Precision Agriculture for Future Farm Systems

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Historical Perspective:

Soil Specific Management. 30 years ago.

Soil fertility, matching nutrient to crop needs.

2 Aspects to Consider:

Advanced Mechanisation

Precision Agronomy

Advanced Mechanisation

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Notable changes:

Autosteer, ISOBUS, Implement/Machinery control. (Spraying technology for example)

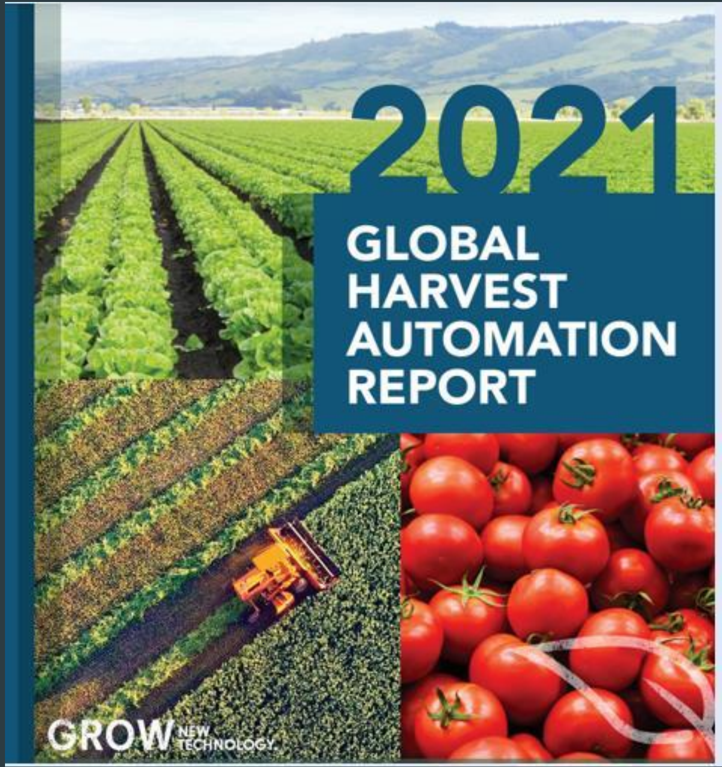
Precision Irrigation. Big efficiency gains in water use.

Autonomous Tractors

Advanced Mechanisation

The W.G CENTER for Innovation & Technology

2021 Global Harvest Automation Report



Advanced Mechanisation

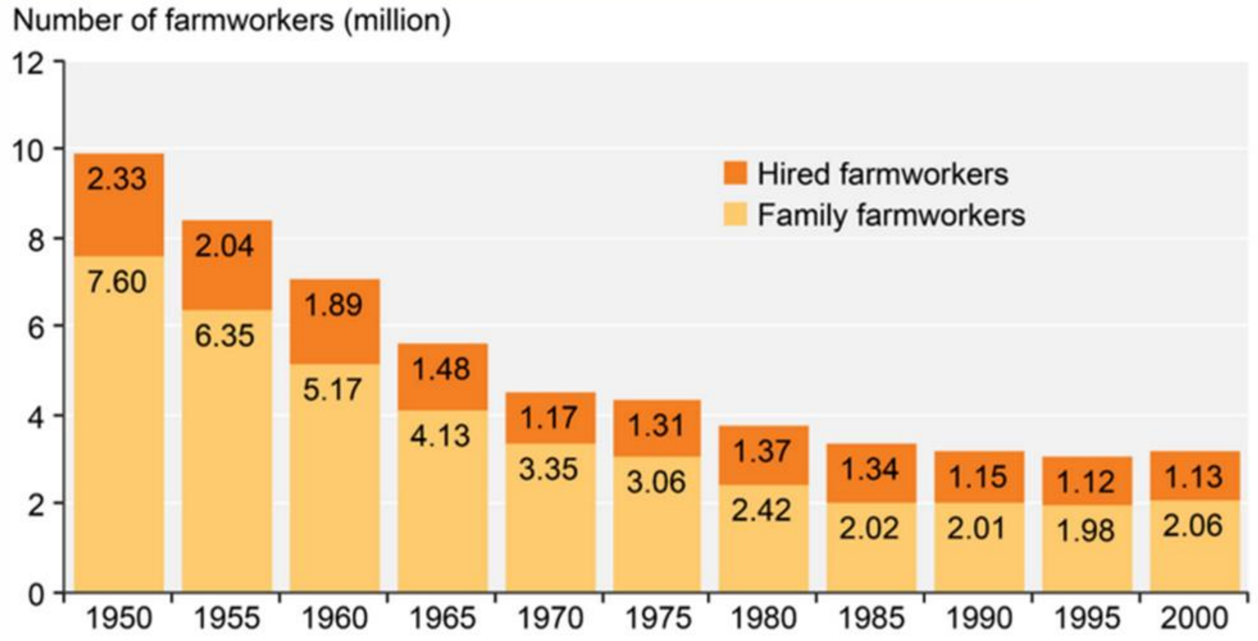
Traditional Drivers

Better work conditions. Easier working.
Better productivity, better timeliness.
Better quality,

Major driver is labour availability.
Domestic population increasingly disinterested.
Aging workforce. Less physically able.
Accelerated decline post Covid.

Added pressure on climate uncertainty.
- Crop quality, yield,
- Pest and disease challenges
- Operational timeliness etc.

