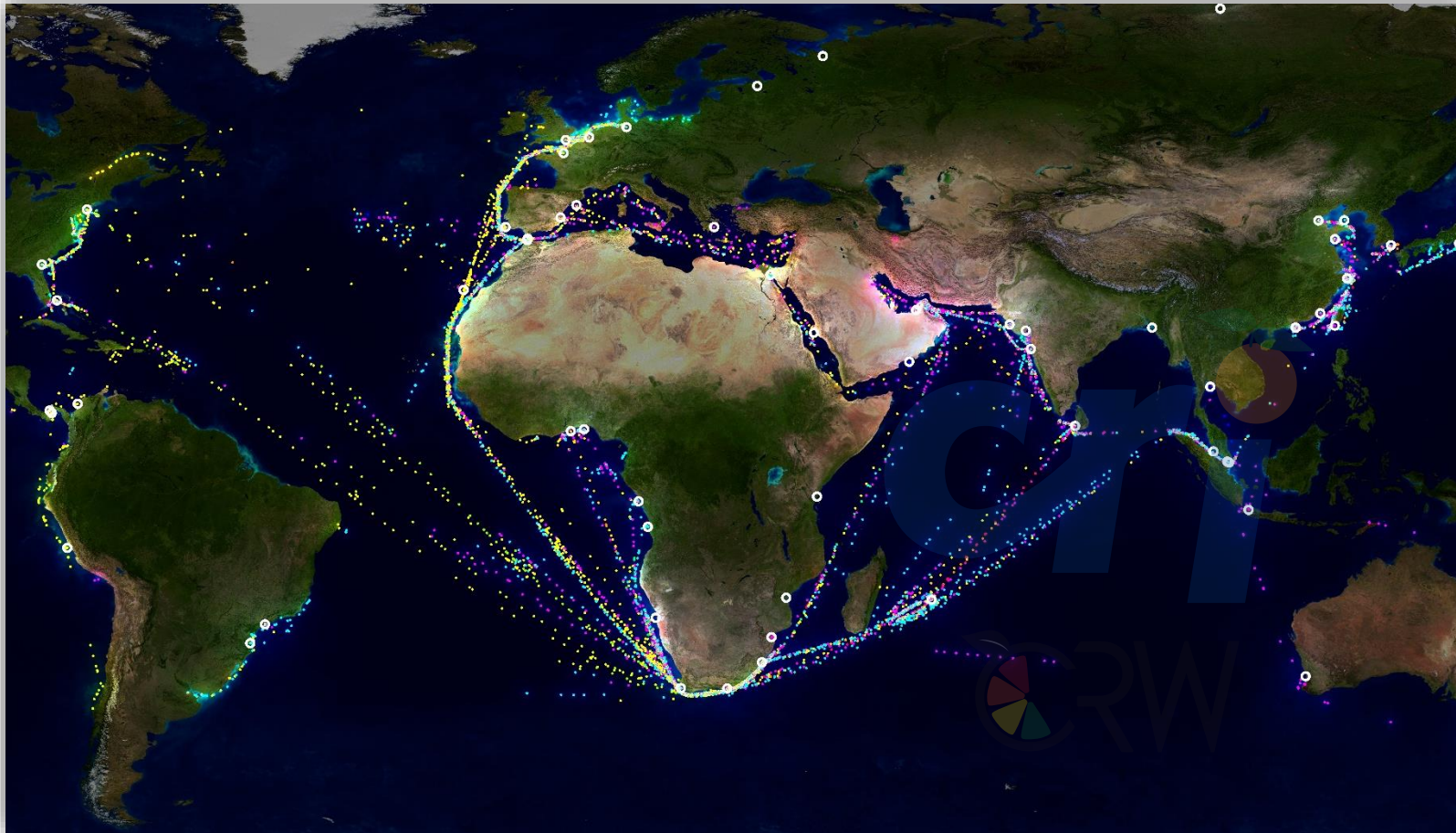




Cold Chain Management for Effective FMS Shipping

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