

# Innovating Avocado

## *From Lab to Orchard and Beyond*

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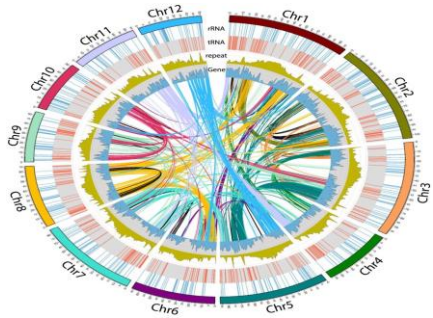


Mitter Lab: Innovating Avocado  
We love Challenges.... We love Avocado...

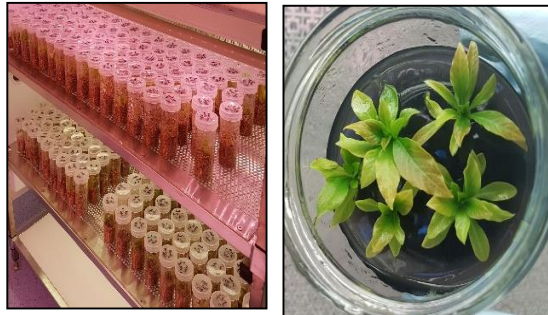
# Innovating Avocado – The list keeps on growing...



