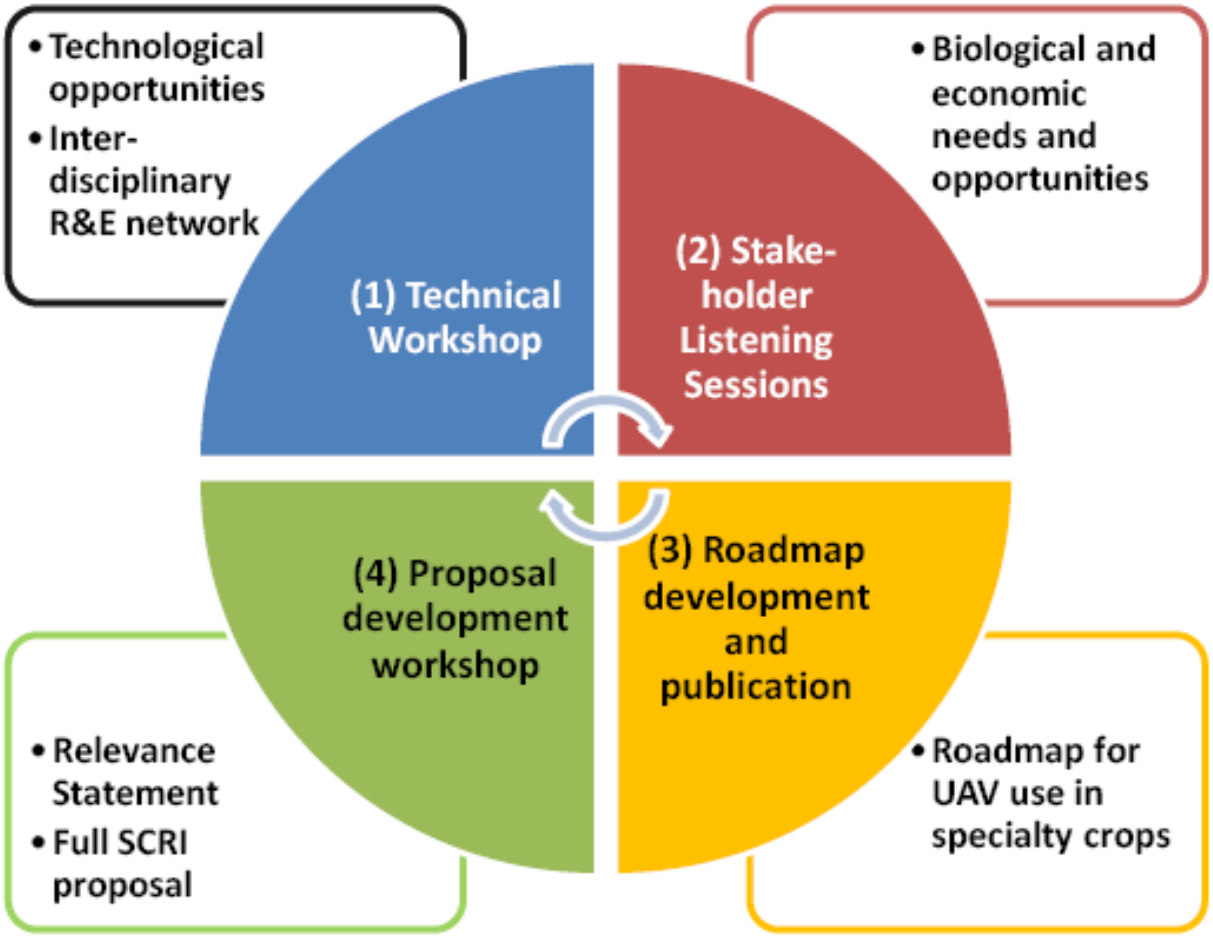
# Planning Grant Process



# Thanks on behalf of the planning grant PIs:

- Gary McMurray, Georgia Tech Research Institute
- Reza Ehsani, University of Florida
- Glen Rains, University of Georgia
- Harald Scherm, University of Georgia
- Chad Dennis, Middle Georgia State College

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# Anticipated Outcomes

- Forming of a coherent, interdisciplinary network of scientists, engineers, and stakeholders from the UAV and specialty crop sectors with shared goals and vision;
- Identification and prioritization of specific research, extension, and technology development needs and opportunities for UAV application in the target crops based on technological and economic considerations;
- Publication and distribution of a Roadmap for UAV use in specialty crops to guide future work; and
- Submission of a Stakeholder Relevance Statement and full proposal to the FY15 SCRI grants program.