Emerging Technologies for Precision Management in Vegetables

Precision Engineering Program

Dr. Yiannis Ampatzidis

Assistant Professor

Southwest Florida Research and Education Center

Agricultural and Biological Engineering Department,

University of Florida

4^{th} Agricultural Revolution

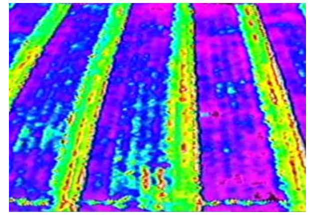
Digital Farming / Big Data / Internet of Things (IoT)

Smart Farming / Smart-Intelligence Machinery

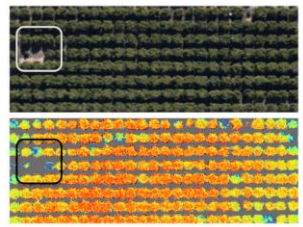
Robotics / Artificial Intelligence (AI) / Automation

UAV Imaging

- Thermal

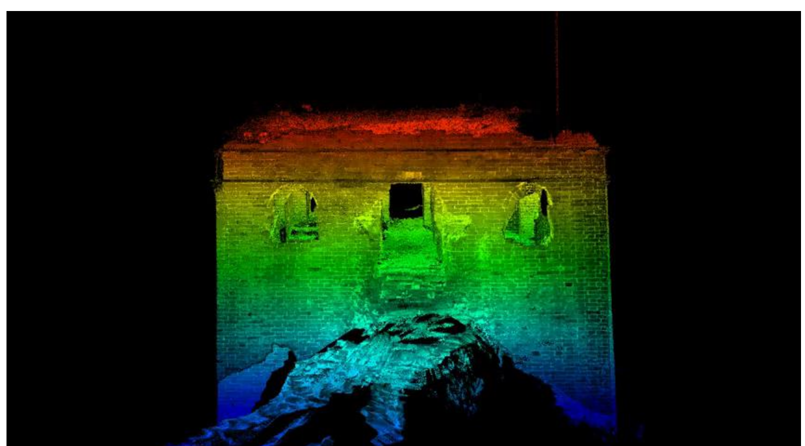


- Multi-Spectral
- Hyperspectral



- Visual – RGB

- LiDAR



UAV-based EDIS Documentation

- Kakarla S.C., and Ampatzidis Y., 2018. ***Instructions on the Use of Unmanned Aerial Vehicles (UAVs) for Agricultural Applications***. EDIS, University of Florida, IFAS Extension.
- Kakarla S.C., De Morais L., and Ampatzidis Y., 2019. ***Pre-Flight and Flight Instructions on the Use of Unmanned Aerial Vehicles (UAVs) for Agricultural Applications***. EDIS, University of Florida, IFAS Extension.
- Kakarla S.C., and Ampatzidis Y., 2019. ***Post-Flight Data Processing Instructions on the Use of Unmanned Aerial Vehicles (UAVs) for Agricultural Applications***. EDIS, University of Florida, IFAS Extension.
- Ampatzidis Y., 2018. ***Applications of Artificial Intelligence for Precision Agriculture***. EDIS, University of Florida, IFAS Extension.

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UNIVERSITY of FLORIDA

Southwest Florida Research and Education Center

Remote Pilot License Training

In order to obtain a Remote Pilot Certificate from FAA under the Small UAS (Part 107) rule, you must pass the initial aeronautical knowledge exam. This training will prepare you to pass this exam and obtain your certificate.

What you learn:

Airspace and Aeronautical Symbols

Aeronautical Charts

FAA Part 107 Regulations

Airspace Classification

Aviation Weather

Risk Management

and much more ……….

Tuesday, April 30th, 2019

9:00 a.m. - 3:45 p.m.

UF / IFAS Southwest Florida Research and Education Center

2685 SR – 29 / Immokalee, Florida 34142

UAV-based high throughput phenotyping

Register for your spot on the Eventbrite link ($75 per person) below. There is no registration fee for extension agents, and UF faculty, students and staff ($10 is requested for lunch). Still need to register here:

https://www.eventbrite.com/e/remote-pilot-license-training-tickets-59955736221

Lunch is provided.

For questions, call 239-658-3415 or email Jennifer Derleth at jderleth@ufl.edu.

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Remote Pilot License Training

April 30, 2019

Southwest Florida Research and Education Center

Agenda

9-9:15 am

- Opening remarks and introductions- Dr. Yiannis Ampatzidis and Jennifer Bearden -15 min

9:15-9:55 am

- Section 1 – Aircraft identification and registration – 30 min

Break/questions – 10 minutes

9:55-11:15 am

- Section 2 – Airspace and Aeronautical Symbols – 50 min
- Sectional Chart Reading Activity – 20 min

Break/questions – 10 minutes

11:15-12:15 pm

- Section 3 – Aviation weather and effects – 50 min

Lunch Break

1-1:20 pm

- UF procedures- John Rouse – 20 min

1:20-2 pm

- Section 4 – Risk management – 30 min

Break/questions – 10 min

2-2:45pm

- Section 5 – Aeronautical knowledge – 30 min

2:45-3:15 pm

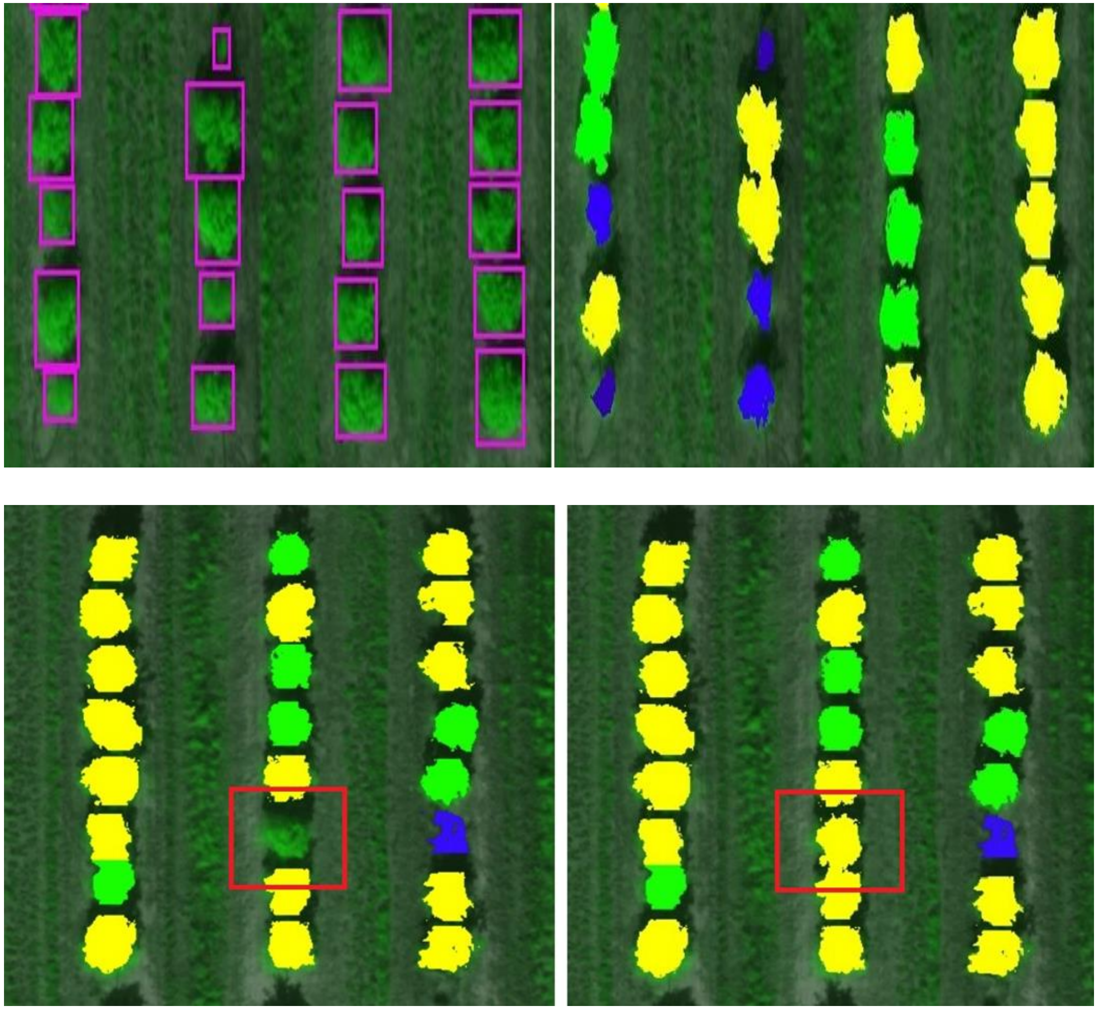
- Applications in Agriculture-Yiannis Ampatzidis and Jennifer Bearden-30 mins

Final questions – 20 min

Planning Committee: Yiannis Ampatzidis, Jennifer Bearden, Jim Fletcher, Gene McAvoy

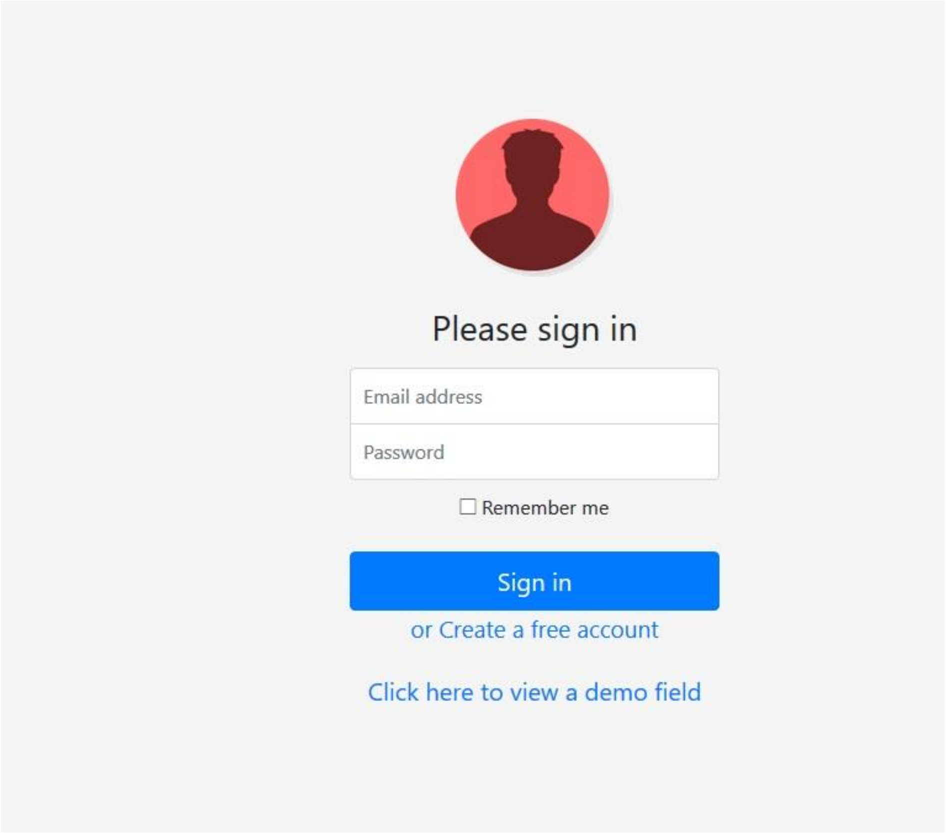
KIWI UAV Spraying System

UAV-based Object Detection using Artificial Intelligence (AI)