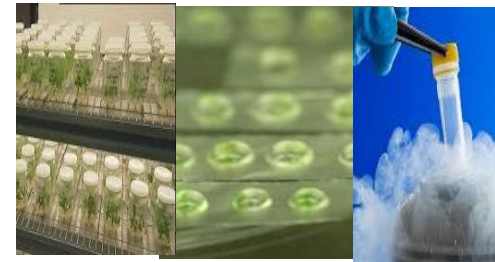
## Avocado genomics



## Propagation



## Cryopreservation



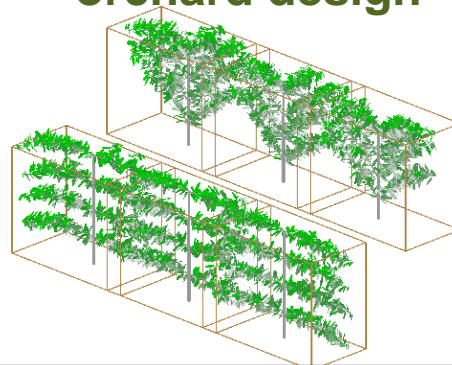
## BioClay-Phytophthora



## Indoor farming /hydroponics/aeroponics



## Digital Twins for orchard design

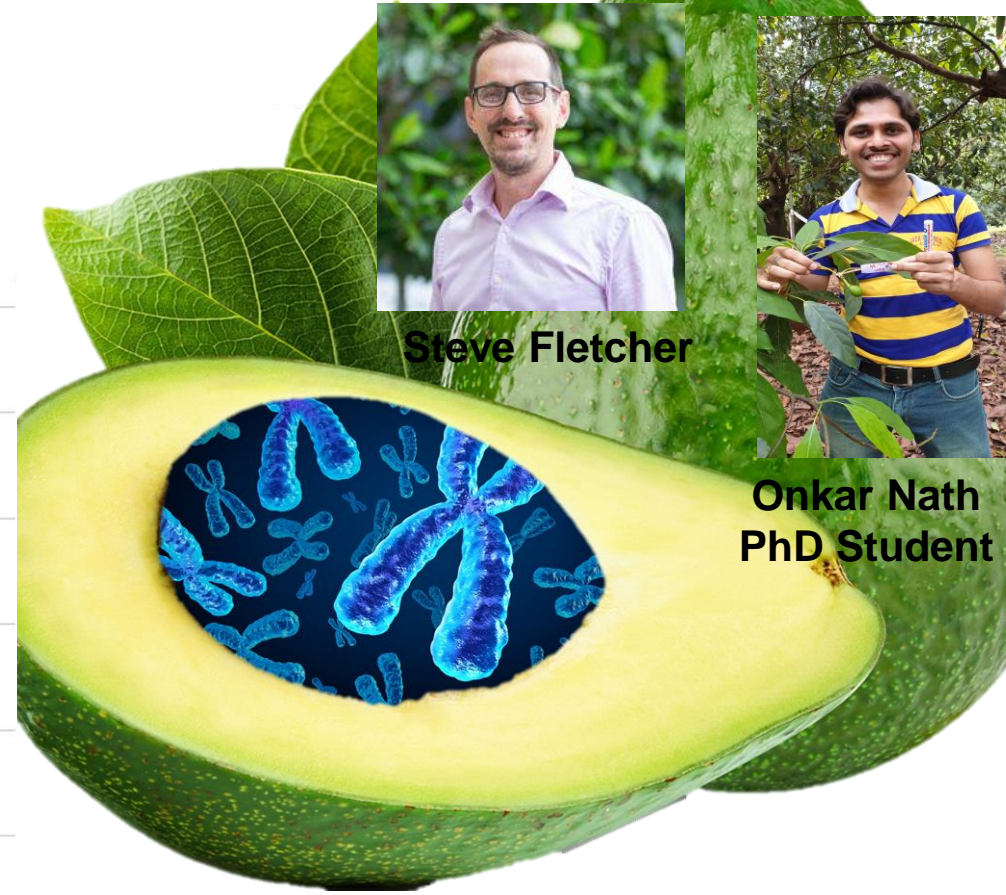
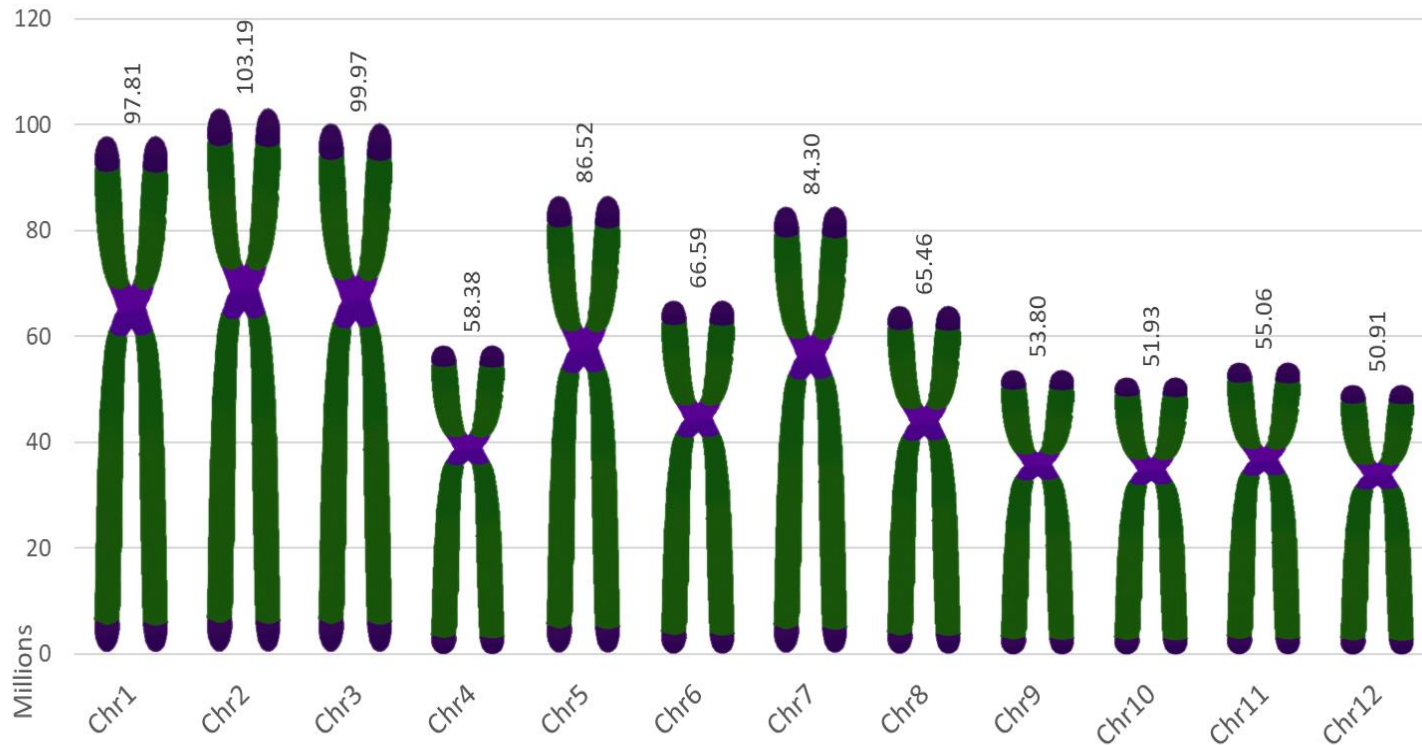


