Food and Nutritional Security

Population 9.5 Billion by 2050 of which more than 68% will be living in cities.

The WHO and FAO recommend a dietary intake of more than 400g of fruits and vegetables per day to prevent malnutrition.

The World Food Programme reports that 66 million primary school-age children in developing countries go to class hungry.

Reduce Crop Losses

It may take 13 years and up to $256 million to research, develop, and register a new crop protection product; only 1 in 139,000 chemicals tested makes it from the laboratory to the farmers' fields.

http://www.croplifeamerica.org/crop-protection/pesticide-facts

PESTICIDES:

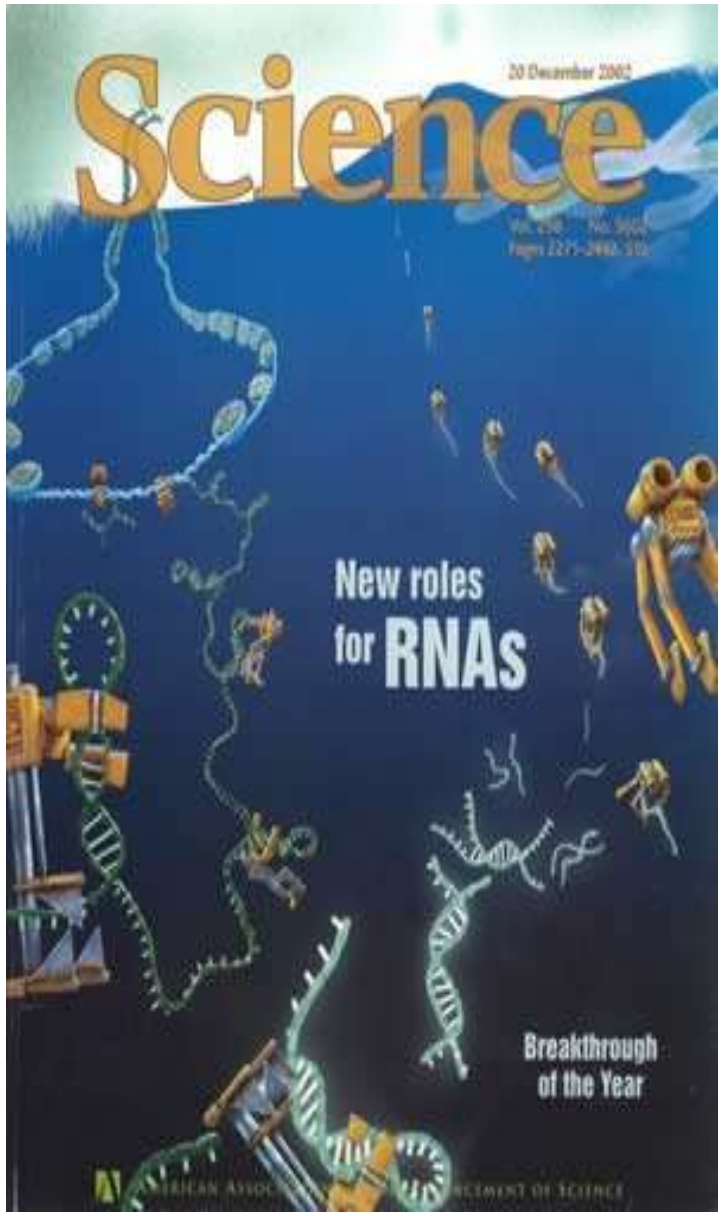
- RESISTANCE
- RESIDUE
- RUNOFF
- LACK OF SPECIFICITY
- NEW CHEMICALS

RNAi based Biopesticides - BioClay

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

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

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



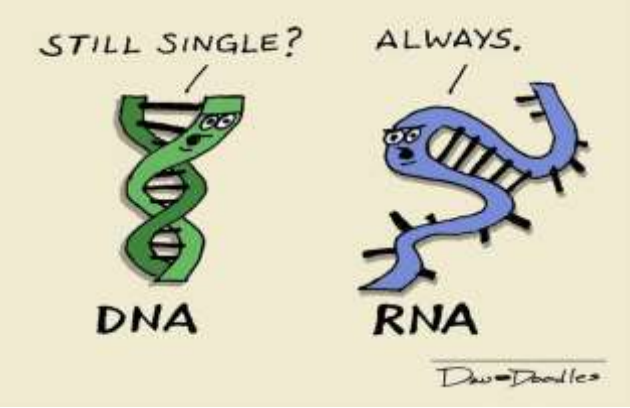
"RNAi is the most important thing to happen in molecular biology during the last 10 to 20 years"