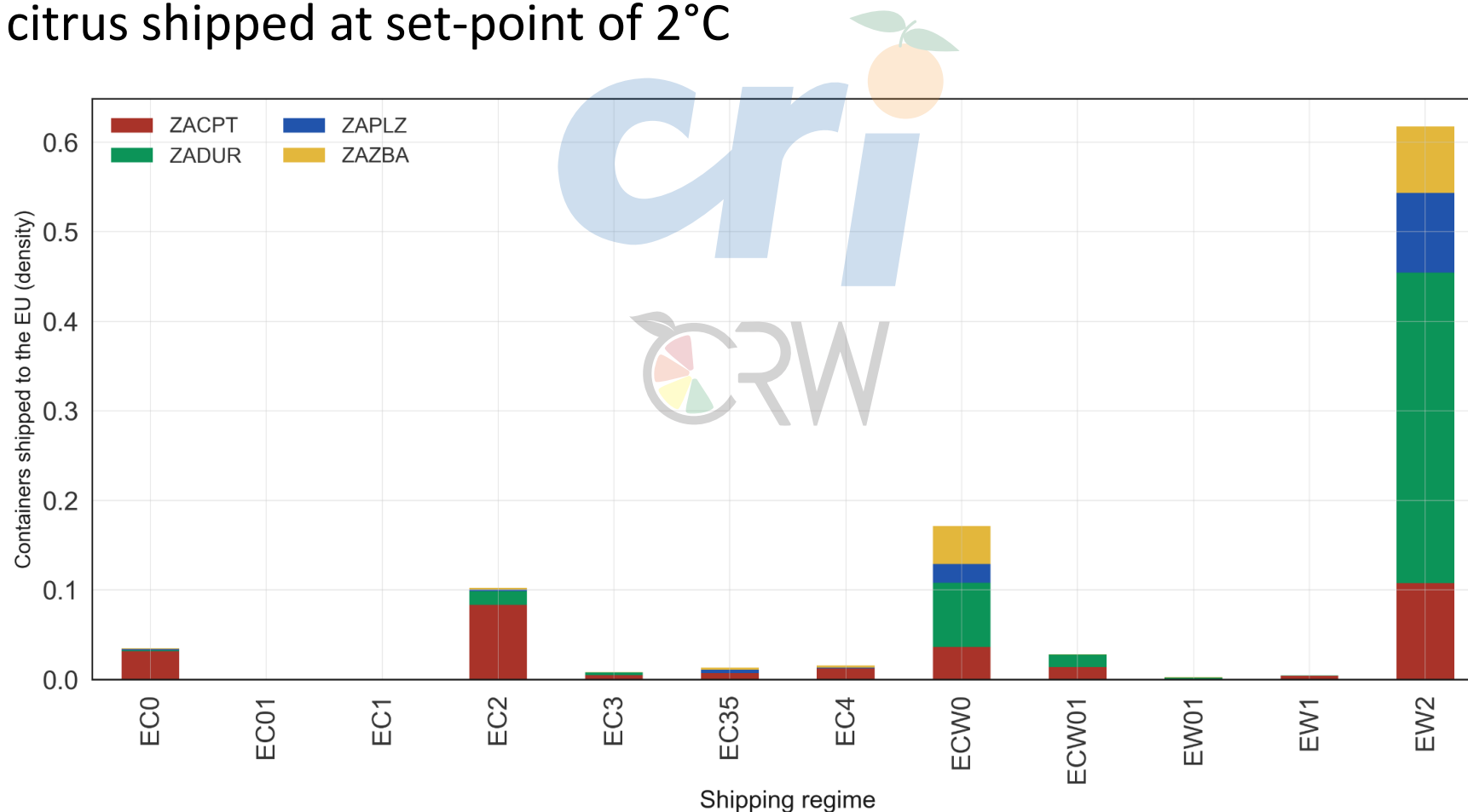
Citrus Research
International

Department of Horticultural
Science, University of
Stellenbosch



FMS stats 2020:

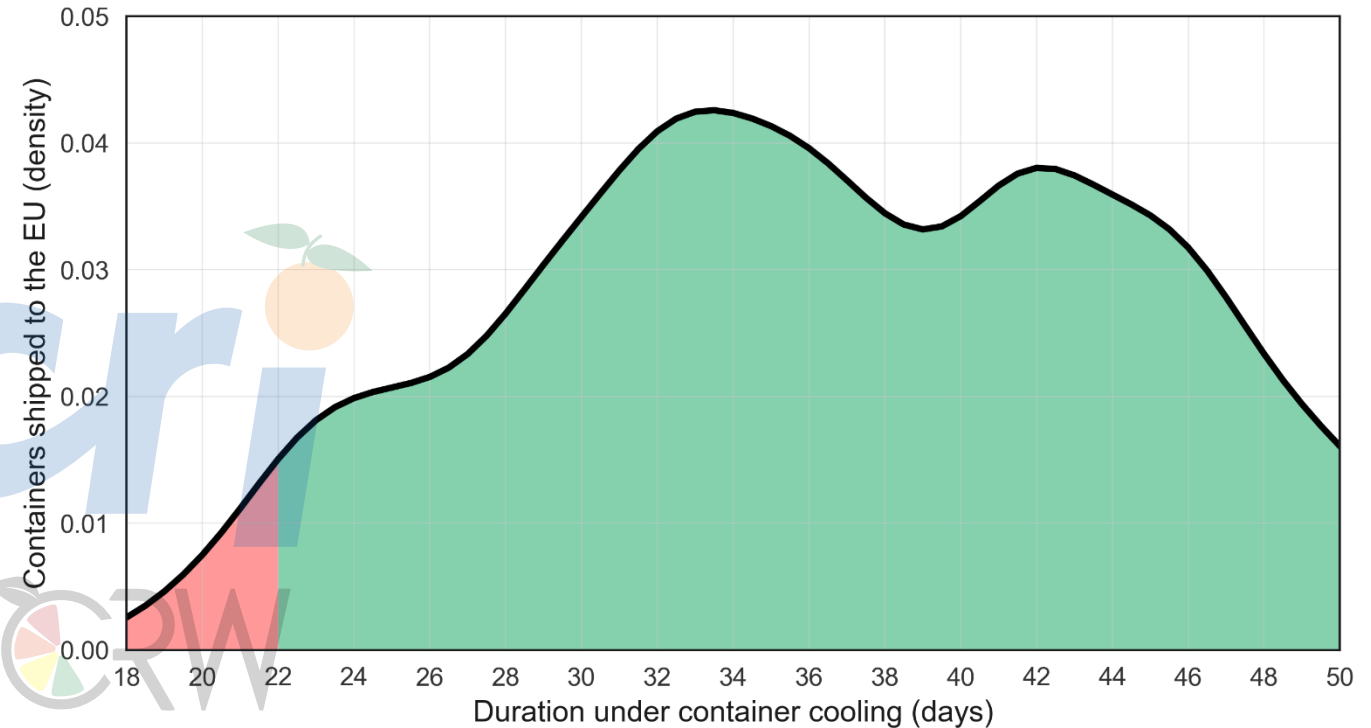
- 14 Interceptions
- >34 000 container shipped to EU
- >62% of container used EW2 and 10% used EC2
- Most FMS citrus shipped at set-point of 2°C