## LCA - Sustainability Tissue Culture- Nursery- Orchard



<https://www.quora.com/Can-you-grow-an-avocado-with-hydroponics>

# Chromosomal level genome of Hass



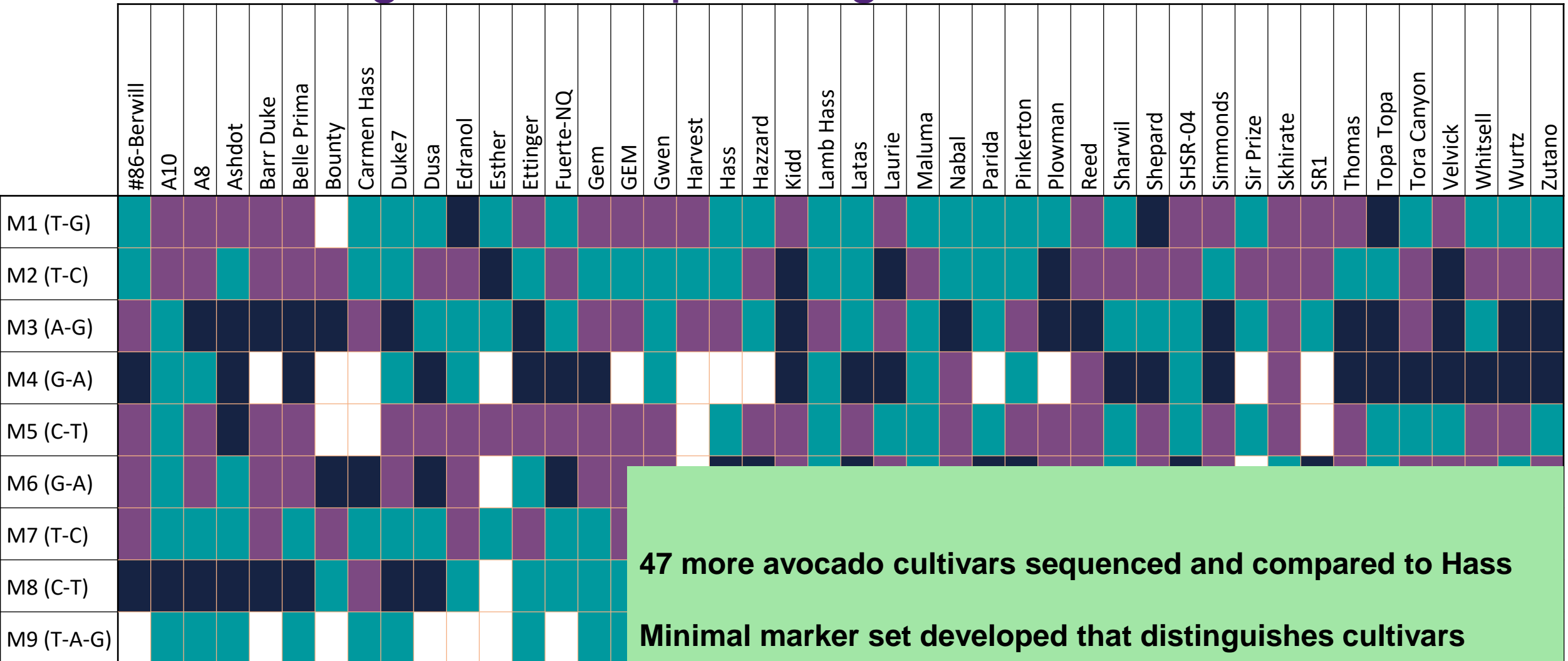
Steve Fletcher

Onkar Nath  
PhD Student



 **42,642 genes**

# Reference genome sequencing of >45 avocado cultivars



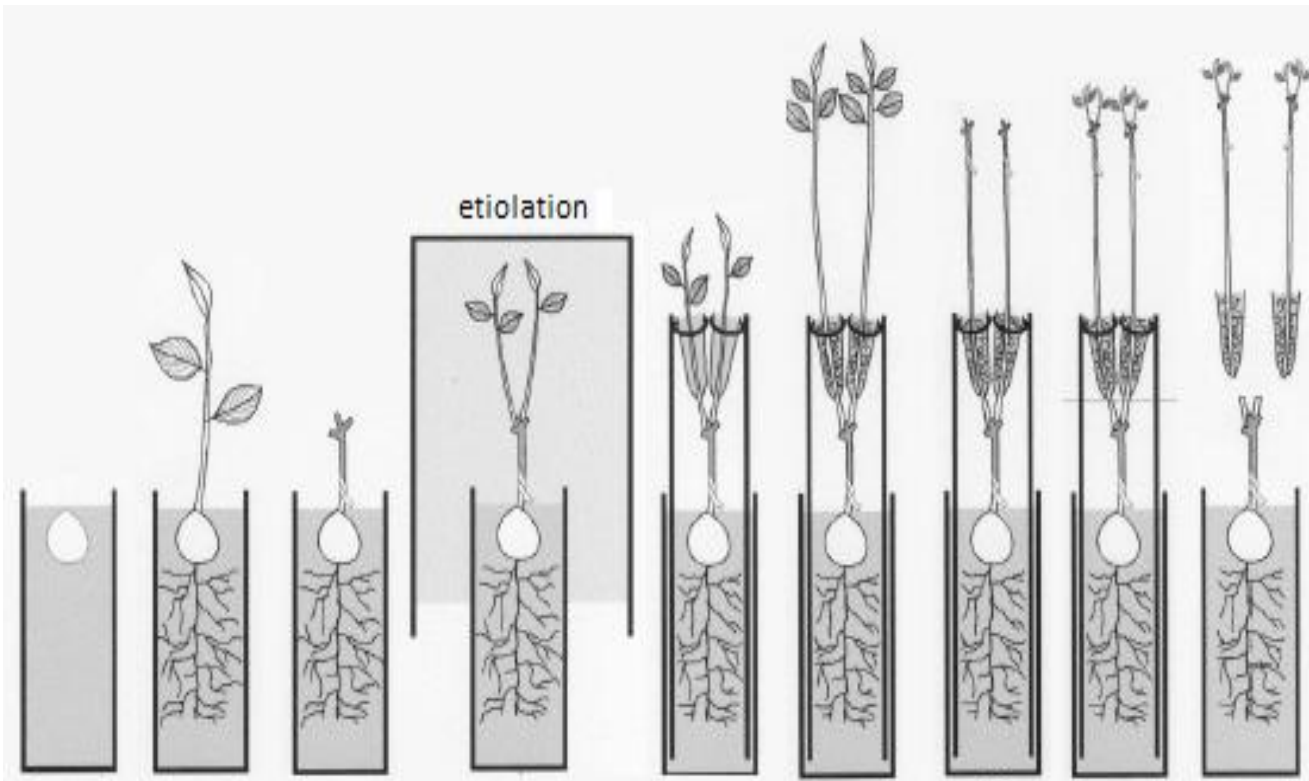
# Innovating Avocado – genomics

- Hass and Gwen Genome as a reference for future studies.
- Identification, characterization and functional analysis of features like genes, proteins, non-coding RNAs etc.
- Markers assisted identification of cultivars
- Further analysis of variants will assist in identifying reasons for differences between cultivars.

