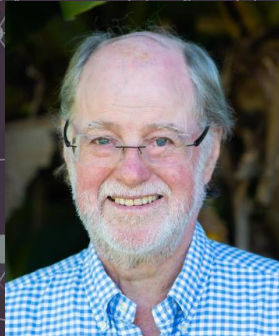


# Queensland Future Conversations: *Protecting Agriculture through Innovation and Science*

October 11, Speakers' Hall, Queensland Parliament House, Brisbane.



MC: Professor  
Rebecca Ford



Distinguished Professor  
James Dale, AC FTSE



Associate Professor  
Shahla Hosseini  
Bai



Dr Narelle Manzie

Queensland Future Conversations



# A safety net for the world's banana production

D/Prof James Dale

Queensland Future Conversations



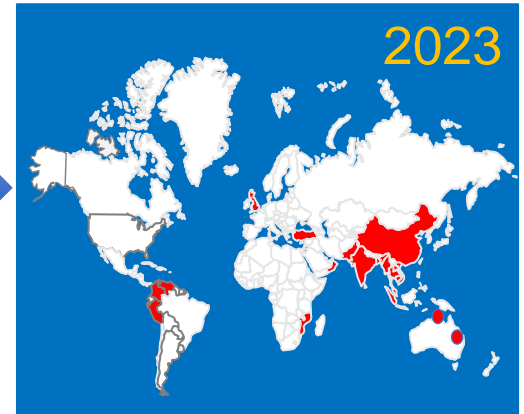
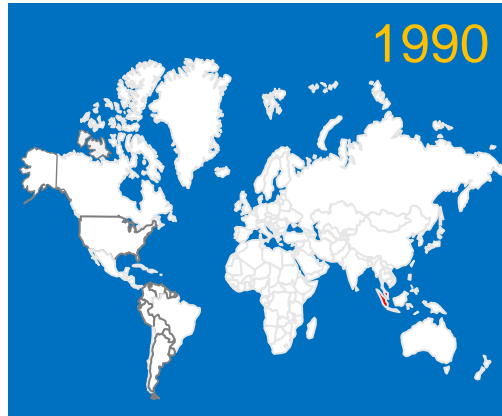
# About bananas

- Top 10 world food crops (usually 5<sup>th</sup> or 6<sup>th</sup>)
- Dessert bananas, cooking bananas & plantains
- >1,000 varieties and landraces **but** >50% of bananas grown in the world are just one type, Cavendish
- Bananas are vegetatively propagated, grown from suckers not seeds
- The vast majority of bananas are selections from “the wild” not bred
- Banana production is under massive threat from diseases



# “Banangeddon”: Panama Disease tropical race 4

- Panama Disease tropical race 4 (TR4) is a soil borne fungus that kills most bananas including Cavendish
- It is devastating banana production in many countries, it’s on the move and is spreading in Australia



# The solution: TR4 resistant Cavendish (+ others)

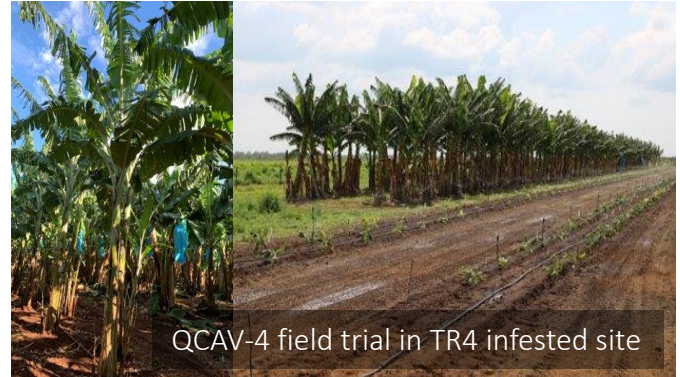
- QUT has transferred a resistance gene from a wild resistant banana to Cavendish bananas by genetic modification
- GM lines of Cavendish were field trialled in the Northern Territory