Neena Mitter
n.mitter@uq.edu.au

Trigger molecule of RNAi is Double stranded RNA

In transgenic or GM plants pathogen specific dsRNA is integrated into the genome of the plant to afford protection

- Community acceptance
- Concerns regarding environmental impact
- Regulation of use
- **Cost and time involved**
- **Lack of transformation protocols**



Dzu.doodles.com

Is there another way?

Can we deliver RNAi as a spray instead of making a GM plant?

http://www.naturalnews.com/gmos.html

ds RNA spray to control virus infection

Pepper Mild Mottle Virus

dsRNA + Pepper Mild Mottle Virus

Tenllado *et al.* (2003)

It works!
dsRNA as a spray

12 papers

10 viruses and 3 viroids

11 host plants

Issues with spray of naked dsRNA as a topical application

- Unstable
- Degradation by enzymes on leaf surface
- Not protected from UV and sunlight
- Can get easily washed off after spray
- Protection lasts for only 5 – 7 days after spray

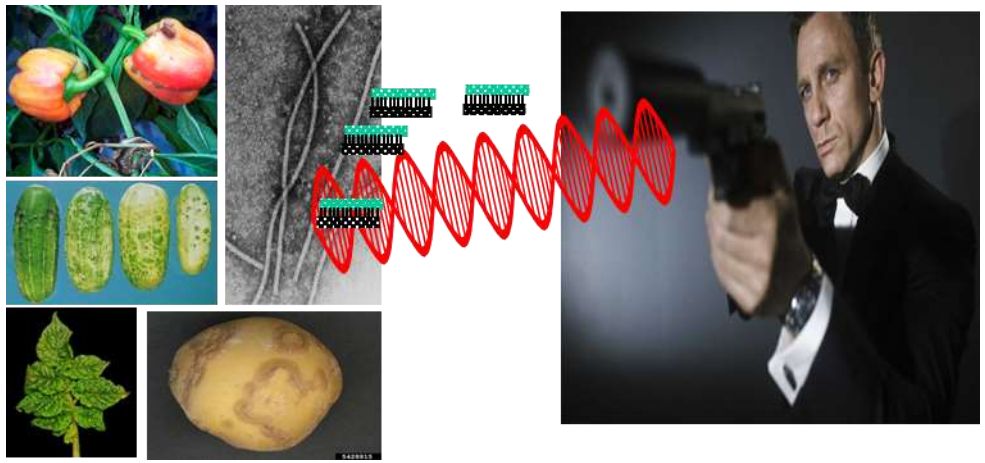
Is there another way?

Can we deliver RNAi as a spray as a stable application?