This genome provides a tool to support future advances in the development of elite avocado varieties with desired traits

# Clonal Rootstock Propagation

Clonal propagation of rootstocks. (Ernst 1999) (with adaptations)



*fruiting scion*

*clonal rootstock*

*nurse plant*



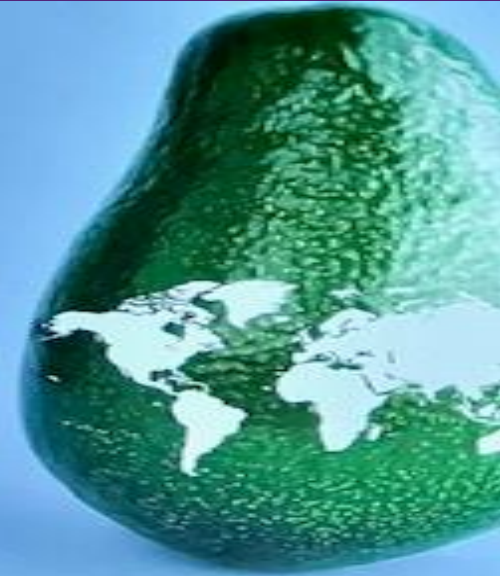
*Dr André Ernst at the Maluma Symposium in March 2020*

*Industry lost a Champion*

 **TRINK  
EMPOWERED COMMUNITIES** 

**New Australian technology can significantly cut  
avocado tree wait times**

June 08, 2021 [\(More News\)](#) [\(Today's Headlines\)](#) [\(Top Stories\)](#)



**10TH  
WORLD  
AVOCADO  
CONGRESS**  
**New Zealand  
2023**



**WE ARE AVOFAMOUS!**

# AVOCADO TISSUE CULTURE: LAB - NURSERY - ORCHARD

200 to 500 plants from < 1mm cutting from a mature tree

Andersons Horticulture – Fruitful collaboration





# Nursery & Field Evaluated - 4 years of data



# Tissue culture plants in Bundaberg, 2019- 2023



First trial site established  
Donovan Family Farms



# End User Perceptions

## International and Domestic Survey

### Domestic cohort:

- 42% identified as growers/farmers
- 19% as breeders/researchers
- 11% Agronomists
- 11% consultants
- 8% as nursery/suppliers



Perceptual Factors Influencing the Adoption of Innovative Tissue Culture Technology by the Australian Avocado Industry. Thorne, H.B.; Axtens, J.; Best, T.

Agriculture 2022, 12, 1288. <https://doi.org/10.3390/agriculture12091288>

# End User Perceptions- Major Survey Finding #1

🌱 >72% cannot access enough plants

🌱 >56% cannot access the quality of plants they want

🌱 >53% cannot access the cultivars they want

→ Confirmed these problems are not just perceived by researchers

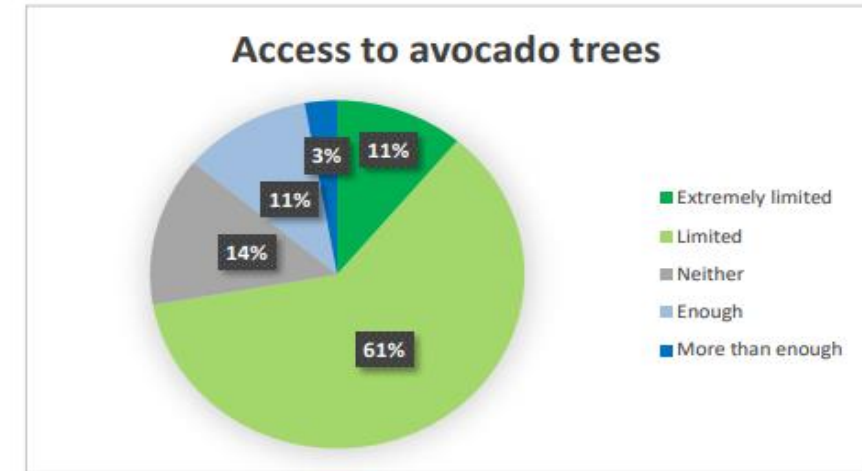


Figure 2. Industry ratings of access to avocado trees.

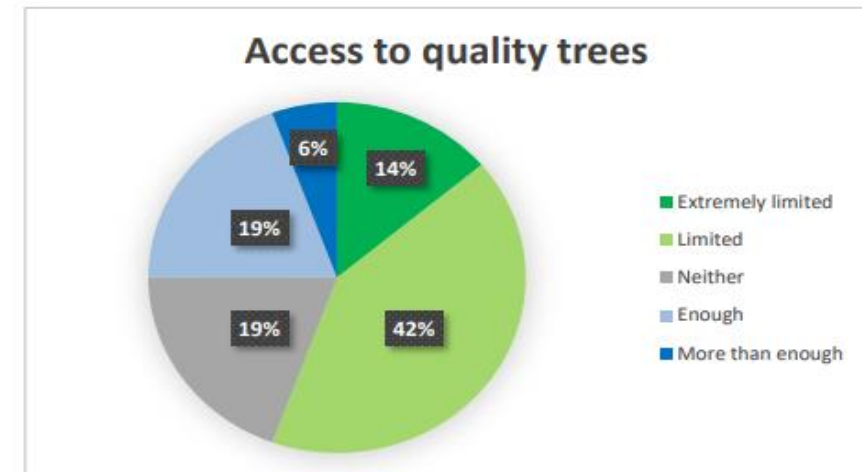


Figure 3. Industry rating of their access to the quality of avocado trees they want.