FMS: Our Duration Problem

% FCM eradication during shipping is **time × temperature dependent**

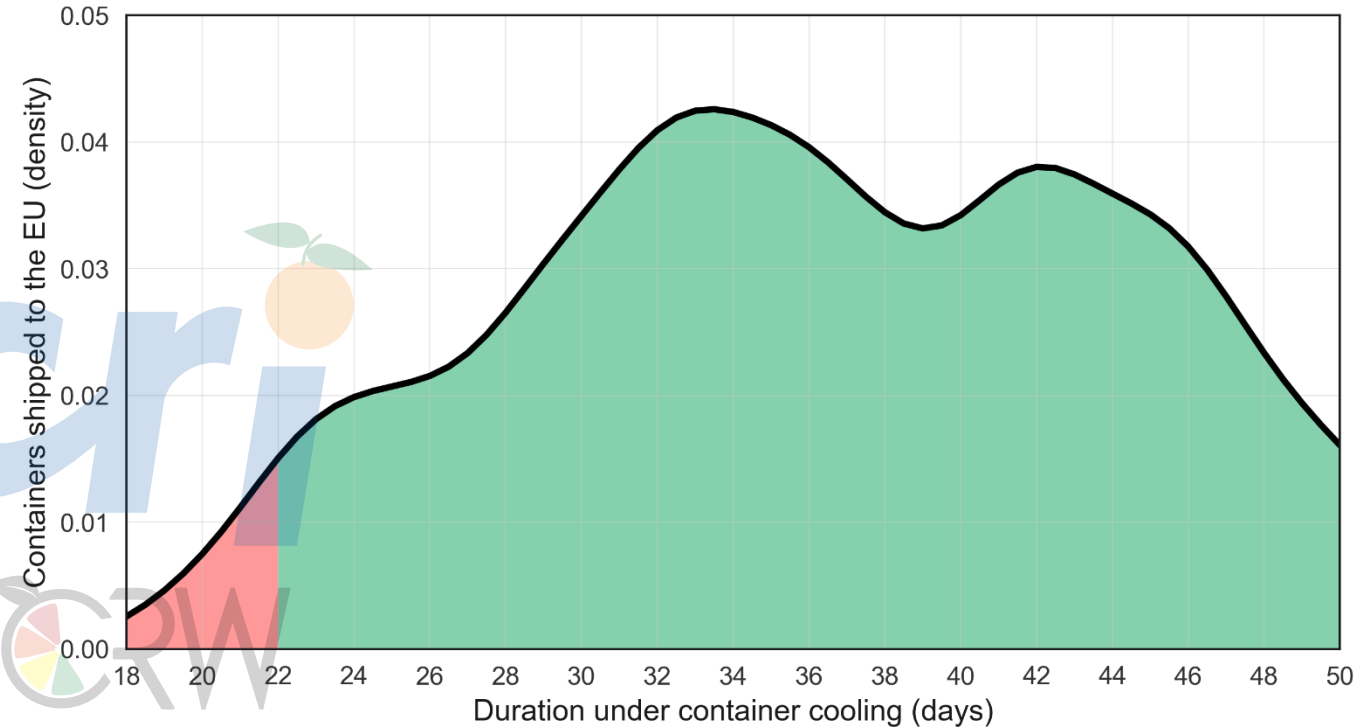
- IF: Setpoint: 0°C
 - then duration = **18 days** (after cool down)
- IF: Setpoint: 1°C
 - then duration = **19 days** (after cool down)
- IF: Setpoint: 2°C
 - then duration = **22 days** (after cool down)



FMS: Our Duration Problem

% FCM eradication during shipping is time × temperature dependent

- IF: Setpoint: 0°C
 - then duration = **18 days** (after cool down)
- IF: Setpoint: 1°C
 - then duration = **19 days** (after cool down)
- IF: Setpoint: 2°C
 - then duration = **22 days** (after cool down)



There is uncertainty in some of our FMS shipments!

