

**10th
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AVOCADO
CONGRESS
New Zealand
2023**



wacnz2023.com

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Aotea Centre
Auckland, New Zealand

Navigating AgTech in the horticulture tree crop industry

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RADFORDS



AARSC
Applied Agricultural
Remote Sensing Centre

UNE
University of
New England
















Purpose of this presentation

How can AgTech add value to the avocado sector right now,
What is on the horizon?
What are the barriers to the uptake of existing AgTech?




Why me (AARSC)?

 	<ul style="list-style-type: none"> Projects on Avocado forecasting and crop mapping in Australia from 2014
 	<ul style="list-style-type: none"> Led two national multi-industry/collaborators projects evaluating a range of technologies in tree crops (including avocado)
 	<ul style="list-style-type: none"> Commenced the development of spatial systems and in-house training to improve traceability within the Australian avocado industry
 	<ul style="list-style-type: none"> PhD studies on pollination, Phytophthora, UAV and LiDAR on avocado
	<ul style="list-style-type: none"> Yield forecasting of COSTA citrus and avocado orchards (2022)
	<ul style="list-style-type: none"> Evaluating yield forecasting of Avocado in South Africa (SAAGA)
	<ul style="list-style-type: none"> Mapping and yield forecasting of South African macadamia (SAMAC)
 	<ul style="list-style-type: none"> Evaluating yield forecasting of citrus in Peru

Are we any good (AARSC)?



	AARSC named as leading 'Earth Observation Research Team' in the 2022 inaugural Earth Observation Australian awards
	The ATCM awarded 'Best Dashboard' at the global 2021 Esri User Conference in San Diego (70,000 delegates)
	The AARSC awarded 'Best organisation in imagery application' for the Asia Pacific and Australian regions (2020)
	The Australian Macadamia Society awarded AARSC the industry Innovation Award for 2021
	'Poggendorff Lecture Award' Royal Society of New South Wales for contribution to Agriculture, in particular remote sensing (2016).

There are lots of AgTech



Sensor Networks



Mobile Apps



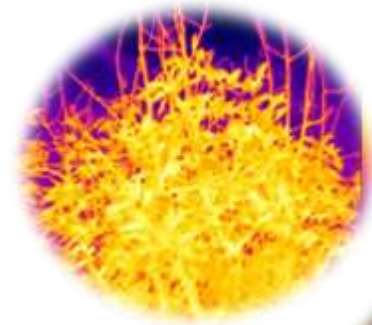
Proximal Sensing



Asset tracking



LiDar



Thermal



NIR



Machine vision



UAV



Satellite



Airborne

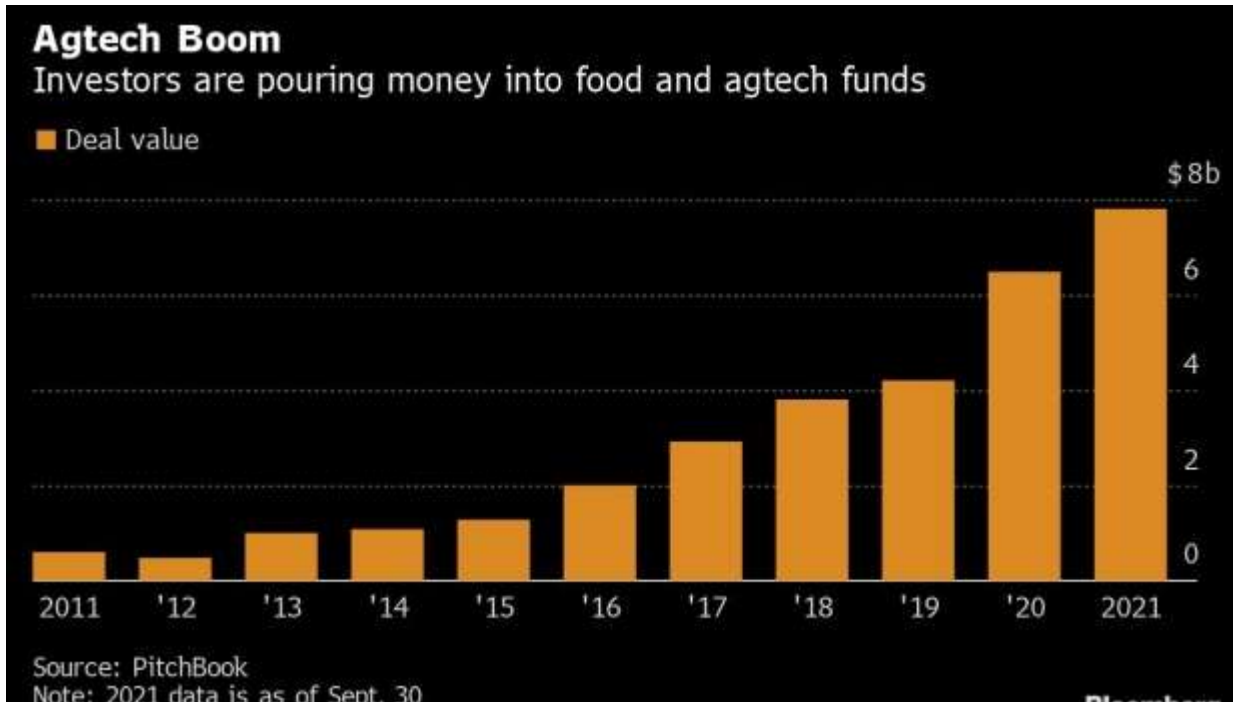


Robotics



Spore trapping

Is AgTech all hype?



The global AgTech market value is set to triple in size by 2026, with an expected acceleration in growth from USD 12.4 billion in 2020 to **USD 34.1 billion by 2026** (BIS Research, 2022)



2019: Descartes Labs snaps up \$20M more for its AI-based geospatial imagery analytics platform, It brings the total raised by Descartes Labs to \$60 million



2022: With Descartes Labs running out of money and few sales options, Descartes Labs, despite all of its value, was **sold to Antarctica Capital** for basically nothing.



Is the hype real: Drones?

According to the 2022 *Agricultural Drones* market for Agricultural drones

“The agriculture drones market is expected to reach \$1.5 billion by 2028”
(<https://www.marketsandmarkets.com/Market-Reports/agriculture-drones-market-report.html>)

“18 Jan 2023 — Agriculture Drones Market Report by The Insight Partners”
(<https://www.globenewswire.com/en/news-release/2023/01/18/1078881/0/en/Agriculture-Drones-Market-Report-by-The-Insight-Partners.html>)

“Venture Capital investment in agriculture drone startups is beginning to pick up”

“2019: At least 67 drone startups have raised a total of \$183 million in funding, according to a report by Drone Industry Insights”

“May 2022. The [shutdown of Skydio](#) and the disappearing acts of [Measure](#), [Keyence](#), and [Krisp](#). Doomsayers all crying that the drone market is a bubble”



According to a report, the global

market for agricultural drones is expected to reach \$1.5 billion by 2028”
(<https://www.marketsandmarkets.com/Market-Reports/agriculture-drones-market-report.html>)

“Venture Capital investment in agriculture drone startups is beginning to pick up”

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“May 2022. The [shutdown of Skydio](#) and the disappearing acts of [Measure](#), [Keyence](#), and [Krisp](#). Doomsayers all crying that the drone market is a bubble”

What The Farming ?

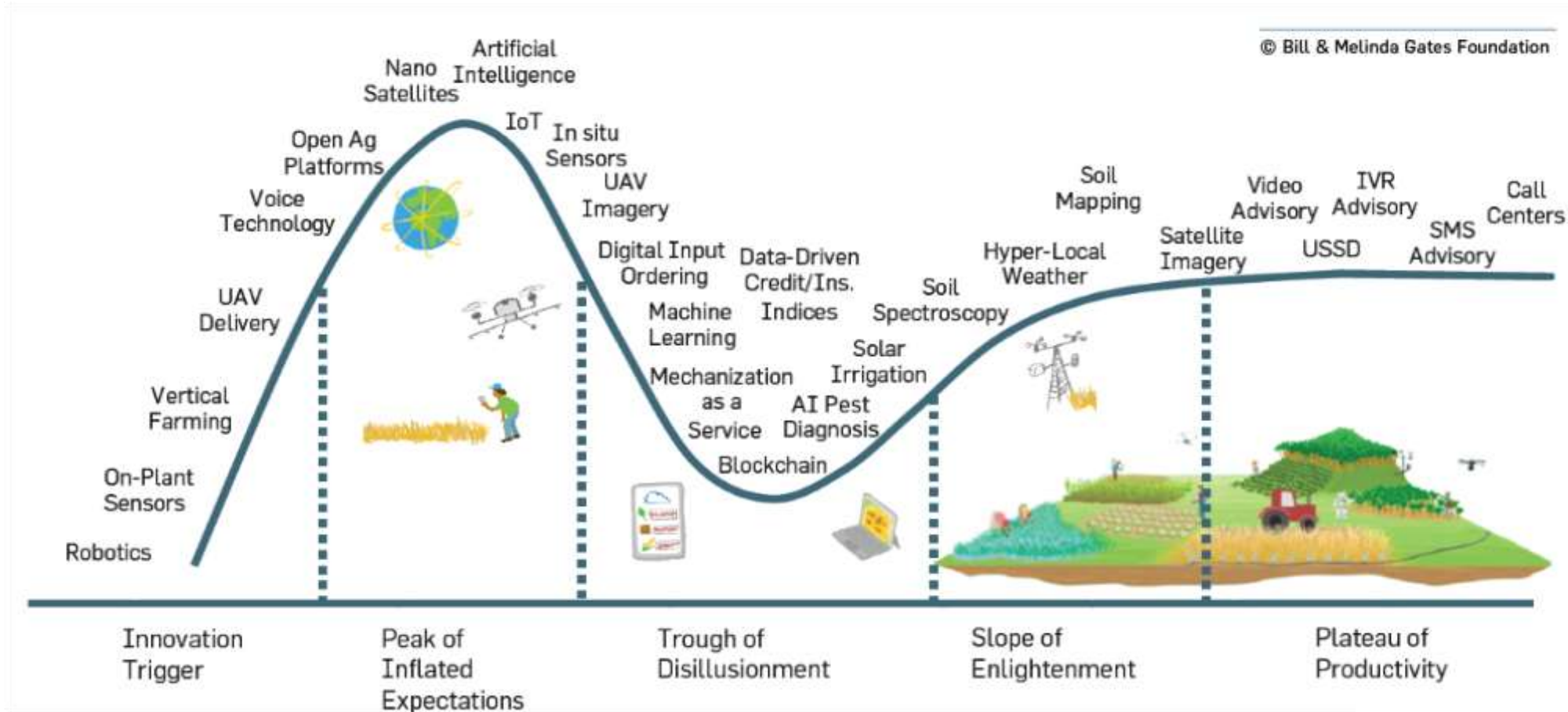
Is AgTech the next dot.com bubble?

My take on the whole dot-com bubble was that a lot of people who wanted to make a lot of money got too excited and hyped up the commercial aspects of the Internet prematurely.

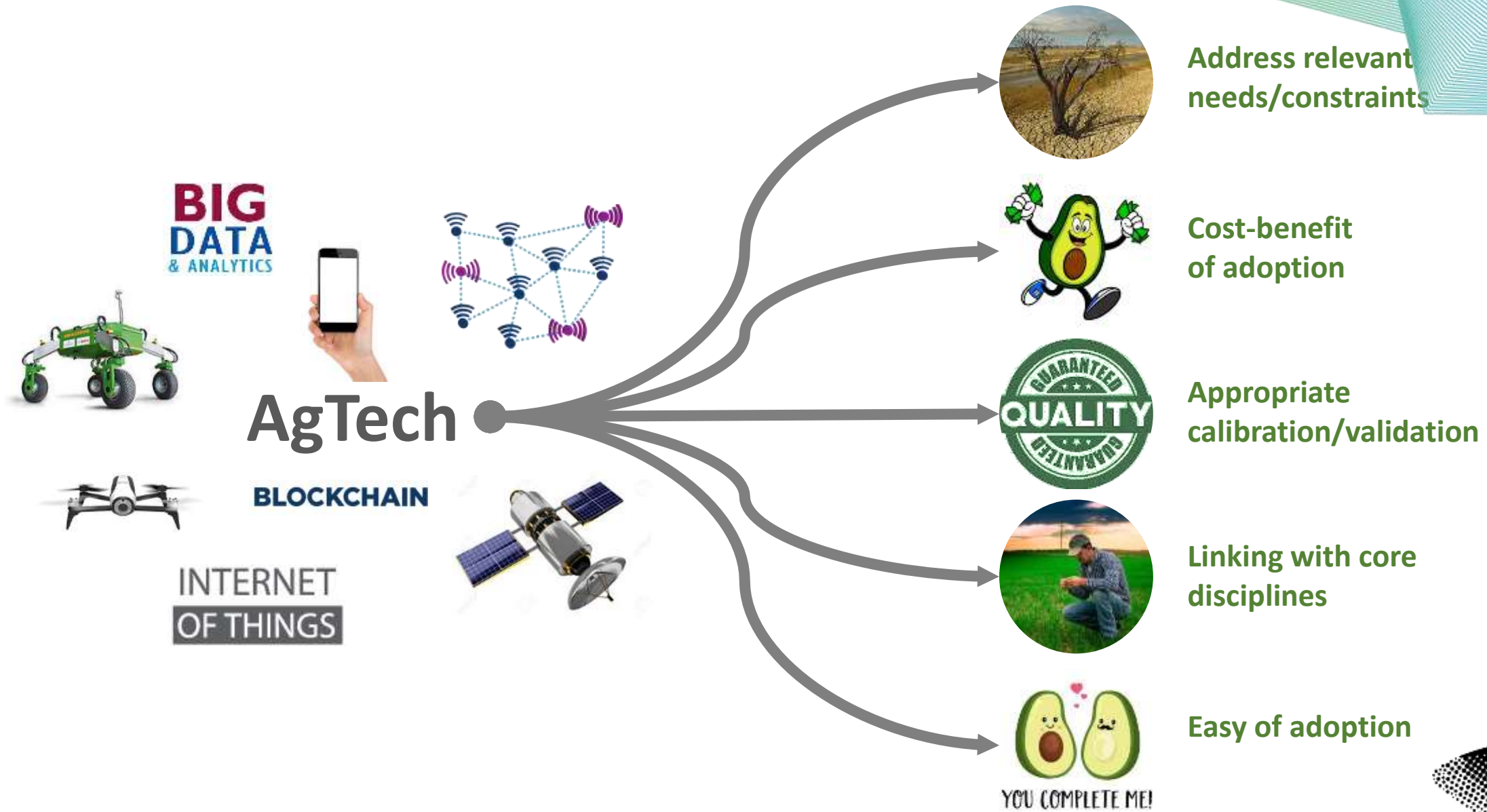
— *Craig Newmark* —



Gartner hype cycle of AgTech



Application is the key, not the tech



Lets talk Avocado



Start with what the Aus Avocado Industry/ growers want



We want to know where all our orchards are. This would help with planning, yield forecasting, post natural disaster response and biosecurity.