*Musa acuminata* ssp  
*malaccensis*



Single resistance gene  
RGA2

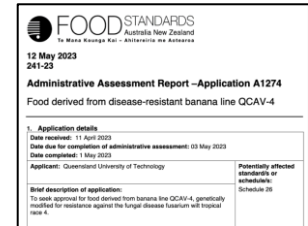
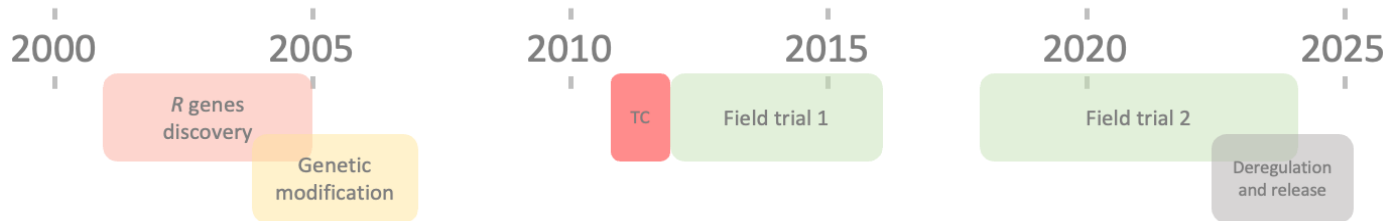
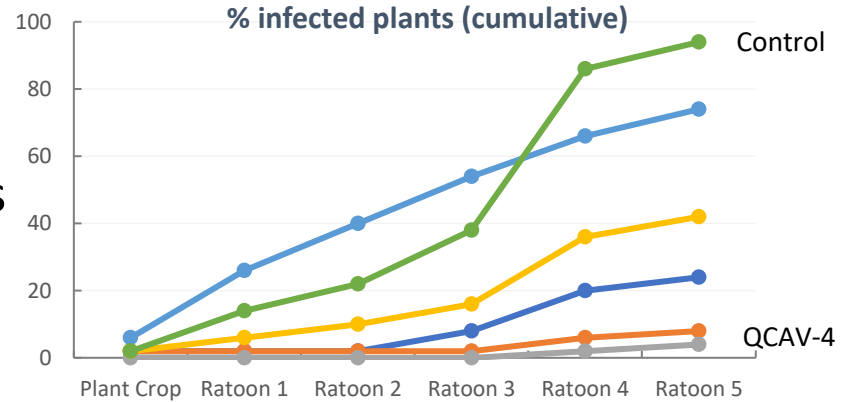
Cavendish





# QCAV-4: a GM Cavendish banana “immune” to TR4

- After 6 years of field trial QCAV-4 is nearly immune to TR4
- The yield of QCAV-4 is the same as normal Cavendish
- We have now applied for commercial release in Australia



### 3 Key Takeaways

- *QCAV-4 is likely to be the first GM banana released in the world and the first GM fresh fruit in Australia*
- *QCAV-4 is our safety net if TR4 becomes devastating in Australia with potential for export*
- *With climate change, a burgeoning world population and globalisation, we will need all the tools available to meet the food demands of the future*



James Dale

Queensland University of Technology

[j.dale@qut.edu.au](mailto:j.dale@qut.edu.au)

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# RNA based biopesticides for sustainable crop protection

Dr Narelle Manzie

Mitter Lab

Prof Neena Mitter, FTSE, NAAS  
Director, Centre for Horticultural Science,  
Director ARC Research Hub for Sustainable Crop protection

QAAFI, The University of Queensland, Australia

[n.mitter@uq.edu.au](mailto:n.mitter@uq.edu.au)

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**EU Target: 50% reduction in chemical pesticides by 2030**

**In USA: 100,009, 000 kg of insecticides/annum sprayed on food crops = 228 fully loaded jumbo jets**

**In 2022, >8000 pesticides on the Australian market, divided between commercial farming use (75%) and domestic or urban use (25%)<sup>1</sup>.**