## Major Survey Finding #2

- 👉 2/3 Domestic respondents believe TC could be beneficial
- 👉 Most desired characteristics:
  - Quality of TC root system
  - Disease tolerance/Disease-free status
  - Fruit quality
- 👉 What would be the major influencer for TC adoption?
  - Field Observations (80%) and Professional Recommendations (83%)

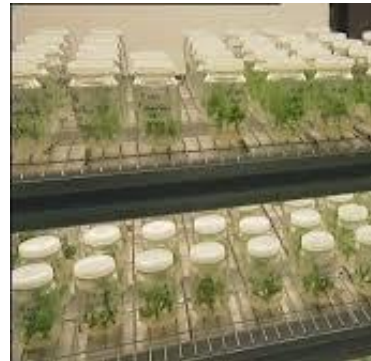


→ Field-testing performance is essential for industry acceptance

A major financial benefit at the grower level will be on-demand supply of desired trees – earlier planting = earlier returns

Speed to market – new rootstocks and scions

# Frozen orchards – plants now in the field



Developed the worlds first cryopreservation protocol using shoot tips for avocado germplasm conservation – NEED FOR GLOBAL CONSORTIUM – CRYOBANKS FOR AVOCADO

Science

# Cryopreserved avocado shoots could mean guacamole on Mars

Researchers are working to head off any chance of an "avocado apocalypse" on Earth.



Amanda Kooser

Sept. 10, 2020 10:02 a.m. PT

2 min read



Enlarge Image

University of Queensland's Neena Mitter and Chris O'Brien inspect avocado tissue cultures in the lab.

Peter Geale/University of Queensland

Humans are intent on going to Mars, but what will martian cuisine be like? Thanks to the work of researchers at the University of Queensland in Australia, there could be a side of guacamole to go with all the Mars potatoes.

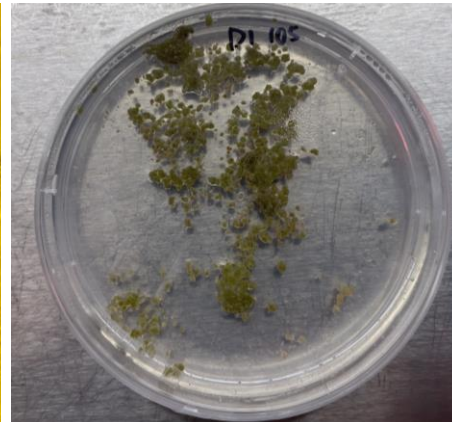
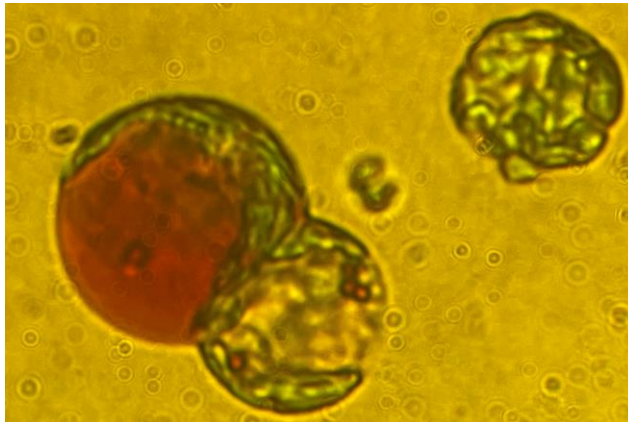
# Cell Fusion/ Gene Editing (CRISPR):

