Growing Robust Avocado Fruit: *Systems thinking to inform decision making*

Joyce, D.[1], *Kiloes, A.*, *Ullah, A.*, *Chen, Y.*, *Aziz, A.*

[1]Department of Agriculture & Fisheries – Queensland

daryl.joyce@daf.qld.gov.au

Queensland Government

Avocado **fruit robustness** defined …

… "*the fruit's ability to withstand the rigours of postharvest handling to provide a quality product that maintains consumer satisfaction and drives repeat purchase*."

(Joyce, D. *et al*. 2022. HI AV21005 'Growing Robust Avocados' project MRT)

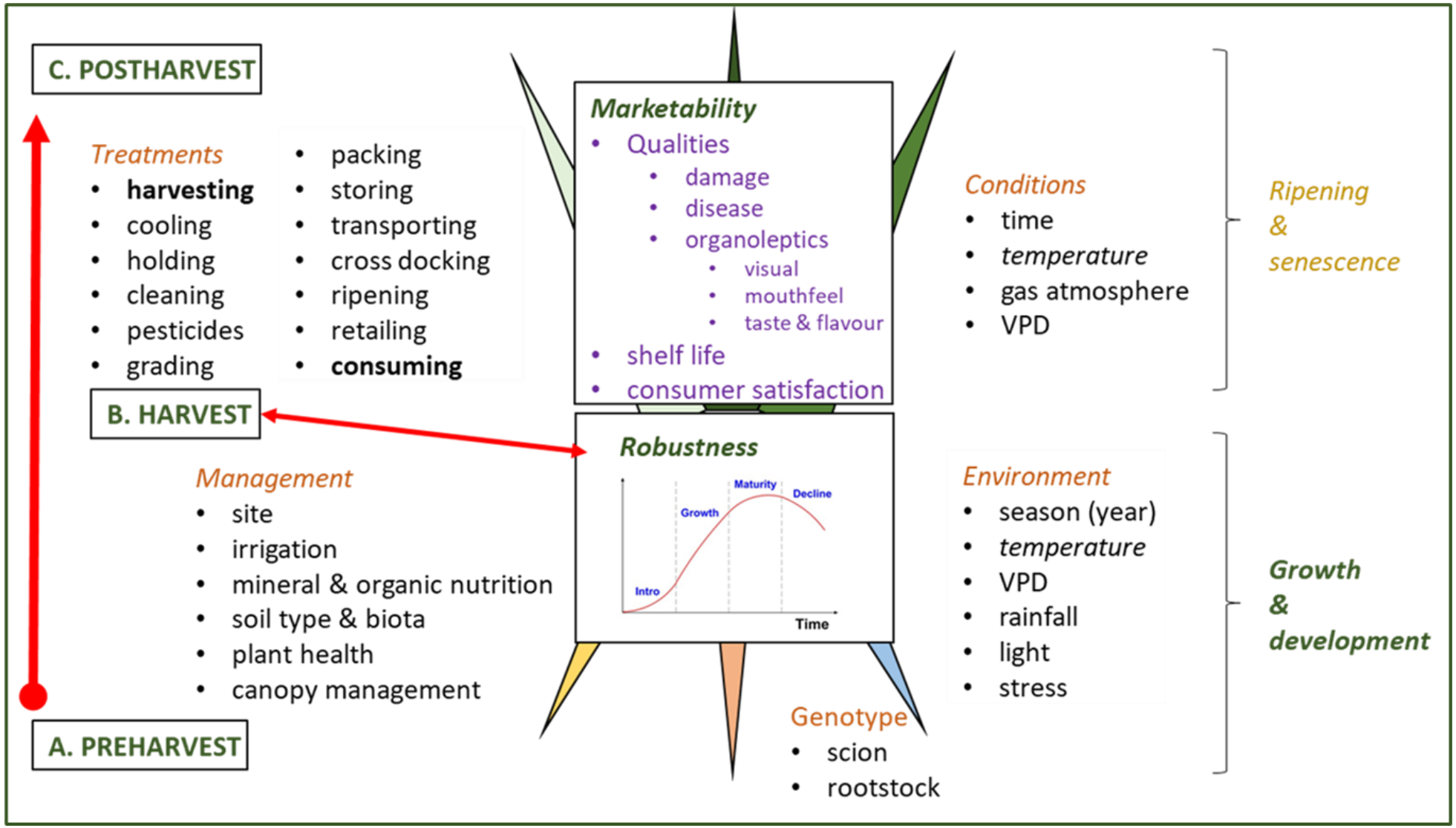
Robust fruit
for logistically
'long' supply chains;
e.g., export by sea

Value proposition …

- This paper advocates the application of ***systems thinking*** in the context of *avocado fruit robustness*.