http://www.naturalnews.com/gmos.html

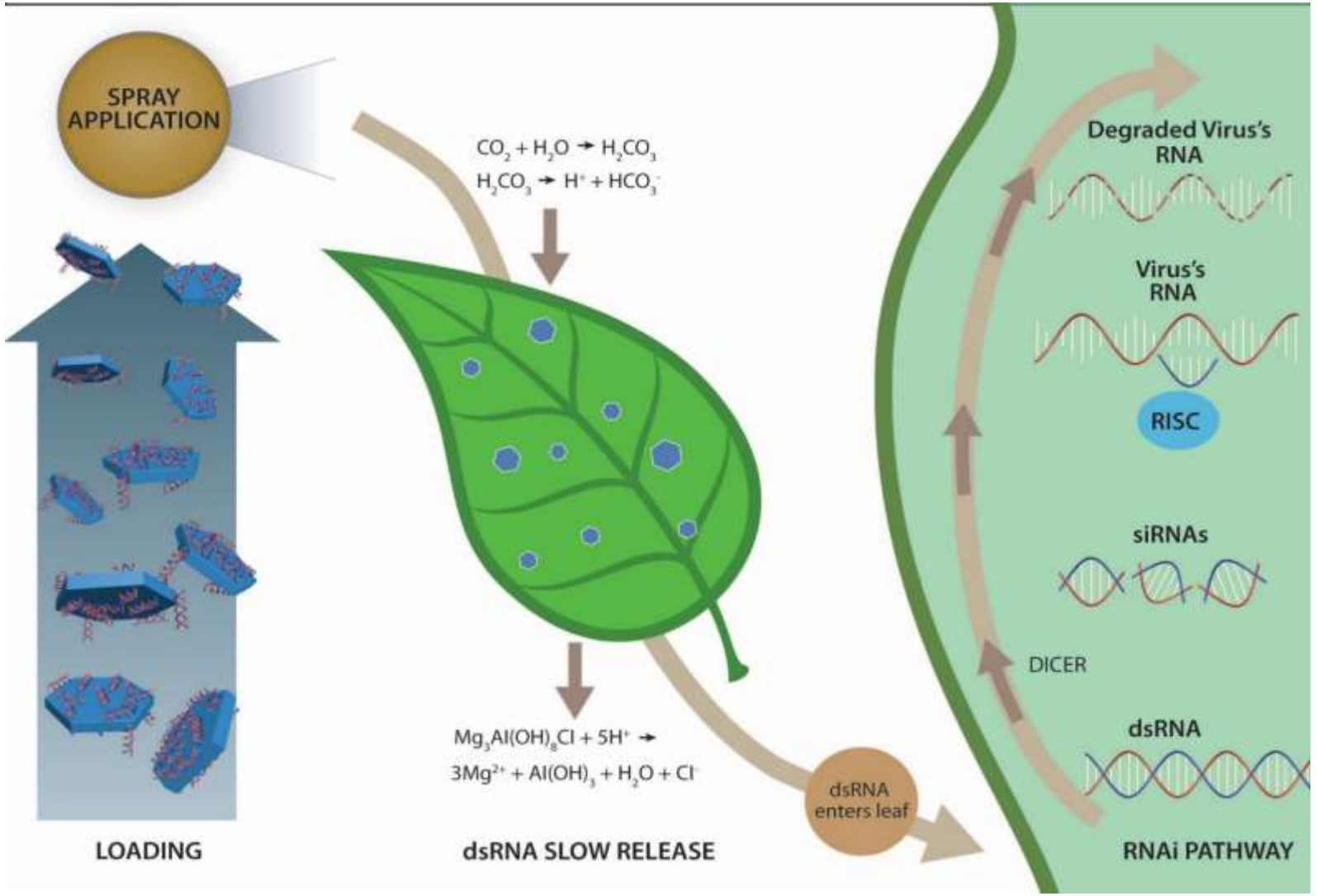
BioClay –Delivery of RNAi as a Spray Formulation

A stable, non-toxic, non-GM spray application for sustainable crop protection- clay particles to deliver RNA interference