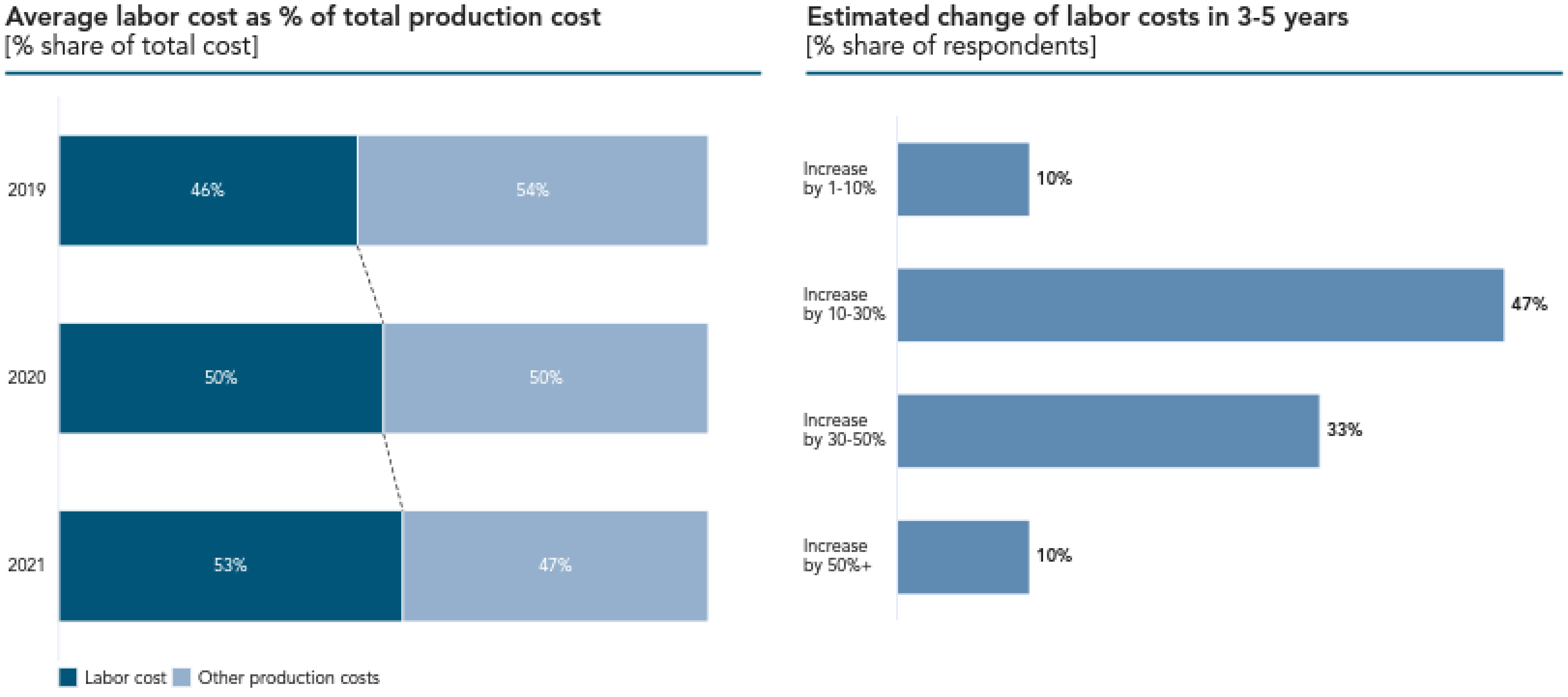
Family and hired farmworkers on U.S. farms, 1950-2000



Note: Family farmworkers include self-employed farmers and unpaid family members. Hired farmworkers include direct hires and agricultural service workers employed by farm labor contractors.
Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, Farm Labor Survey (FLS). The FLS stopped estimating the number of family farmworkers beginning in 2001. As of 2012, the survey no longer counts contracted agricultural service workers.

2021 Global Harvest Automation Report

SURVEY RESULTS SHOWED THAT AVERAGE LABOR COST SURPASSED ~50% OF TOTAL COSTS IN 2021, AND MOST GROWERS ANTICIPATE LABOR COSTS TO RISE BY 10-30% IN THE NEXT 3-5 YEARS



Source: Grower survey, Western Growers, Roland Berger

Figure 8 Historic and anticipated evolution of labor costs based on survey responses

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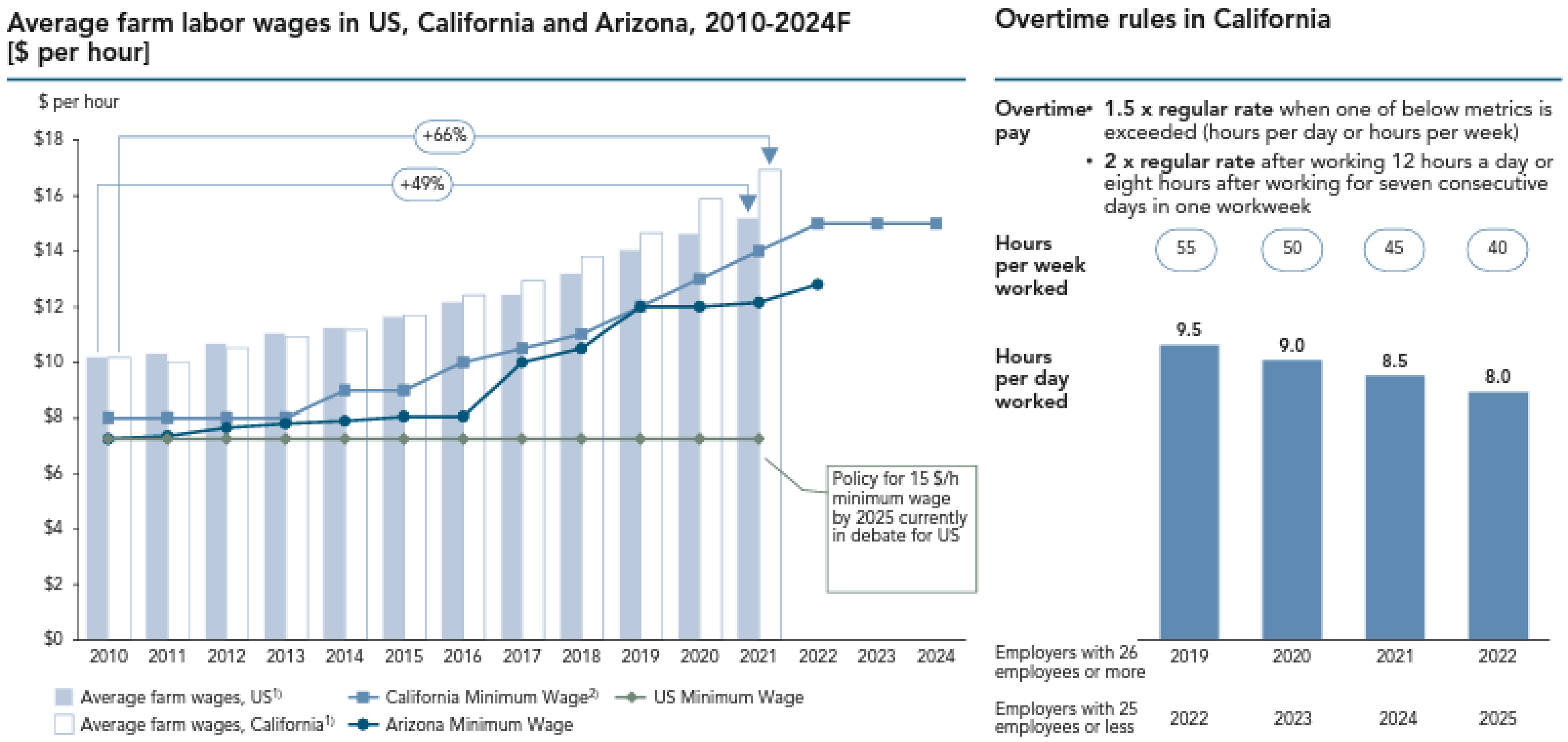
AVERAGE FARM LABOR WAGES IN CALIFORNIA HAVE RISEN BY 66% SINCE 2010 AND OVERTIME RULES ARE TIGHTENING



1) Only concerns field workers and not working in the livestock field
2) California minimum wage is taken for companies with over 26 employees; smaller company wages are lagging one year and reach USD 15 / h in 2023