## Cell Fusion Technology – Non GM

Ability to hybridise diverse germplasm without the need for flowering



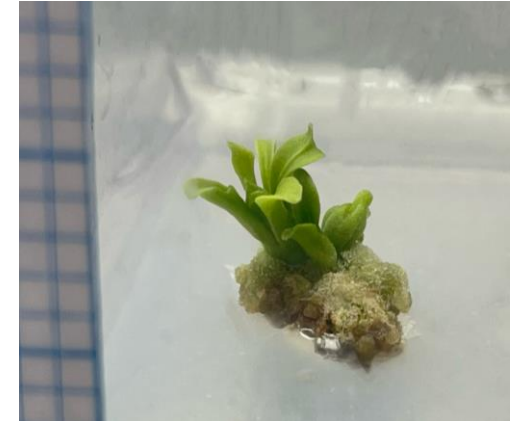
Yuxin Xue



Callus proliferation



Regenerative callus



Shoot regeneration





Prof Paul Gauthier

# Unleashing the Power of Avocado Indoor

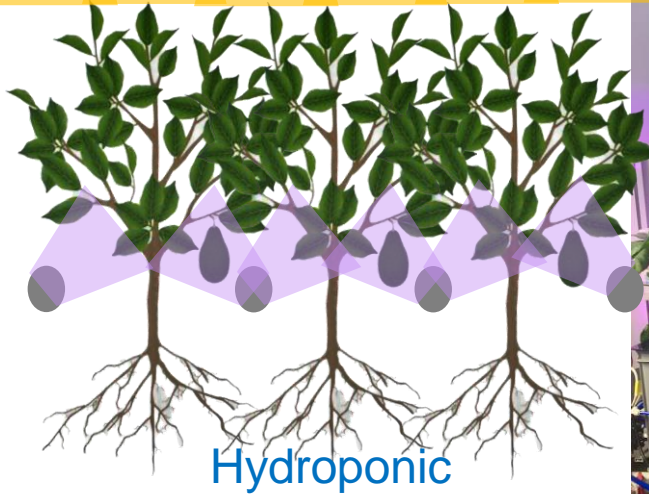
## Speed Breeding

Aeroponics/hydroponics/light/temperature

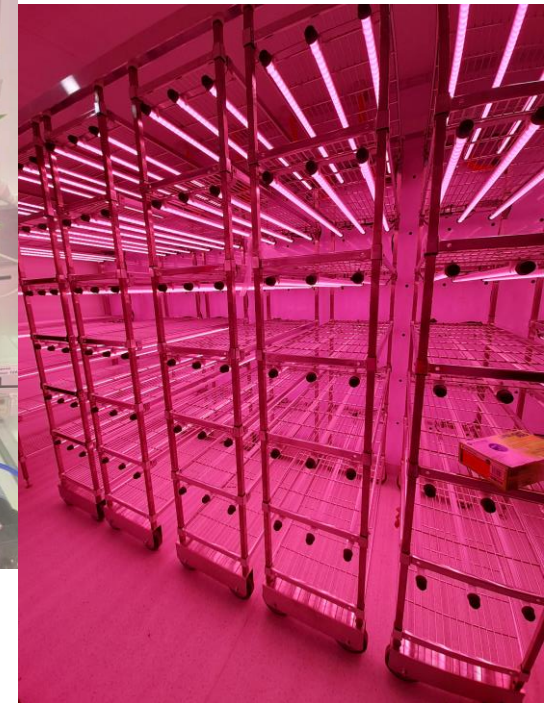
Synchronous flowering  
Reduced time to flowering and fruit set  
Rapid Screening

Pesticide Free Production

LED lighting



Hydroponic



# Avocado in Iceland!

## 6.8 Avocado in greenhouse

In the greenhouse, in order to meet the same amount of light received in the indoor farm, a light intensity of 525 micromol/m<sup>2</sup>s. Since the temperature regime is 25/20 °C, we can simulate the tomato crop with the new temperature and light intensity settings. Results are summarized in Table 25 and Table 26.



Business case for large scale crop production in greenhouse facilities in Iceland for the global market

E. J. Baeza<sup>1</sup>, Y. Dijkxhoorn<sup>2</sup>, K. Logatcheva<sup>2</sup>, W. Hennen<sup>2</sup>, G. Splinter<sup>2</sup>, C. Stanghellini<sup>1</sup> and S. Hemming<sup>1</sup>

Report WPR-1049

<sup>1</sup> Wageningen Plant Research, Business Unit Greenhouse Horticulture, <sup>2</sup> Wageningen Economic Research



Table 36

Summary of main resource uses and predicted avocado yield for Keflavik and Akureyri for HPS lamps.

	Energy used for heating (MJ m <sup>-2</sup> )*	Electricity used for artificial lighting (KWh/ m <sup>2</sup> )	Hours lamps are on (h)	Amount of CO <sub>2</sub> used (kg/m <sup>2</sup> )	Avocado yield (kg/m <sup>2</sup> )
Keflavik-reference scenario	976	1607	6213	46.3	4.4
Akureyri-reference scenario	1019	1623	6228	42.5	4.4

\* This number already includes the extra energy required on an average year to deal with the snow in Keflavik and Akureyri

# RNA-based Biopesticides - BioClay™

Inventors:  
Prof. Neena Mitter  
Prof. Gordon Xu  
Prof. Max Lu

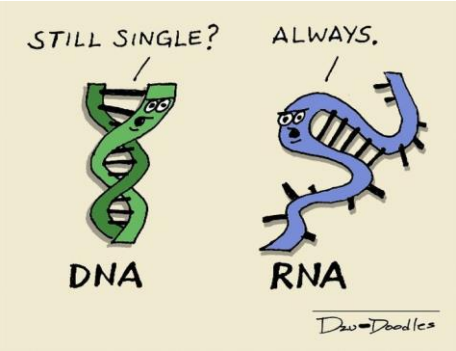
BILL & MELINDA  
GATES *foundation*

- RNA as the biological active ingredient
- Clay particles as carriers of the active

- **Non-GM**
- **NO RESIDUE**
- **SPECIFIC**
- **STABLE**
- **SUSTAINABLE**
- **SAFE**

- Multiple Patents
- Nufarm Australia Limited – industry partner
- ARC Hub ~\$18M





Environmentally friendly?



- Unstable
- Easily washed off
- Short protection window

Stabilise?

Stick to the leaf?

No residue?

Can we deliver RNA sprays as a viable system for growers without genetic modification?

Non-toxic?

Protect from rain?

Easy to adopt?