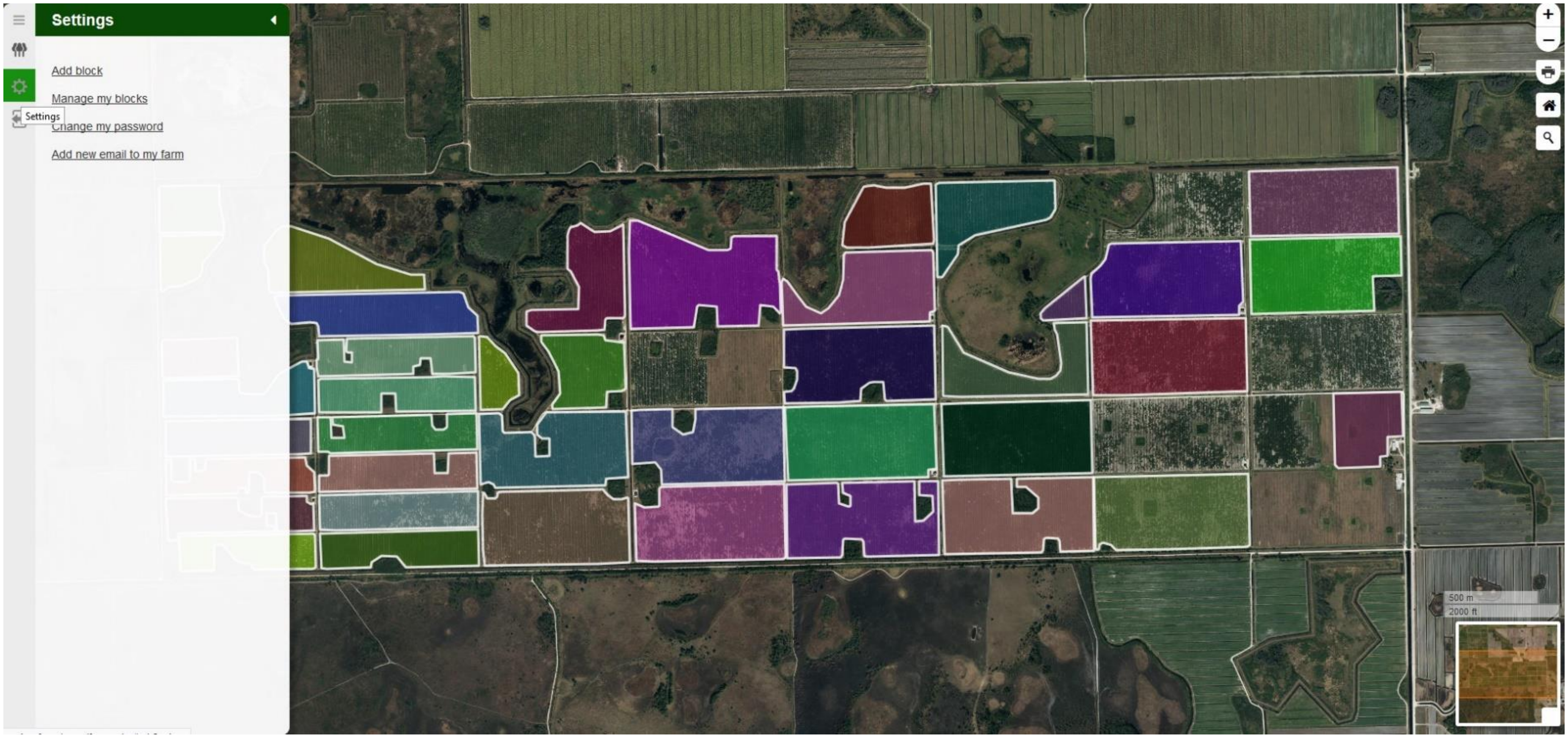
Ampatzidis Y., and Partel V., 2019. UAV-based High Throughput Phenotyping in Citrus Utilizing Multispectral Imaging and Artificial Intelligence. Remote Sensing, 11(4), 410; doi: 10.3390/rs11040410.

Agroview.farm – sing in

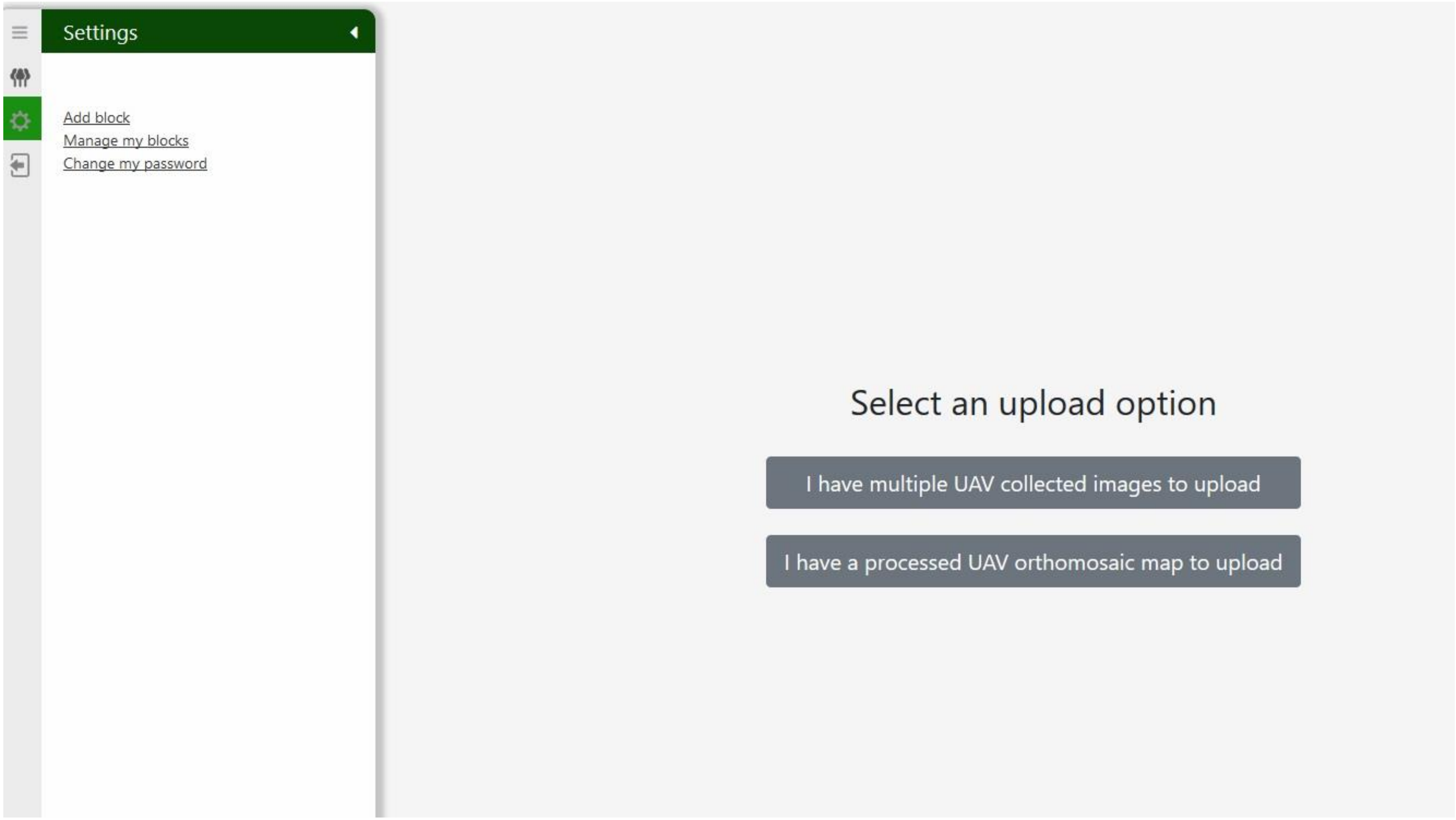


- UAV and ground-based high throughput phenotyping in citrus utilizing artificial intelligence. Huanglongbing Multi-Agency Coordination (MAC) Group. Duration: 8/1/2019 – 7/31/2021.
- UAV-based high throughput phenotyping in specialty crops utilizing artificial intelligence. Florida Specialty Crop Block Grant Program - Farm Bill (SCBGP-FB). Duration: 1/1/2020 – 8/31/2022.