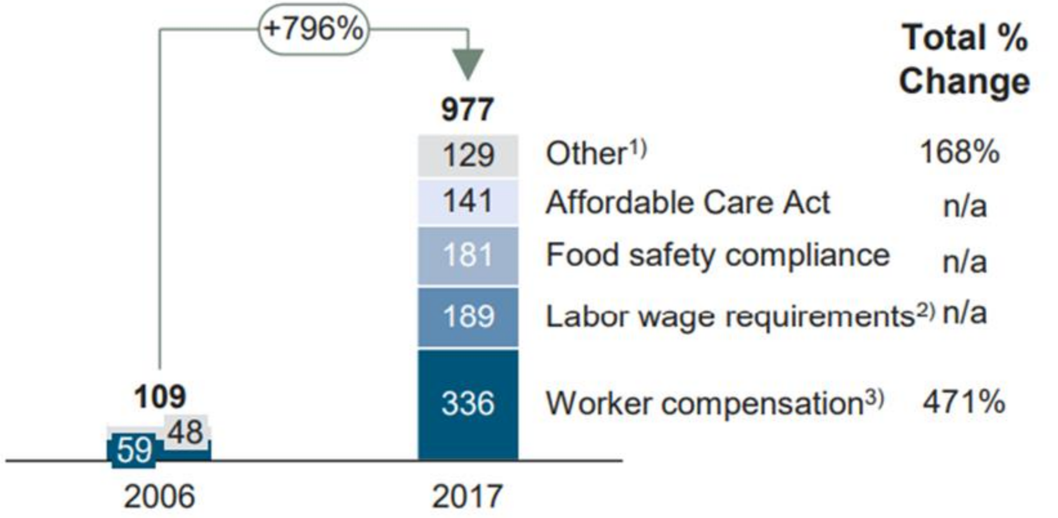
Source: USDA, Cal Poly, Trading Economics, Industrial Commission of Arizona, Roland Berger

Figure 7 Average U.S. and California farm labor cost evolution, 2010-2025 [$ per hour]

2021 Global Harvest Automation Report

A Decade of Change: A Case Study of Regulatory Compliance Costs in the Produce Industry (2018)

Regulatory Cost Changes for Salinas Valley Lettuce Grower, 2006 to 2017 [USD per acre]



Key Takeaways

- Assessment of regulatory costs for lettuce grower in California found that regulatory costs increased by 795% between 2006-2017, while total production costs increased by 25% over the observed period
- As a result, share of regulatory costs rose from approximately 1% to 9% of total production costs between 2006-2017
- Notable regulatory changes include food safety, air and water quality, labor health and safety, and worker compensation

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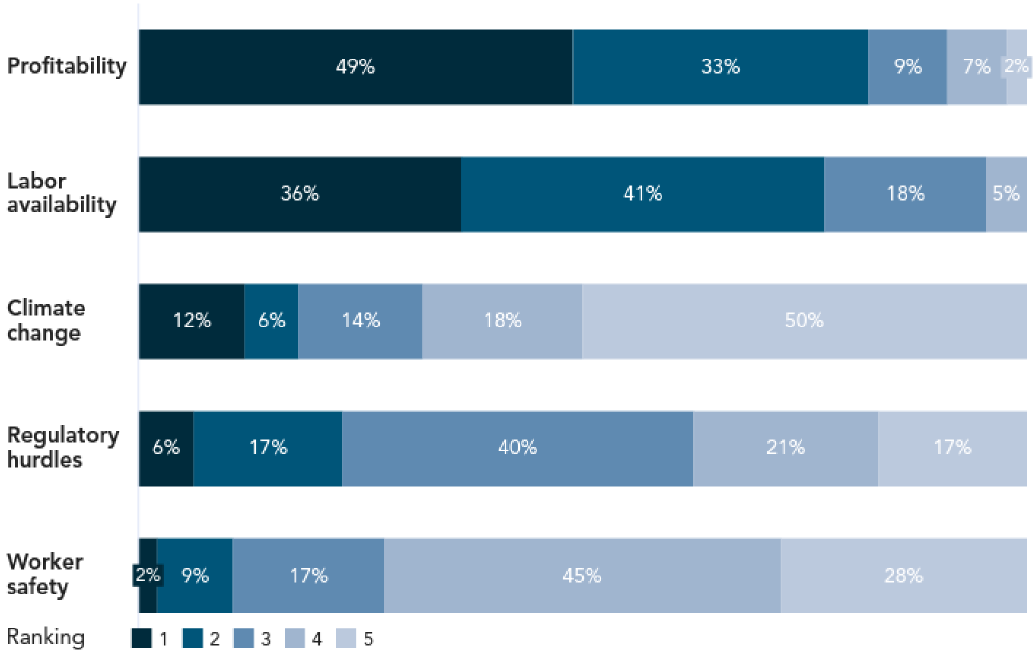
THE TOP 3 CHALLENGES IDENTIFIED BY SPECIALTY CROP GROWERS IN THE SURVEY ARE PROFITABILITY, LABOR AVAILABILITY AND CLIMATE CHANGE



1 = most important; 5 = least important

Source: Grower survey, Western Growers, Roland Berger

Figure 6 Ranking of industry challenges based on survey responses

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Achieving significant mechanisation advances

The W.G CENTER for Innovation & Technology

New Products/ startup requires $50 to 100M to build product and scale.
There are over 200 specialty crops.

The agricultural market is not well suited to Venture capitalist investment.
Off farm investment is much greater than on-farm or on-orchard.

Recent trends have been for larger AgTech companies to acquire innovation

CNH INDUSTRIAL Purchased RAVEN

JOHN DEERE Purchased BLUE RIVER TECHNOLOGY, BEAR FLAG ROBOTICS

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Precision Agronomy

Oversimplified model

Individual pieces of information overvalued.
Startups overvalued and take too long to get going.
They are not able to give comprehensive assistance.
Often add to fragmentation

Reality

Role of the farmer as an integrator grossly undervalued.

Complexity of farming not appreciated by many.

Precision Agronomy

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Is this closer to the reality of running a farm business?