- We propose ***systems thinking*** in a stakeholder group setting for the avocado industry as a *tool for decision-making, management, extension, and communication*.

… an **ocean** of ‘potential’

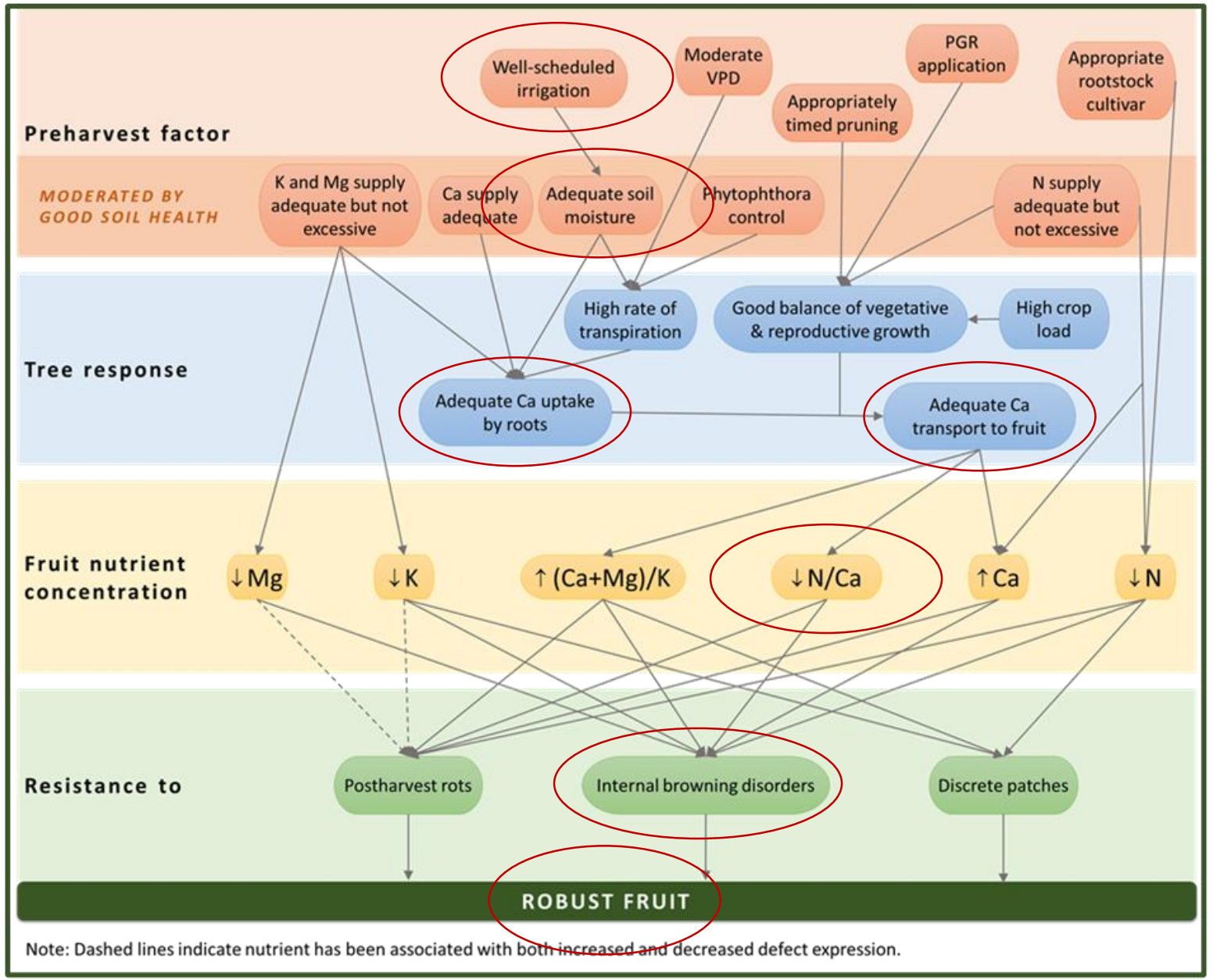


‘Wicked’ **problems need** ‘wicked’ **solutions**

General propositions …

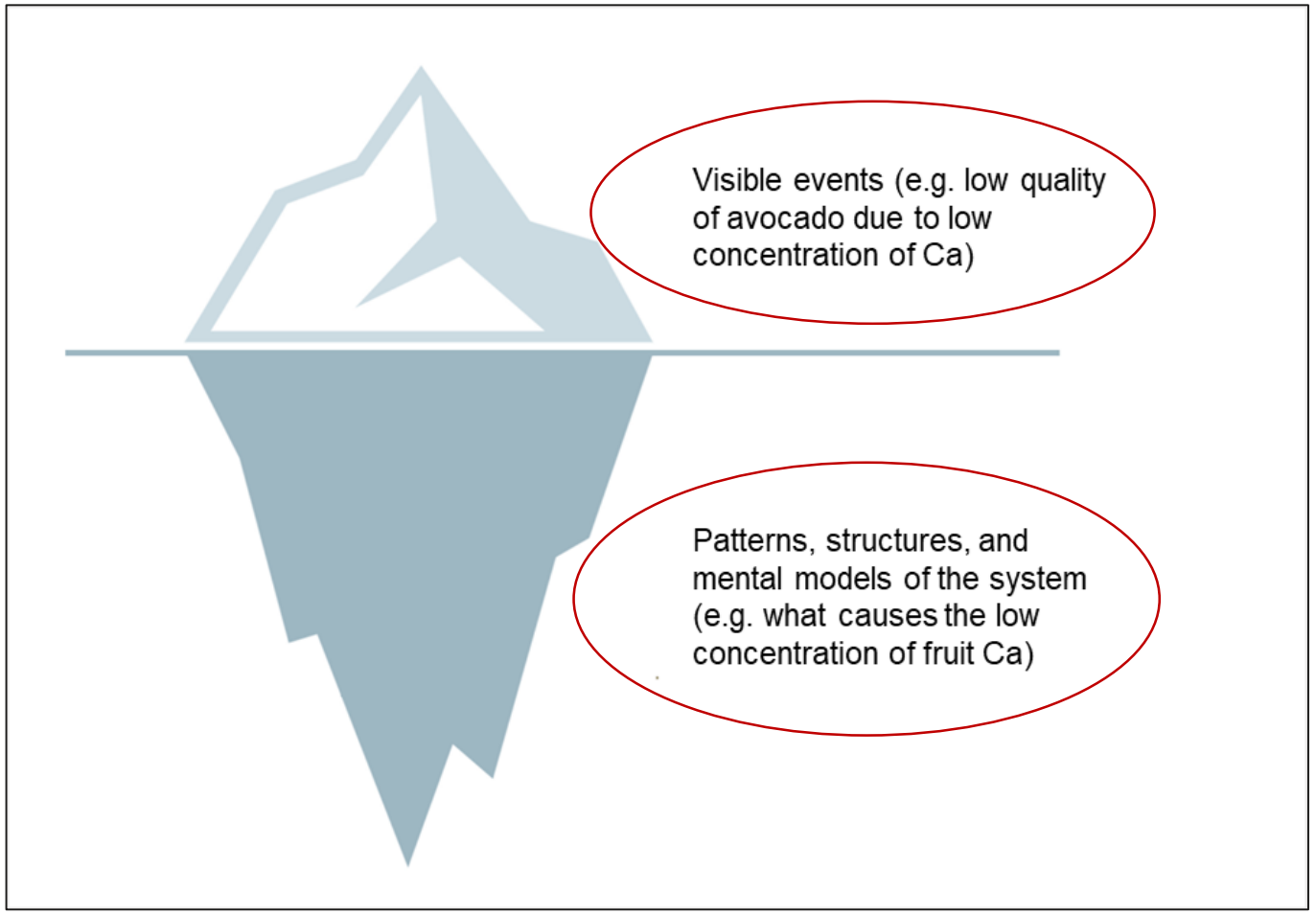
- ✓ Multifaceted issues; viz., determinants
- ✓ No ‘one size’ fits all circumstances; viz., sites, seasons
- ✓ *Reason it out ‘case by case’; viz., within farms; blocks, trees*
- ✓ “Many hands make light work”; viz., R,D&E, practical experience
- ✓ Artificial intelligence (AI); viz., likely to have positive impacts

… ‘*map the* ***currents***’



… '*watch for **icebergs***'

- **Visible** (viz., low fruit level) and **invisible** (viz., limited supply to fruit) calcium (Ca) related determinants of avocado fruit robustness.