We want tools that better measure variations in tree health and we want to better measure yield variability across orchards and across seasons. We want it now 😊



Application 1: Where are all the orchards?

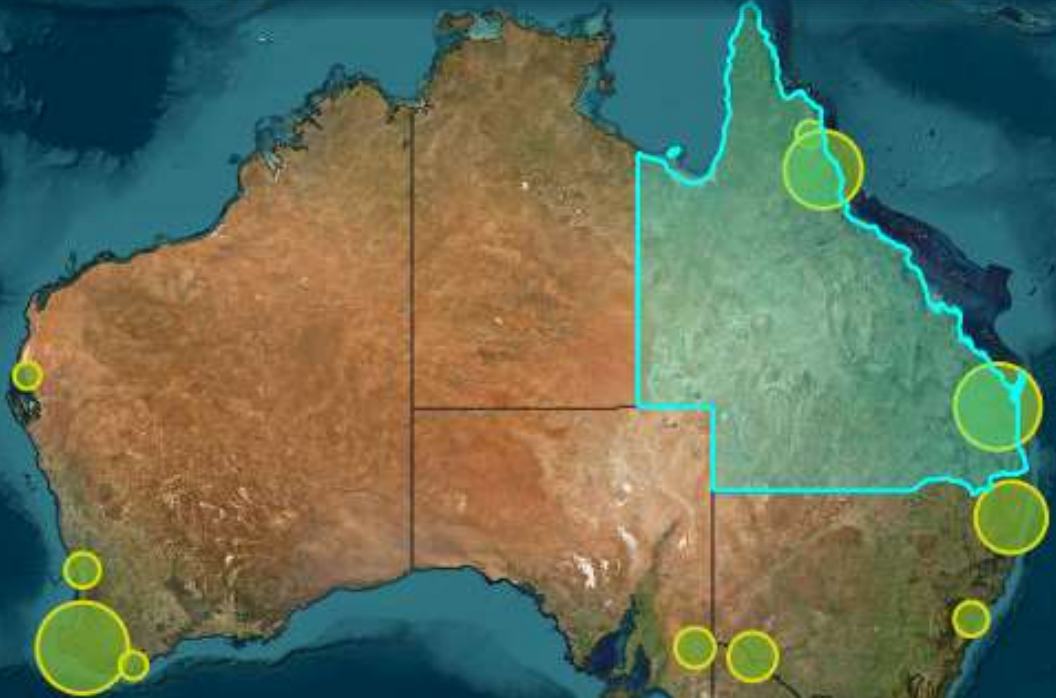
The most important and foundational data for any industry, in any country. This is rarely available in a consistent, accurate and accessible format.

Supports and quantifies:

- Extent and area of production
- annual change (new plantings)
- Forward selling/marketing
- Harvest logistics
- Traceability

Fundamental data for industry:

- Biosecurity preparedness
- Natural disaster response and recovery
- Adoption and automation of some AgTech (e.g. remote sensing/IoT and big data analysis)



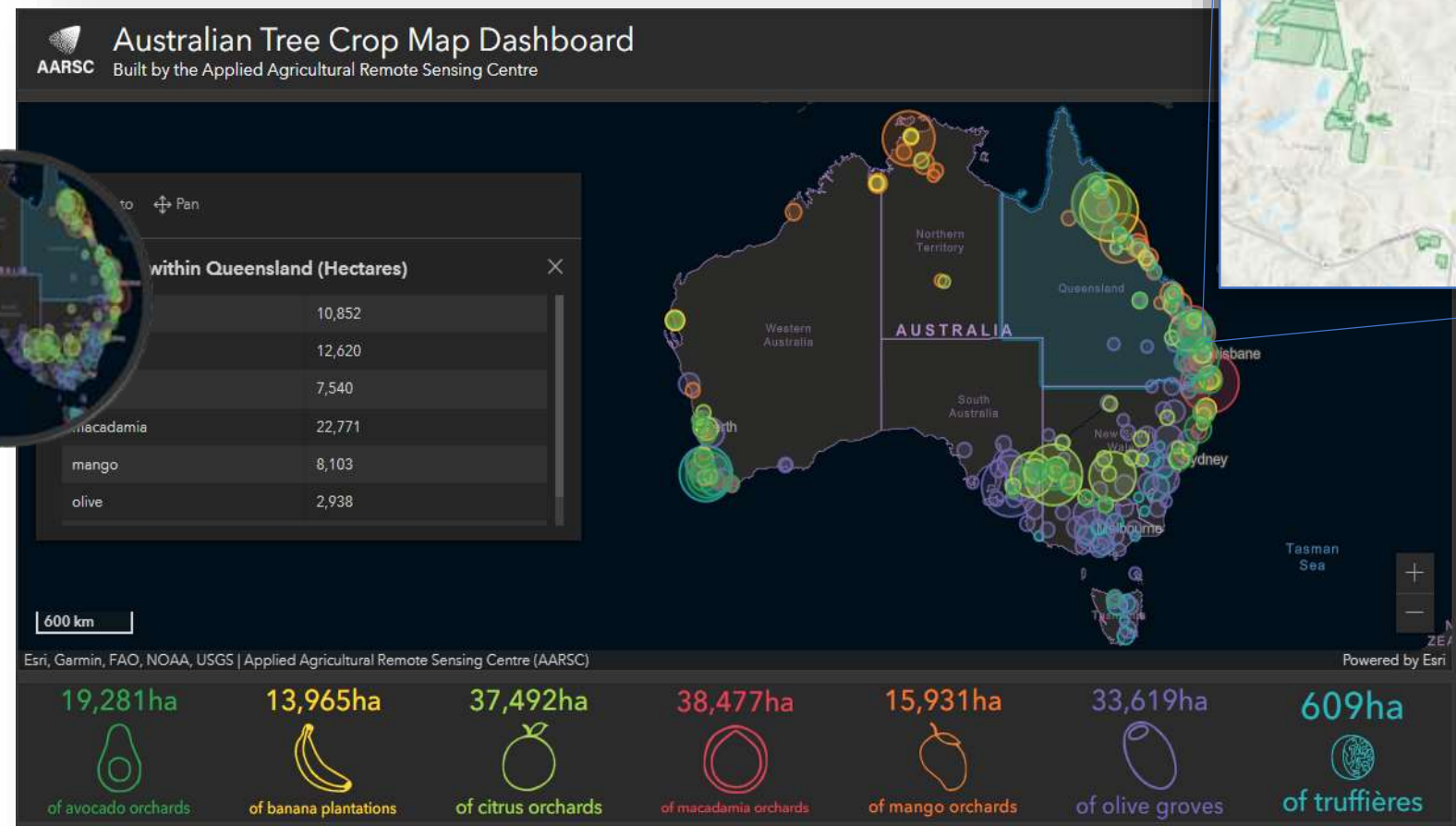
the Australian Tree Crop Map



- Meets Australian mapping standards

- Built from a number of inputs, not just remote sensing

- Easily accessible (Free)
- Designed for use by anyone
- No need for Big Data



Esri showcase: https://www.youtube.com/watch?v=xlL2qBJ_p88

ATCM Dashboard: <https://arcg.is/9n95e>

Traceability: Citrus Australia taking it to the next level

Map built by industry, for industry!

Value-adding:

- Block-level information
- Variety / cultivar / rootstock
- Planting year
- Management
- Tree spacing / density
- International ID standard (GS1)

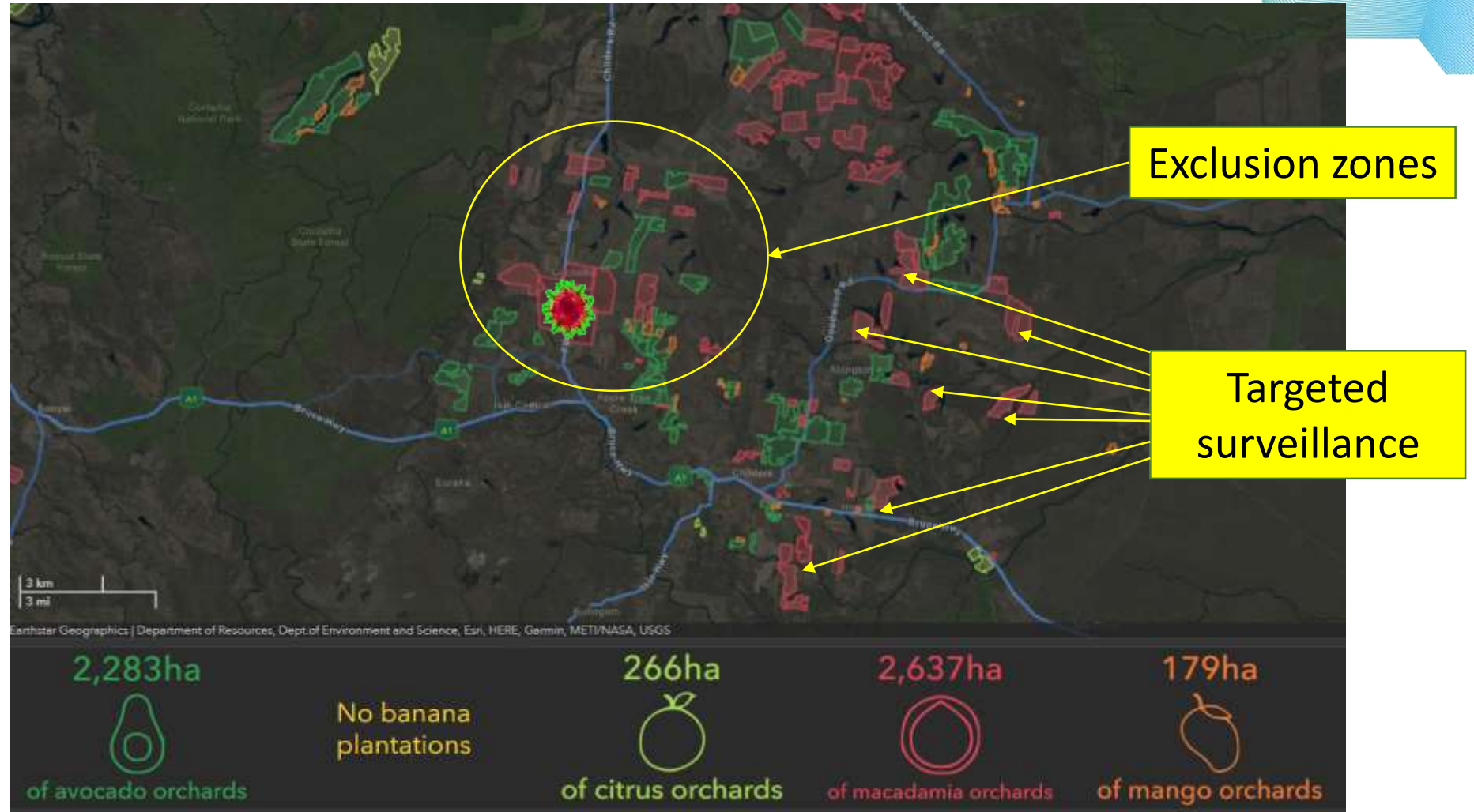


<https://citrusaustralia.com.au/wp-content/uploads/Citrus-Mapping-Report-FINAL.pdf>



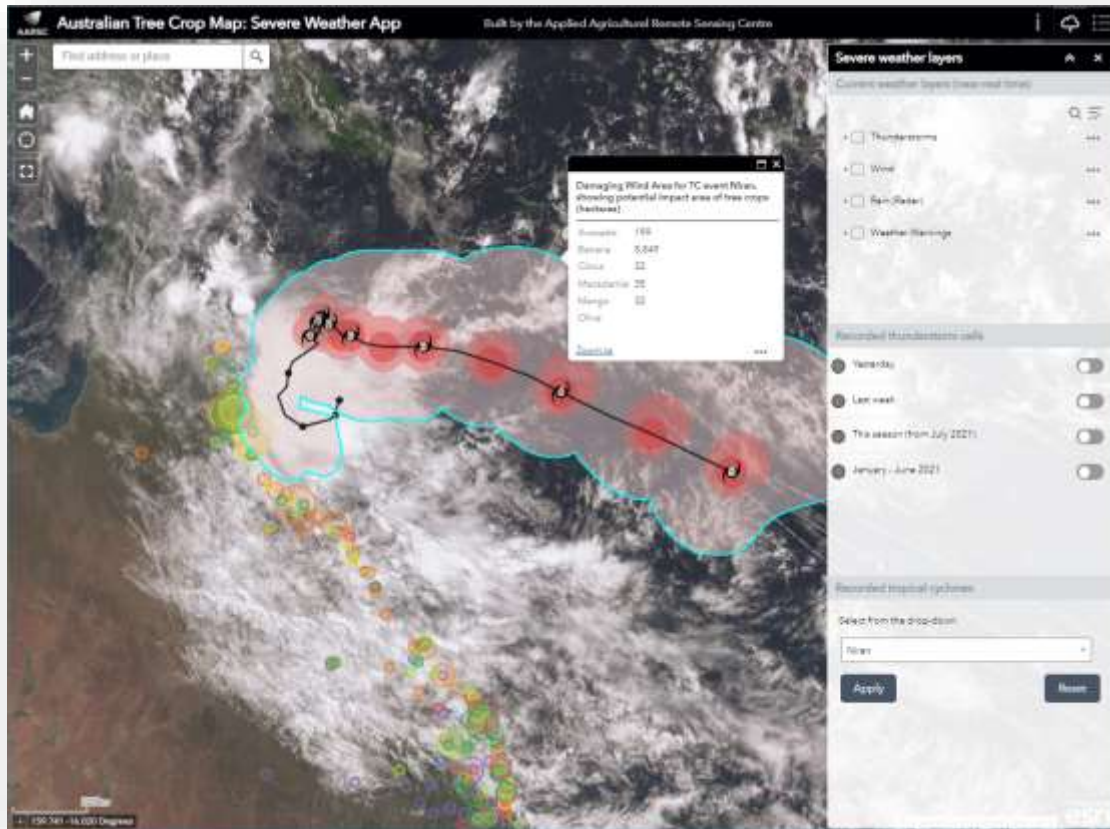
Biosecurity: Establishing exclusion zones and targeted surveillance

- Native vegetation
- Surrounding crops
- Vehicle routes
- Topography
- Watercourses
- Stock routes
- Walking tracks
- Drainage lines