Precision Agronomy

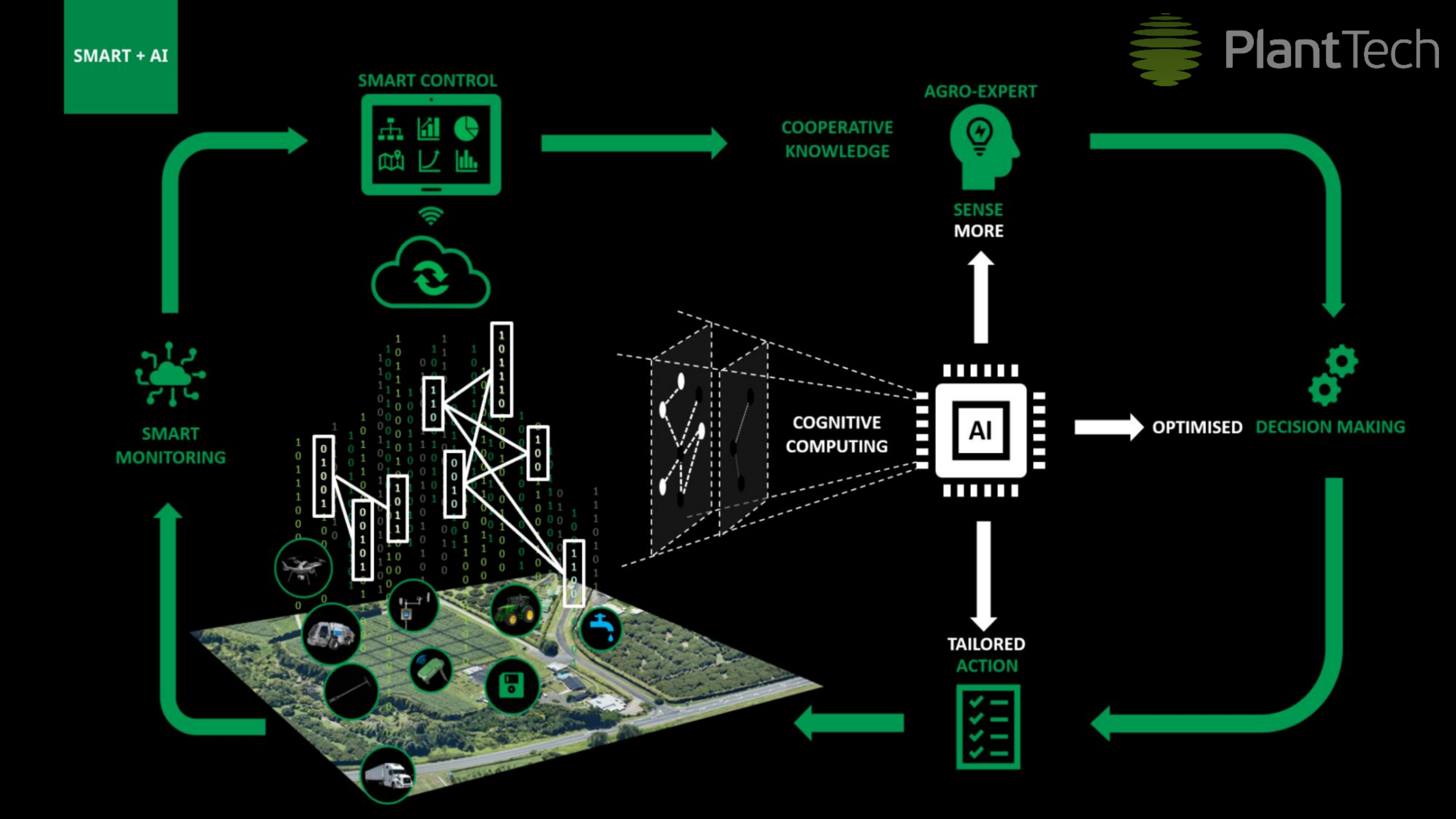
But!

Precision Agronomy new considerations

Increasing costs of production.
    Labour, Ag Chem, Fertiliser, Fuel & Equipment.

Climate variability.
    Further irrigation? Cropping patterns

Regulation.
    Market compliance.
    Nutrient, Waterways.
    Carbon.
    Labour.
    H&S.