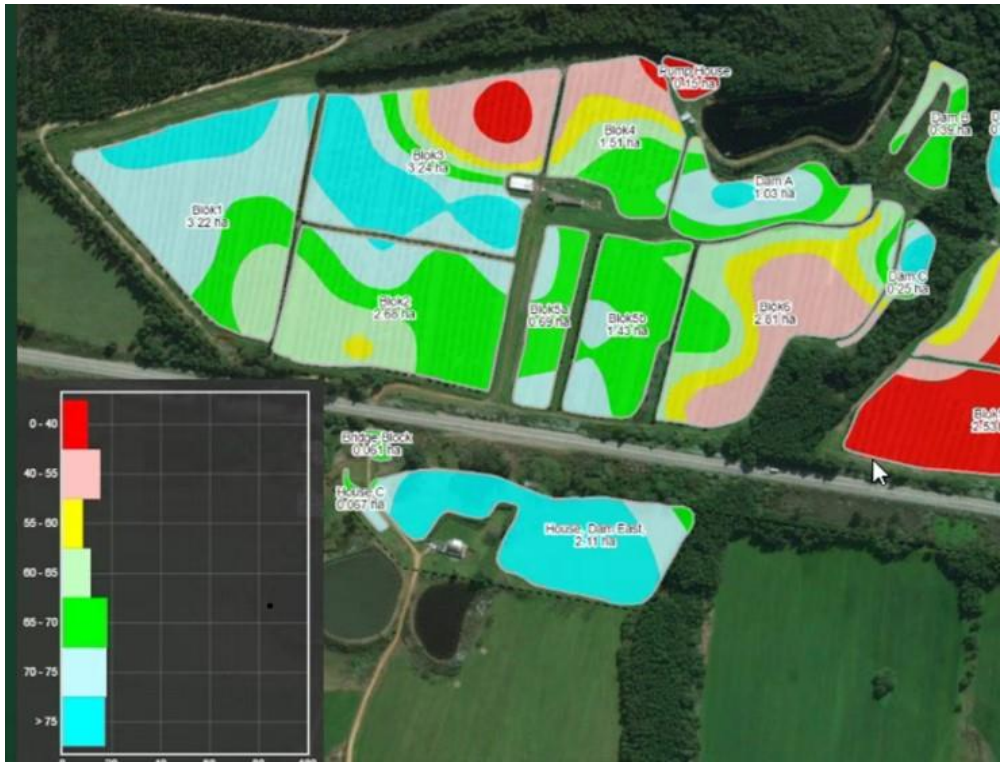
‘Systems thinking’ defined …

… “*a scientific field of knowledge for understanding change and complexity through the study of dynamic cause and effect over time.*”

Maani & Cavana (2007) Systems Thinking, Systems Dynamics.

Soft systems as a **participatory approach** …

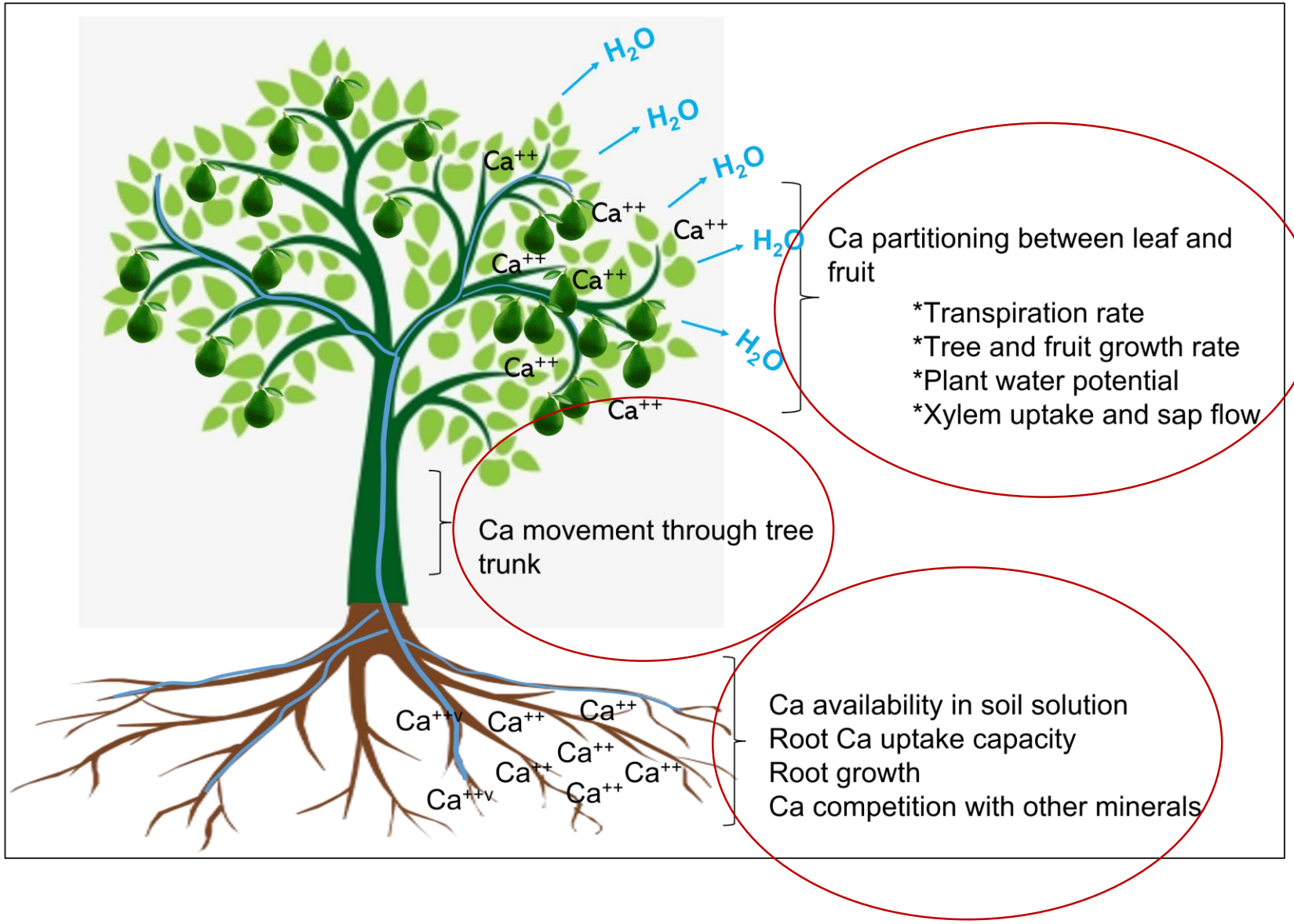
- Stakeholder engagement
  - Expertise and experience
- Collegiately informed understanding
- Collaborative learning
- Site specific management issues
  - **Spatial variation** in avocado orchards
    - Ca^{2+} % base saturation map e.g. →
    - https://agritechnovation.com.au/