Natural Disaster Response & Recovery

Potential impacted orchards, updated in near-real time



ATCM Severe Weather App

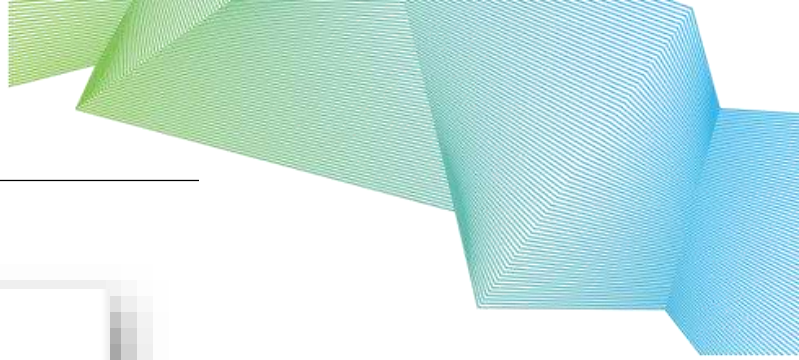
<https://arcg.is/0PvH54>



Bushfire Rapid Response Map

<https://arcg.is/19P55n>

Determining planting age of all orchards



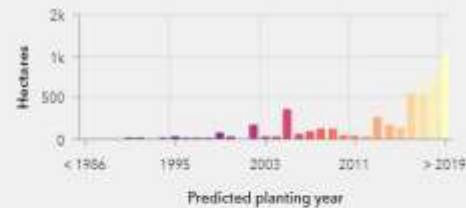
Click here to revisit the start screen and instructions



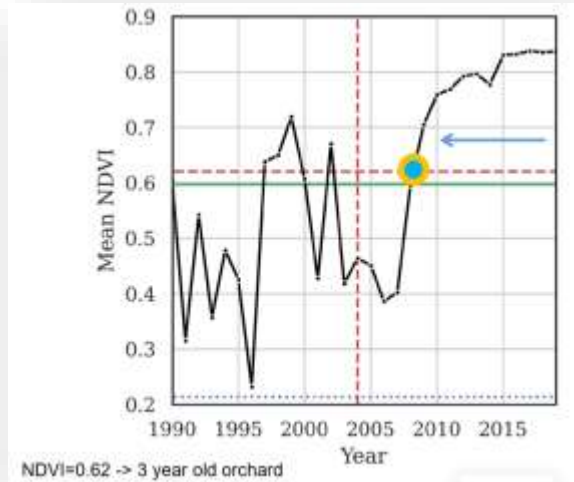
Something missing or incorrect? Submit a comment using the Industry Engagement Web App.

Total area of orchards summarised by predicted planting year

Area statistics update interactively based on the current map extent



Total within current map extent: 4,916ha

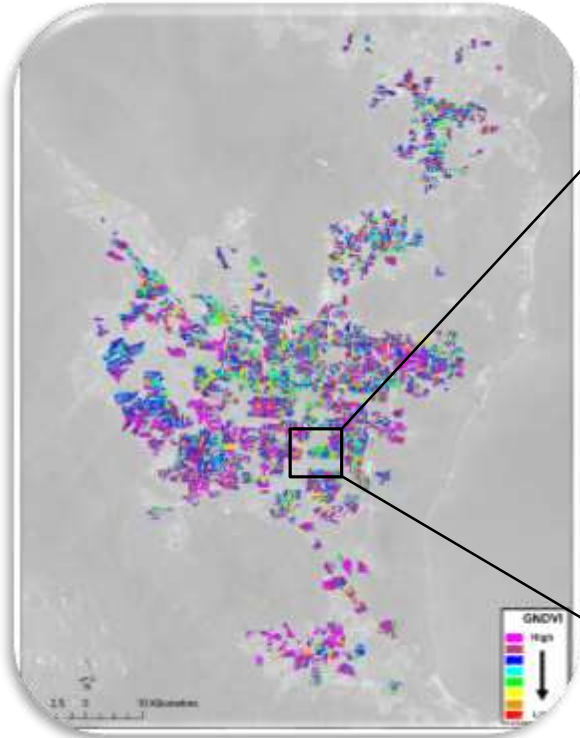


NDVI=0.62 -> 3 year old orchard

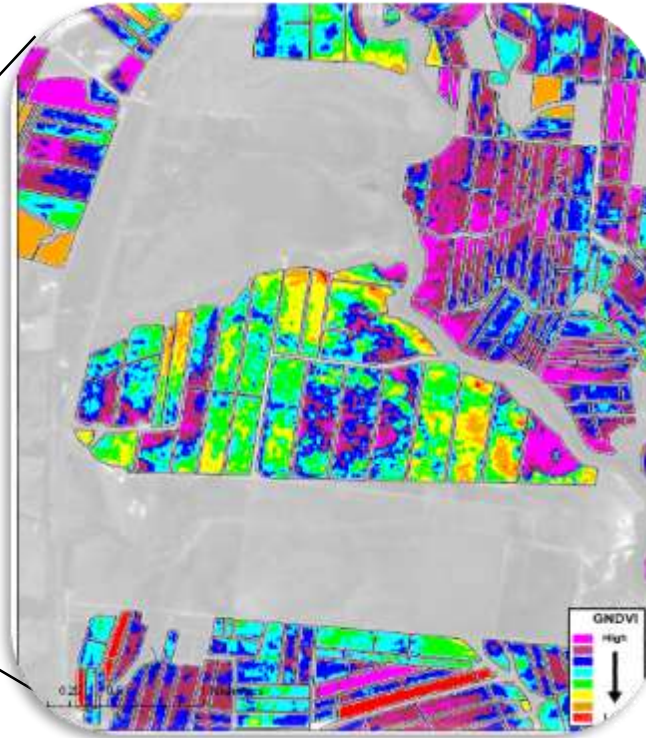
Application 2: Measuring Tree Health



Remote / proximal sensing identifies variability



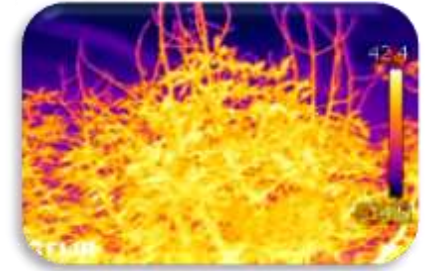
Regional level



Farm level



Orchard block level

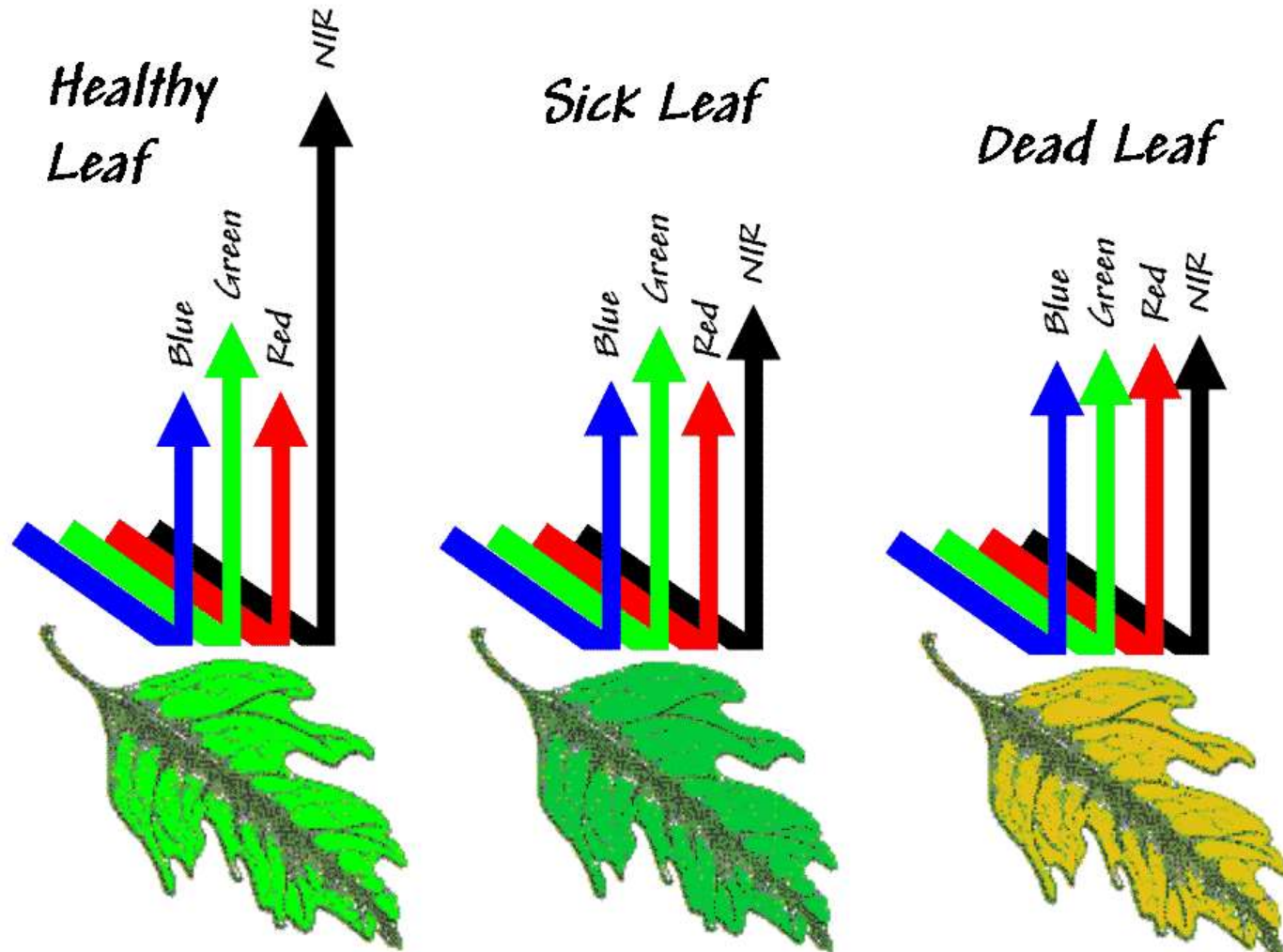


Tree level



Leaf level

Spectral Resolution: Understand what sensors measure



<http://www.innovativegis.com/basis/pfprimer/topic7/Topic7-8.gif>

NDVI: is a good indicator of plant/tree vigour (size and health).

However, other indices may be better correlated to the parameters of interest.

Satellites



Drones, UAS, UAVS, RPAS, etc.



Fixed Wing



Quadcopters



Octocopters



Blimps and balloons



Helicopters



Still paying attention?

Some commercial UAV camera systems



Micro Sense

Blue: 475nm x 20nm
Green: 560nm x 20nm
Red: 668nm x 10nm
Red-Edge: 717nm x 10nm
Near Infrared: 840nm x 40nm

<https://www.micasense.com/rededge/>



Parrot Sequoia

Green: 500nm x 40nm
Red: 660nm x 40nm
Red-Edge: 735nm x 10nm
Near Infrared: 790nm x 40nm

<http://diydrones.com/profiles/blogs/sequoia-in-the-wild>



Slant Range

Green: 550nm x 40nm
Red: 650nm x 40nm
Red-Edge: 740nm x 10nm
Near Infrared: 850nm x 100nm

<http://www.slantrange.com/3p/>

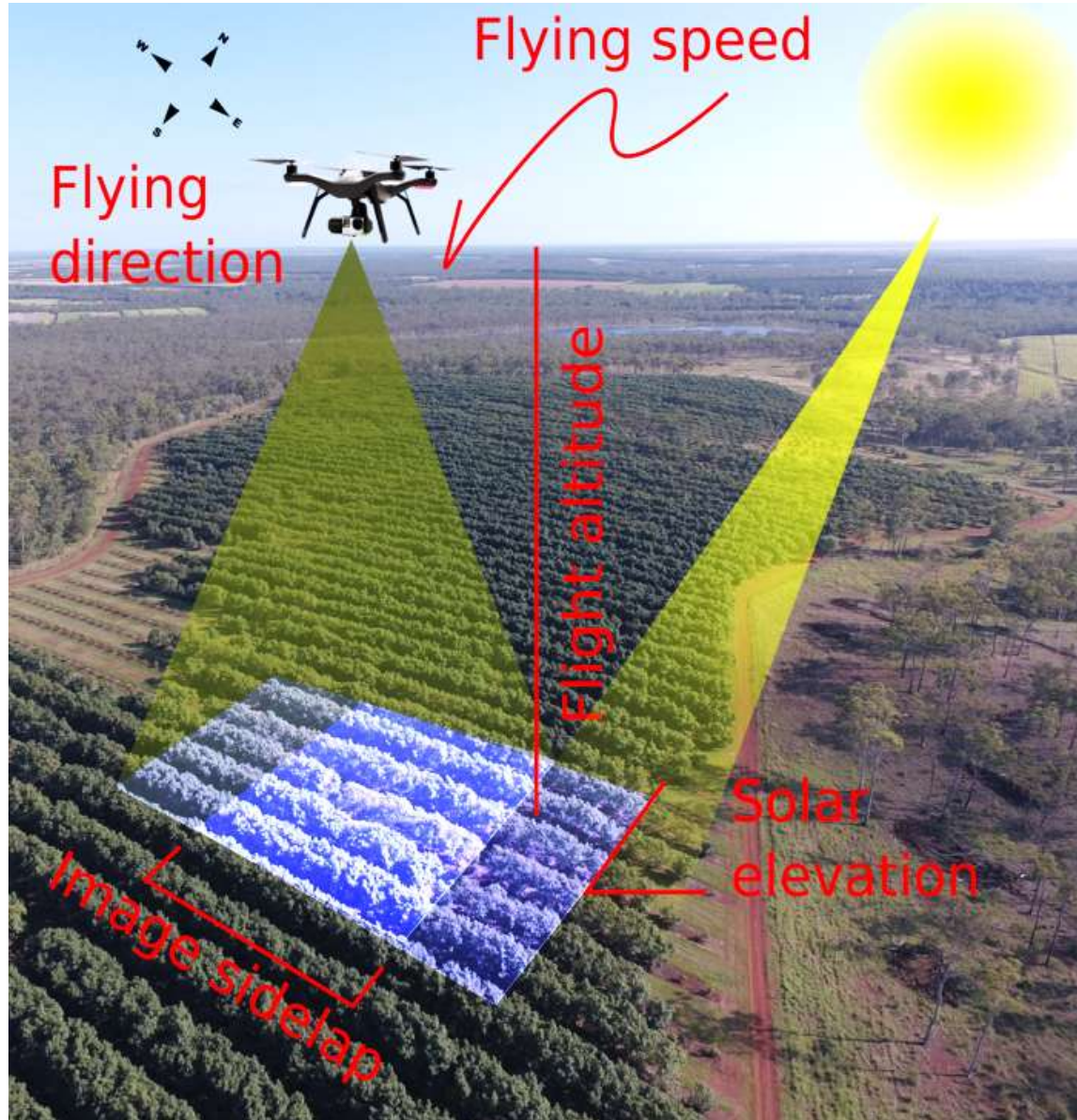


Sentera

Blue: 446nm x 60nm
Green: 548nm x 45nm
Red: 650nm x 70nm
Red Edge: 720 nm x 40nm
Near-Infrared (NIR): 840nm x 20nm