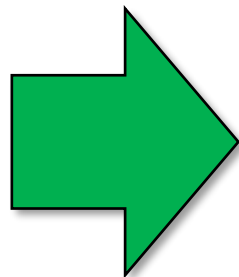
### **PESTICIDES:**

- **RESIDUE**
- **RESISTANCE**
- **RUNOFF**
- **LACK OF SPECIFICITY**
- **NEW CHEMICALS**

1. <https://www.ncrsepa.org/pesticide-use-in-australia>

# RNA interference for Crop protection

Can we deliver RNA as a topical application or 'RNA vaccines for plants' instead of genetically modifying the plant?





No  
residue?

Environmentall  
y friendly?

Stabilise?

Rain  
protection?

## How do we make RNA based biopesticides a viable system for growers?

Easy  
adoption?

Non toxic?

Adhere to  
leaf  
surface?

### Naked RNA sprays

- Unstable
- Easily washed off
- Short protection window



# RNA based Biopesticides - BioClay™

Double Stranded RNA as the biological active ingredient

Clay particles as carriers of the active

## Inventors

Prof. Neena Mitter

Prof. Gordon Xu

Prof. Max Lu

BILL & MELINDA  
GATES foundation

 **SPECIFIC**

 **STABLE**

  
 **SUSTAINABLE**

 **Non-GM**

**No Residue**

Queensland Innovation





# What is BioClay?

Inert biodegradable clay (Mg Fe) particles to deliver RNA

- Applied as a spray application without the need to alter the plant genome
- Clay layers degrade naturally leaving no residue
- Extended stability and slow release of dsRNA on plant surface