SMART + AI
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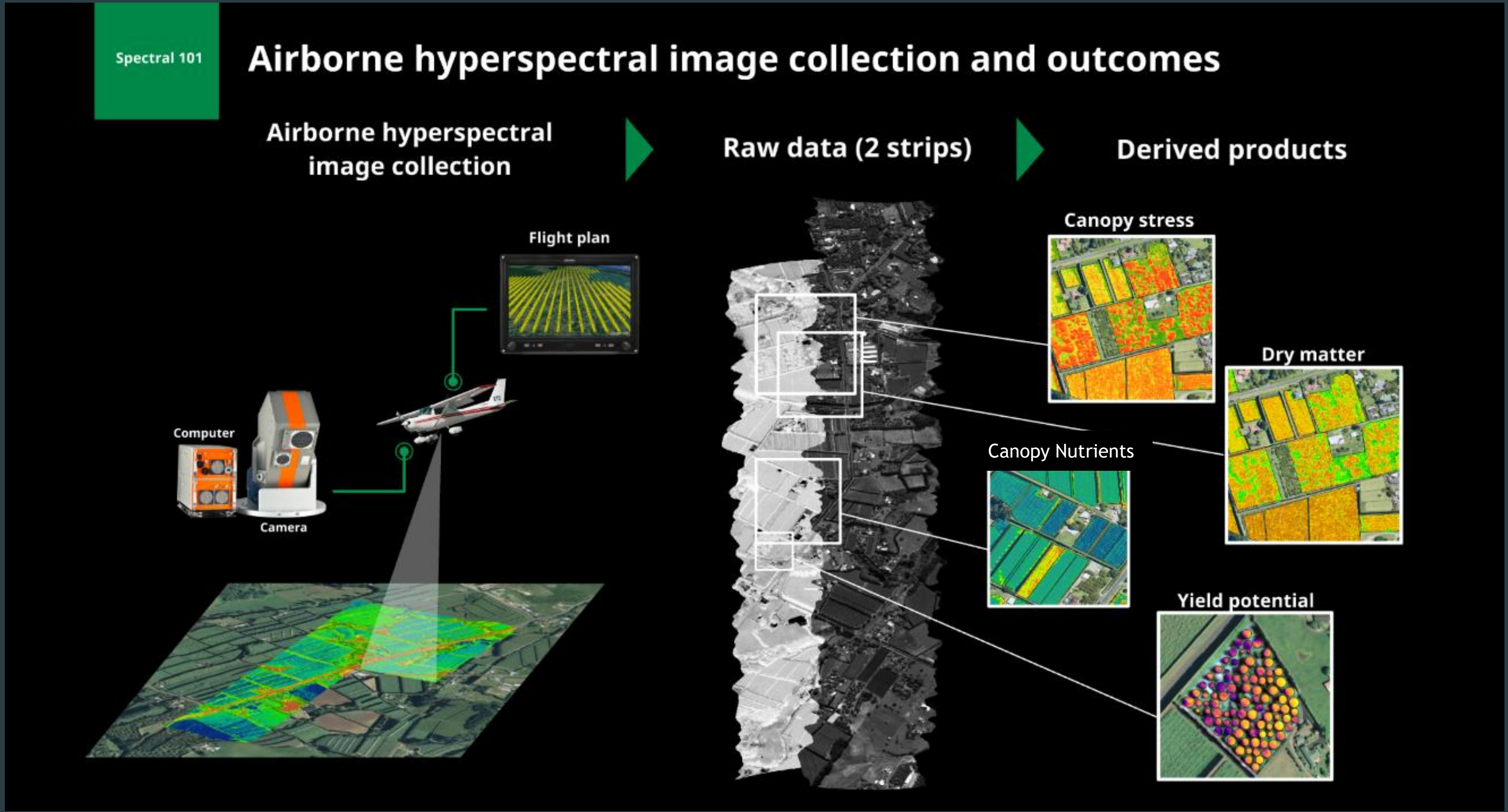
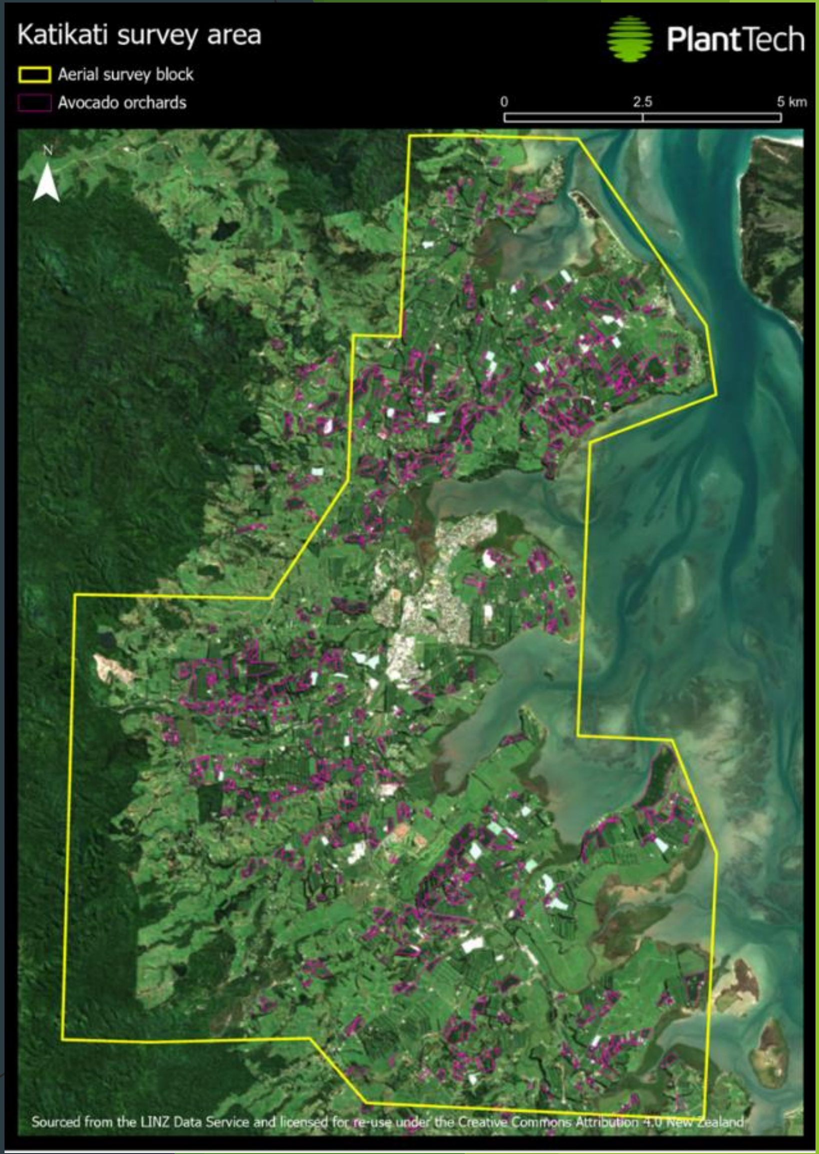
SMART CONTROL
COOPERATIVE
KNOWLEDGE
AGRO-EXPERT
SENSE
MORE
SMART
MONITORING
COGNITIVE
COMPUTING
AI
OPTIMISED
DECISION MAKING
TAILORED
ACTION





- Identify the following:
  - Biodiversity and highly detailed classification of vegetation.
  - Nutrient status of orchard and farm crops.
  - Potential for disease and stress recognition.
  - Whole of catchment monitoring.

Remote sensing and ground sampling
2021-2022 season

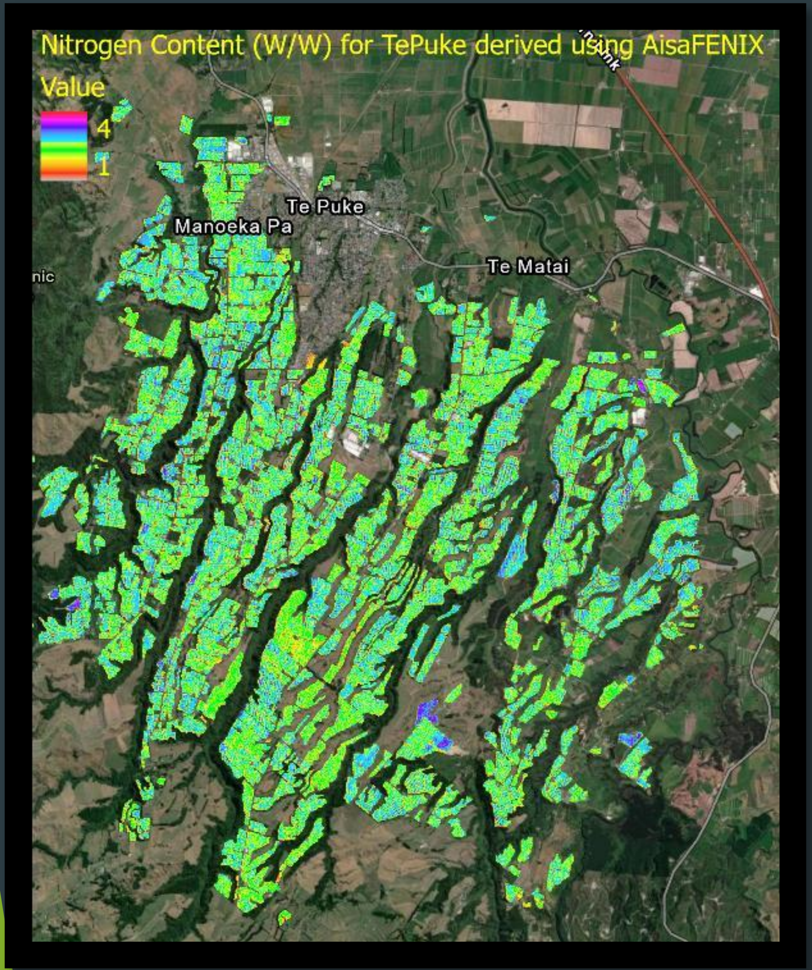
Nutrient	Result	Optimum Range	Low	Optimum	High
total nitrogen % w/w	2.85	2-2.7			
phosphorus % w/w	0.17	0.18-0.28			
potassium % w/w	1.70	1.9-2.5			
sulphur % w/w	0.29	0.31-0.43			
calcium % w/w	1.43	1.1-2.6			
magnesium % w/w	0.18	0.22-0.5			
sodium % w/w	<0.01	0-0.2			
iron mg/kg	86	50-148			
manganese mg/kg	33	34-112			
copper mg/kg	8.3	9-13			
zinc mg/kg	13	12-38			
boron mg/kg	24	24-32			