BILL & MELINDA GATES foundation

Schematic of BioClay



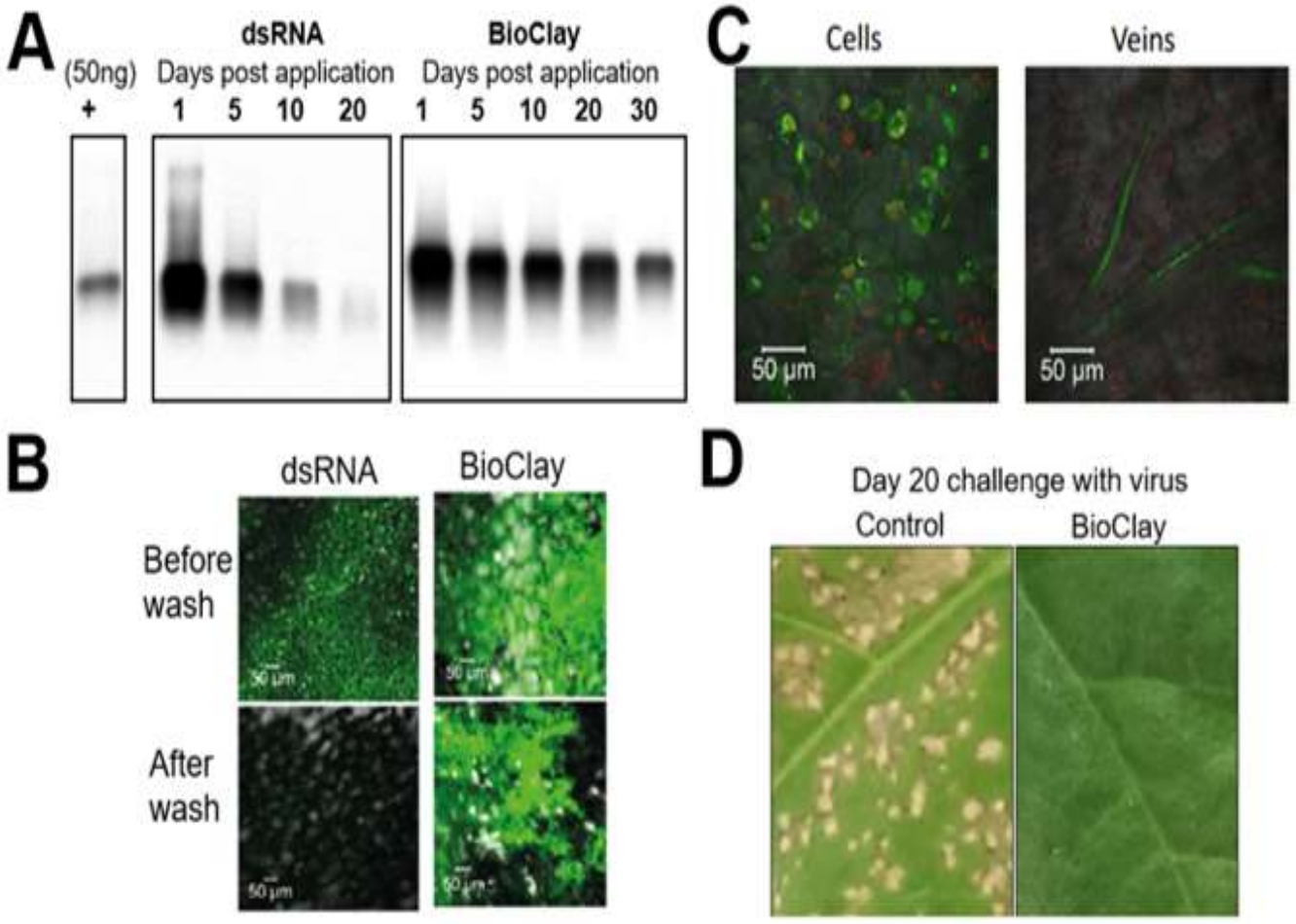
What is BioClay?