**Double stranded RNA of the pest or pathogen is used to kill the pathogen itself – Nature vs Nature**

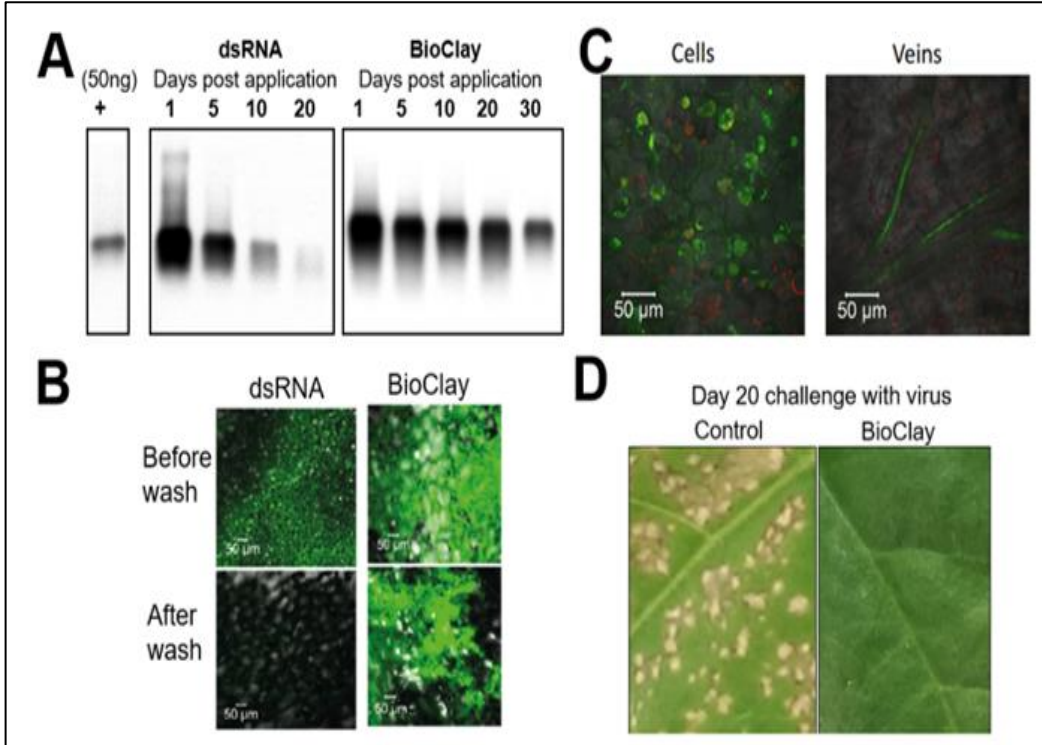


# BioClay- Evidence of Success

Mitter et al, Nature Plants 2017



Dr Worrall and Dr Robinson



A – BioClay dsRNA survives on leaves even after 30 days of spray

B – BioClay does not get washed off

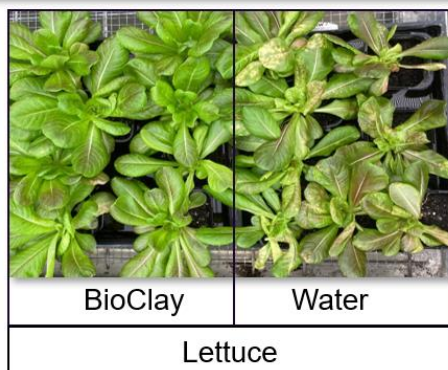
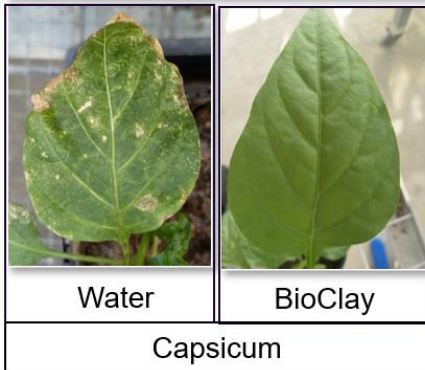
C – The sprayed dsRNA can enter into the plant system

D – The sprayed leaves are protected from virus even after 20 days of spray

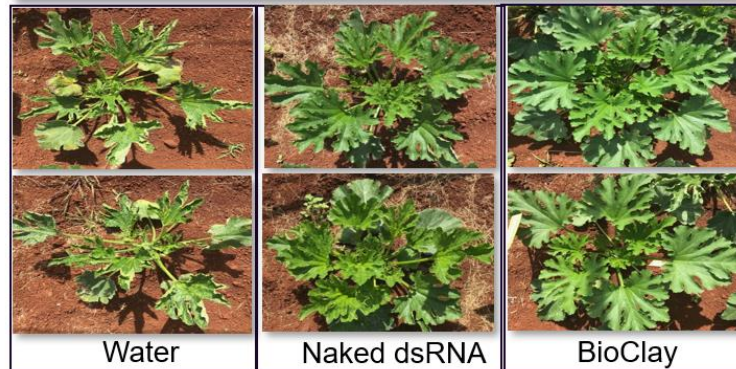
# BioClay™ - Evidence of Success

## Viruses

### Tomato spotted wilt virus



### Zucchini Yellow Mosaic Virus

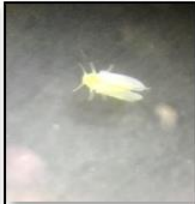


# BioClay™ - Evidence of Success

## Whitefly



BioClay  
Dead



Live

## Botrytis



BioClay



Naked dsRNA



Water

Chickpea

## Rust



Water



Naked dsRNA



# BioClay for control of Fungal diseases

Australian Research Council Research Hub for Sustainable Crop Protection - **QUEENSLAND LEAD**

- Targeting Fungal Diseases
- ~\$18 million cash and in-kind
- Universities, multiple RDCs, State Governments



By controlling fungal plant diseases, farmers can save **125 M TONS** of **FOOD** each year - enough to **FEED 600 MILLION PEOPLE!**