<https://sentera.com/product-category/sensors/>

Optimal flight protocols for drones

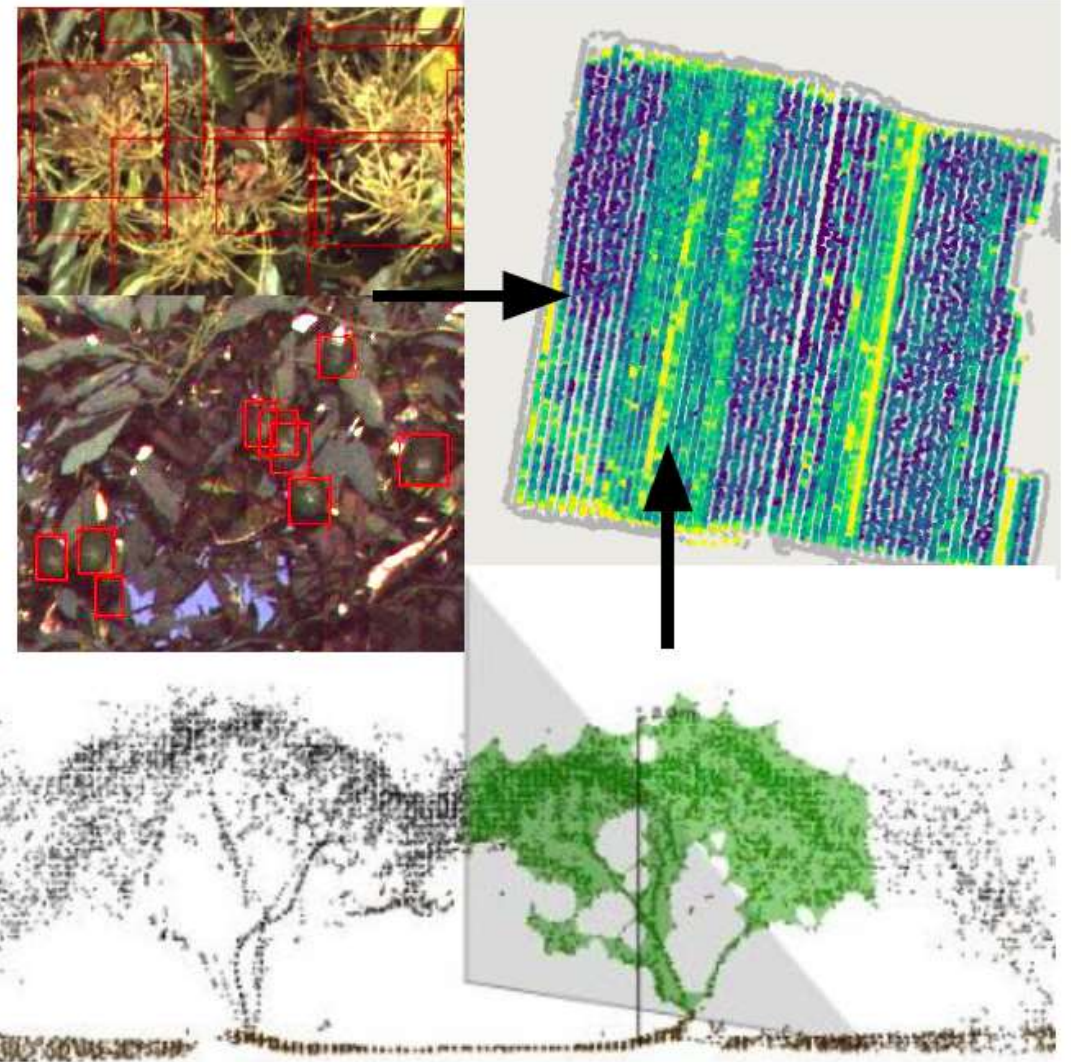


PhD study by Yu-Hsuan Tu (UQ and UNE)

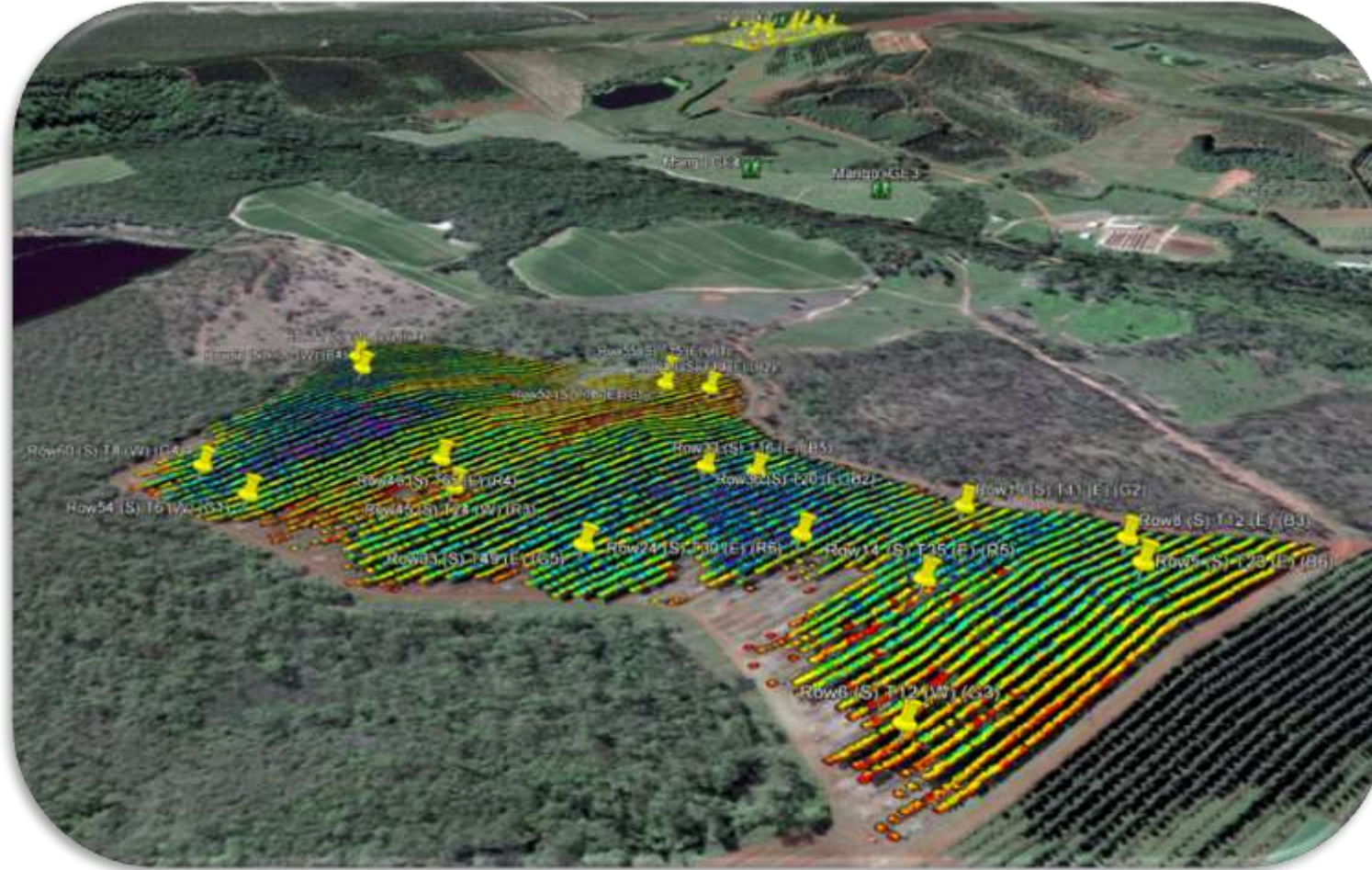
- Flying along the tree row;
- Flying at high solar elevation;
- Flying with a gimbal;
- Flying with high forward and side overlap;
- Recommended flying altitude is around 75 m AGL to obtain a 2 cm;
- Ground calibration panels for radiometric and geometric correction.

Usage and benefits of the data

- Flower mapping for yield potential and pruning
- Monitoring yield (fruit count / size) after drop
- Mapping canopy volume / density to:
 - Identify and prune excess canopies for
 - improved light interception
 - Identify and prune fruit-rot risk areas
 - Improve sprayer calibration



You have an image, so now what?



Supporting targeted agronomy



Yield / quality



Sensor placement



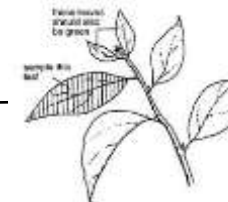
PCR barcoding



Soil testing



Visual inspection

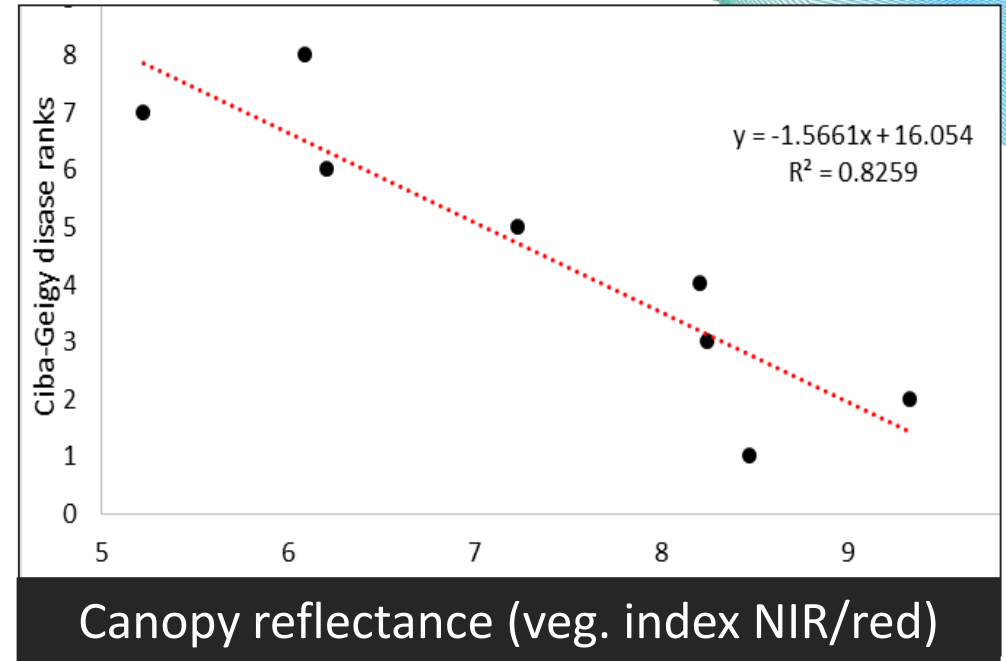
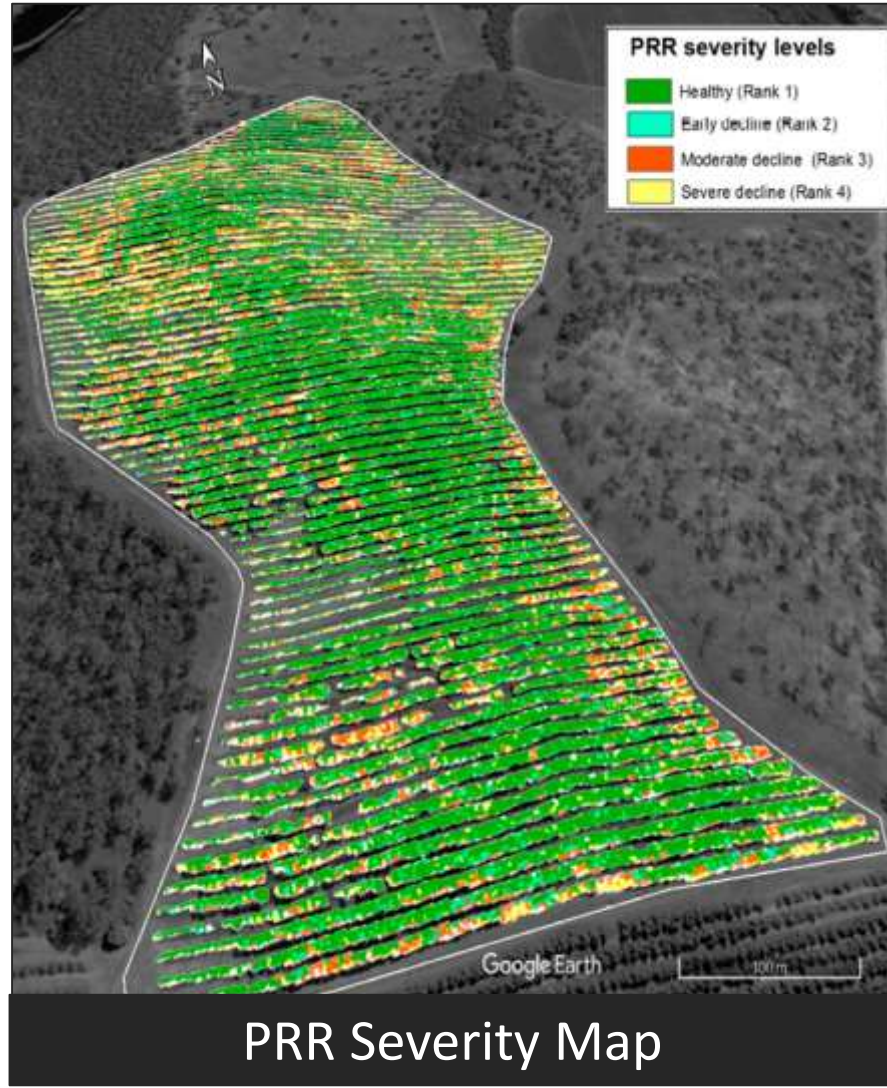


Leaf testing



Disease or pest App
E.g. Tumaini banana

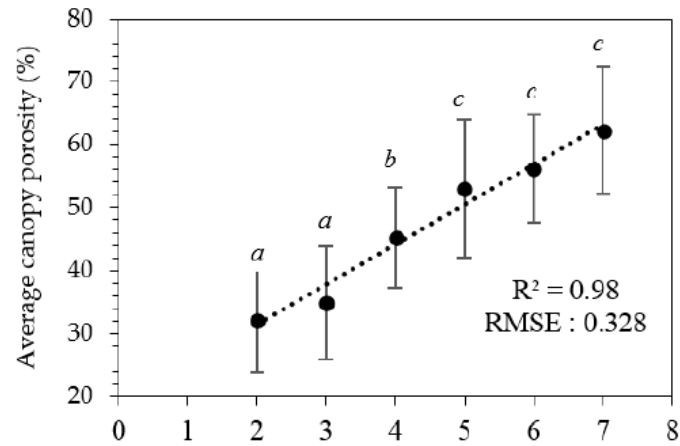
Phytophthora root rot (PRR)