Remote Sensing

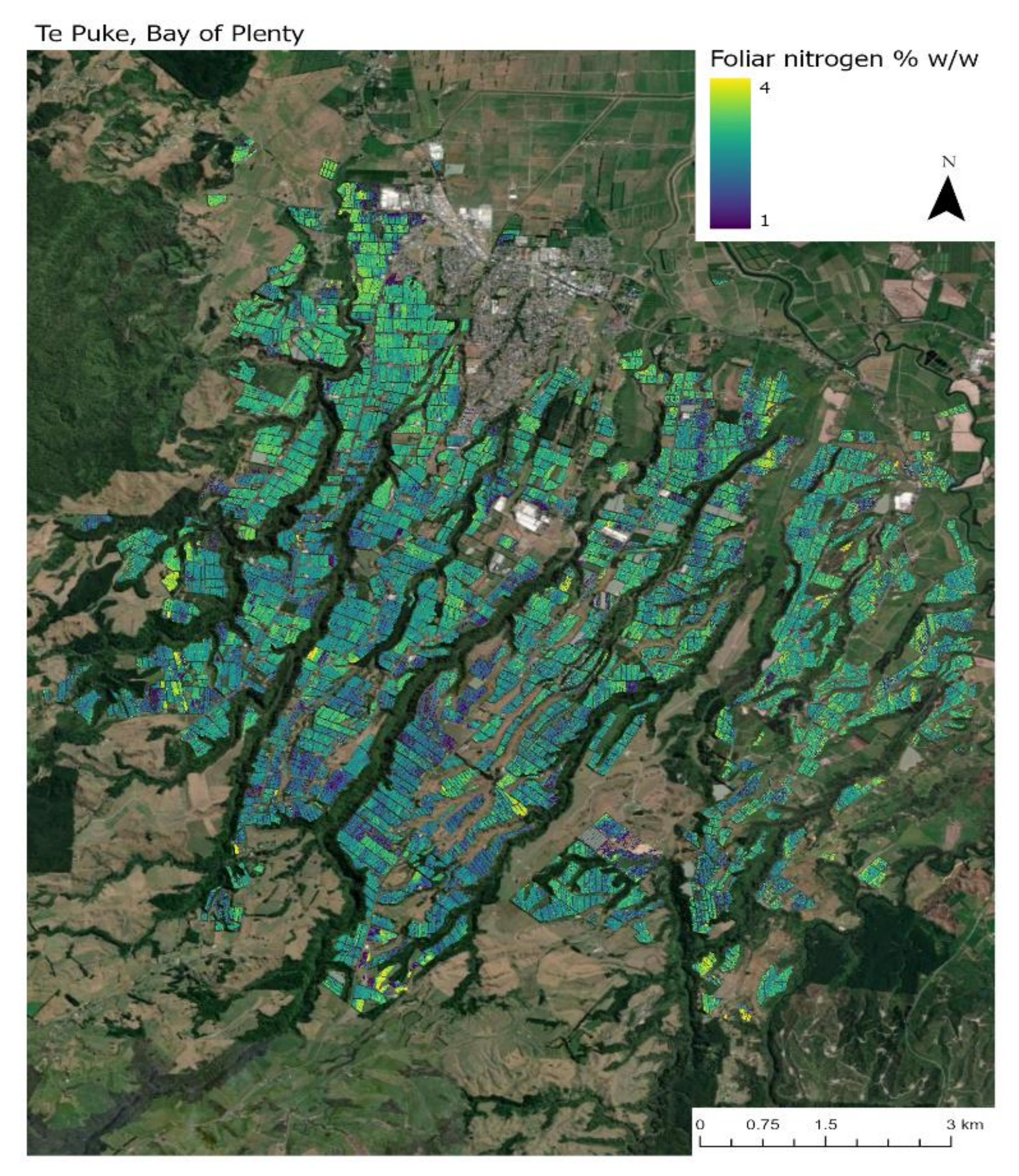
Surveys scheduled for early December and early March.

Production focus is on Apples, Kiwifruit and Avocado.

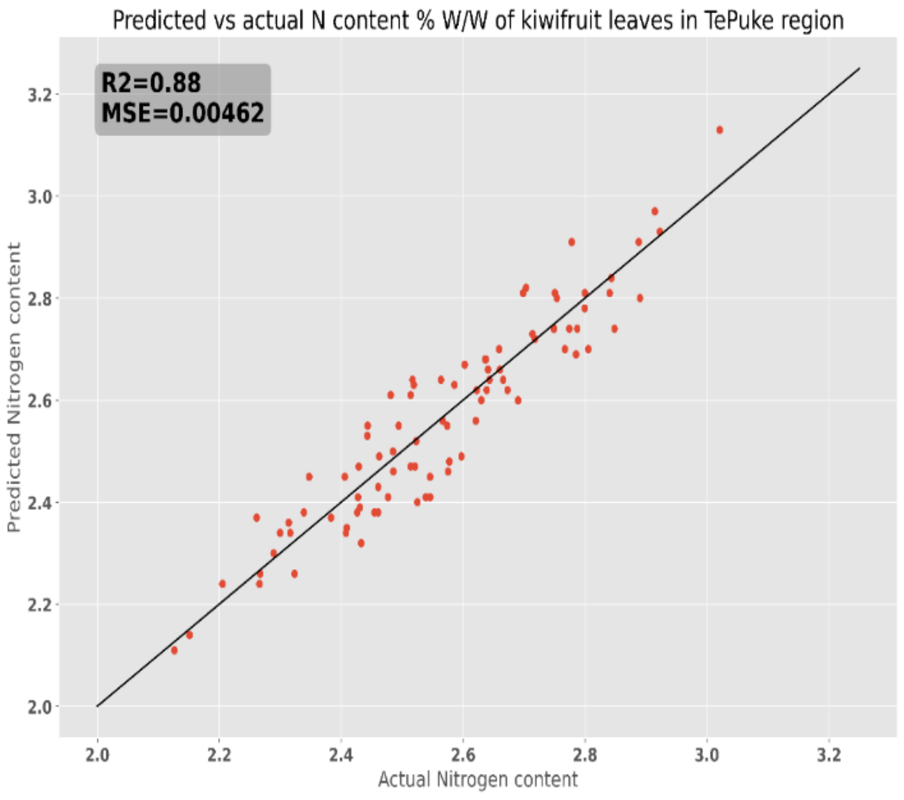
Looking to describe the biodiversity within the Katikati area in particular.