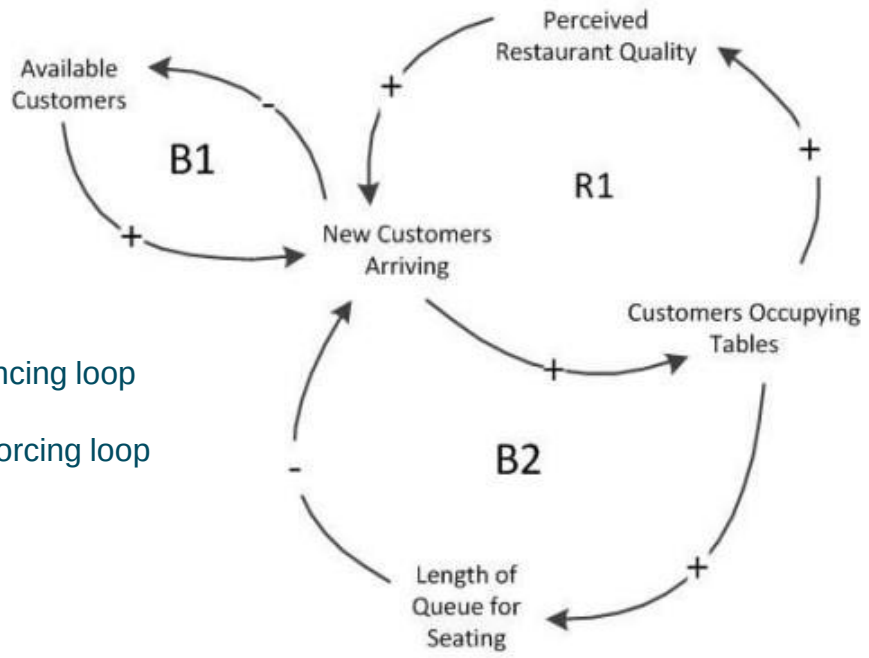
Avocado **fruit N to Ca ratios** (N:Ca) …

- High fruit nitrogen (**N**) and low fruit calcium (**Ca**) together negatively influence the fruit quality offering to consumers (Joyce et al., 2022).
- Simply applying more Ca to the soil does not necessarily improve fruit robustness.
- Many genetic (**G**) x environment (**E**) x management (**M**) factors indirectly affect Ca availability in the soil and its uptake, translocation, and partitioning within the tree.
- Interactions among groups of determining factors can be linked diagrammatically to reveal relationships that underpin system performance.

What's actually going on with Ca?