PhD study by Surantha Salgadoe using drone, aerial and satellite data

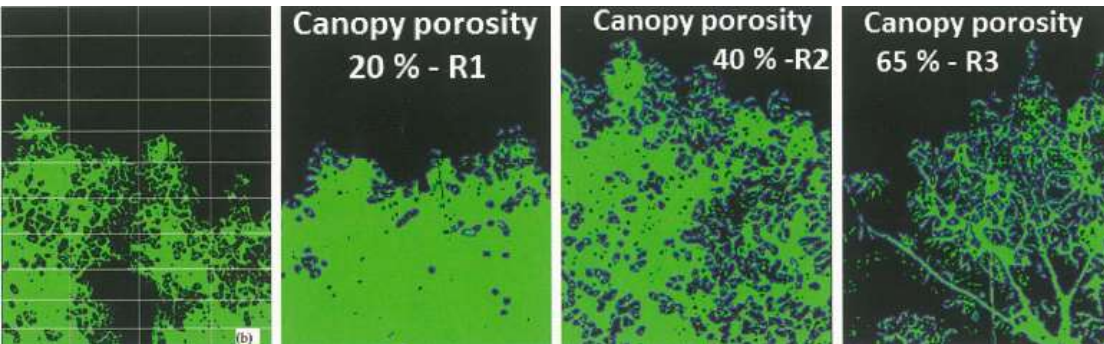
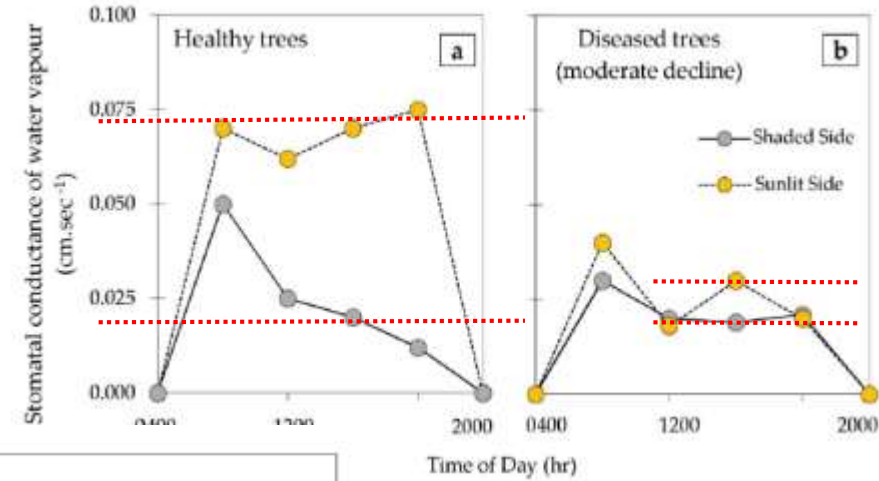
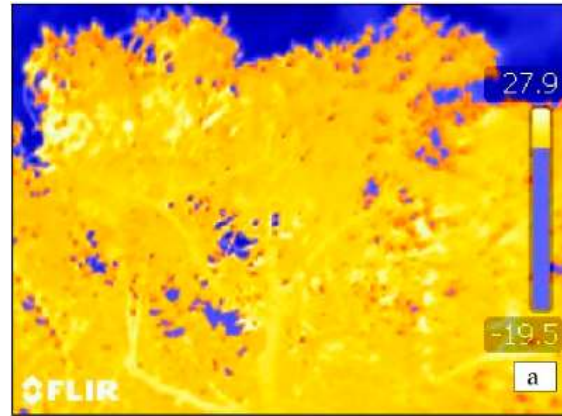
Phytophthora root rot (PRR)

Canopy porosity

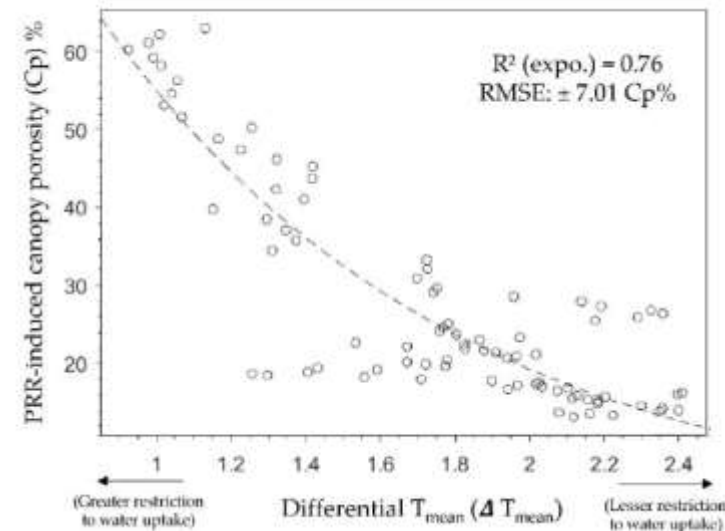


(a) Ciba-Geigy disease ranks *

Canopy temperature



R1 healthy, R2 moderate, R3 severe



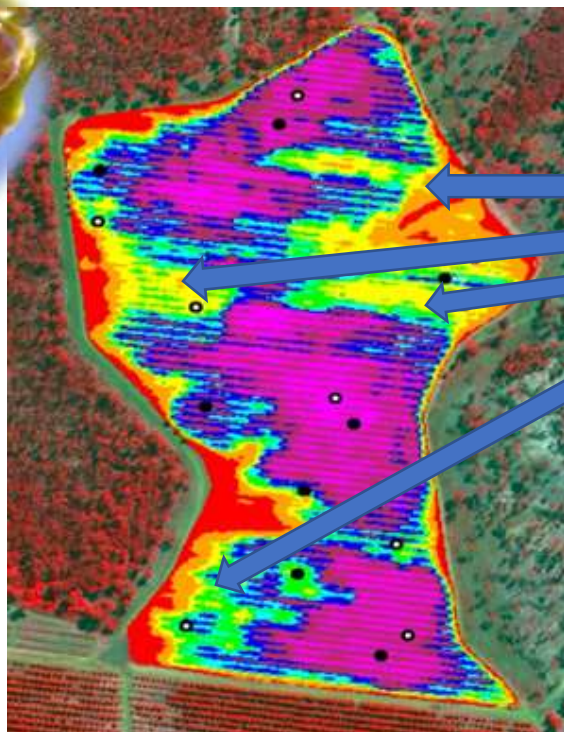
PhD Study by
Surantha Salgadoe



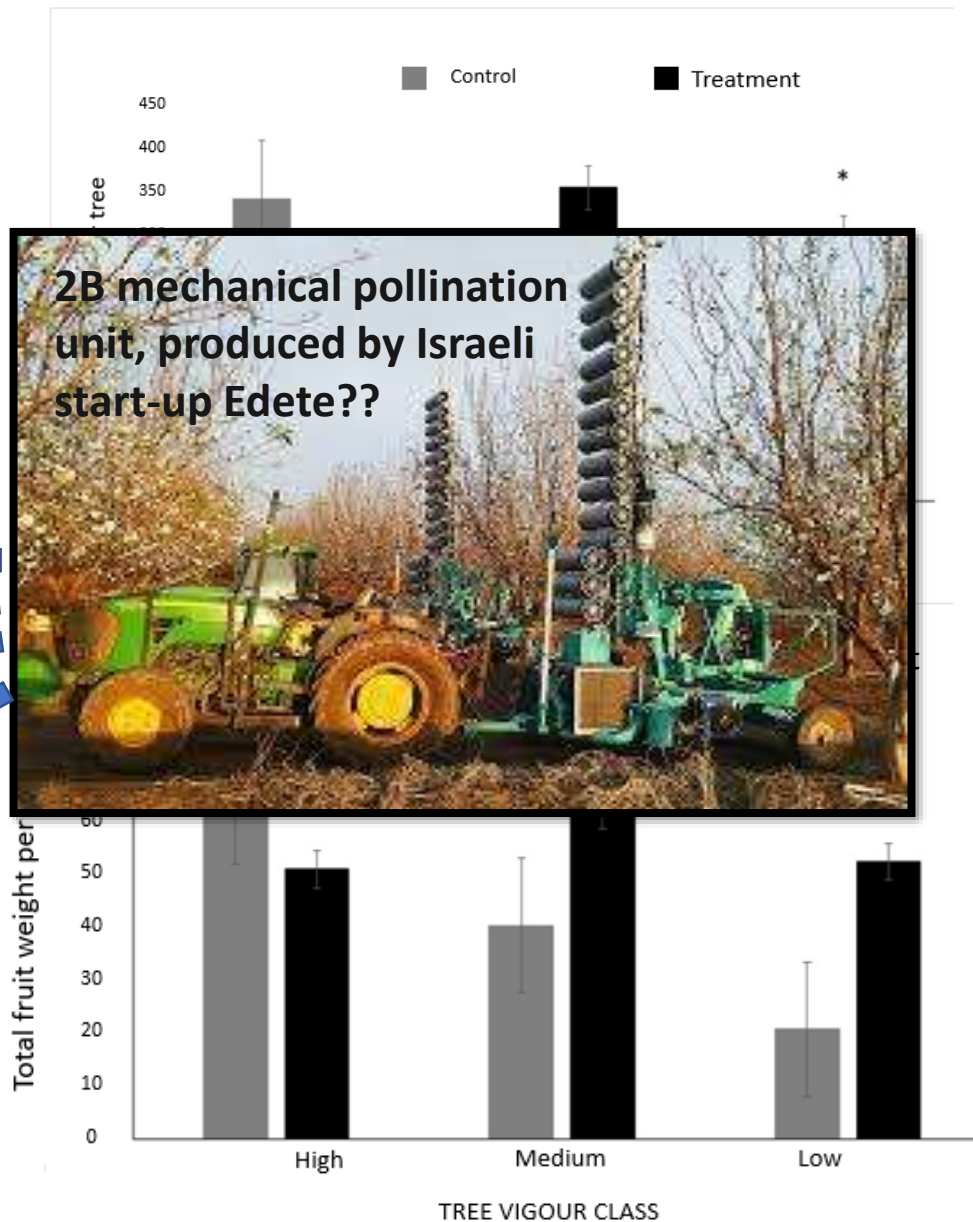
Pollination efficacy in mixed vigour trees

Bryony Willcox
(PhD study: UNE, Plant and Food)

- 5 blocks/ 18 trees per block
- 4 reps of low, medium and high vigour received additional hand pollination.
- 2 reps of each class retained as controls.