<https://www.croplife.org.au>





# The Research Hub process - Translation



IDENTIFY & DESIGN



SYNTHESISE



LABORATORY



GLASSHOUSE



FIELD



BIOCLAY PRODUCT



REGISTRATION

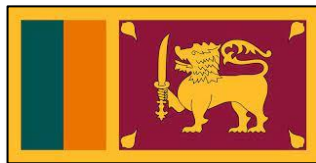
SOCIAL LICENSING

↑ MECHANISM ↑

↑ SCALE UP ↑

\$17 Million – Australian Research Council

<https://crophub.com.au/>



54 team members  
18 Nationalities, 10 Post Docs, 8 PhD  
50% gender balance

# Risks to the environment - persistence

- Non-formulated dsRNA rapidly degrades in the environment, presenting few risks related to persistence
- No basis for concentration of topically-applied dsRNA in higher organisms in the food chain (FASANZ)



Front. Plant Sci., 12 February 2020

## A Perspective on RNAi-Based Biopesticides

[Stephen Fletcher](#)<sup>1</sup>, [Philip Reeves](#)<sup>2</sup>, [Bao Tram Hoang](#)<sup>1</sup> and [Neena Mitter](#)<sup>1\*</sup>

<sup>1</sup>University of Queensland, Saint Lucia, QLD, Australia

# Trade and Markets – addressing the issue of maximum residue limits (MRLs)

- Short or nil withholding periods (set to allow chemical residues in edible commodities for domestic markets)
- Short or nil export intervals (to satisfy the standards imposed by overseas trading partners)

# Not GMO technology

On 8<sup>th</sup> October 2019 the Australian Parliament formally agreed with the Office of the Gene Technology Regulator's (OGTR) proposal that topically-applied dsRNA be exempt from GMO regulations



## Gene Technology Amendment (2019 Measures No. 1) Regulations 2019

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### 24 Schedule 1A (at the end of the table)

Add:

- 11 Introduction of RNA into an organism, if:
  - (a) the RNA cannot be translated into a polypeptide; and
  - (b) the introduction of the RNA cannot result in an alteration of the organism's genome sequence; and
  - (c) the introduction of the RNA cannot give rise to an infectious agent.

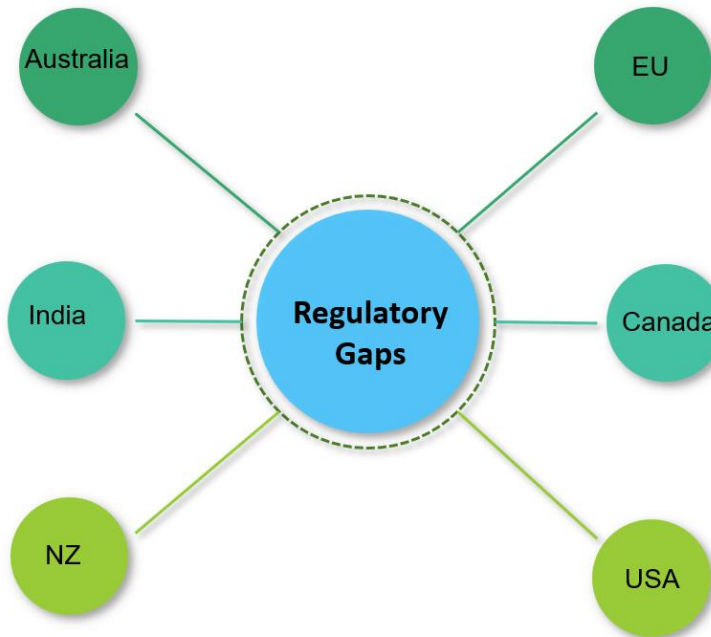


# Regulatory Status: Country specific findings 'not-fit-for-purpose'

**Decision made.** Non-transformative RNAi technologies are not considered as gene technology under existing legislation, and thus require reduced criteria for assessment (however, this remains untested).