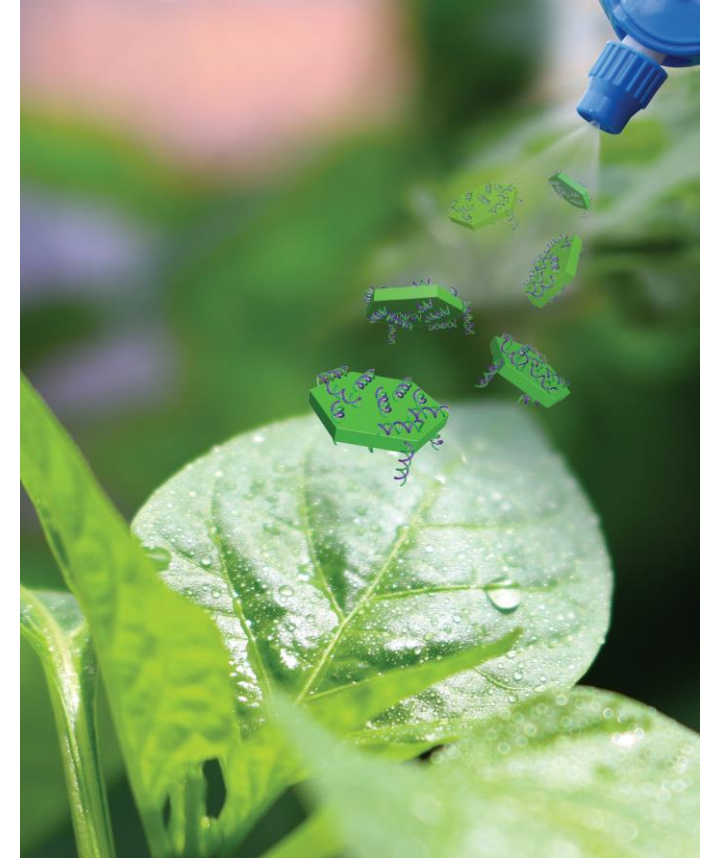


# What is BioClay?

Inert biodegradable clay (Mg + Fe) to deliver RNAi

- 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 Platform

## Australian Research Council Research Hub for Sustainable Crop Protection - Targeting Fungal Diseases

~\$18 million cash and in-kind

Universities, multiple RDCs,  
State Governments and  
Nufarm Australia Limited

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

The Queensland Alliance for Agriculture and Food Innovation (QAAFI) is a research institute of The University of Queensland (UQ), supported by the Queensland Government.

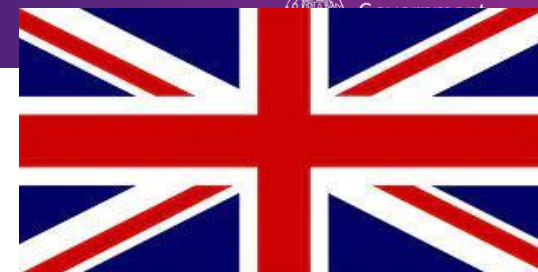
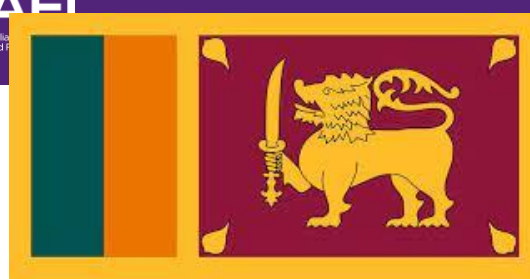
By controlling fungal plant diseases,  
farmers  
can save **125 M TONS**  
of **FOOD** each year -  
enough to **FEED 600**  
**MILLION PEOPLE!**



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



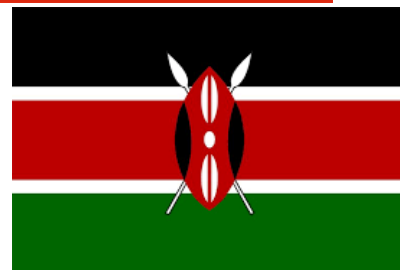
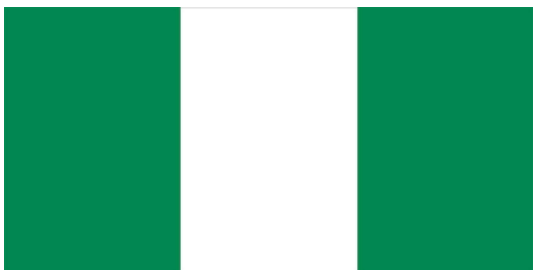
Sustainable  
Crop Protection  
**HUB**