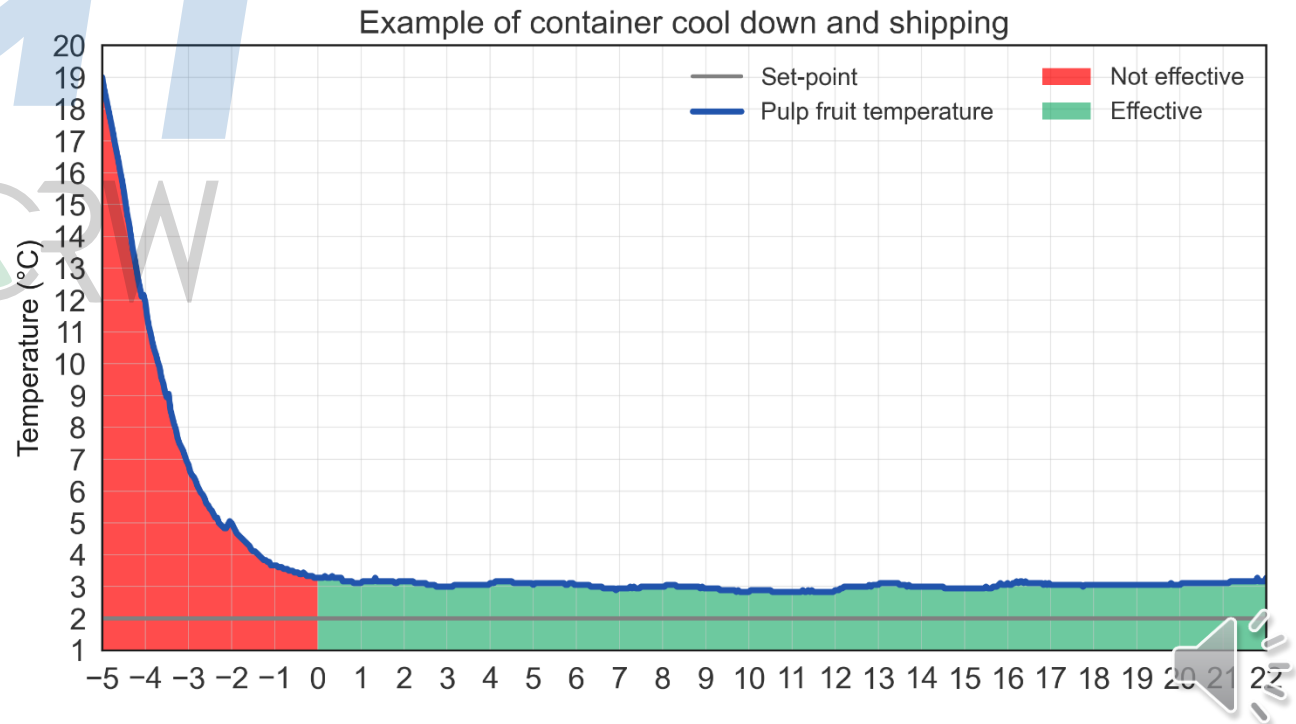
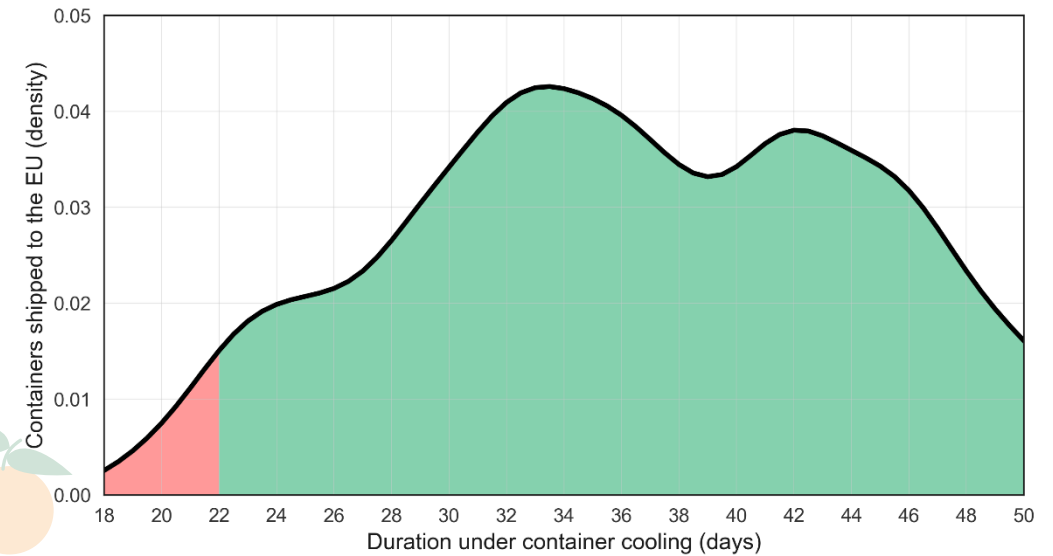
This will become an issue in the near future

Very possibly this year



FMS: Our Duration Problem

- At Set-point: 2°C
 - We need 22 days at stable temperature (set-point + 1°C)
 - For ambient loading: 4-5 days until fruit are cool
- Therefore
 - For Ambient loading with EW2
 - Shipments should be > 27 days!