**Unclear.** Process-based system may be suitable for RNAi technologies.

**Decision made.** Non-transformative RNAi technologies would not fall under existing legislation



**Current Status.** Regulation falls under existing chemical pesticide regulation and risk assessment is unlikely to be fit for purpose.

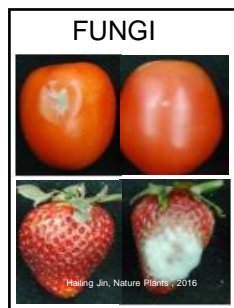
**No explicit decision made.** Relating to non-transformative RNAi technologies, however assessments made expect it to easily allow for these technologies when required.

**Partially considered by existing regulation.** Potential precedent being set relating to bioinformatics risk assessments for transformative GM technologies.

# Endless possibilities

Queensland owned  
and invented  
Innovation aimed at  
contributing to the  
supermarket trolley

Design of  
regulation and  
public  
opinion are  
crucial



# RNA for Ag Initiative – Support needed

## For Queensland and Australia as Global Leaders

- **dsRNA manufacturing**, niche space for research and commercial scale supply – Ag RNA different from vaccine mRNA
- **RNA biology and innovation** – Addressing climate change, desired endogenous traits and more
- **Partnerships** - Government, industry, academia, growers, end users and communities under one umbrella
- **Adoption and translation** - Policy, Regulation and Communication

- Reducing pesticide emissions
- Biosecurity, Climate resilience
- Crop and animal health and much more
- Facilitating Trade and exports
- Food and Nutritional security



**Dr Narelle Manzie** | Science Research Manager,  
ARC Research Hub for Sustainable Crop protection  
Queensland Alliance for Agriculture and Food  
Innovation

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[qaafi.uq.edu.au](http://qaafi.uq.edu.au)

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# Machine vision Agriculture of the future