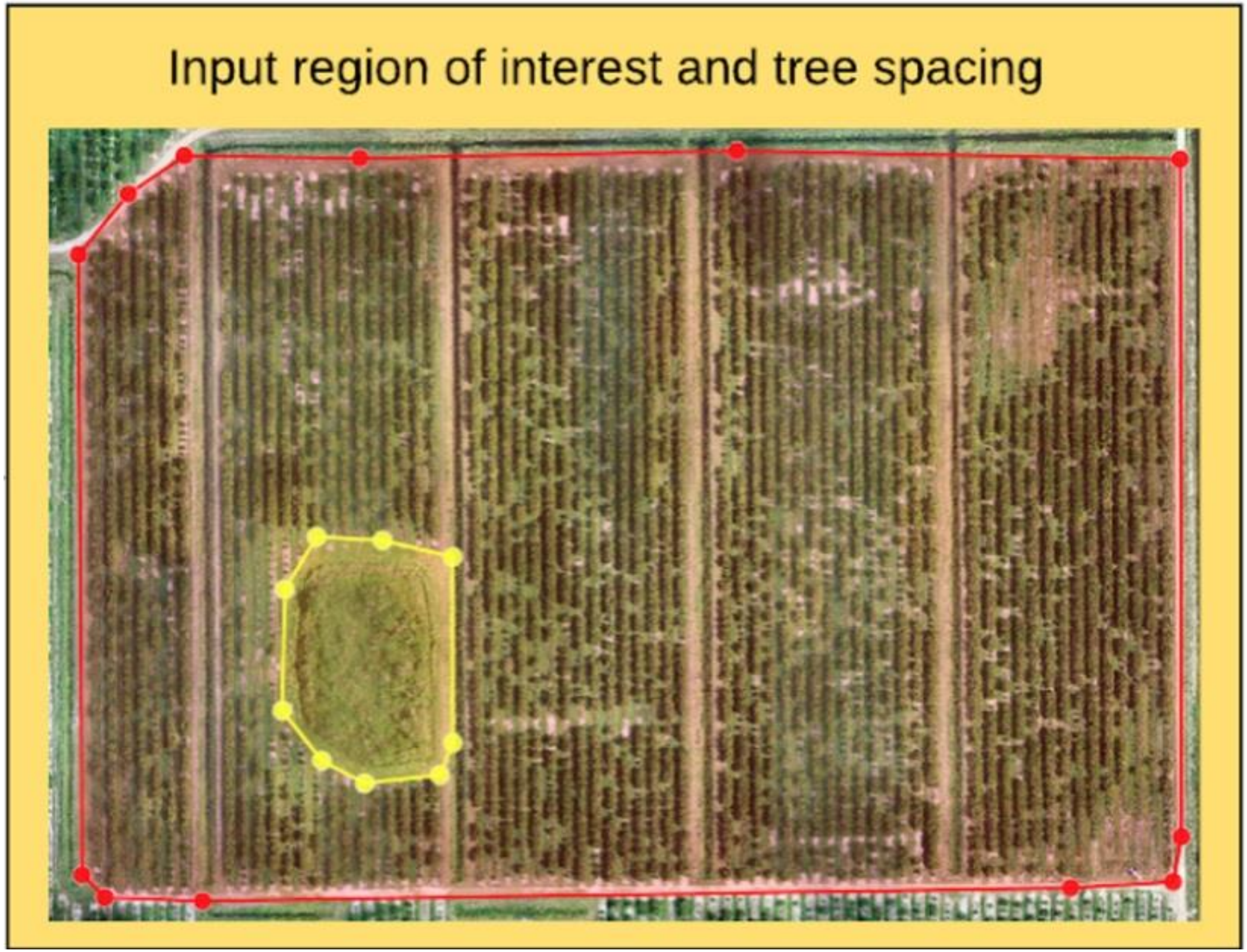
Agroview – settings



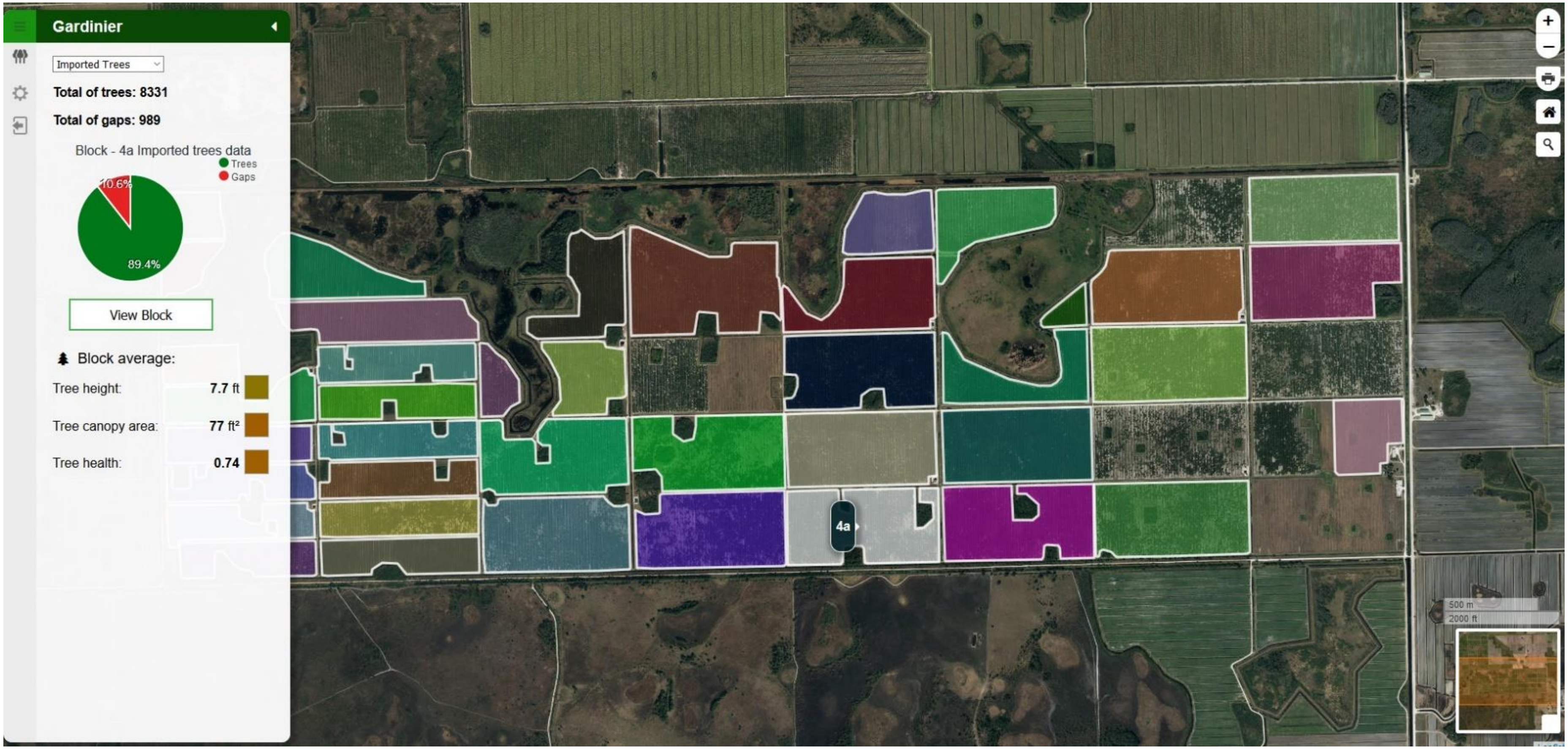
Agroview – add block



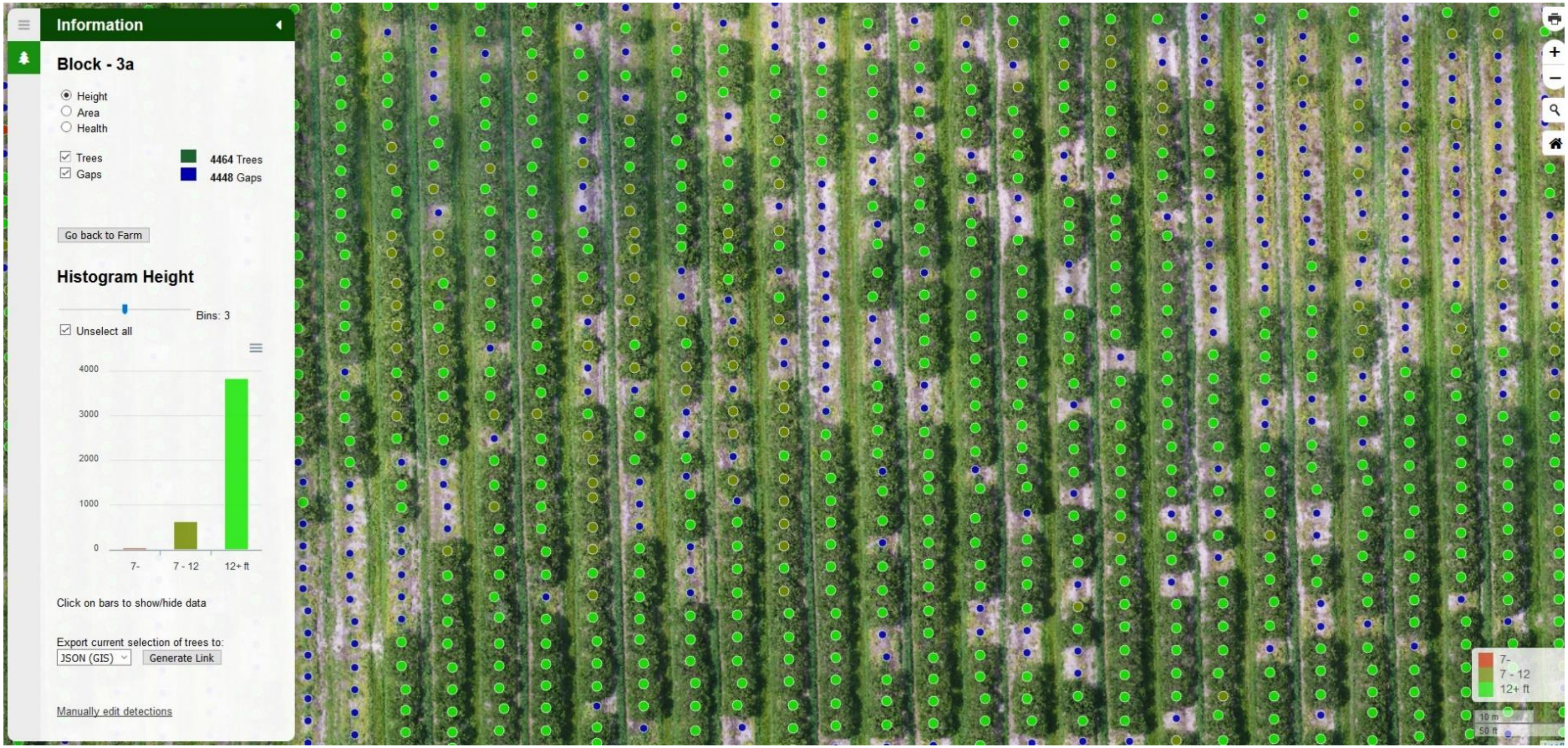
Agroview – create field boundaries



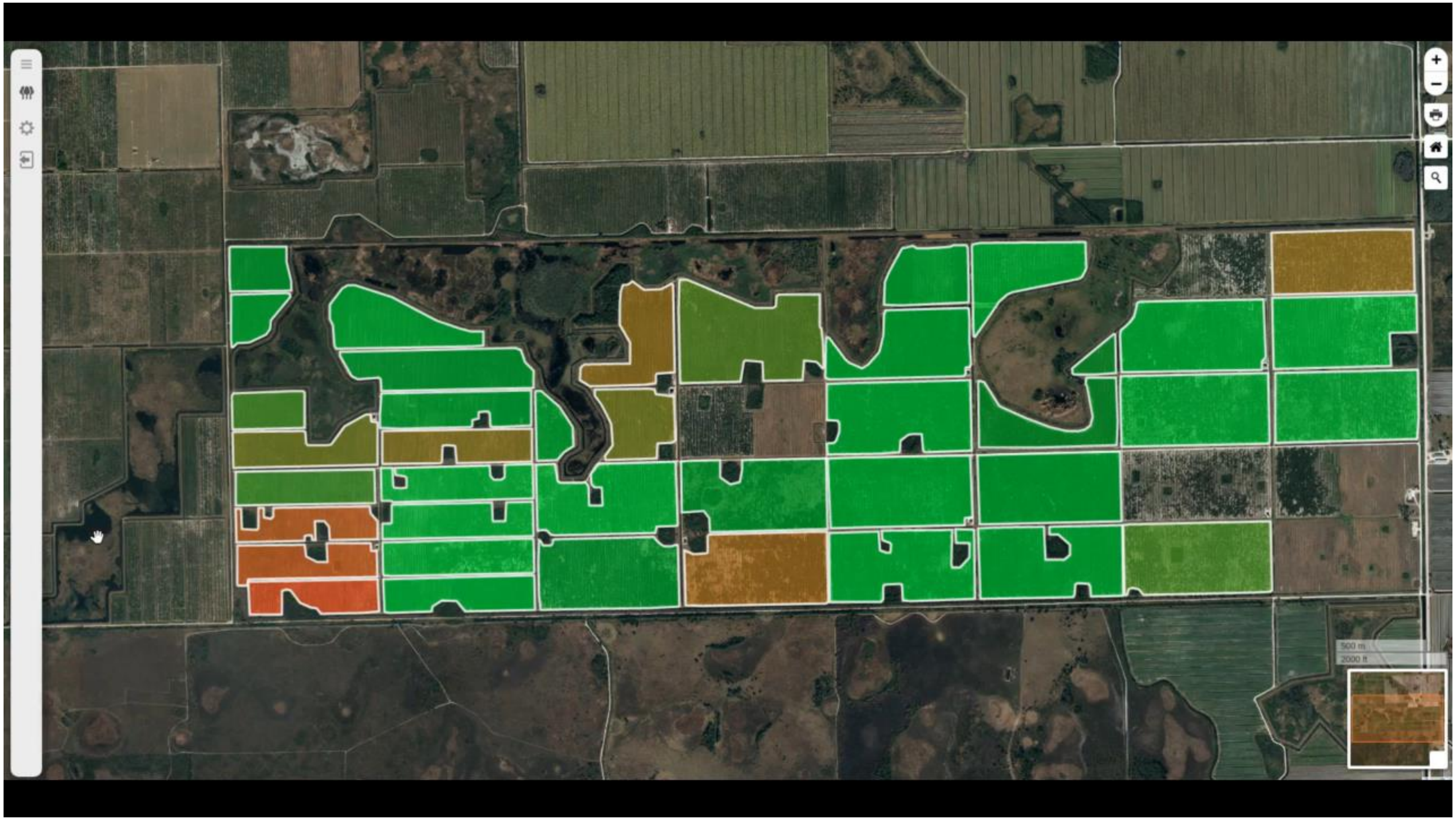
Agroview – farm analytics



Agroview – field analytics

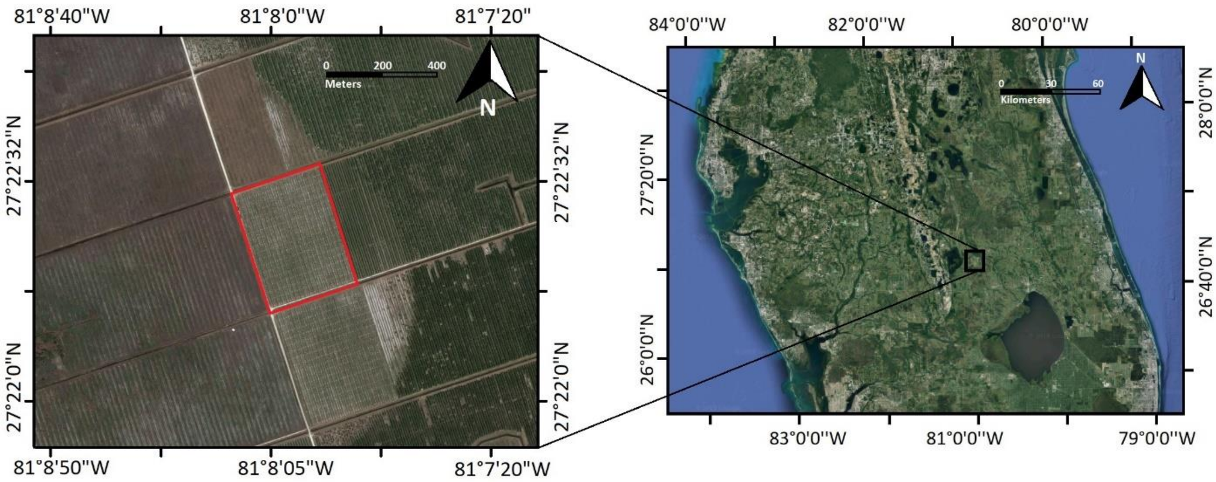


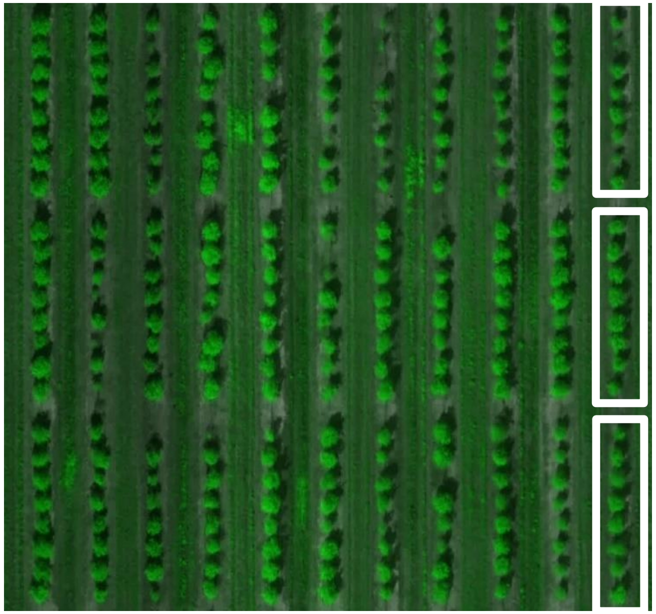
Cloud-based application to process, analyze, and to visualize UAV collected data



https://twitter.com/i/status/1202671242647490560

Citrus Rootstock Evaluation Utilizing UAV-based Remote Sensing and Artificial Intelligence

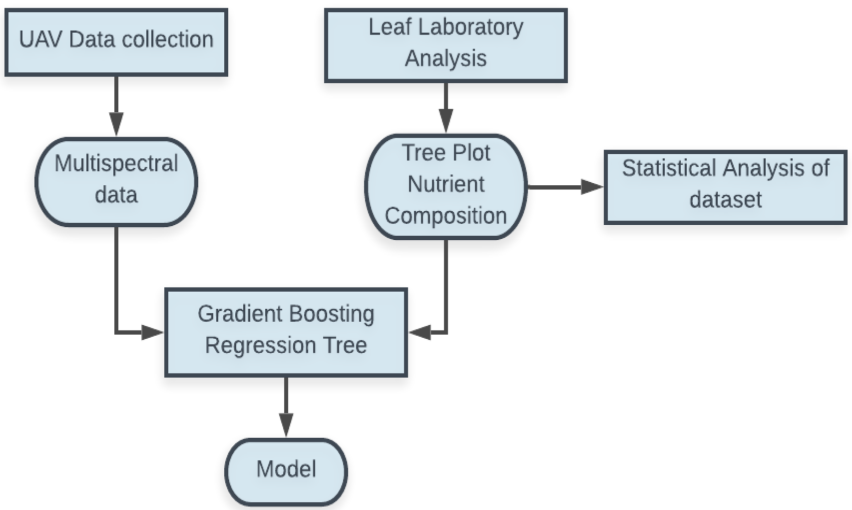




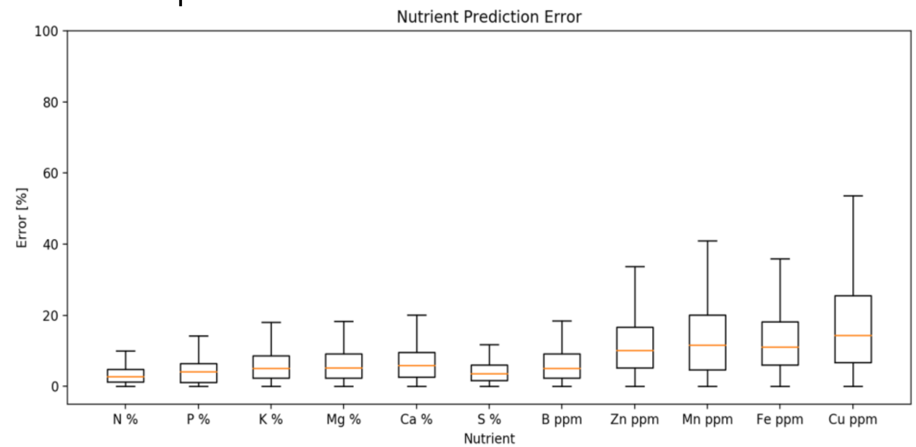
Ampatzidis Y., Partel V., Meyering B., and Albrecht U., 2019. Citrus Rootstock Evaluation Utilizing UAV-based Remote Sensing and Artificial Intelligence. *Computers and Electronics in Agriculture*, 164, 104900, doi.org/10.1016/j.compag.2019.104900.