Causal Loop Diagram (CLD) …



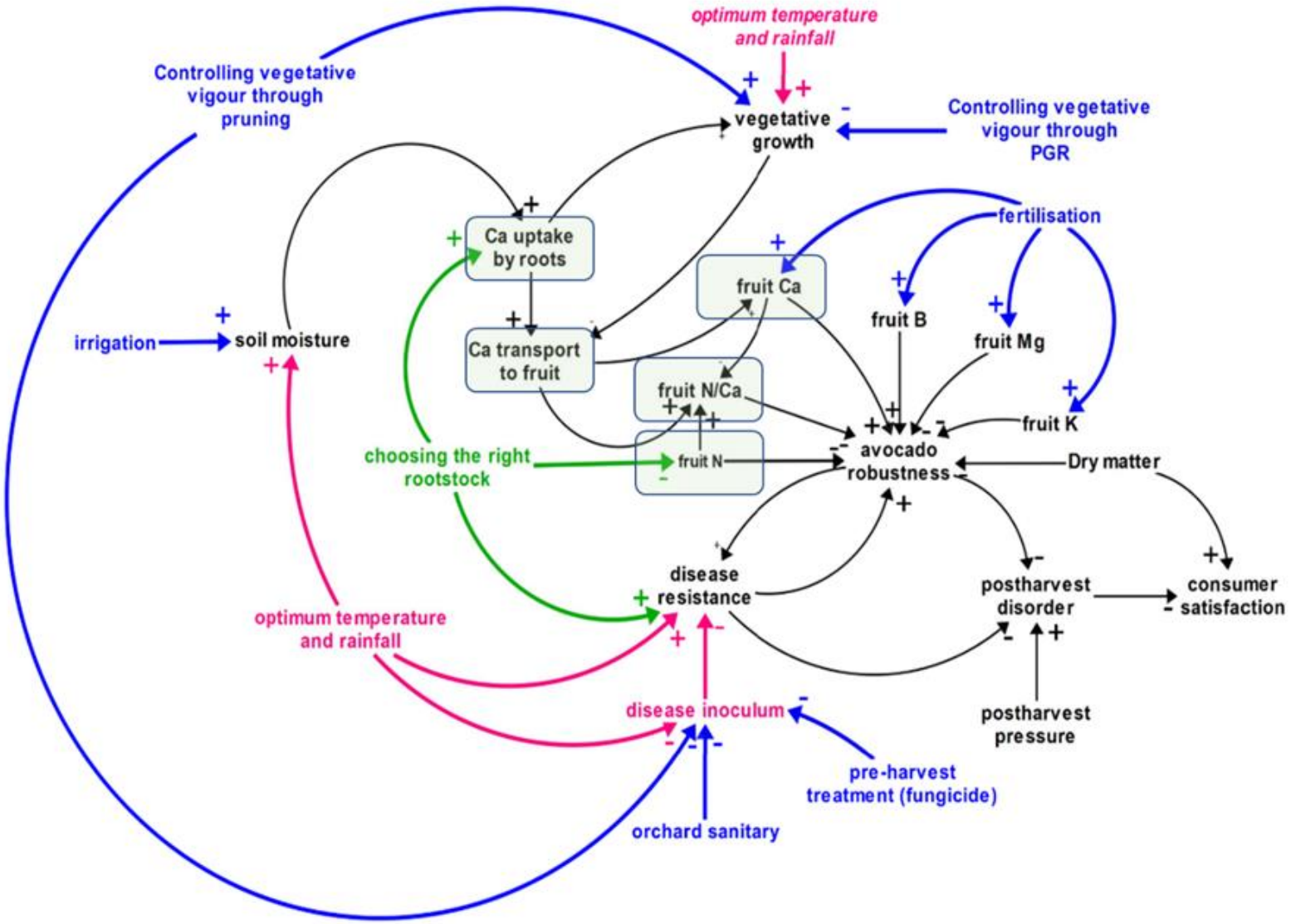
B = balancing loop

R = reinforcing loop

Figure 9. Example of a Causal Loop Diagram (Simple Restaurant Influence Diagram)

Source: Nozdryn-Plotnicki (2010)

- **Systems thinking** to comprehend interactive processes
- **Stakeholder involvement** to empower understanding
- **CLDs** to depict system operation and inform its management
  - Qualitative *models can be made* quantitative