Inert biodegradable clay to deliver RNA

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

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

BioClay- It works



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

B – The sprayed dsRNA can enter into the plant system

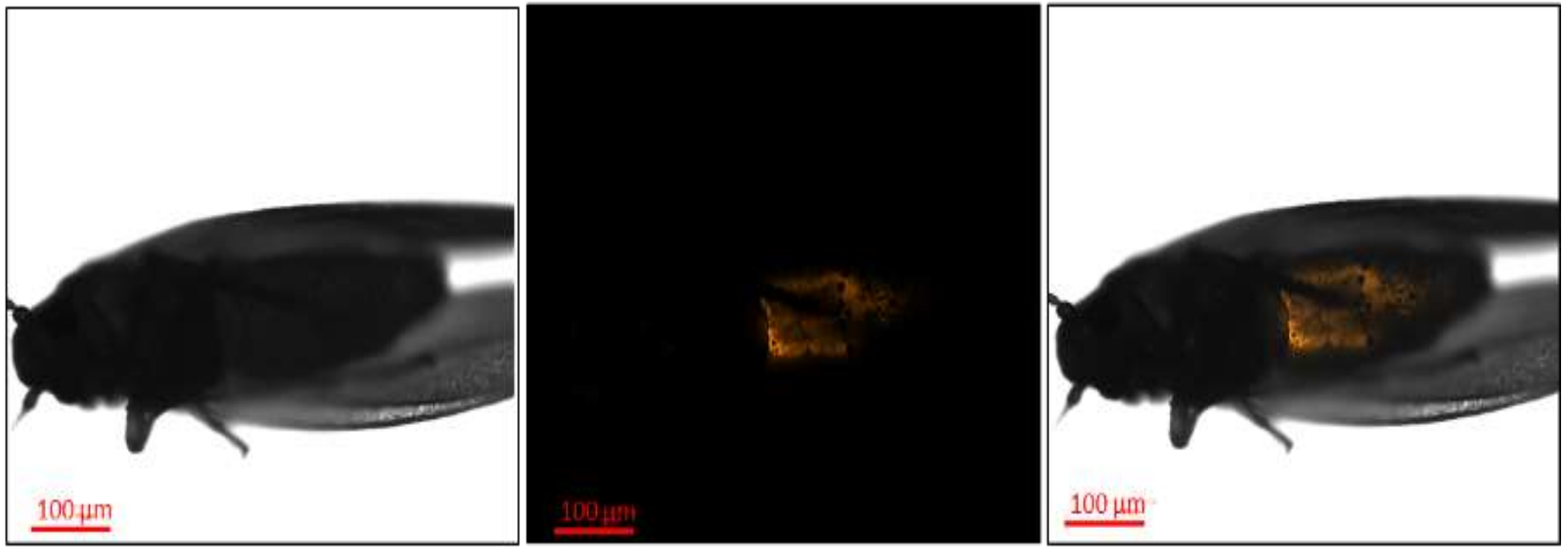
C – BioClay does not get washed off by water/rain