One of classified NDVI Avocado blocks surveyed in this study

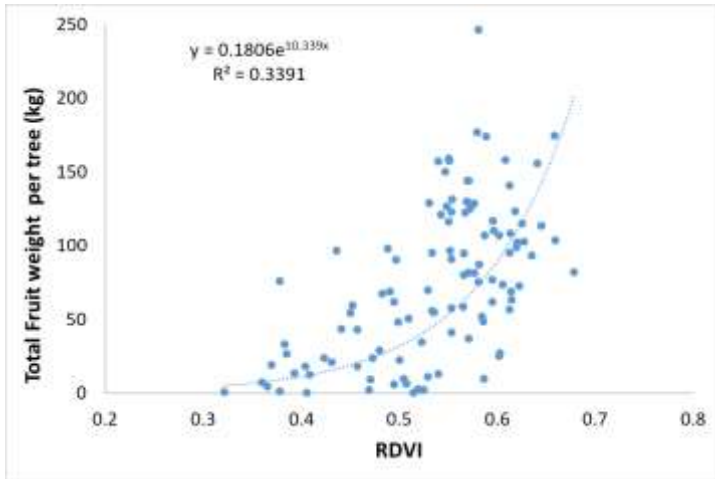


Application 3: Yield Forecasting

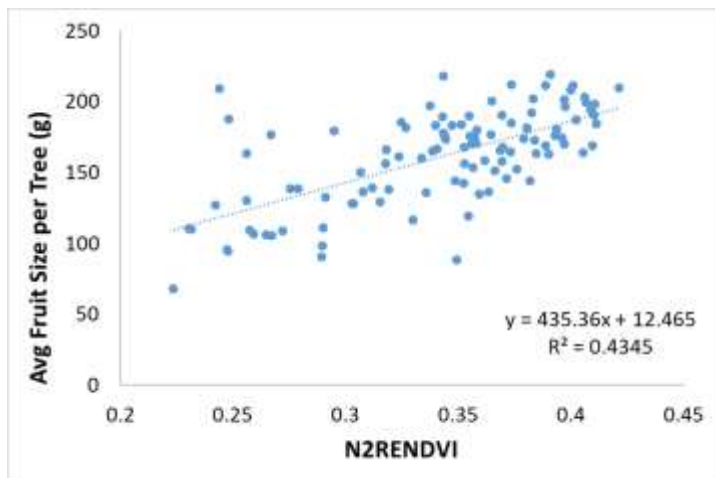


Relationship between canopy vigour and yield/fruit size

Measured from 108 avocado trees from 6 avocado orchards



Total Fruit Weight (kg)
to canopy reflectance

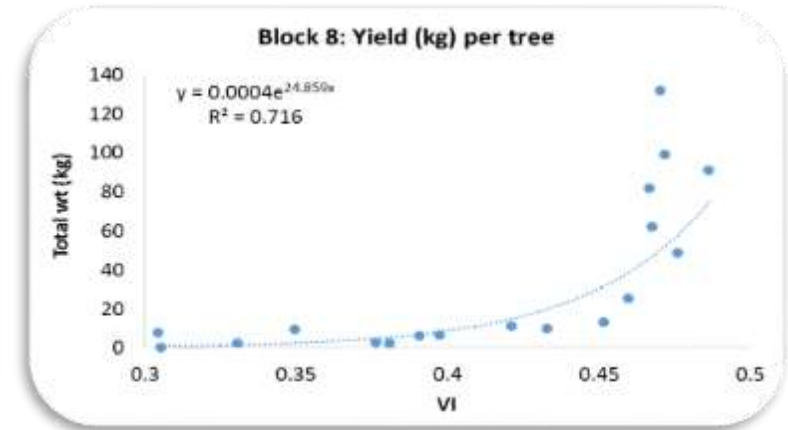
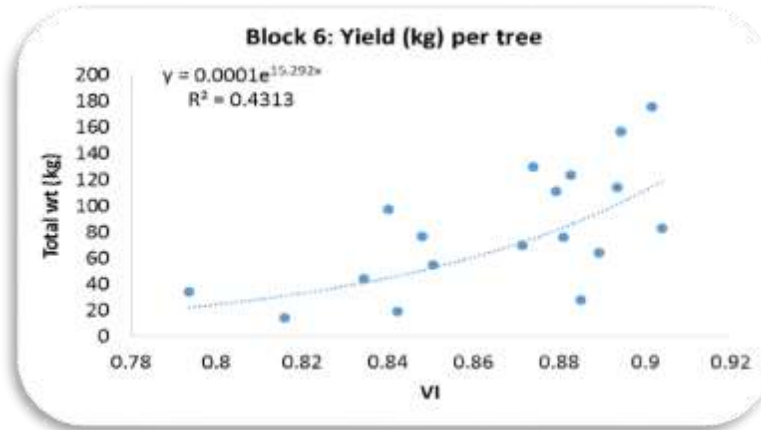
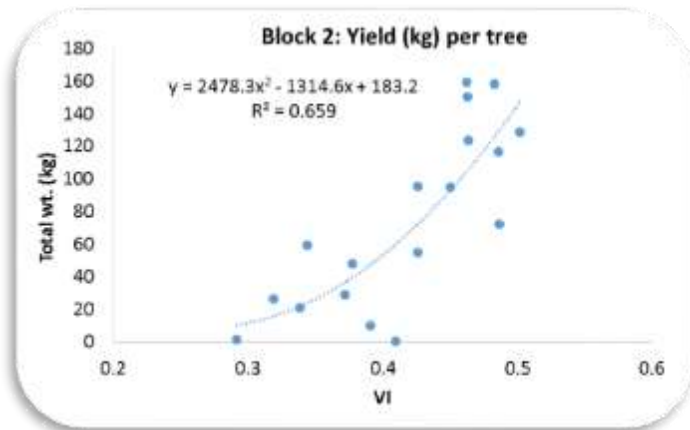
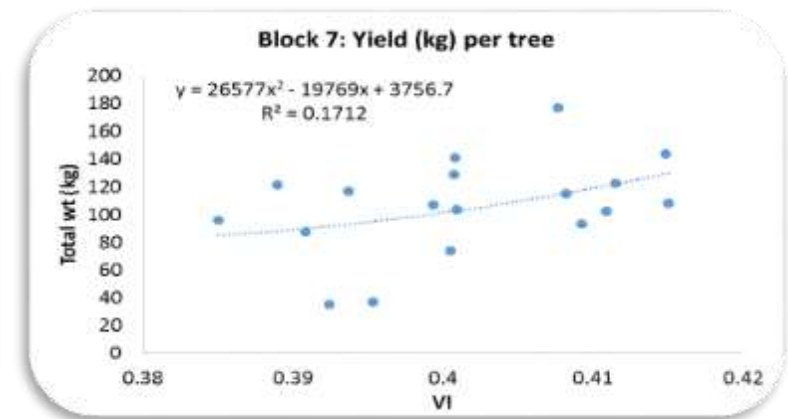
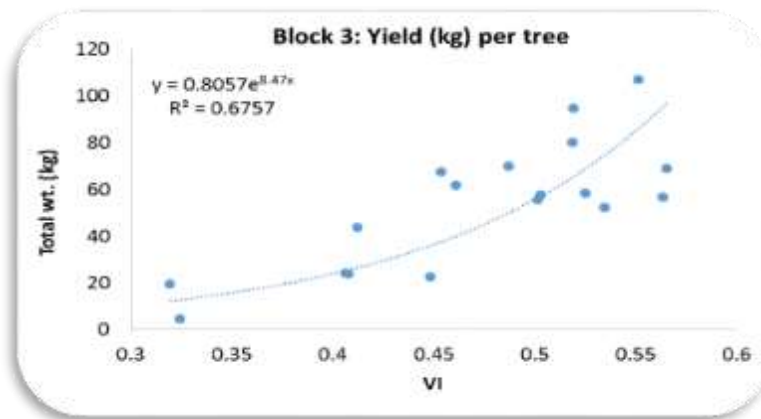
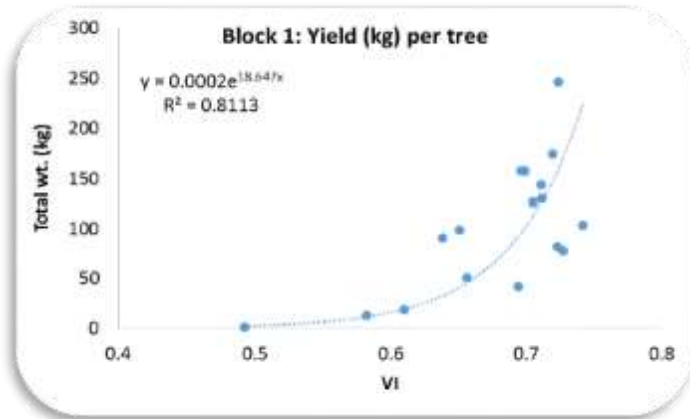


Average Fruit Weight (g)
to canopy reflectance



But the relationship is not consistent

Influenced by season, location, variety, management, irregular/biennial bearing



Remote sensing methods for Avocado yield forecasting

Method 1: 18 trees / farm calibration (single image capture)

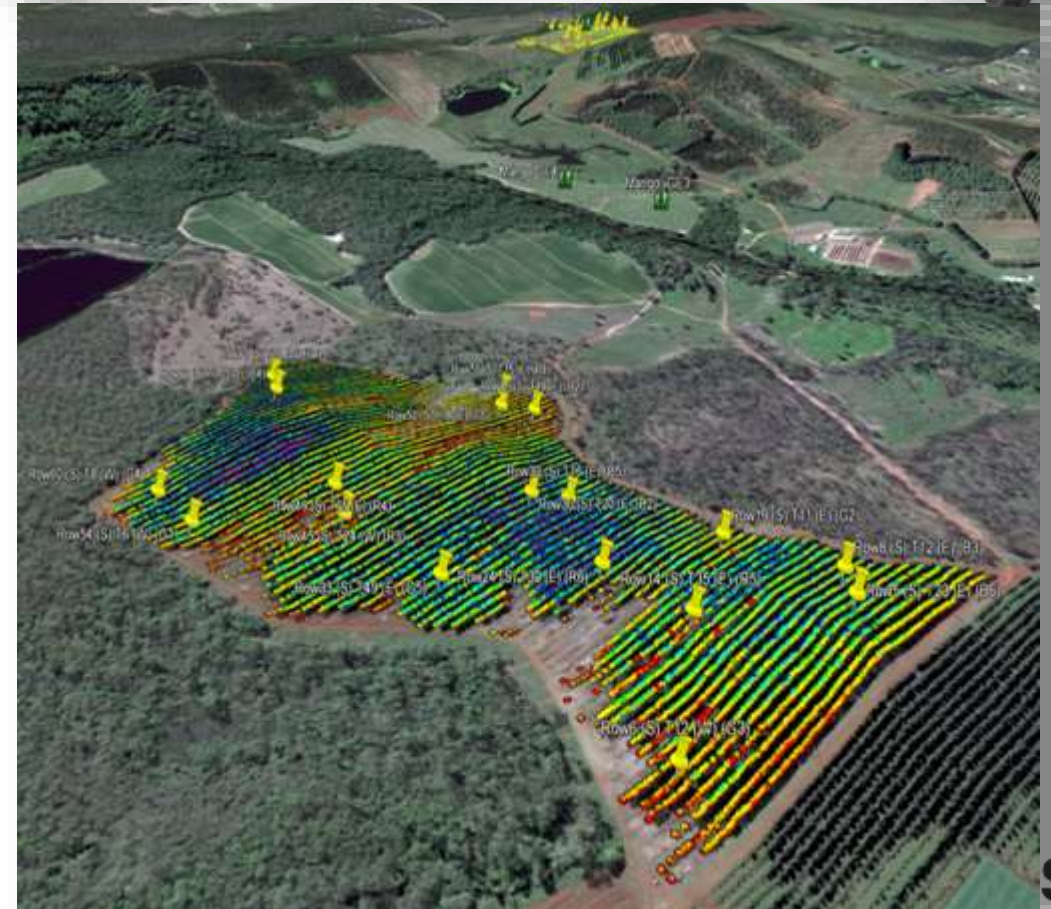


Pros

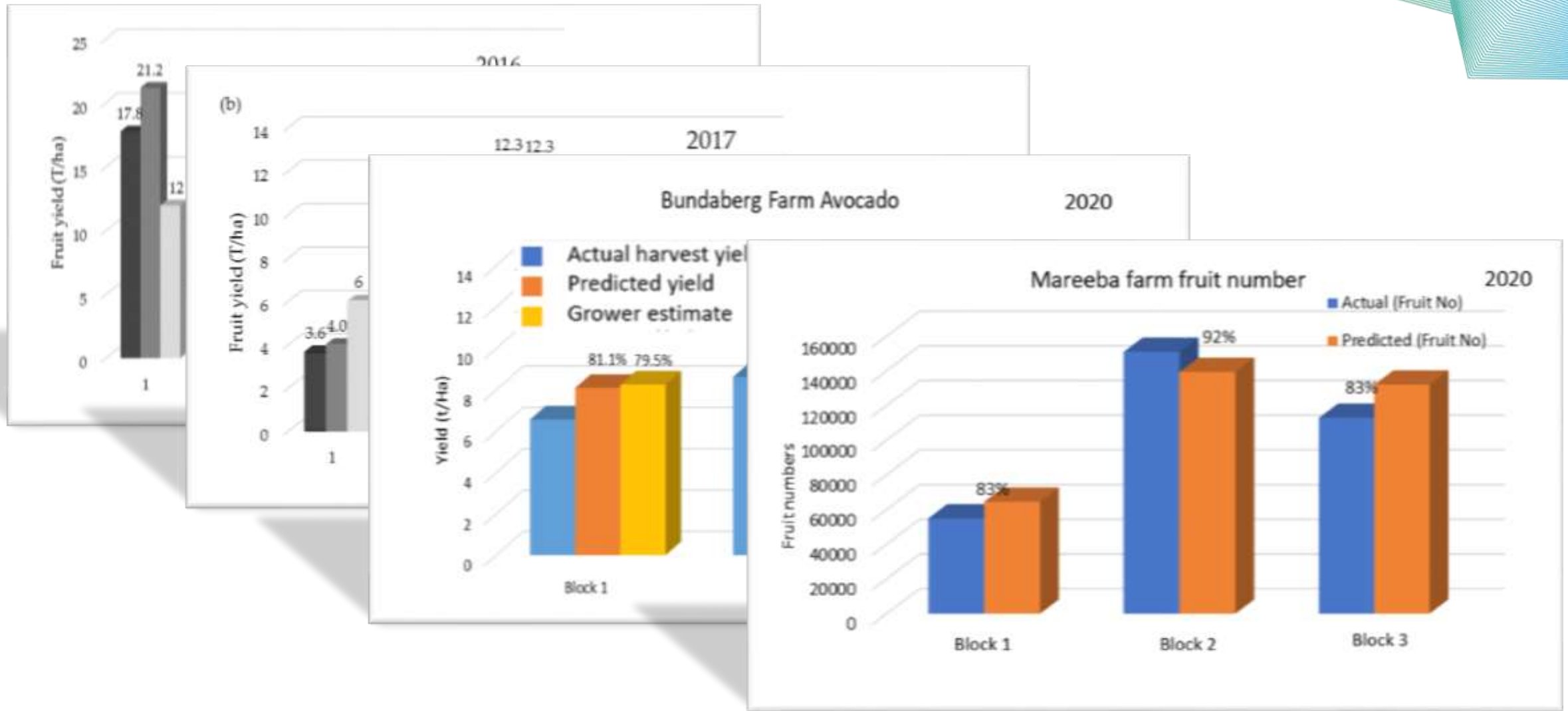
- Does not require historic data
- Better representation of orchard variability than grid sample
- Less labour, only 18 trees to count
- Able to map yield variability within orchard
- Can include measures fruit number per tree, fruit weight, or other quality parameters

Cons

- Requires high-res imagery which costs the grower
- Requires in field counting of fruit
- Predictions only made once fruit is visible



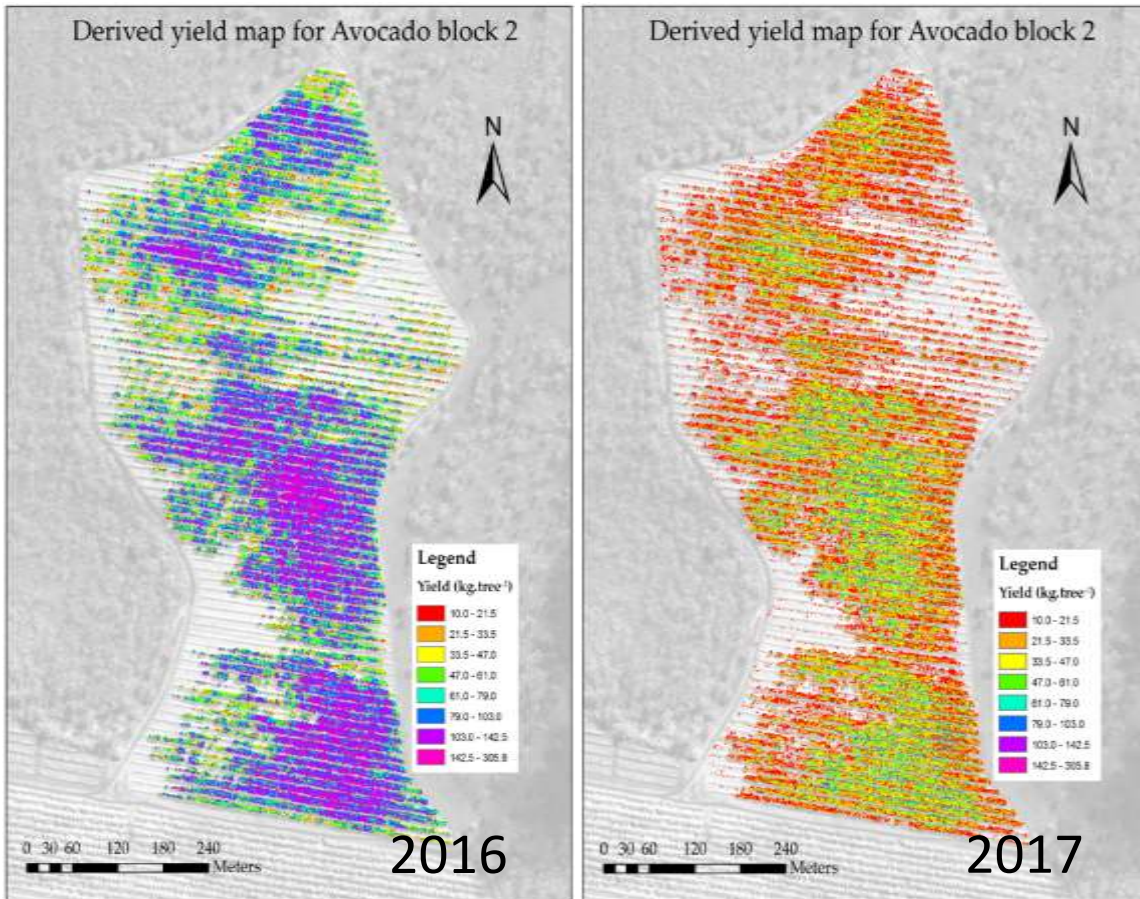
18-tree forecasting accuracies at the block level