Best Management Practices
Machine Learning Prediction Model:
Gradient Boosting Regression

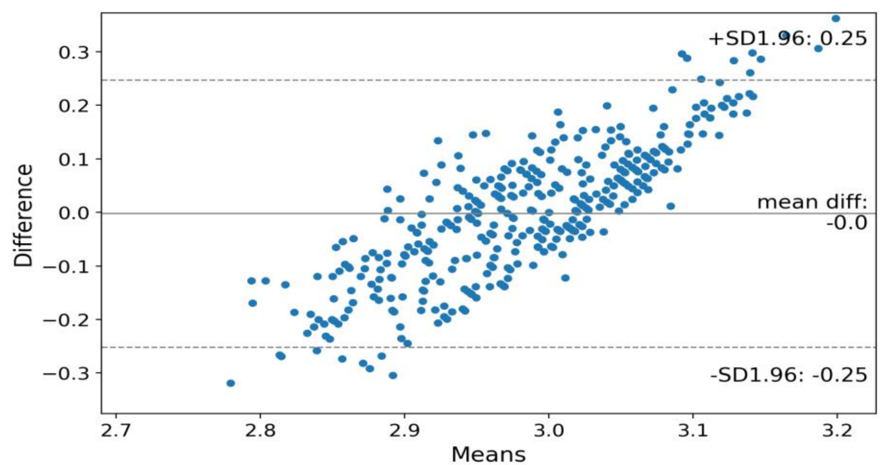
Workflow of the dataset collection, analysis and regression model



Whisker plot of the distribution of errors for each nutrient



Bland and Altman diagram for nitrogen measurements



Best Management Practices
UAV-based Nutrient Estimation and Precision Fertilizer Applications

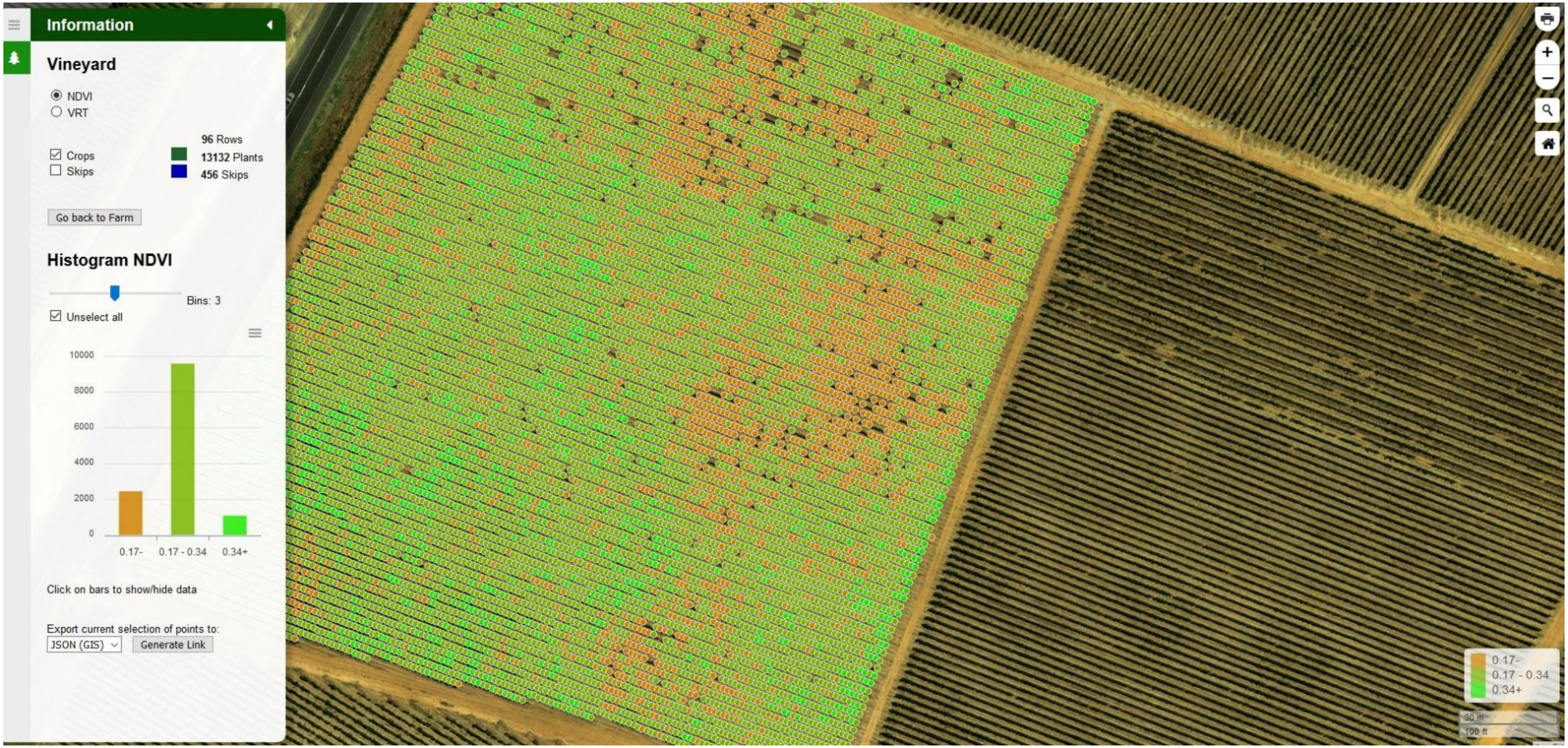
Manual Data Collection

- 800 trees (Hamlin and Valencia)
- 8 hours sample collection
- 4 people
- 2 weeks lab analysis
- Estimated cost: ***$10,500***

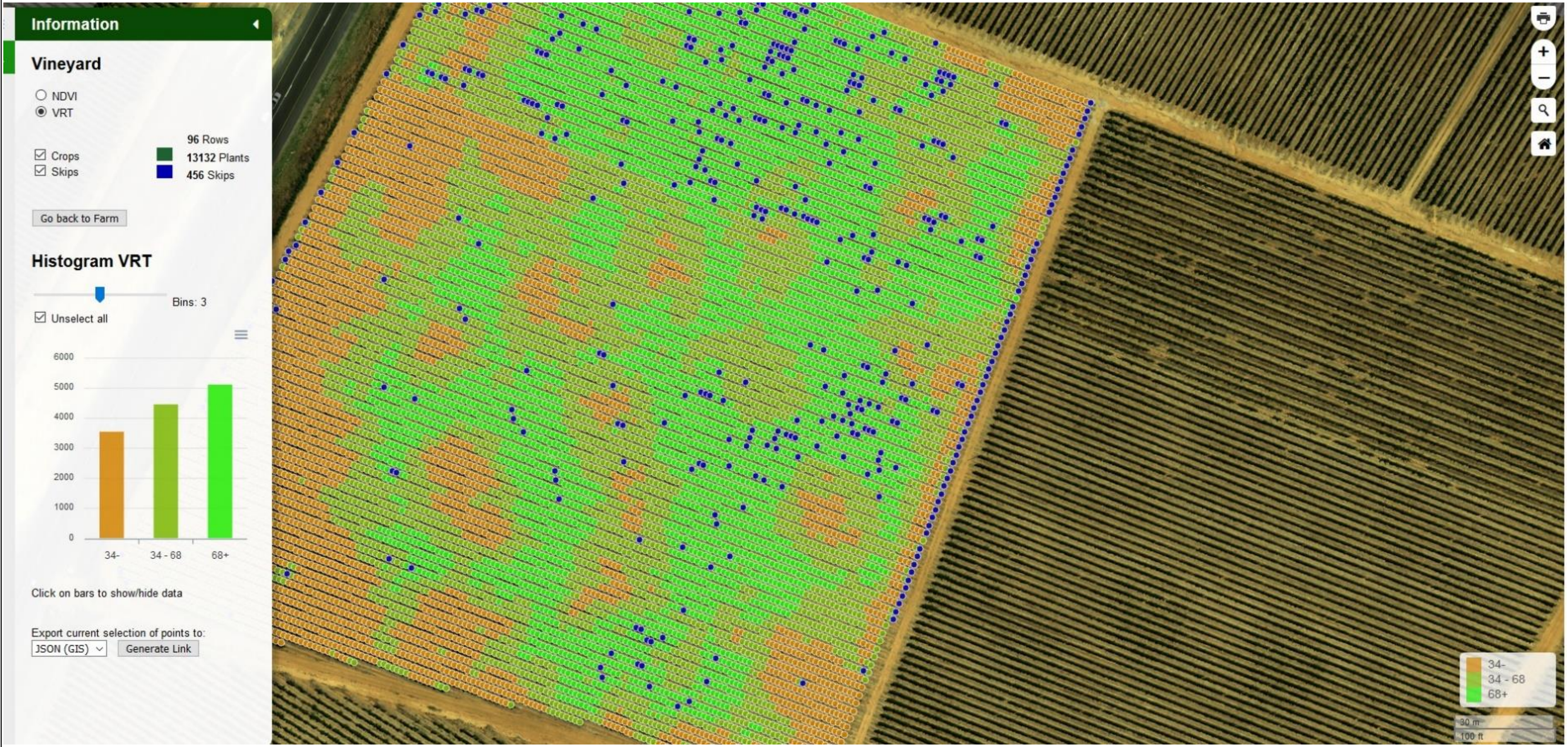
UAV-based with Agroview

- 5,000 trees
- 30 min flight
- 1 person
- 5 min analysis
- Estimated cost: ***$100***