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

Mitter et al, Nature Plants 2017

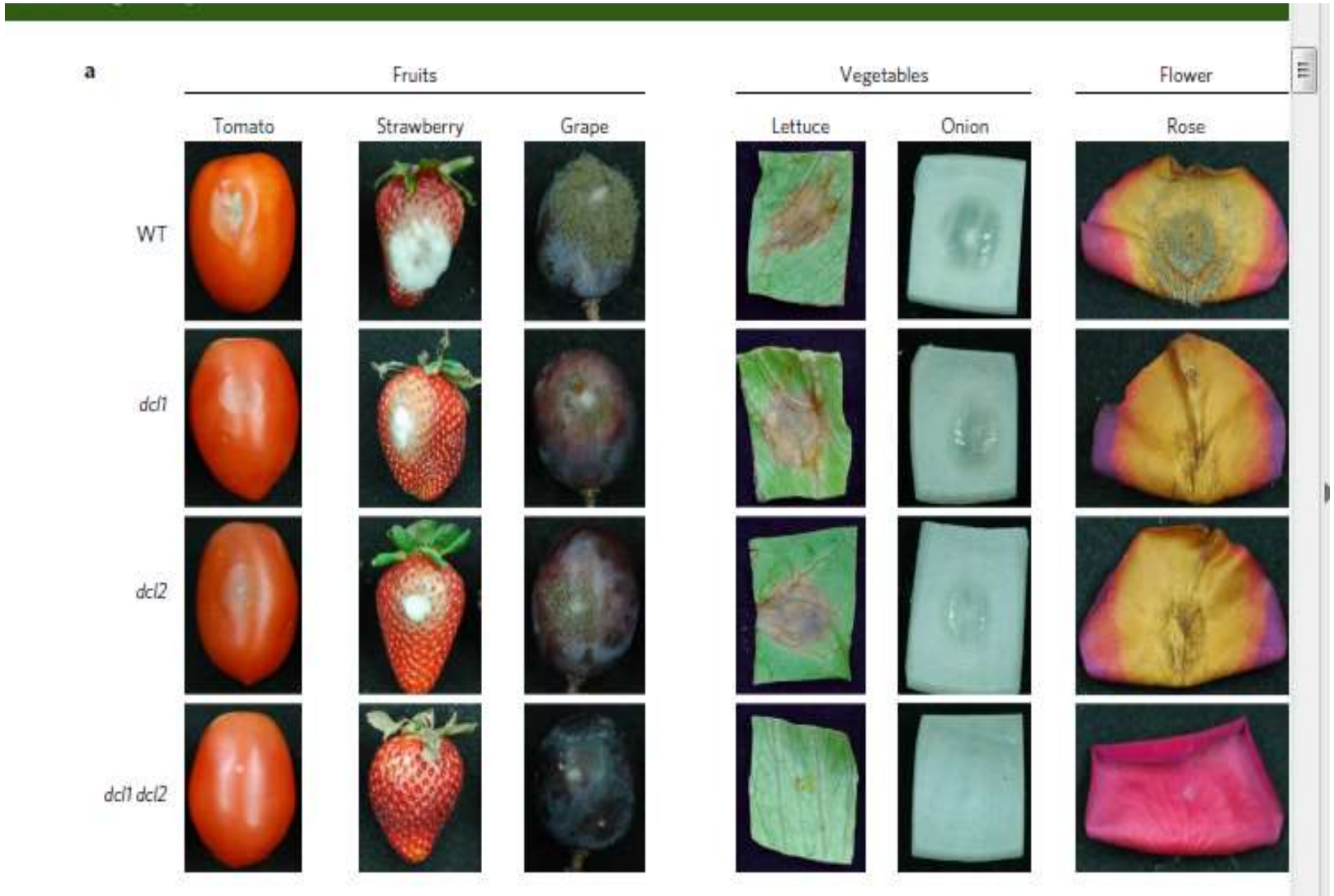
BioClay for Tomato Spotted Wilt Virus

BioClay for insect pests: RNA uptake in Whitefly



Adult whitefly showing presence of dsRNA in the abdomen 48 after after feeding on a sprayed leaf

DsRNA spray for Botrytis



Bidirectional cross-kingdom RNAi and fungal uptake of external RNAs confer plant protection Ming Wang---- and Hailing Jin , Nature Plants 2016

Topical RNA application – NON-GM

In Australia, the Office of the Gene Technology Regulator has legislated topically-applied RNA is exempt from GMO regulations (Schedule 1A – Techniques that are not gene technology)

This item provides that techniques involving applying RNA to an organism to temporarily induce RNA interference are not gene technology, provided that:

- the RNA cannot be translated into a polypeptide
- the organism's genome sequence cannot be altered as a result, and
- an infectious agent cannot be produced.