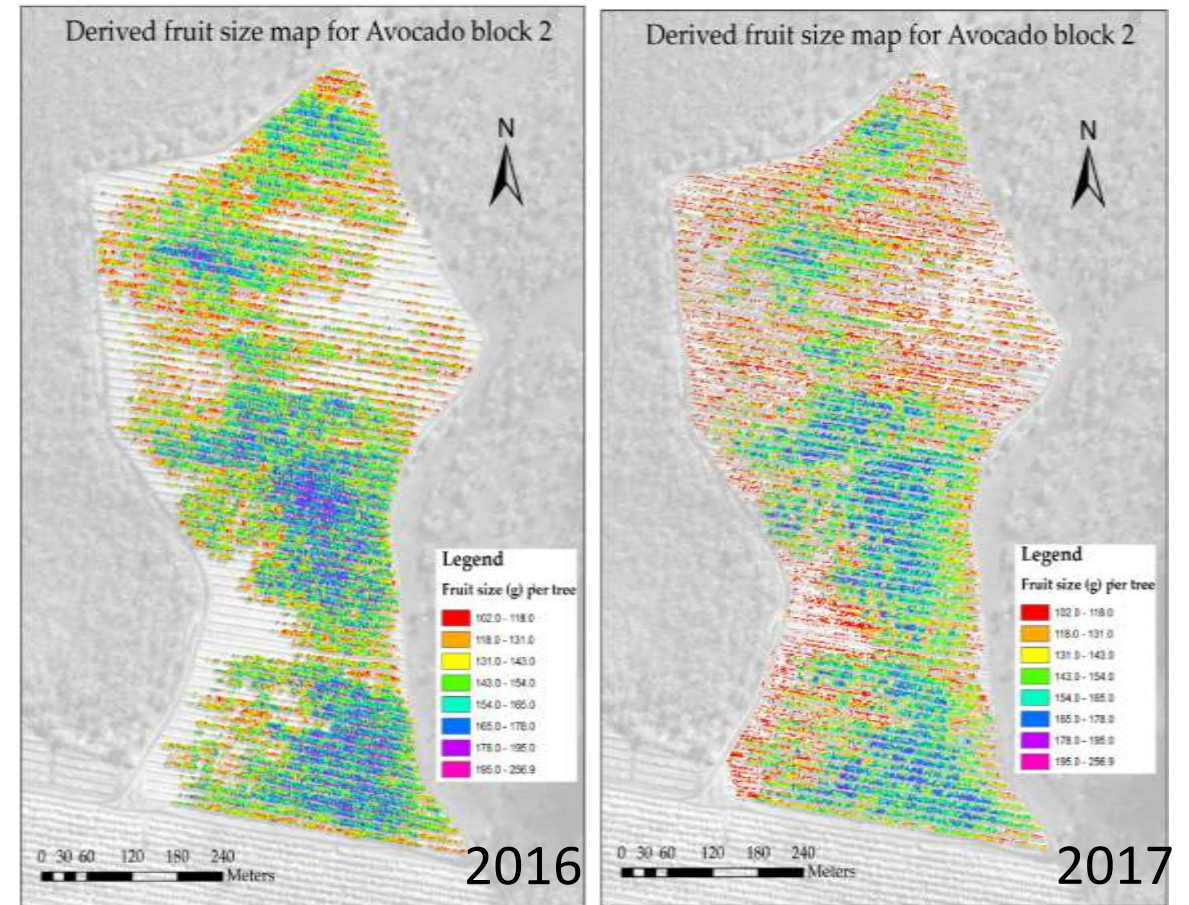
Comparison between actual yield (t/ha) to that predicted from satellite imagery and grower estimate.

Derivation of yield (kg per tree) / Fruit Size maps

Yield



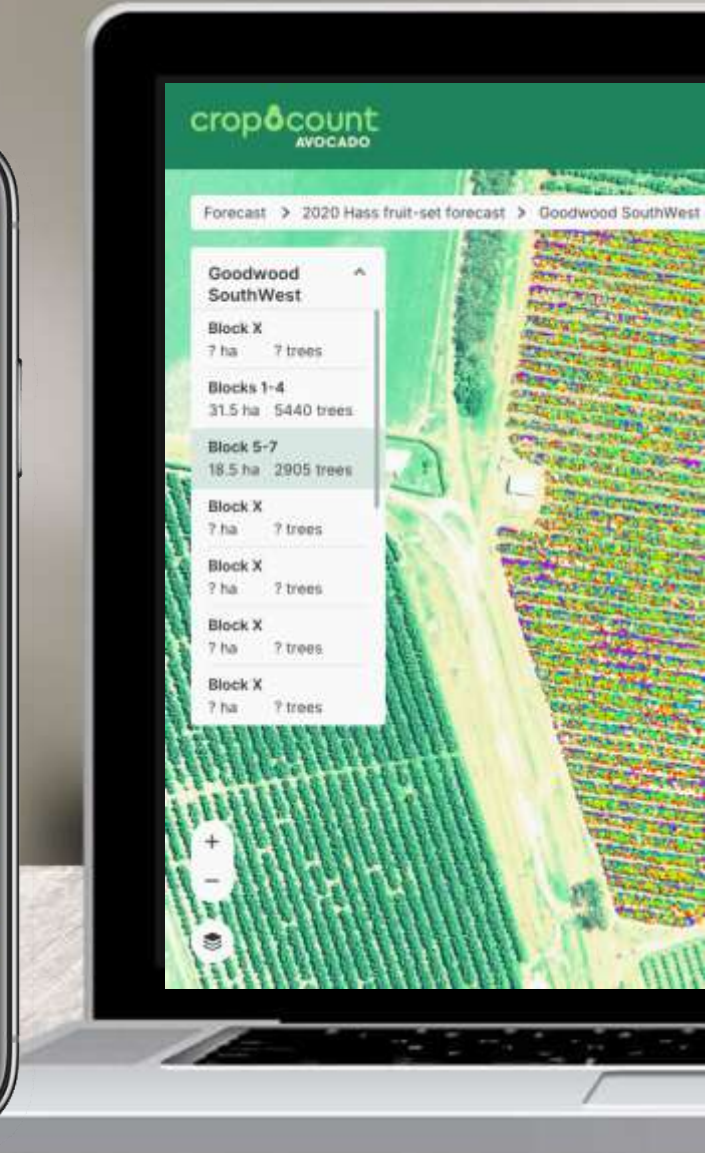
Fruit size



Crop Count (MVP)

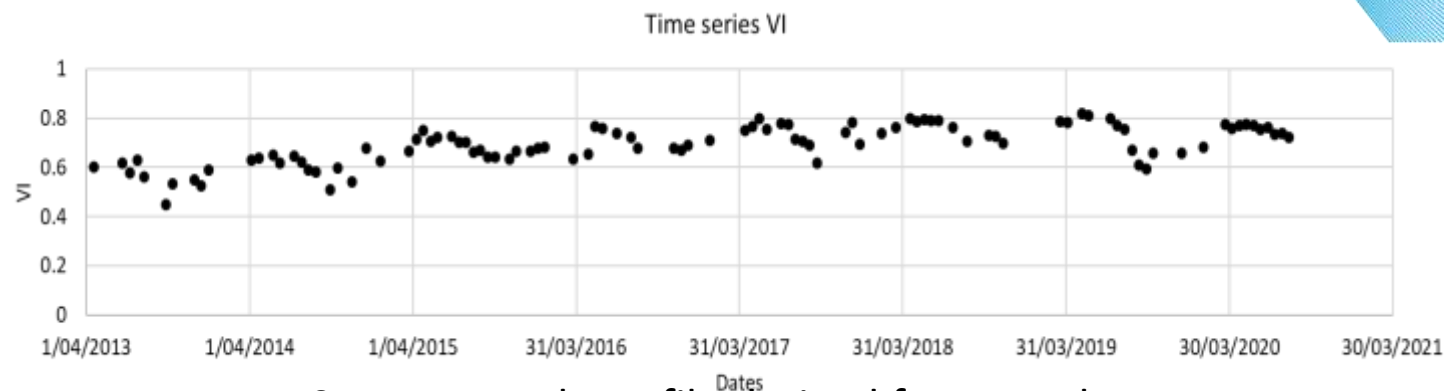
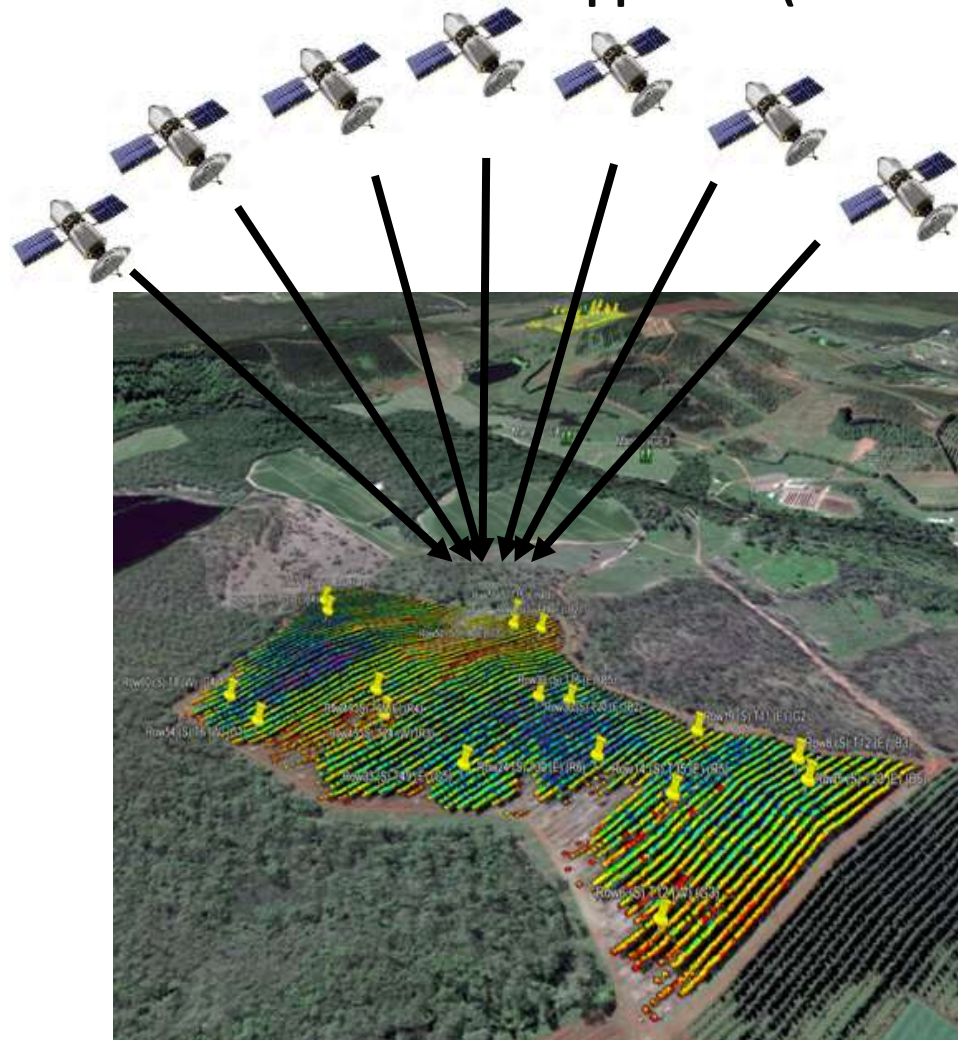
Crop Count combines satellite imagery with on ground calibration to produce yield distribution maps

https://youtu.be/NmrCO_fSbRU



Remote sensing methods for Avocado yield forecasting

Method 2: 'Time-series' approach (multi-temporal image capture)



10-year growth profile derived from Landsat

Pros

- Uses freely available imagery
- Requires no in-field fruit counting
- Provides forecasts many months before harvest

Cons:

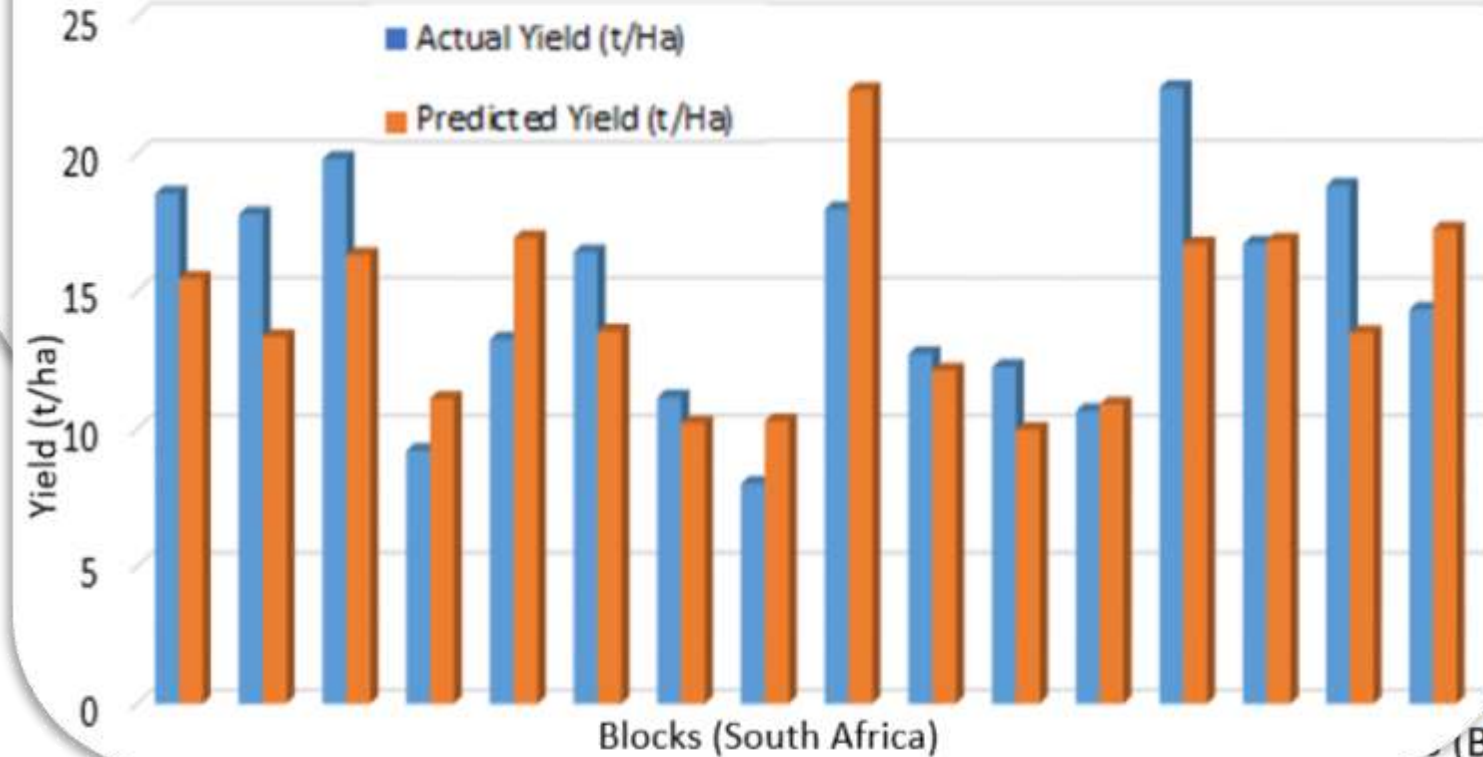
- Requires historic yield data (at least 4 years)
- Less responsive to extreme events / irregular bearing