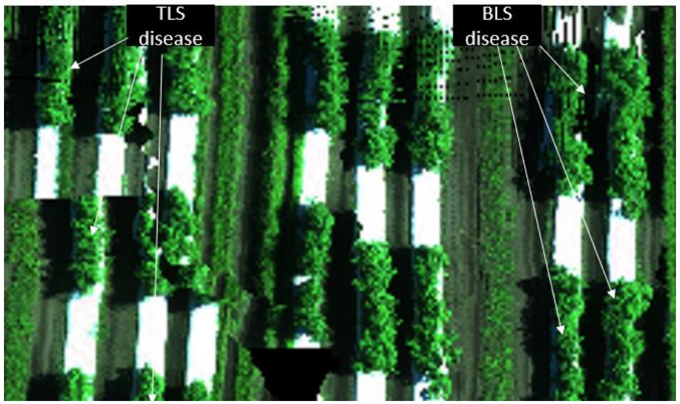
Vineyard Map - NDVI

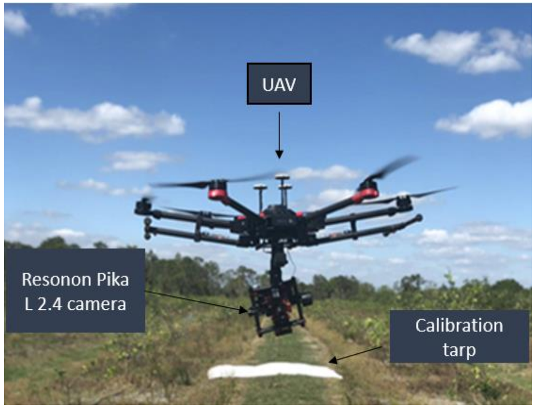


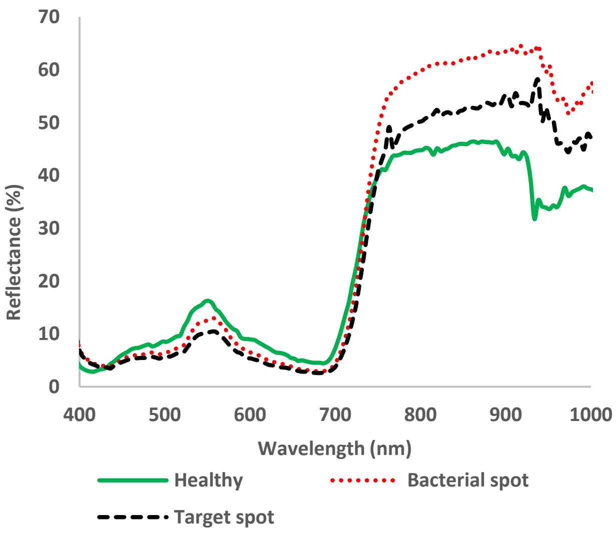
Vineyard Map - VRT

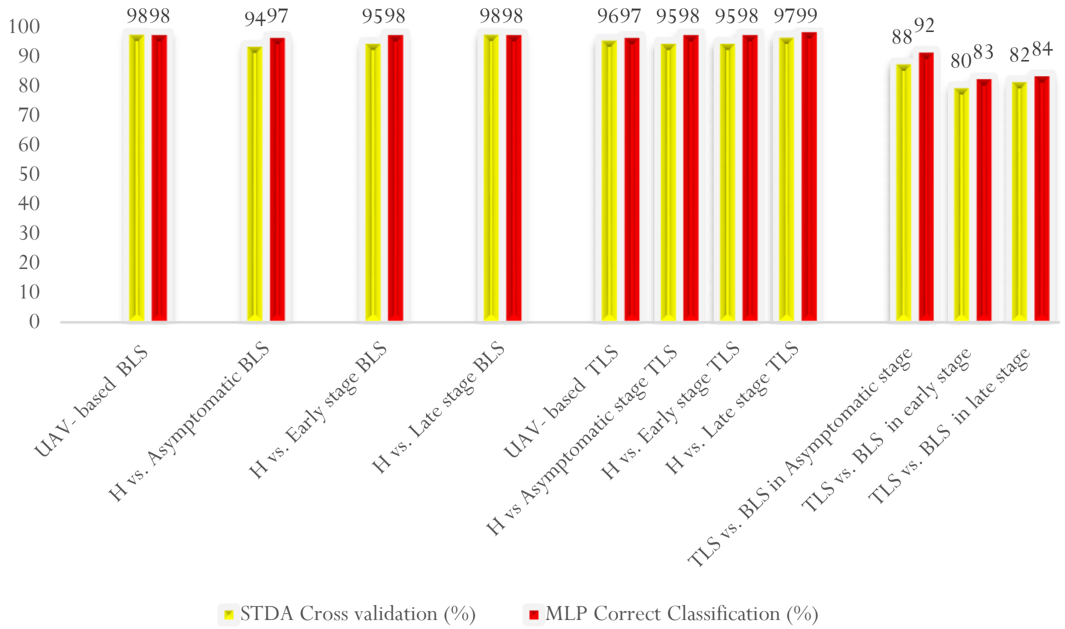


Detection of target spot and bacterial spot diseases in tomato using UAV-based hyperspectral imaging

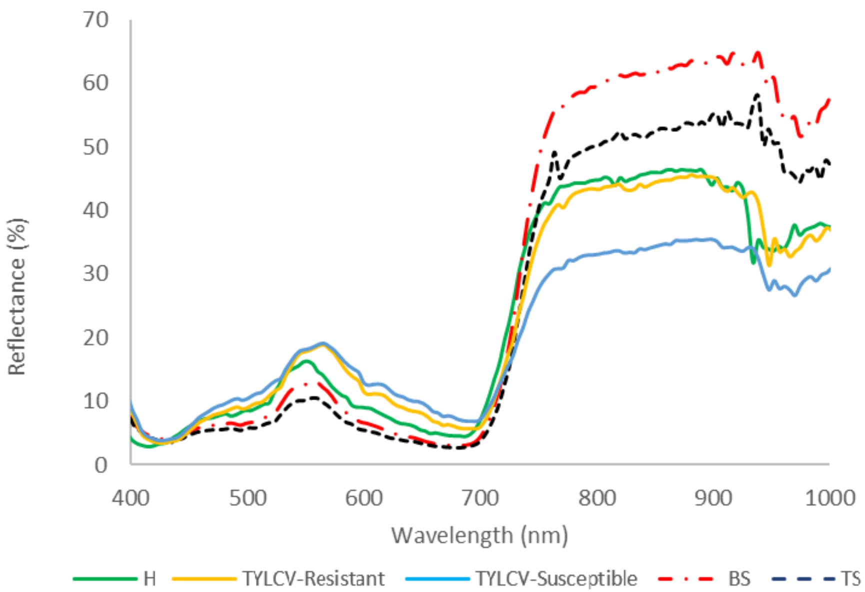


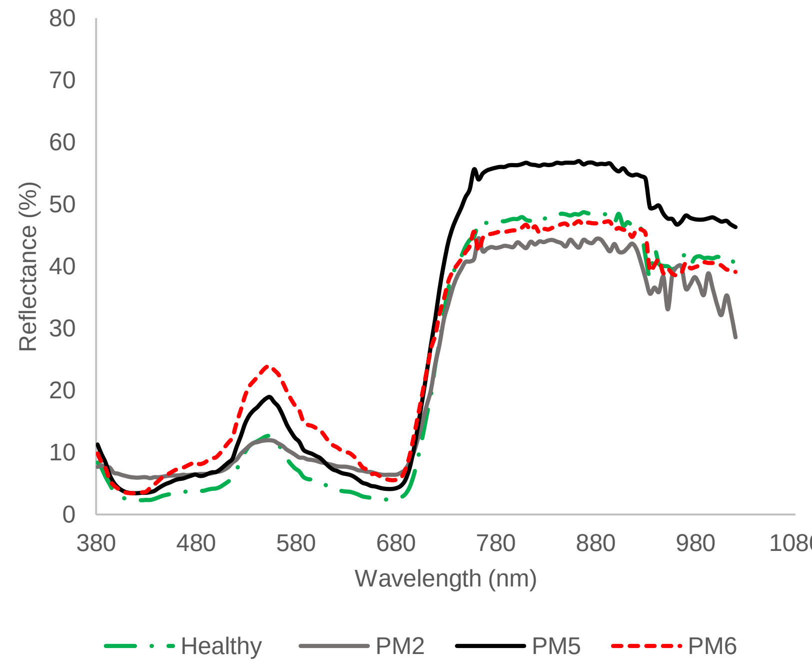






UAV-based Disease Detection Hyperspectral Imaging

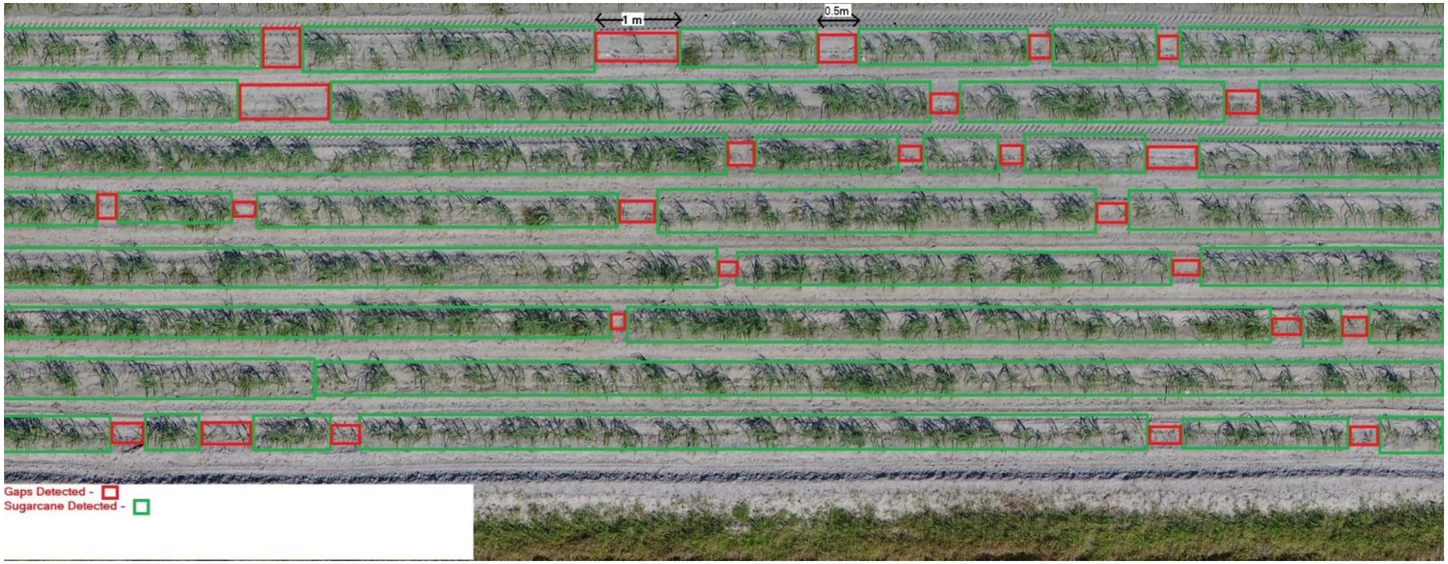


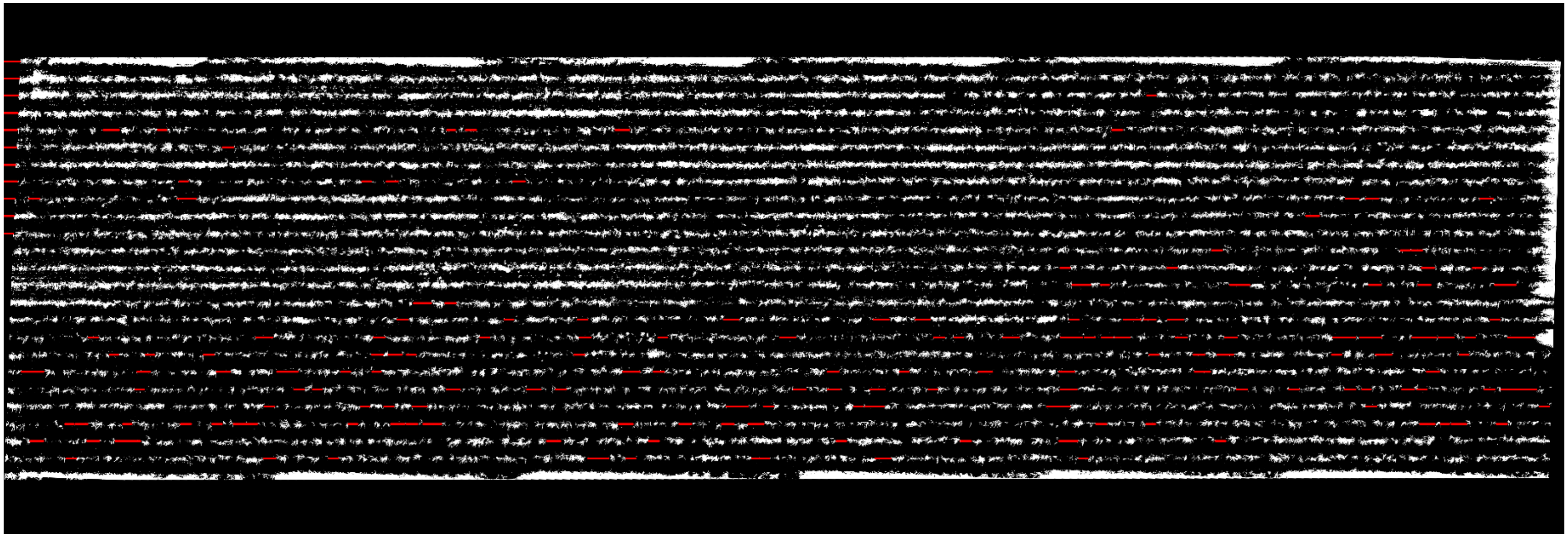


Spectral reflectance signatures of *Tomato yellow leaf curl virus* (TYLCV, on susceptible and resistant tomato varieties), Bacterial Spot (BS), and Target Spot (TS) infected tomato plants

Spectral reflectance signatures of healthy squash plants and Powdery Mildew (PM) infected plants in different disease development stages (asymptomatic, early and late stages).

Detecting Skips in Sugarcane Fields





Yield prediction in winter wheat under stress environmental conditions

- Panel A: 40 genotypes (250 plots) (2018-2019) for heat stress tolerance.
- Panel B: 260 genotypes (2017-2018) under irrigated and drought conditions.

- Plot size: 5.1 m2 (3.3 x1.52 m)

- UAV-based hyperspectral data (400–1000 nm) at 200 ft

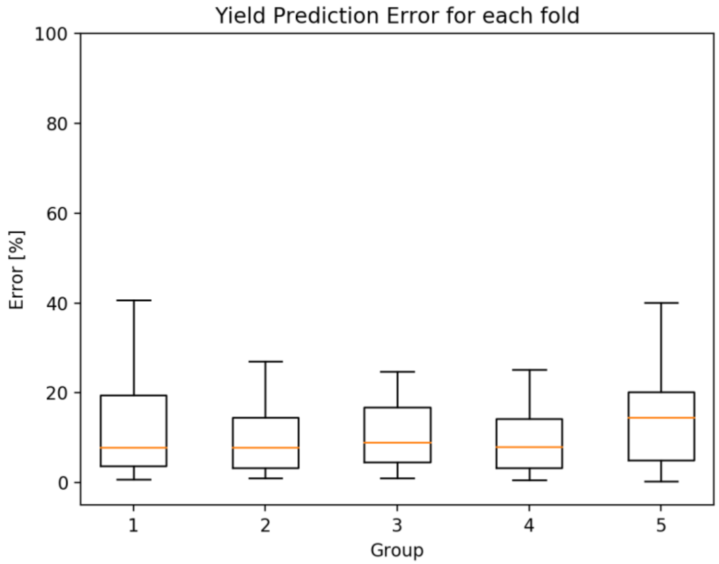
(last fight: 1 month before harvest).