Associate Professor  
Shahla Hosseini-Bai

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# Food waste

Loss of \$36 billion/year<sup>1</sup> - Australia

Loss of \$2,500/year – each household<sup>2</sup>

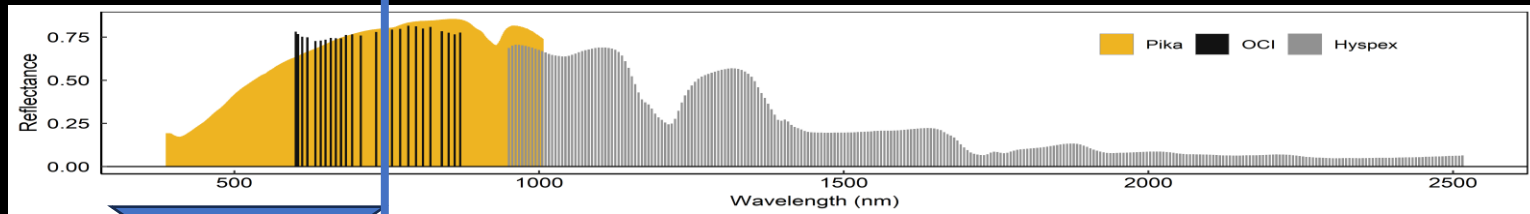
**What is the solution?**

We are developing new AI tools

1: <https://www.foodbank.org.au/food-waste-facts-in-australia/?state=qld>

2: FIAL (2021). National Food Waste Strategy Feasibility Study

# Machine vision is more powerful than our eyes



Our eyes can see up to here

Machine can see and separate bad nuts

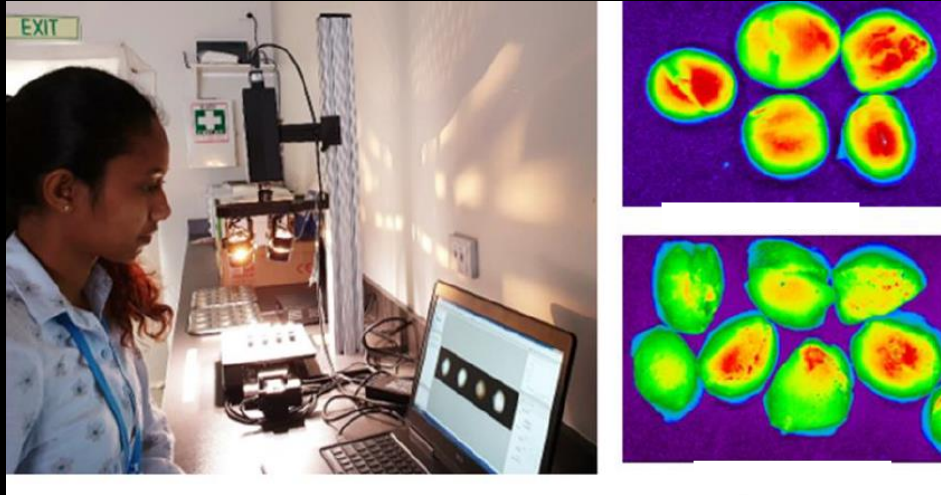
Saving \$2million/year in nut loss

Funded by

Advance Queensland Industry Fellowship

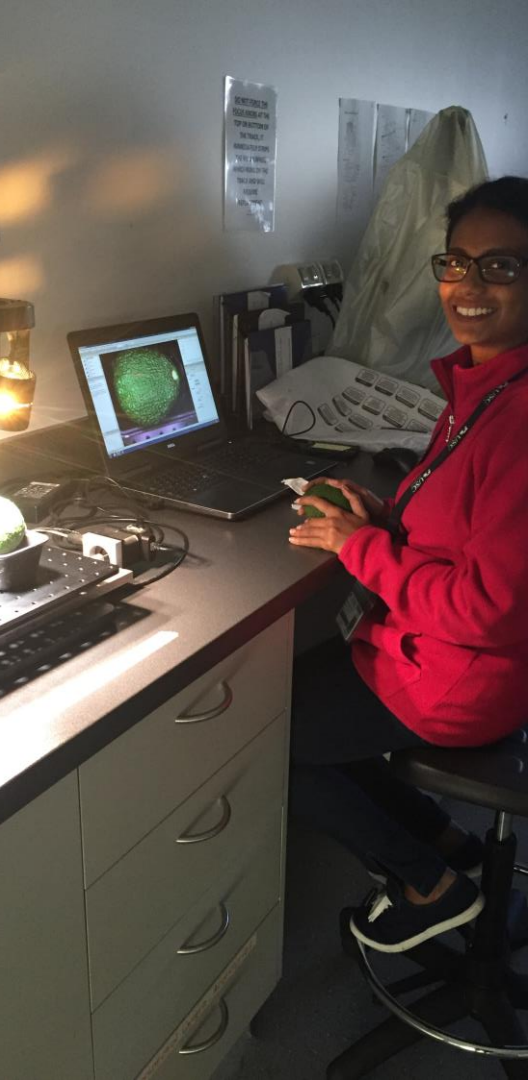
Queensland processors – Bundaberg  
Griffith University

Now being trialed in macadamia



Good nut

Bad nut



Being trialed in  
avocado

**Our machine vision  
can tell exactly  
how long until an  
avocado is ripe**







## Other applications

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- How much carbon is in the soil?
- When to apply fertilisers to crops?