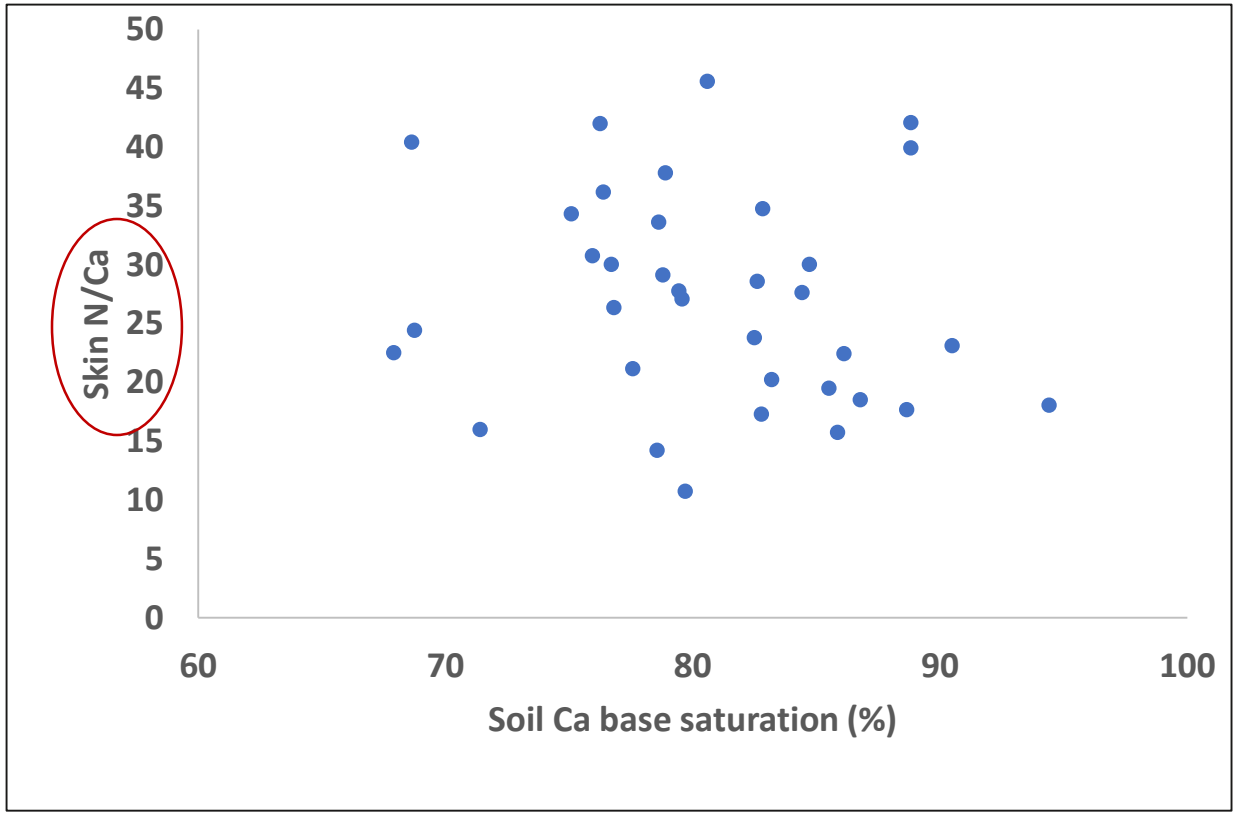


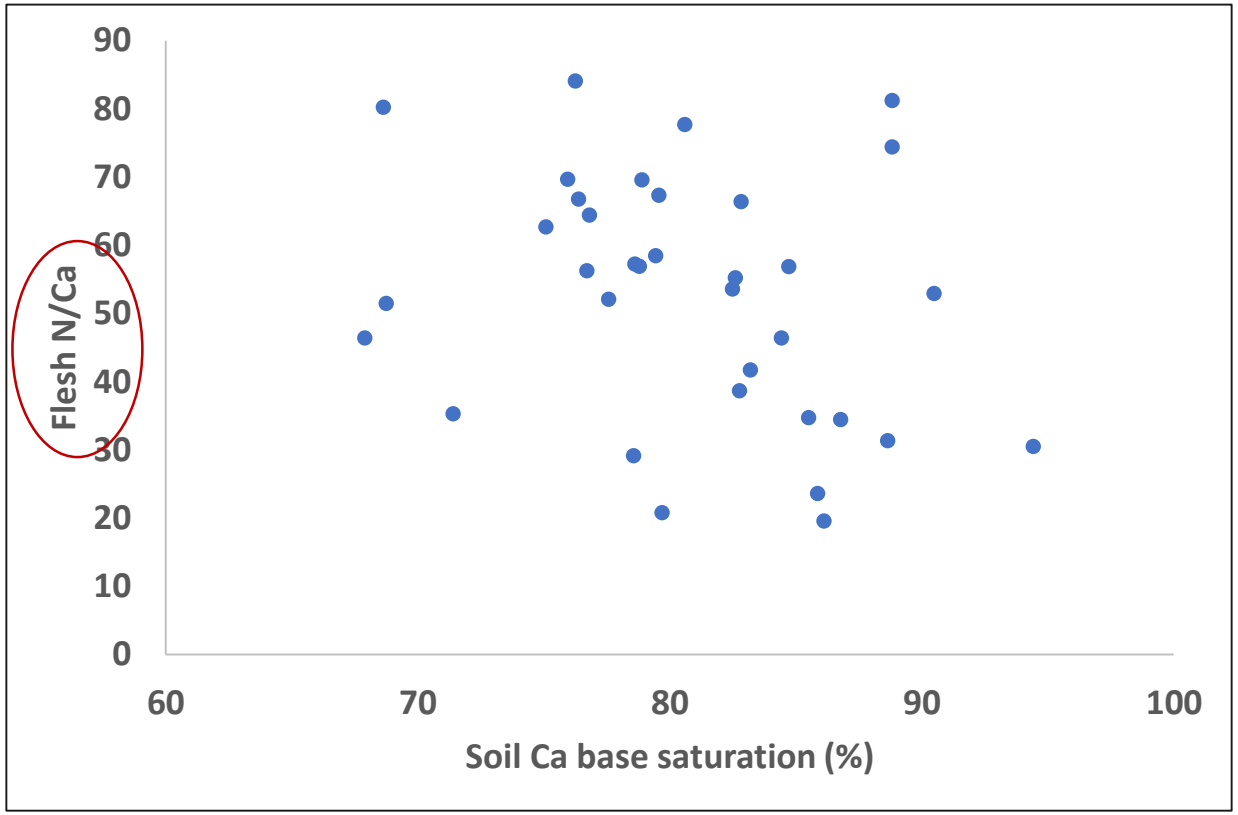
… the ‘big picture’ **CLD**

Researcher generated CLD depicting genetic (**green**), environmental (**pink**), and management (**blue**) factors that influence avocado fruit robustness.

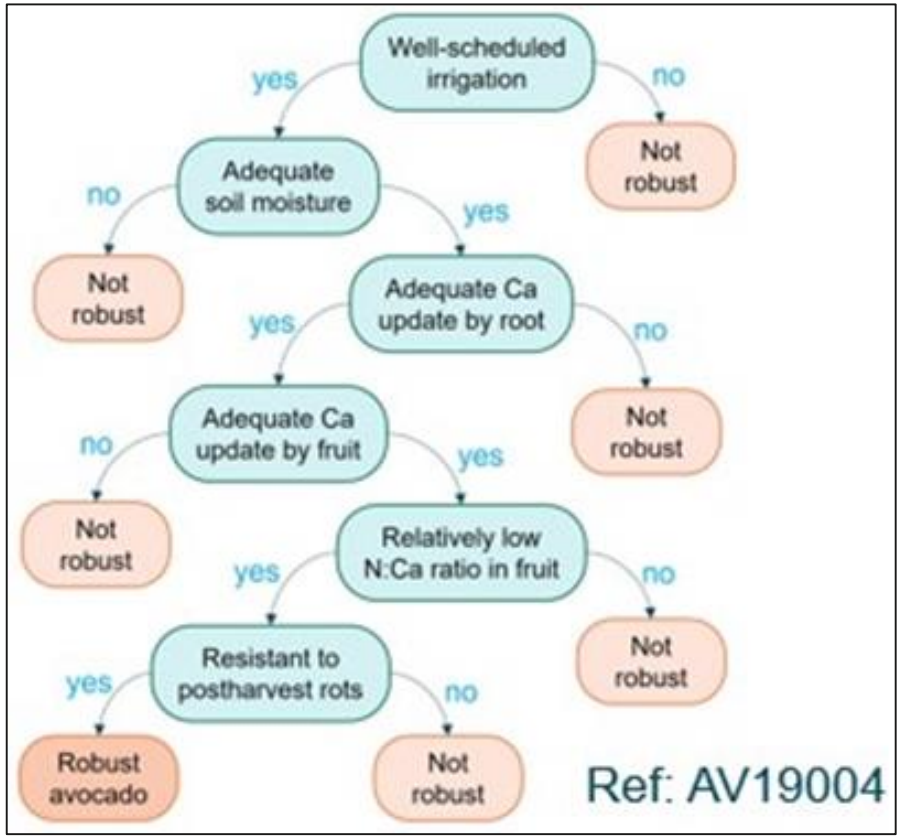
Soil Ca % base saturation vs *skin* and flesh N:Ca

No direct correlation for >65%!?





An integrative decision tree derivative …



How CLDs work …

- Within the CLD, **polarity** for “fruit N” to “avocado robustness” is **negative (-)** to indicate an **increase in fruit N** is associated with a **decrease in fruit robustness**.
- In contrast, **polarity** for “fruit Ca” is **positive (+)** to indicate an **increase in fruit Ca** is associated with an **increase in fruit robustness**.
- Similarly, fruit N and Ca are either negatively or positively influenced by other factors, such as choice of rootstock (genotype) and tree nutrition (management).
- CLDs can function as a Decision Support Tool (DST) to inform and ideally optimize orchard management.

Inherent take home messages

- *Systems thinking* to **comprehend** processes
- *Stakeholder involvement* to **improve** understanding, awareness, and applicability
- *Causal Loop Diagrams* to **capture** interactions

Strategic take home messages

- Systems thinking helps to understand the interactive processes underpinning production of robust avocado fruit.
- Stakeholder involvement empowers understanding beyond that identified through data analysis alone.
- CLDs offer a platform that depicts how the complex production system works towards better informed management actions.
  - They collate processes and depict interactions.

… the ideal outcome

https://www.foodiecrush.com/how-to-ripen-avocados-perfectly/

https://hassavocadoboard.com/wp-content/uploads/Hass-Avocado-Board-07-Common-Fruit-Defects.pdf