Yield prediction in winter wheat under stress environmental conditions

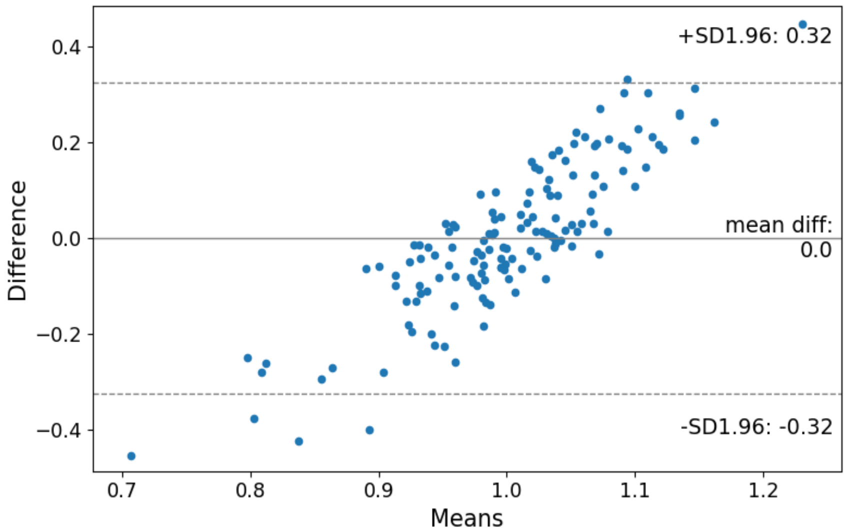
Mean Absolute Percentage Error (MAPE) for each group in the cross-validation of Panel A.

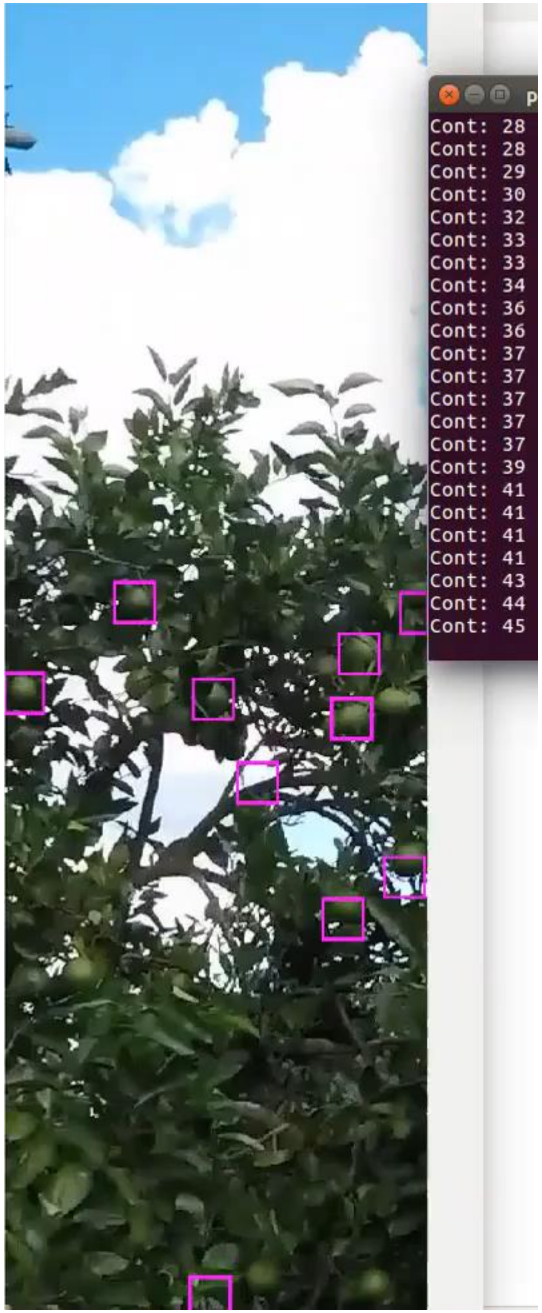
	Group 1	Group 2	Group 3	Group 4	Group 5	Mean
MAPE	15,6%	10,2%	12,2%	12,0%	17,1%	**13.4%**

Whisker graph for the error in yield prediction for Panel A.



Bland and Altman diagram in percentage for the Panel A dataset.





https://twitter.com/i/status/1042058065481269248

Smart Spray Technologies

Example: more than 90% of the cropland in the U.S. are being sprayed by more than 3 billion pounds of herbicides that costs around $26 billion each year.

Overuse of these chemicals creates *herbicide-tolerant weeds with around 250 known* species of resistant weeds.

GreenSeeker by Trimble

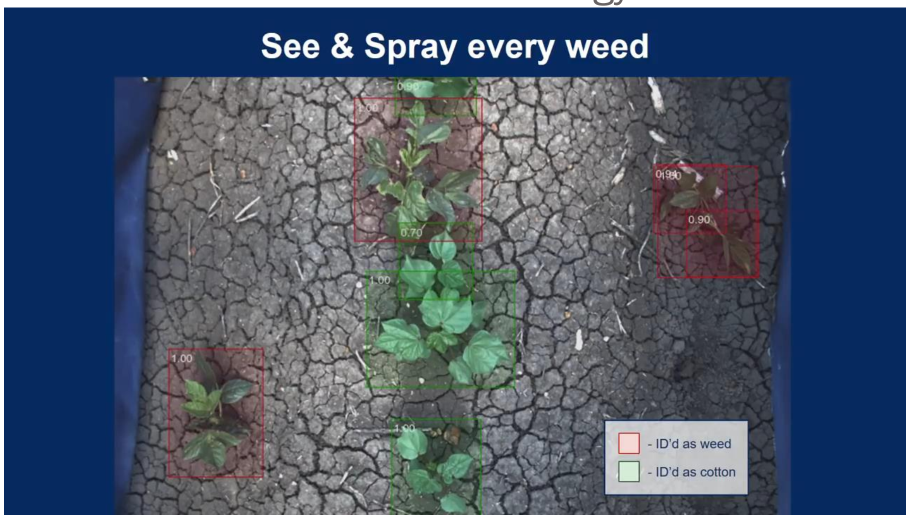
"The Trimble® GreenSeeker® crop uses optical sensors to measure and quantify crop health—or vigor. It can precisely manage crop inputs on-the-go. With GreenSeeker, you can address field variability by applying the right amount of fertilizer, in the right place, at the right time."

https://agriculture.trimble.com/product/greenseeker-system/

Artificial Intelligence for Precision Pest Management in Vegetables and Strawberry

Precision Weeding

Blue River Technology

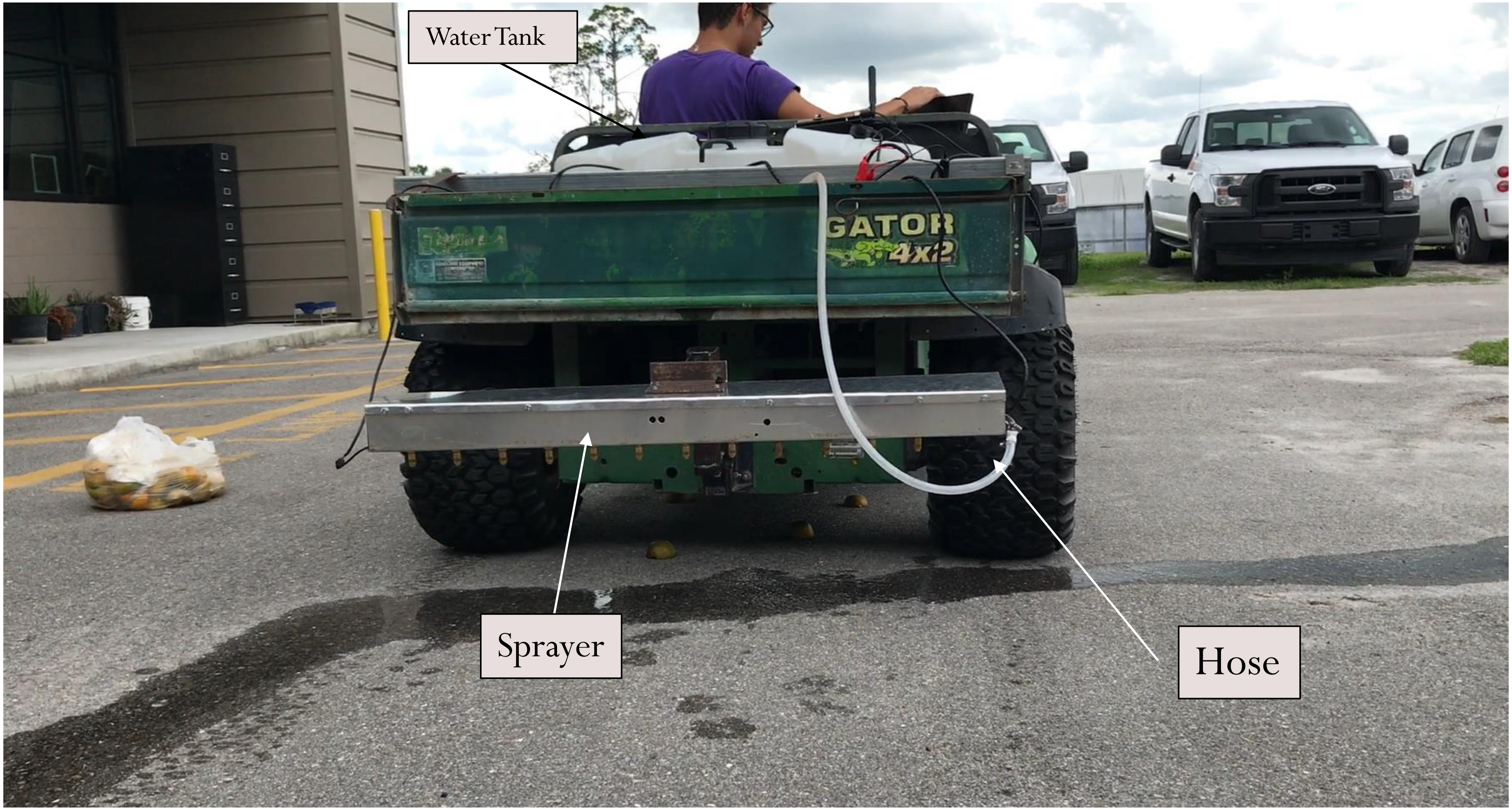


- 5,000 plants per minute
- 40 acres/day by one machine
- ¼ precision in inches at 4 mph

Smart Weed-Killing Robots

https://www.cnbc.com/2018/06/04/weed-killing-ai-robot.html

Precision Sprayer (PS) for Weed Management

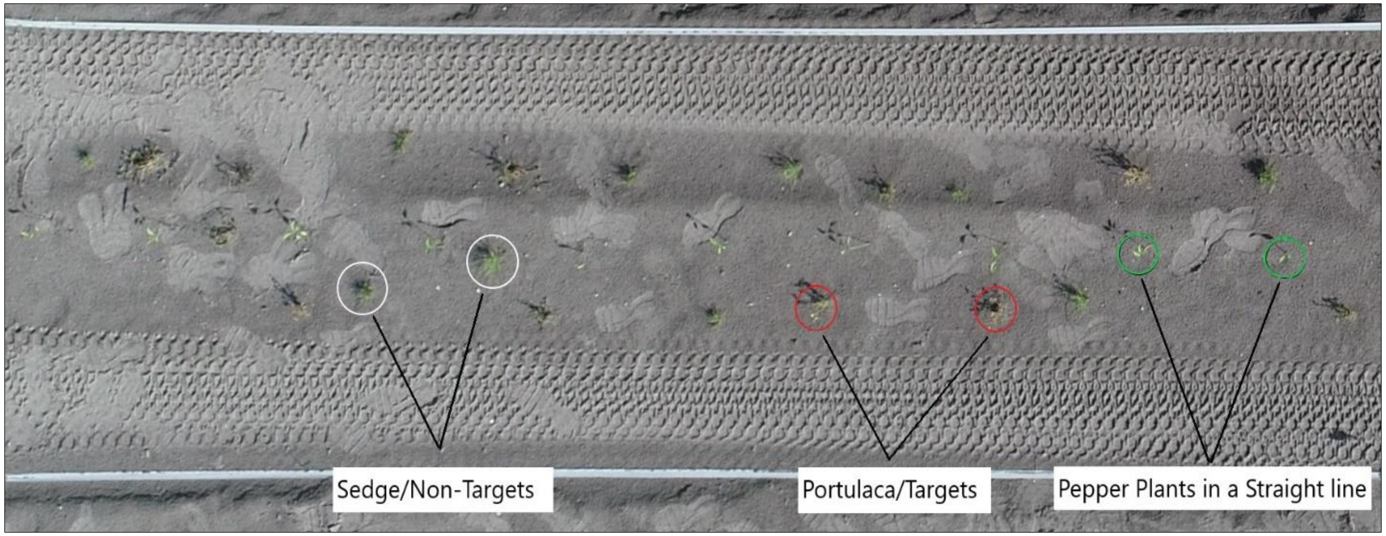


Partel V., Kakarla S.C., and Ampatzidis Y, 2019. **Development and Evaluation of a Low-Cost and Smart Technology for Precision Weed Management Utilizing Artificial Intelligence**. Computers and Electronics in Agriculture, 157, pp. 339-350.