N prediction using machine learning - Hyperspectral data

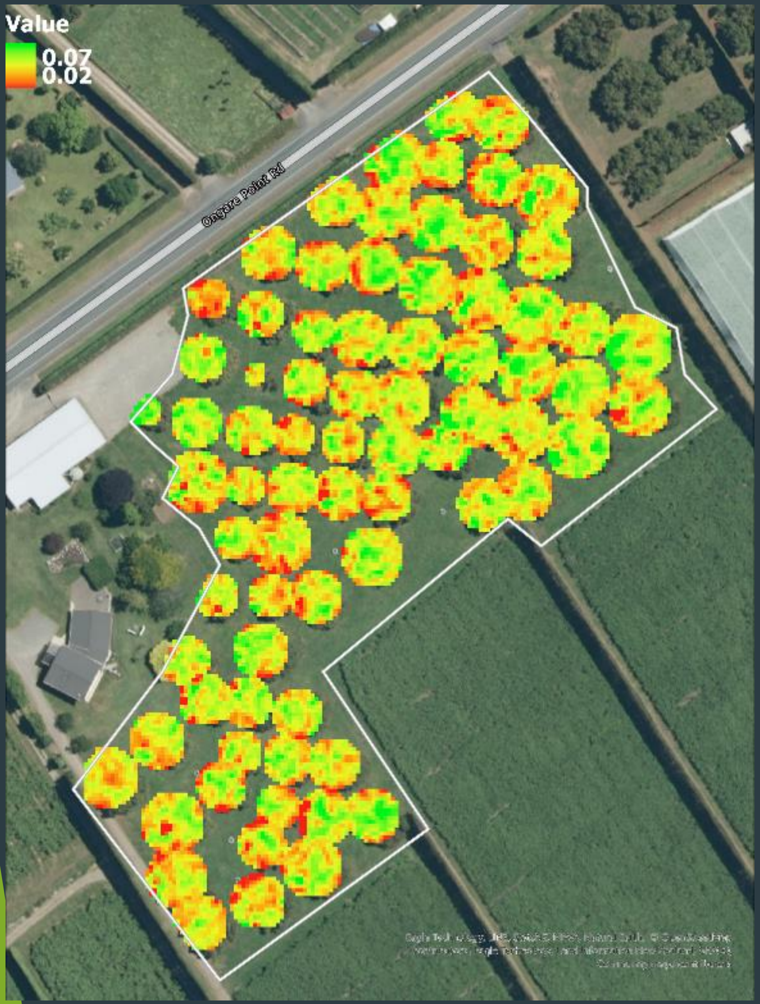


- Use of Hyperspectral imagery allows us to predict foliar macro and micro nutrient levels with high accuracy and with low uncertainty
- By knowing the nutrient levels it is possible to predict fruit quality, yield and disease.