AUSTRALIA

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

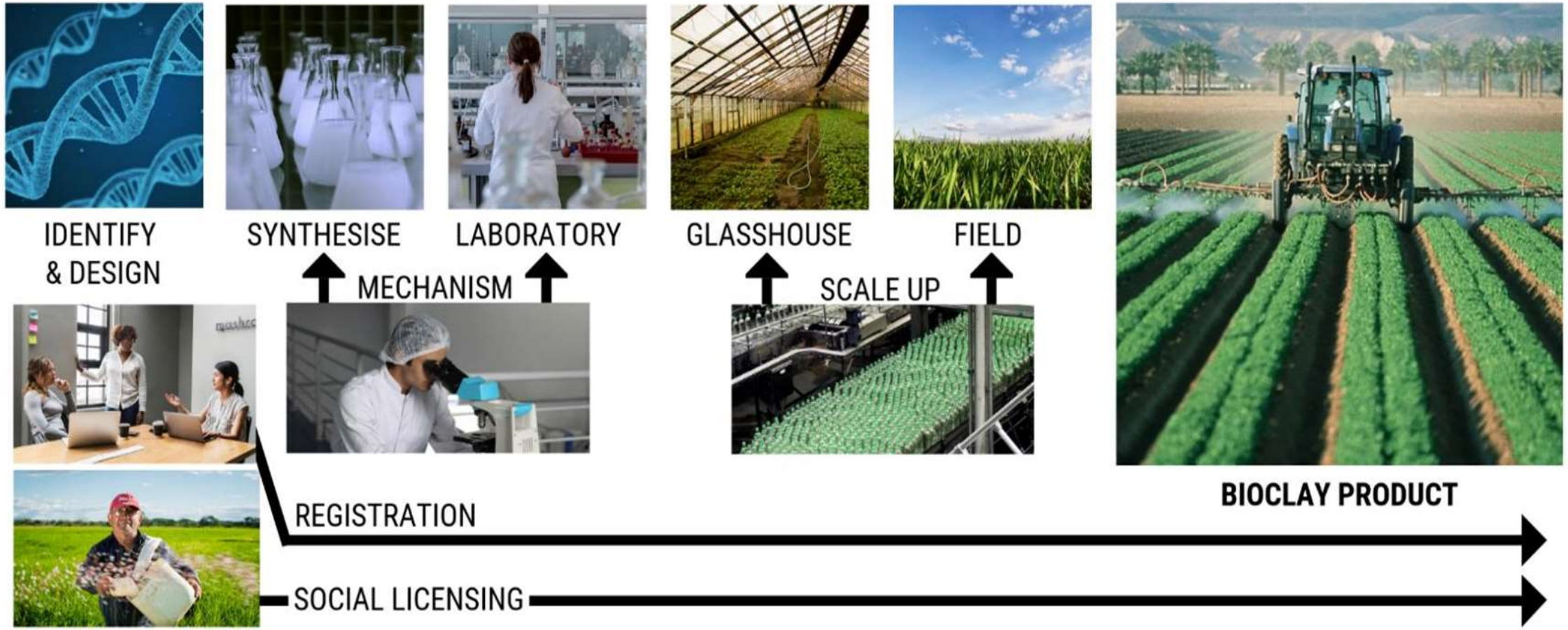
BioCClay for control of Fungal diseases

ARC Research Hub for Sustainable Crop Protection -
Targeting Fungal Diseases and Officially Opened in Aug 2020

- ~$18 million cash and in-kind

Universities, multiple RDCs,
State Governments and
Industry partners

The Research Hub process



RNA based biopesticides:

- Topical spray
- Tissue Culture
- Seedling applications
- Baits
- Feed

✓ Non - GM
✓ No residue
✓ Specificity
✓ Minimal issue of resistance development
✓ Value across plant and animal health

RNA based pesticides for the 'Agriculture of Tomorrow"