Before

After

Experimental Design

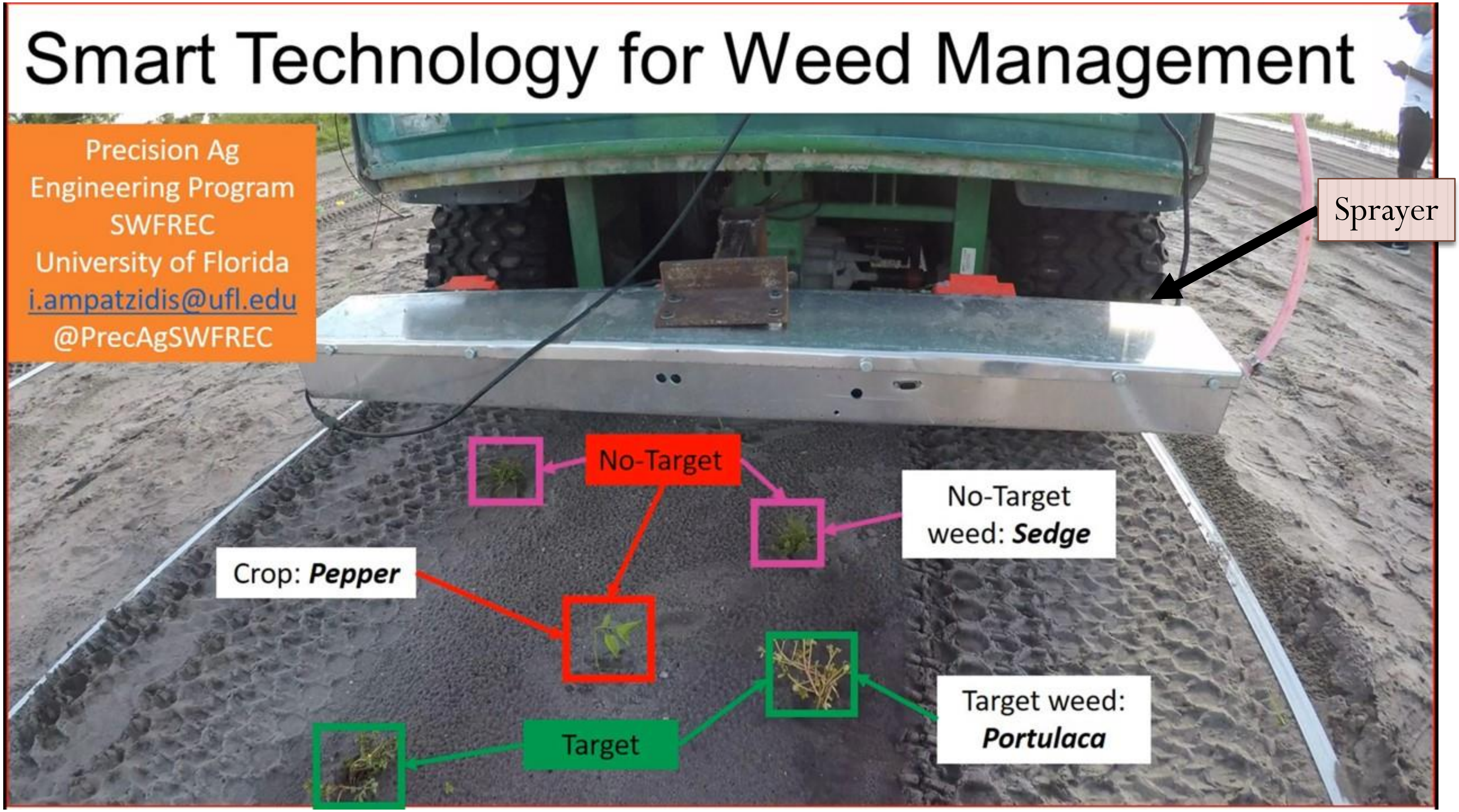



Portulaca (target weed)


Sedge (non-target weed)

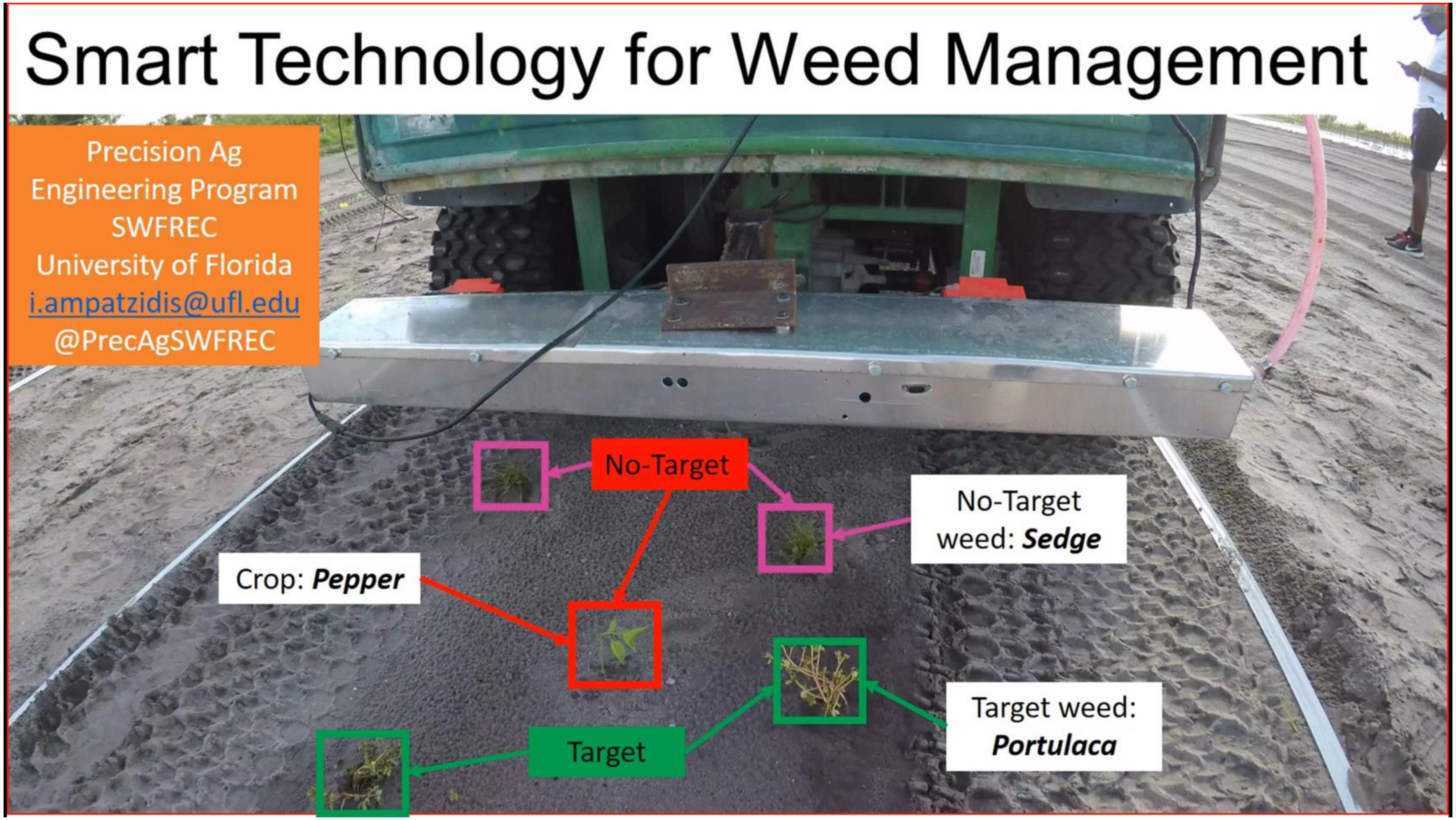

Pepper plant (non-target)

Precision Sprayer (PS) for Weed Management



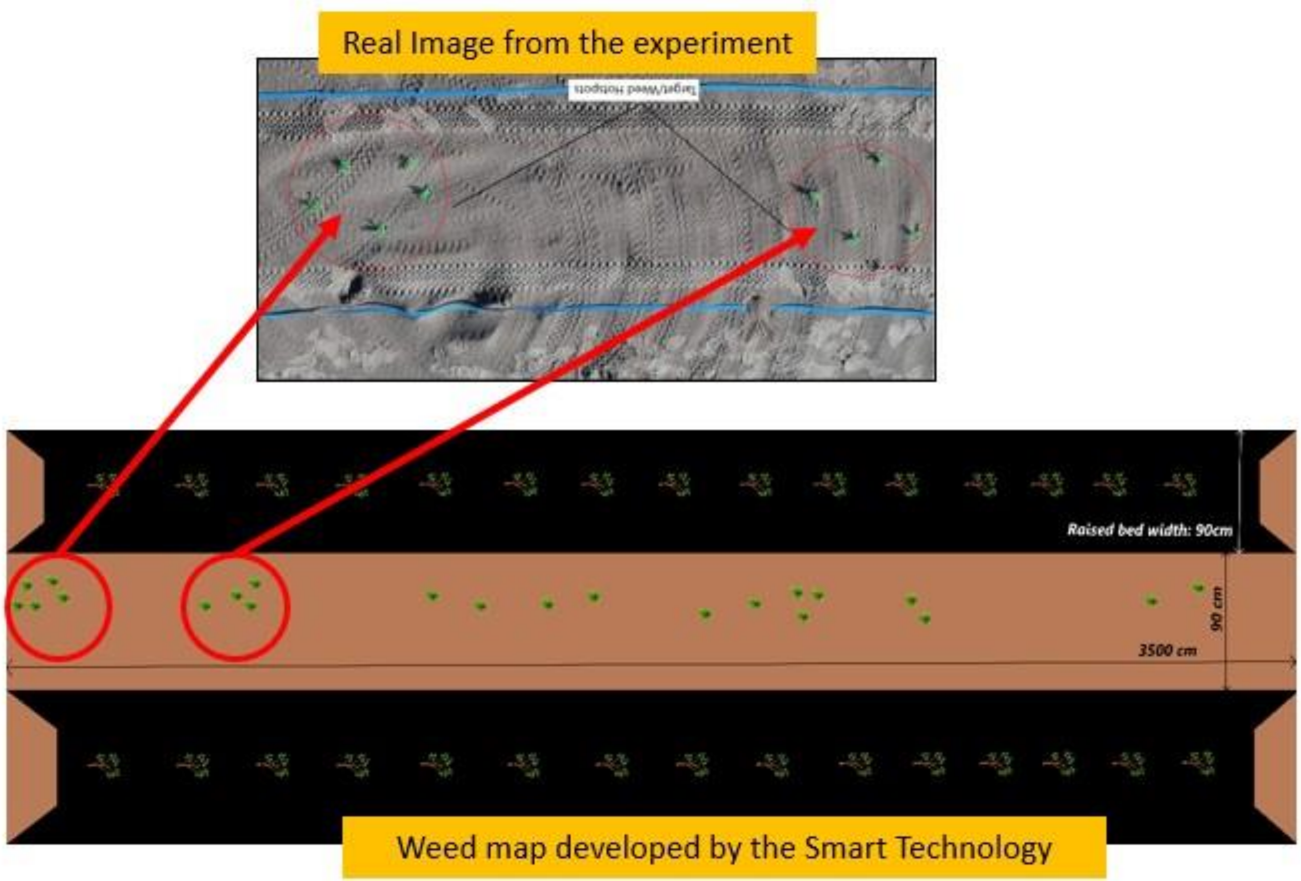
https://twitter.com/i/status/1045013127593644032