Does the 'Time series' met

Farm-wide predicted yield (combined blocks)

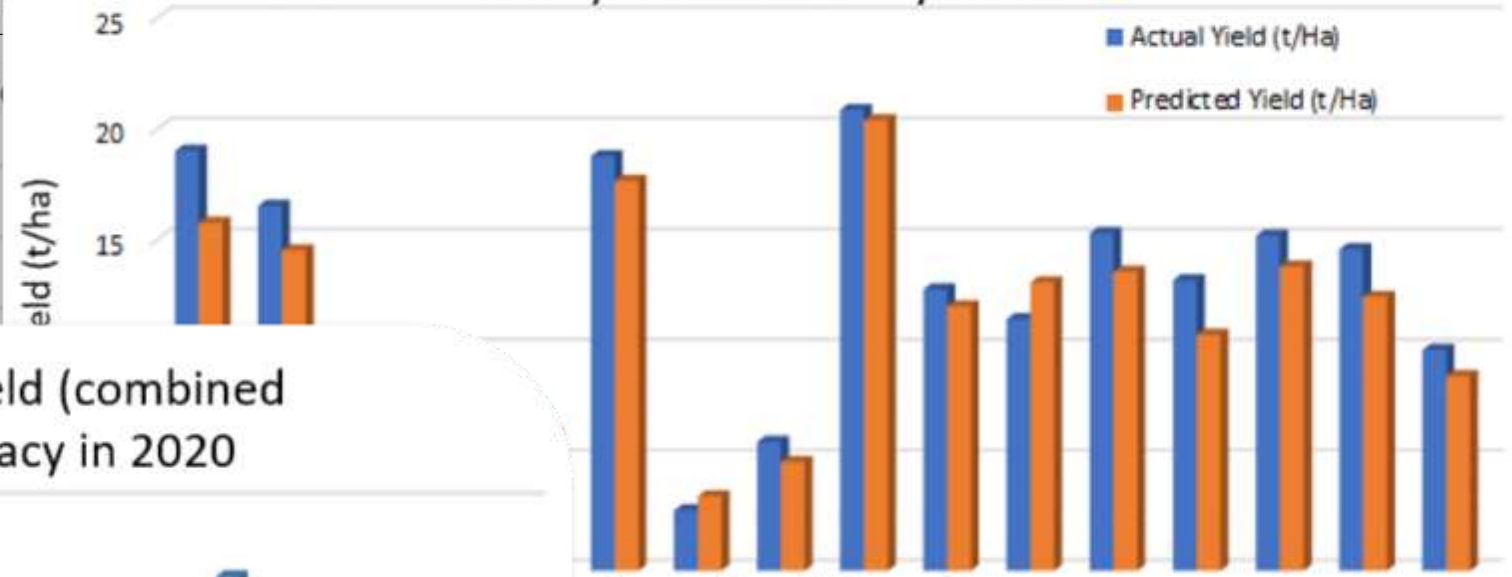


Farm-wide predicted yield (combined blocks) = 94.4% accuracy in 2020

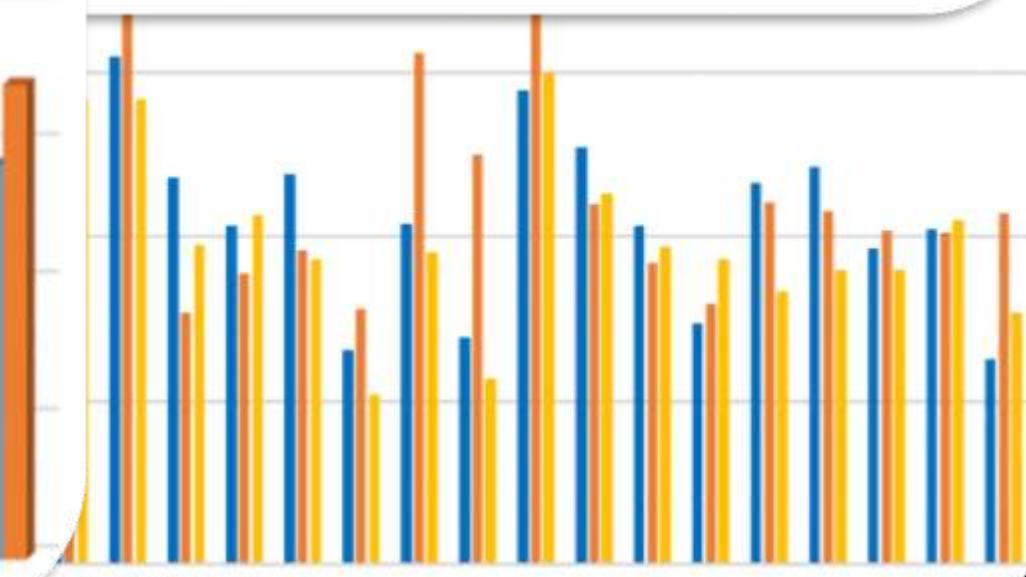


Blocks (South Africa)

Farm-wide predicted yield (combined blocks) = 92% accuracy in 2020



Blocks (South Australia)

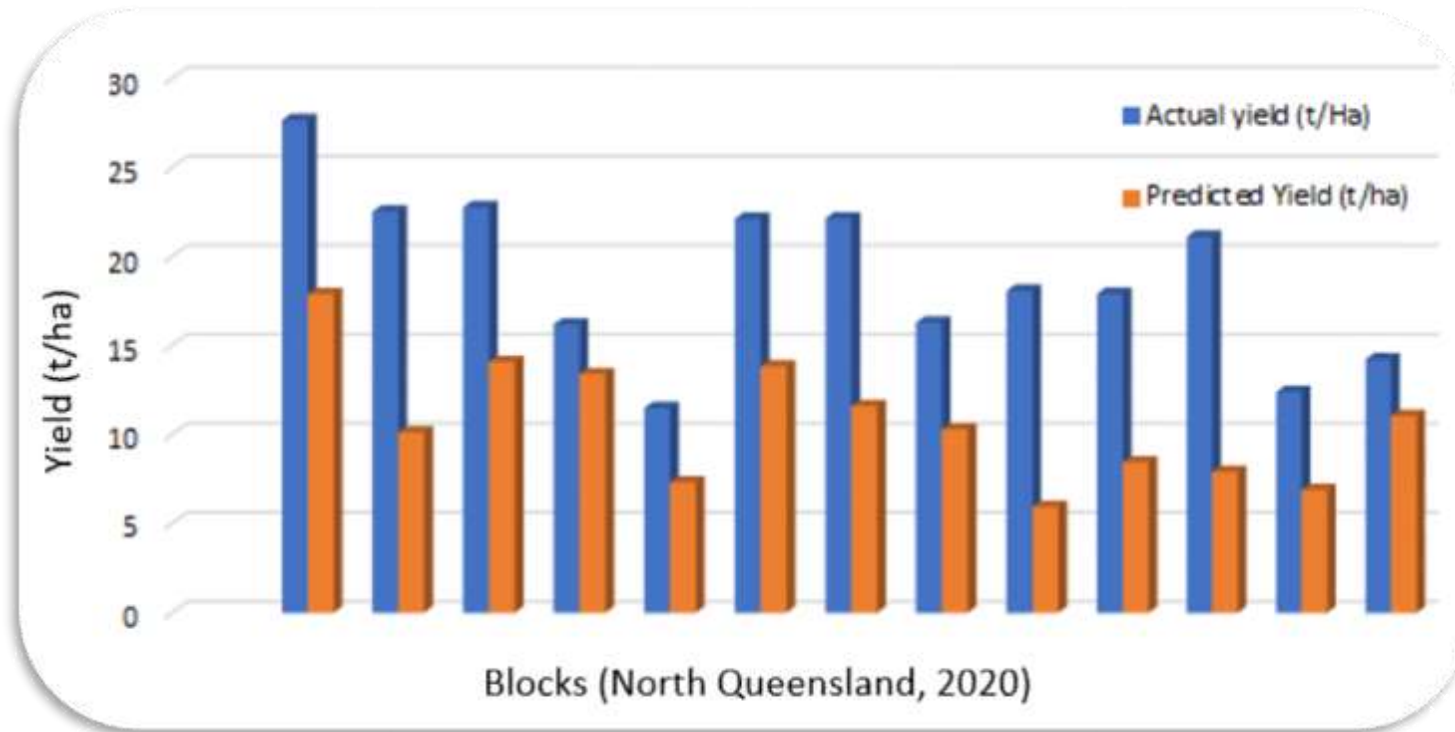


Blocks (Bundaberg)

Yield forecasting: 'Time-series' method



Not a silver bullet!

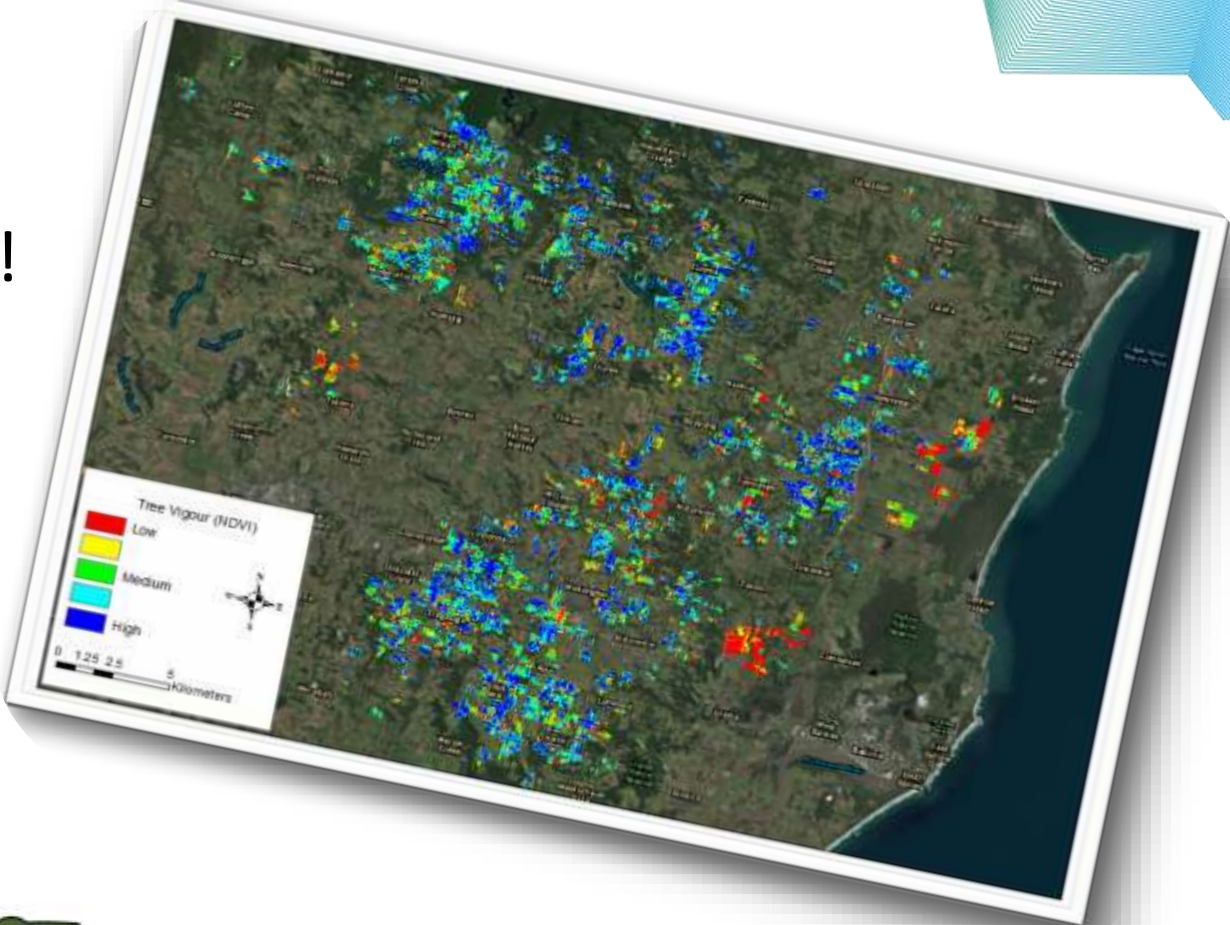


- Extremely high yielding year that exceeded any previous years in the model
- Biennial/ irregular bearing (very low years) currently a limitation, but we are working to better predict it 😊

Refer to Dr Moshir Rahman presentation

Next step:

Automated farm/regional/national scale mapping and forecasting for all!



Wrap Up:



- There are many promising AgTech options currently available to Avocado growers. However, it is the application that best dictates which is best suited...



- Only believe half of the hype, and **always** request actual evidence of prior adoption and/or validation...



- If it doesn't produce outputs that exceed commercial practice, is impractical or expensive to adopt, then don't use it...



- Future evolution of AgTech requires communication, collaboration and coordination between industry, researchers and commercial providers.

Acknowledgements

Thank you to New Zealand Avocado for the opportunity to present at this congress.

Also the Australian Government Department of Agriculture, Agriculture and Water, Horticulture Innovation and Avocado Australia for funding and supporting much of the research and the many participating growers and industry groups.

Thank you



@une_aarsc



www.une.edu.au/aarsc



AARSC

Applied Agricultural
Remote Sensing Centre



Questions?