**54 members**  
**17 nationalities**



Sustainable  
Crop Protection  
**ARC HUB**



# The Research Hub process



IDENTIFY & DESIGN



SYNTHESISE



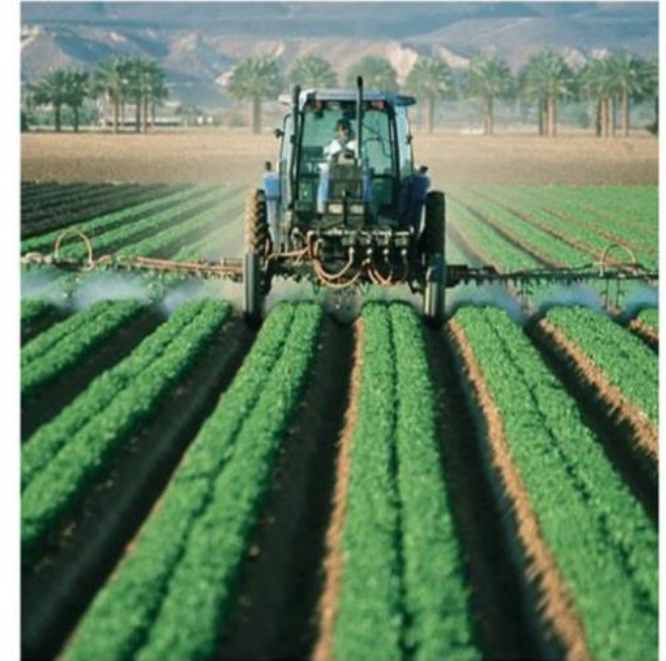
LABORATORY



GLASSHOUSE



FIELD



BIOCLEY PRODUCT

↑ MECHANISM ↑

↑ SCALE UP ↑



REGISTRATION

SOCIAL LICENSING





# BioClay it works -



Tomato spotted wilt virus/capsicum

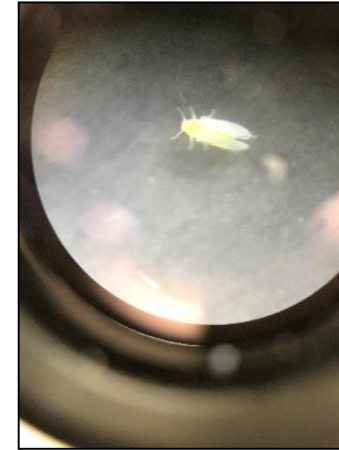


Water

Naked dsRNA

BioClay

Zucchini yellow mosaic virus



Live Whitefly



BioClay Dead Whitefly



water

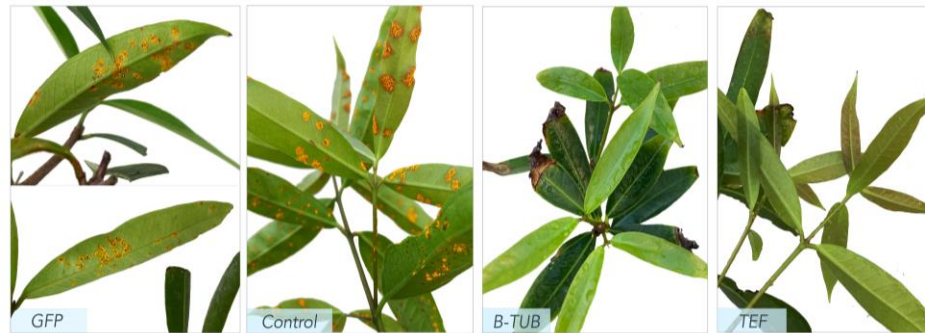


Naked dsRNA



BioClay

Botrytis on chickpea



dsRNA protects lemon myrtle trees from rust



BioClay

Control

# Targeting *Phytophthora cinnamomi*



No *P. cinnamomi*



+ *P. cinnamomi*



+ *P. cinnamomi* + dsRNA

Unpublished

Unpublished

# Testing different RNA application methods

## Crown dips



## Foliar sprays



## Petiole soaking



## Trunk injections



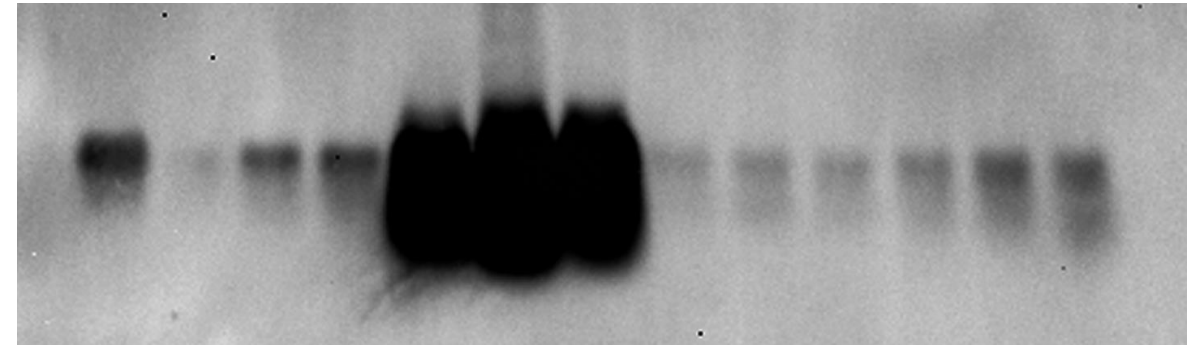
# dsRNA can be delivered to avocado leaves and roots via foliar sprays and trunk injections



Dr Anne Sawyer



	leaves						roots					
	injected			sprayed			injected			sprayed		
+ve	1	2	3	1	2	3	1	2	3	1	2	3



**Intact dsRNA is present in new leaves and roots 6 weeks post delivery**

On **8<sup>th</sup> October 2019** the Australian Parliament formally agreed with the Office of the Gene Technology Regulator's 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.

# Trade and Markets

## Naked dsRNA:

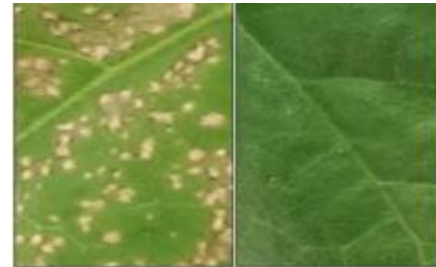
- Short or nil withholding periods (set to allow chemical residues in edible commodities for domestic markets)
- Short or nil export intervals (to satisfy the standards imposed by overseas trading partners)

Innovations aimed at contributing to the supermarket trolley

Endless possibilities...

Design of regulation and public opinion are crucial

VIRUSES



FUNGI



Hailing Jin, Nature Plants, 2016

INSECTS



PROTECTED CROPPING !!



PACKHOUSES!!



ANIMAL HEALTH !!



BIOSECURITY!!





Australian Government  
Australian Research Council



The Australian Wine  
Research Institute



Wine  
Australia





Seen in the [@UQ\\_News](#) car park this morning. Rumors are that it belongs to [@neenamitter](#) from [@QAAFI](#) . Looking forward to seeing what [@QAAFI\\_Animal](#) drives to work 🤔



Thank you  
FROM A VONDERFUL  
MITTER TEAM