VIRUSES

INSECTS

PROTECTED CROPPING

FUNGI

POST HARVEST

Innovations aimed at contributing to the Supermarket Trolley

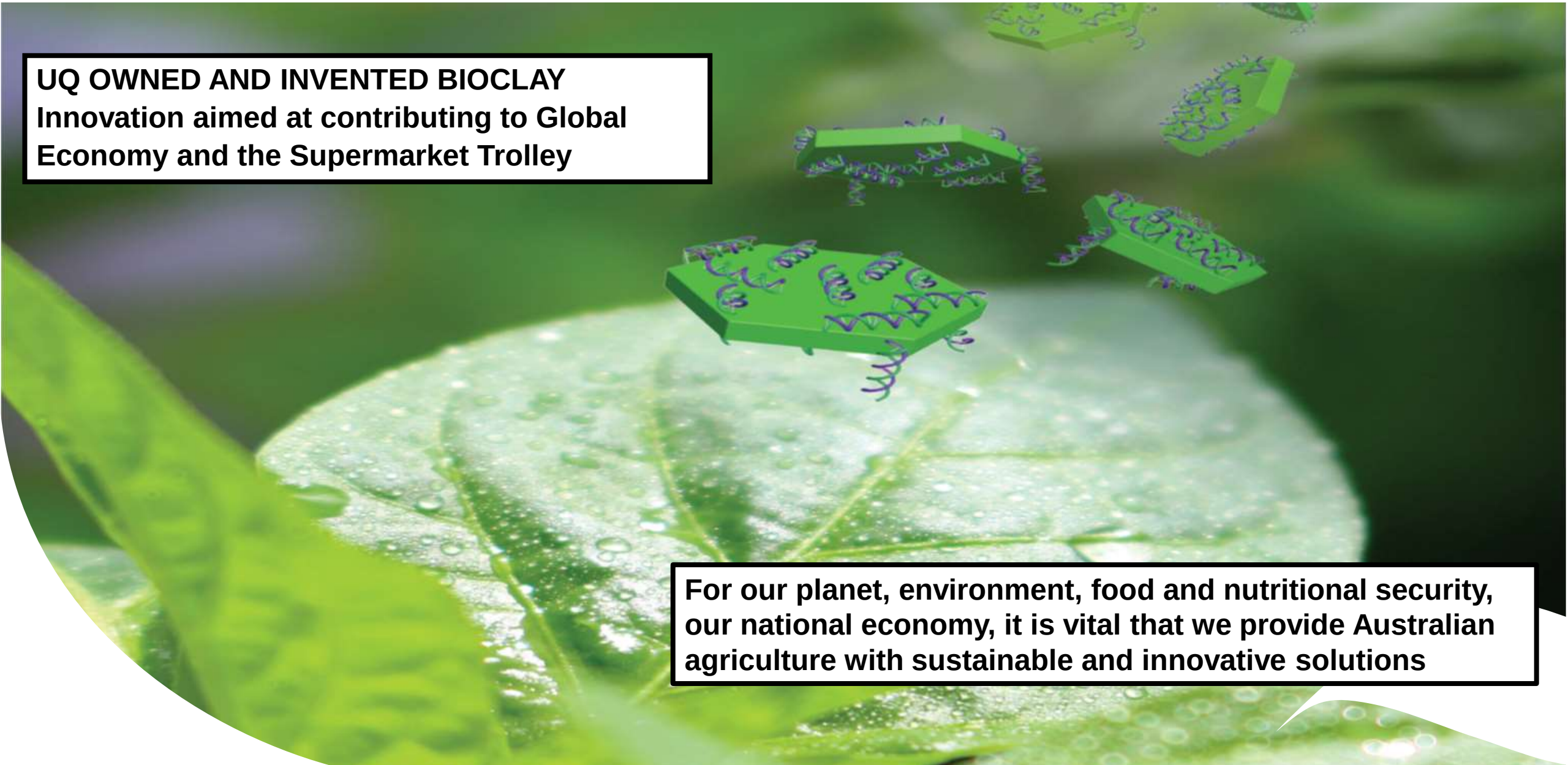
Design of regulation and public opinion are crucial

Endless possibilities……

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

QAAFI
Queensland Alliance for Agriculture and Food Innovation

Queensland Government



UQ OWNED AND INVENTED BIOCLAY
Innovation aimed at contributing to Global Economy and the Supermarket Trolley

For our planet, environment, food and nutritional security, our national economy, it is vital that we provide Australian agriculture with sustainable and innovative solutions

Thank you FROM THE BIOCLAY TEAM

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