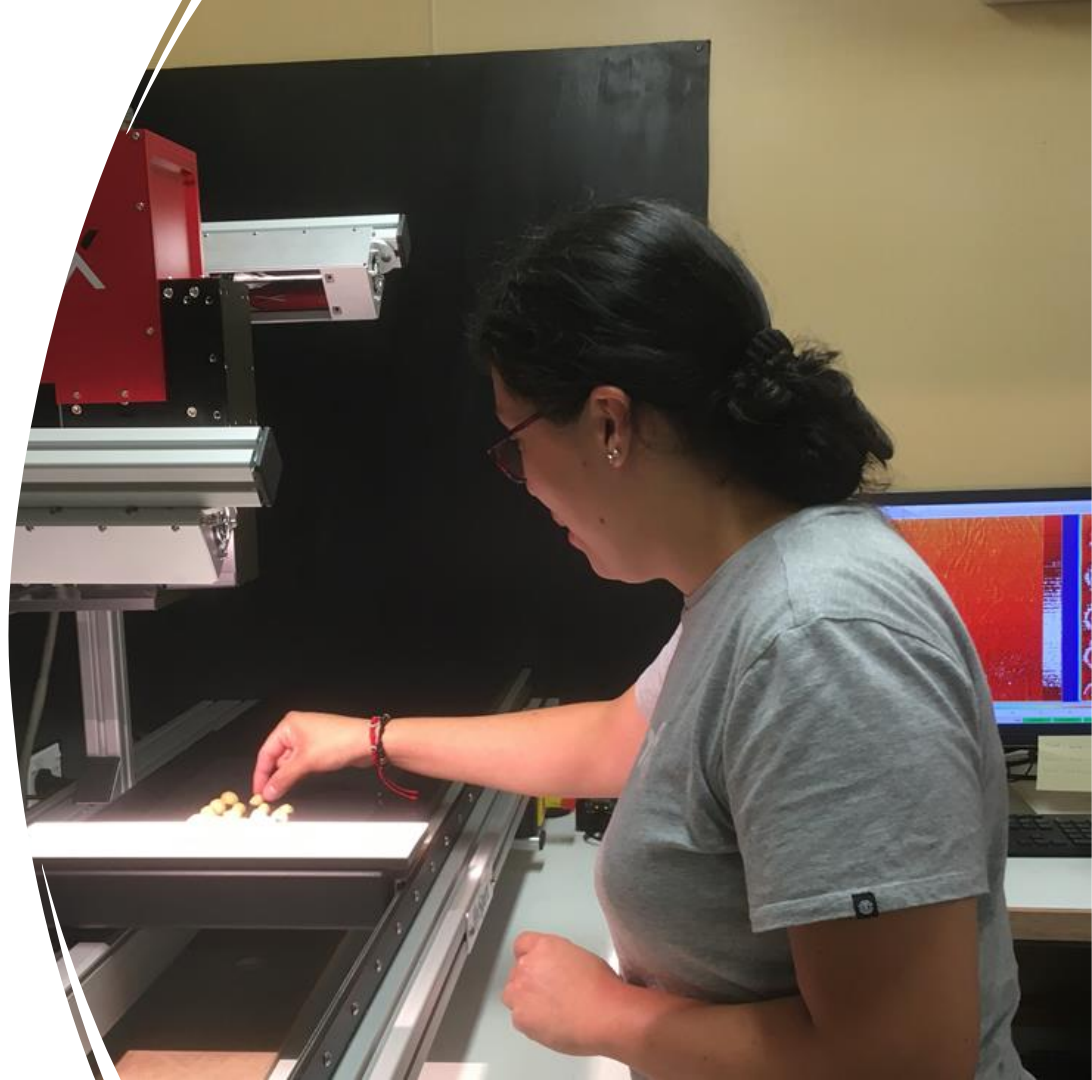


# Can't afford to be left behind!

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For the jobs of the future, we need to invest in

- Advancing AI for automation
- Developing machine vision technologies for food and agriculture
- Commercialising these technologies for food and agriculture





**Associate Professor  
Shahla Hosseini Bai**  
email: [s.hosseini-  
bai@griffith.edu.au](mailto:s.hosseini-bai@griffith.edu.au)

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# Expert Q&A



Distinguished  
Professor James  
Dale, AC FTSE



Associate Professor  
Shahla Hosseini Bai



Dr Narelle  
Manzie

Queensland Future Conversations

# Thank You

Researcher biographies and slides can be found here:



Dates for the 2024 Queensland Future Conversations will be released shortly

Queensland Future Conversations