Precision Sprayer (PS) for Weed Management Demo/Video



https://twitter.com/i/status/1045013127593644032

Precision Sprayer (PS) for Weed Management



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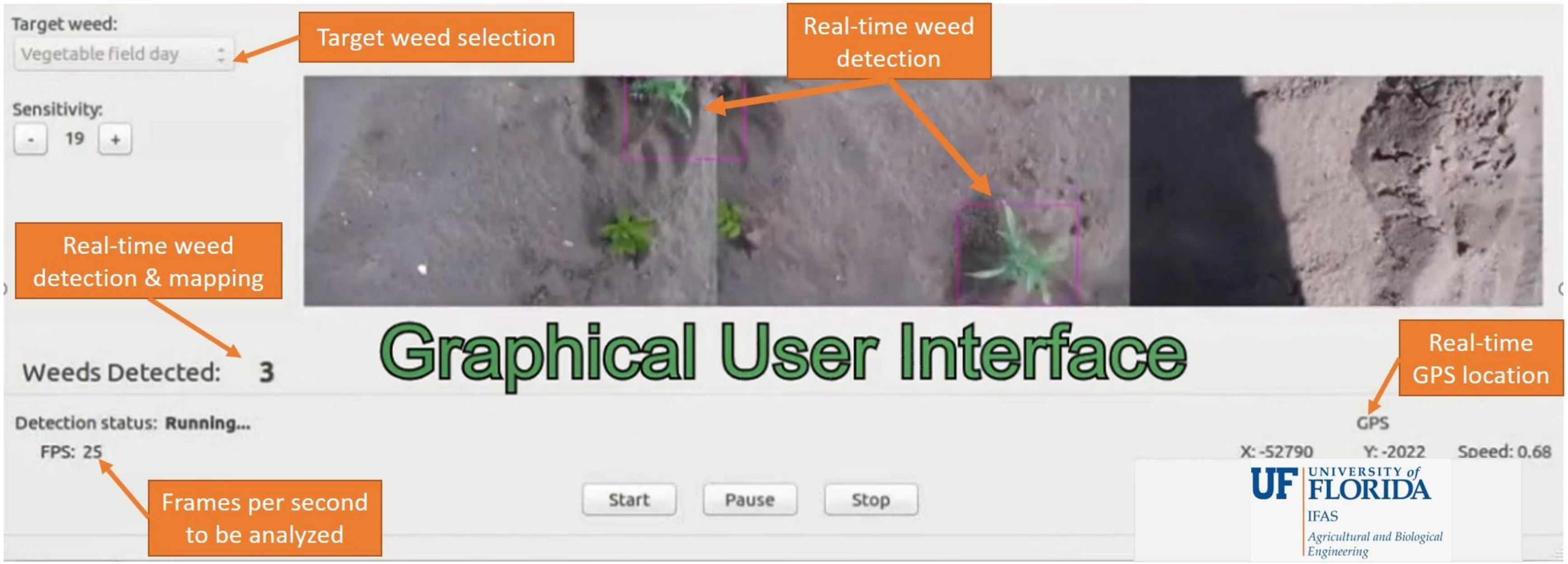
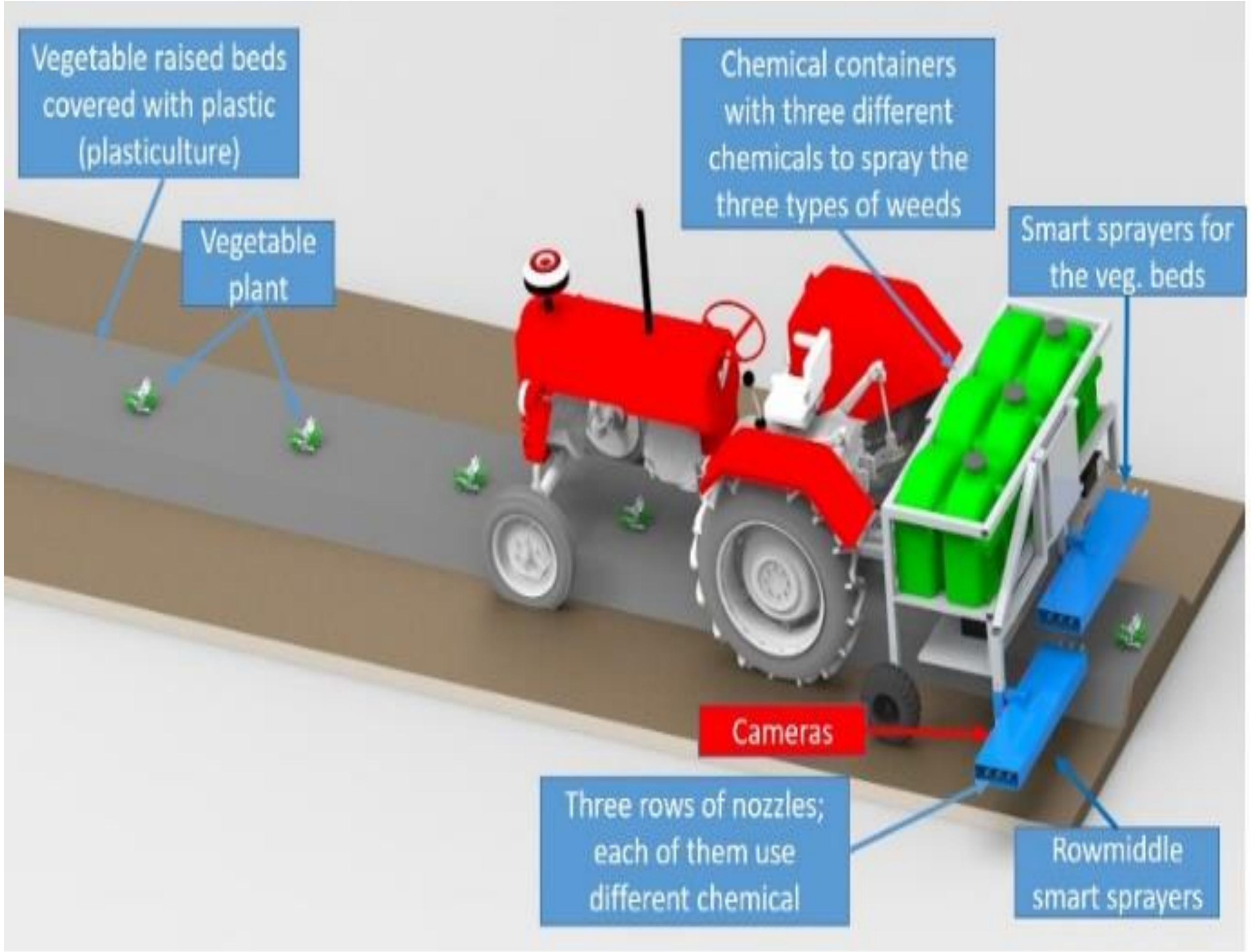
Precision Sprayer (PS) for Weed Management



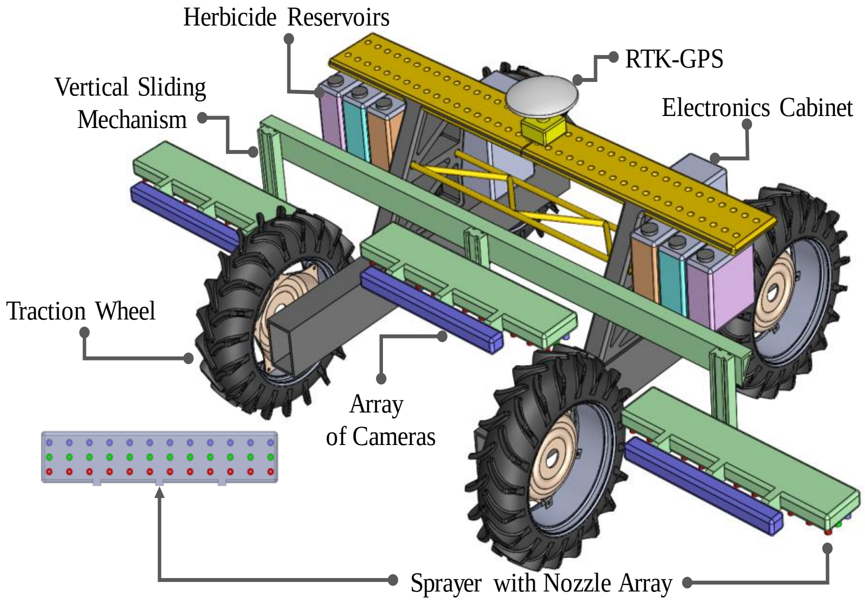
Partel V., Kakarla S.C., and Ampatzidis Y, 2019. **Development and Evaluation of a Low-Cost and Smart Technology for Precision Weed Management Utilizing Artificial Intelligence**. Computers and Electronics in Agriculture, 157, pp. 339-350.

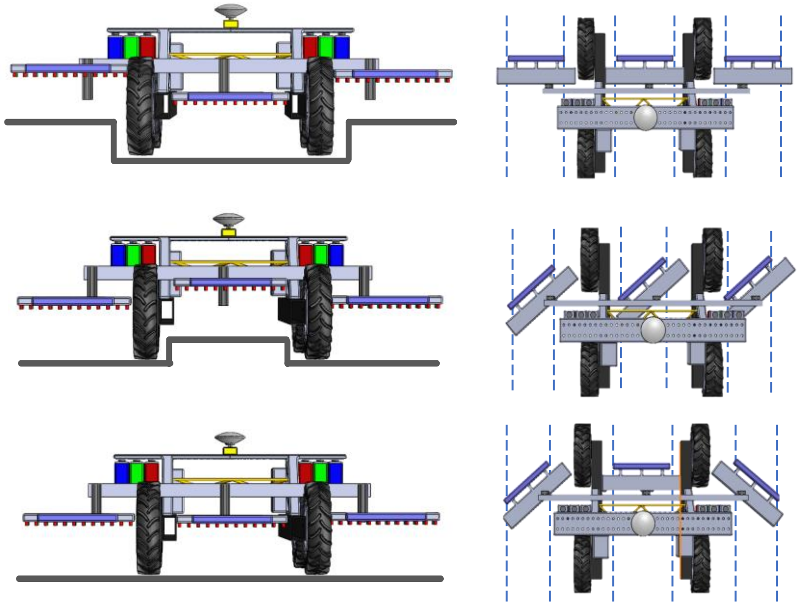
High Throughput Multi-Robot Weed Management for Specialty Crop



NRI: INT: COLLAB: ***High Throughput Multi-Robot Weed Management for Specialty Crop***. National Robotic Initiative (NRI), Nasional Research Foundation (NSF).

High Throughput Multi-Robot Weed Management for Specialty Crop





NRI: INT: COLLAB: ***High Throughput Multi-Robot Weed Management for Specialty Crop***. National Robotic Initiative (NRI), Nasional Research Foundation (NSF).

Potential to Mechanically Harvest Specialty Crops

Types of Machinery

- Harvest-aid systems
- Trunk shakers
- Canopy shakers
- Entire crop harvesters
- Fruit harvesters (robotic arms, vacuum systems etc.)
- Robots

Agrobot Strawberry Harvester

https://www.youtube.com/watch?v=RKT351pQHfI

https://www.youtube.com/watch?v=RKT351pQHfI

Tomato Robotic Harvester
Four Growers

https://www.youtube.com/watch?v=-qQffIHmlXk&feature=youtu.be

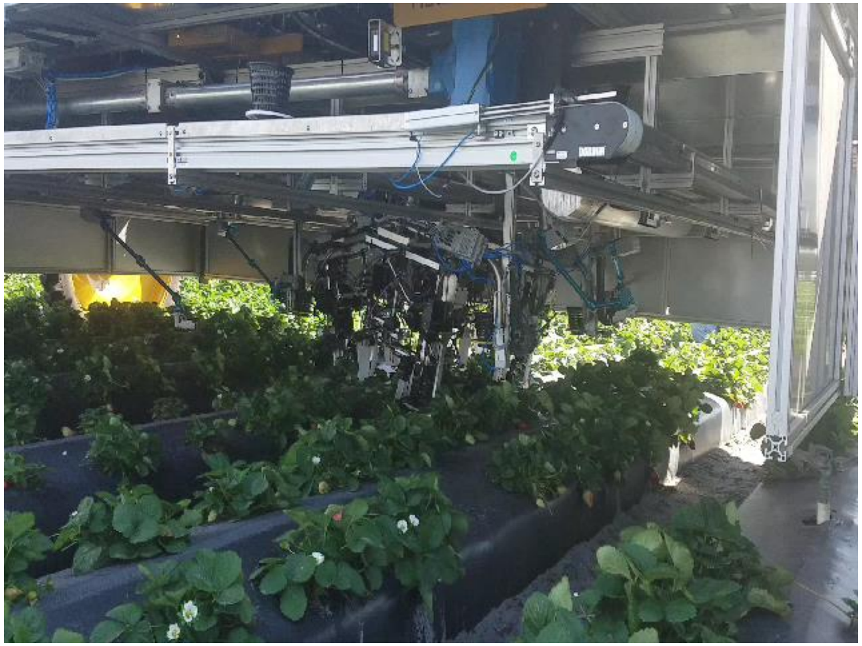
Harvey the Robotic Capsicum (Red Pepper) Harvester

https://www.youtube.com/watch?v=8rq4iSTsg68

Strawberry Robot in Japan

https://www.youtube.com/watch?v=9Su2XQyuavM

Mechanization of Strawberry Harvesting for Long Term Sustainability



PI: Yiannis Ampatzidis. Mechanization of Strawberry Harvesting for Long Term Sustainability. Specialty Crop Research Initiative, USDA/NIFA. Budget: $3,145,307.

Questions/Comments?
Thanks for your attention!

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Yiannis Ampatzidis
Assistant Professor
Agricultural and Biological Engineering Department
University of Florida
Southwest Florida Research and Education Center, Immokalee
Office: 239-658-3451

From Left to Right: **Daniel Escobedo** *Summer Intern*, **Jorge Escobedo** *Summer Intern*, **Dr. Jaafar Abdulridha** *Post Doctoral Associate*, **Dr. Yiannis Ampatzidis** *Program Leader*, **Dr. Xiuhua Zhang** *Visiting Scholar from China*, **Dr. Thanos Balafoutis** *Visiting Scholar from Greece*, **Magda Derival** *Research Assistant*, **Shirin Ghatresamani** *PhD Student*, **Sri Charan Kakarla** *Engineer* Not Pictured: **Victor Partel** *Research Assistant*

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