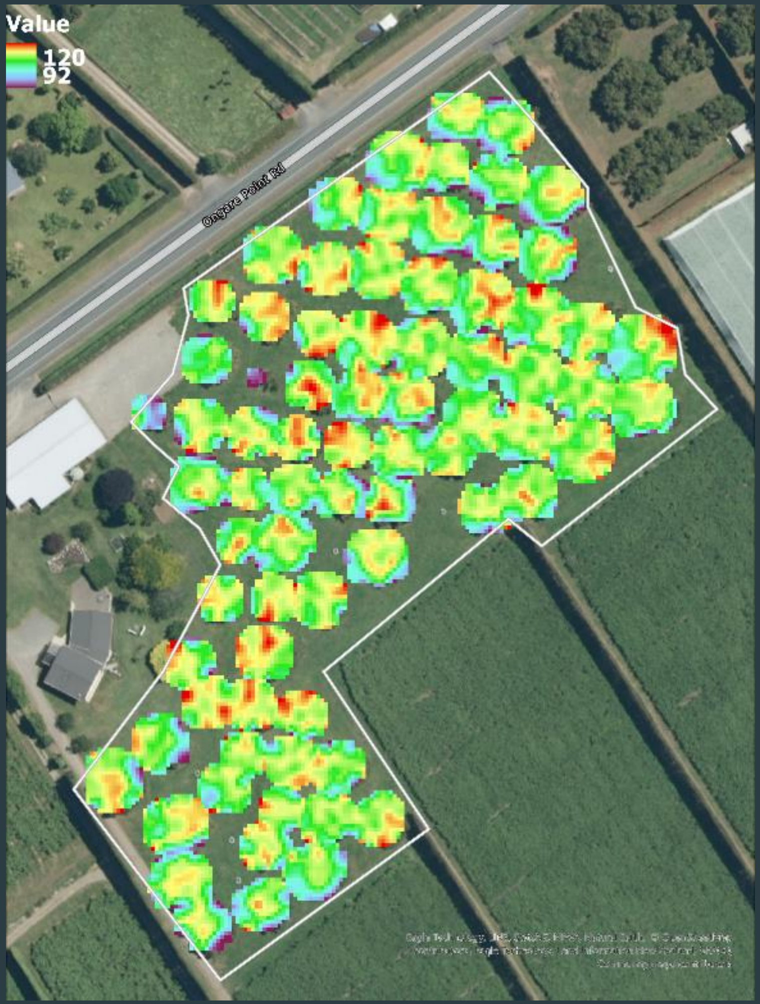


Monitoring individual Avocado tree characteristics

Equivalent water thickness ug/cm2

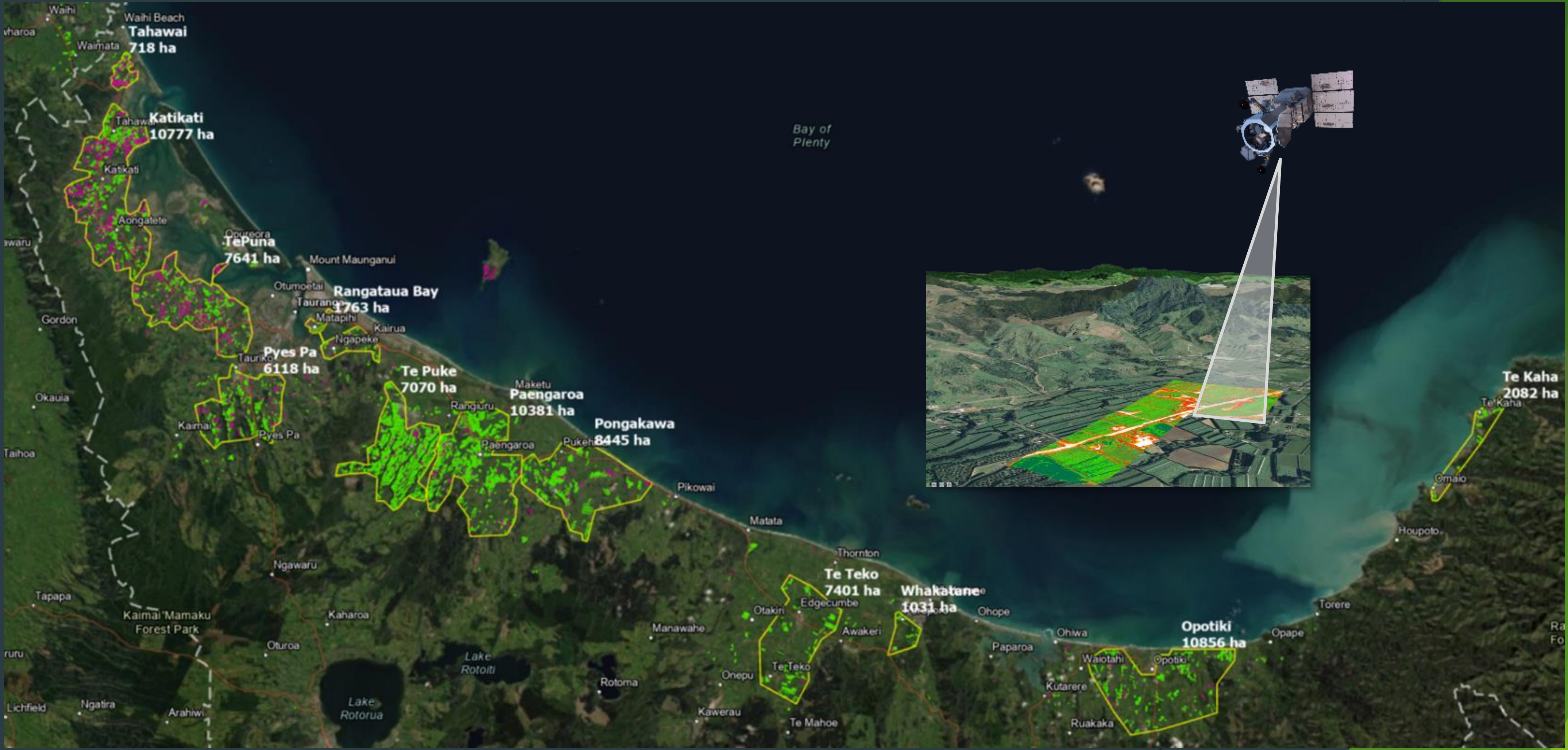


Chlorophyll ug/cm2



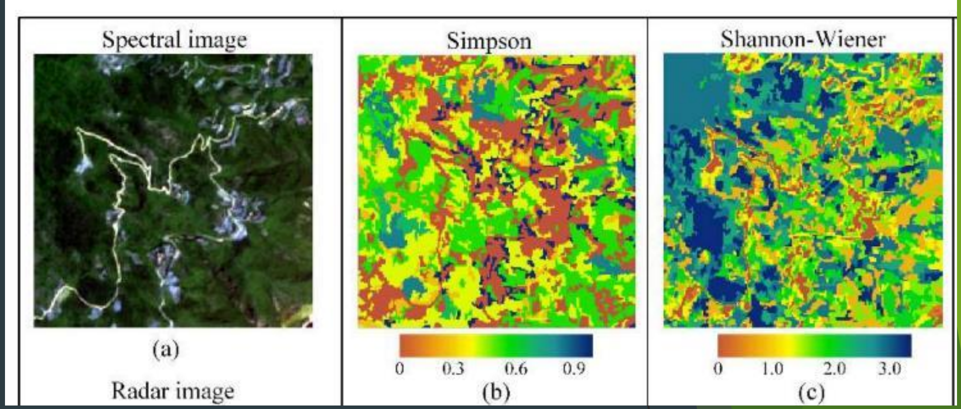
It is possible to monitor biophysical and biochemical characteristics of each individual tree

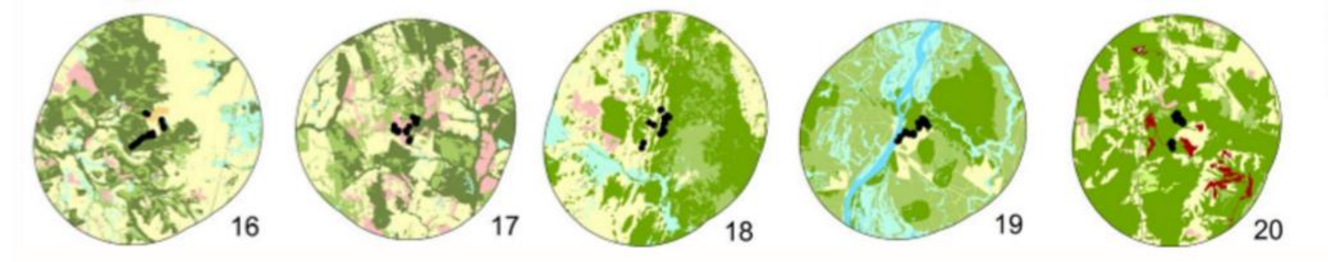
Kiwifruit and Avocado Orchards Bay Of Plenty

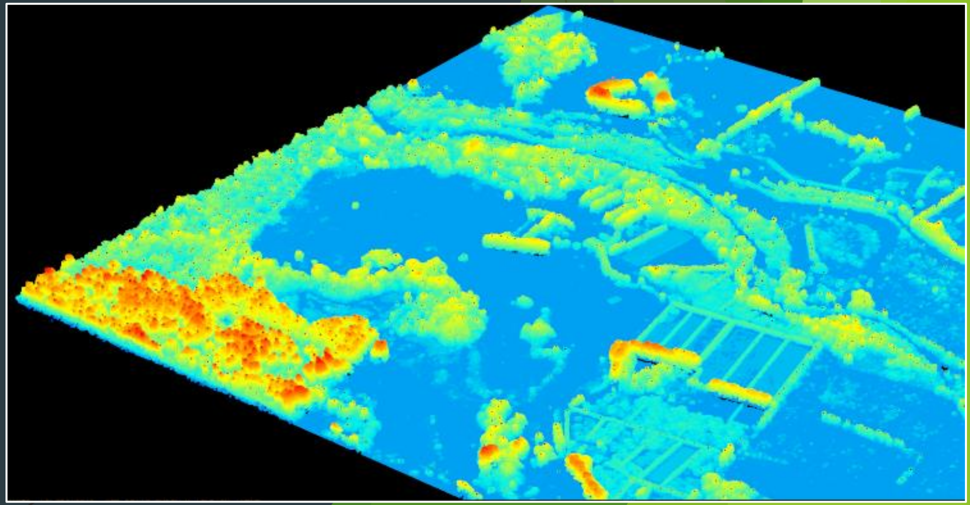


Remote sensing biodiversity indices

- Land use
  - Heterogeneity
  - Relative abundance
- Spectral diversity
  - Species diversity
- Lidar
  - Canopy cover
  - Carbon sequestration
  - Leaf area index
  - Primary production







Describing our environment: Carbon Sequestration and Biodiversity

Conclusions

Many challenges ahead.

How do we create opportunities to do the following?

How do we make life easier?

Trying to reduce complexity and allow others to appreciate existing complexity.

Integration of data and systems.

How do we make sure data is respected?

Data being permissioned through better agreements.

Understand the real value of data.

Consistent advice.

How do we make sure data is timely and fit for purpose?