FMS: Our Duration Problem

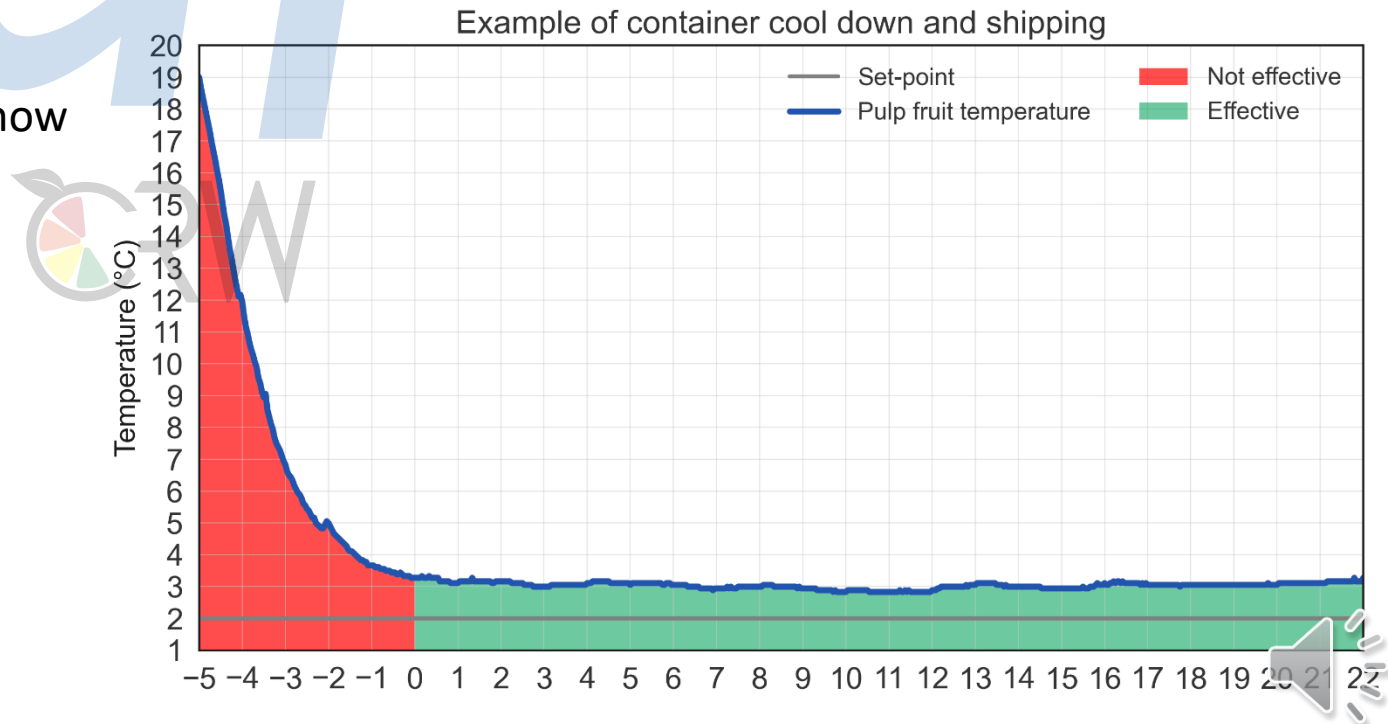
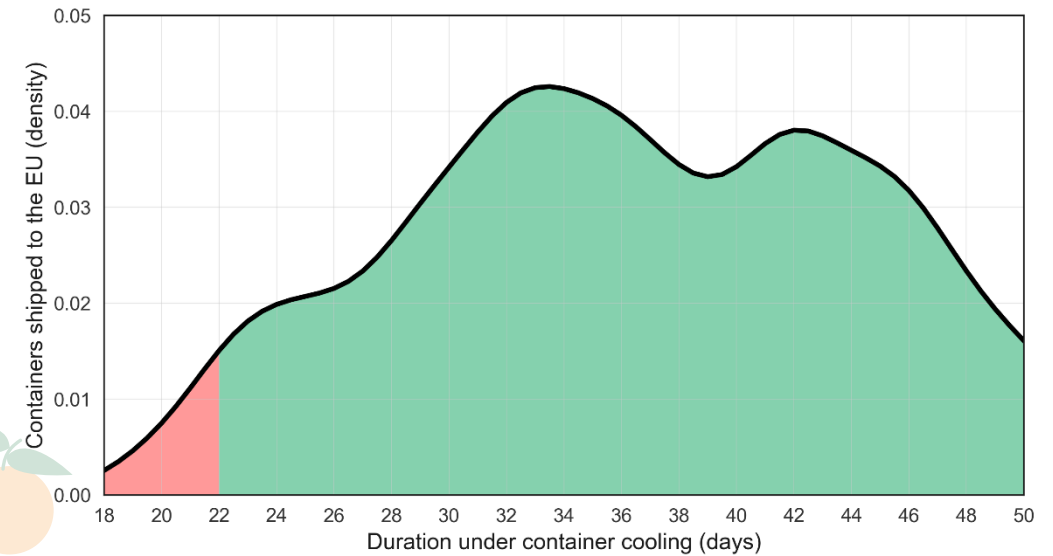
So what now?

Expect stricter regulations

Start preparing now to ease the coming changes

Begin implementing steps to extend the cold chain now

- Setup systems to know when this will be necessary
- Extend cold storage (using shipping set-point)
- Extend the container dwell period before shipping
- Invest in cold storage infrastructure



QUESTION 1

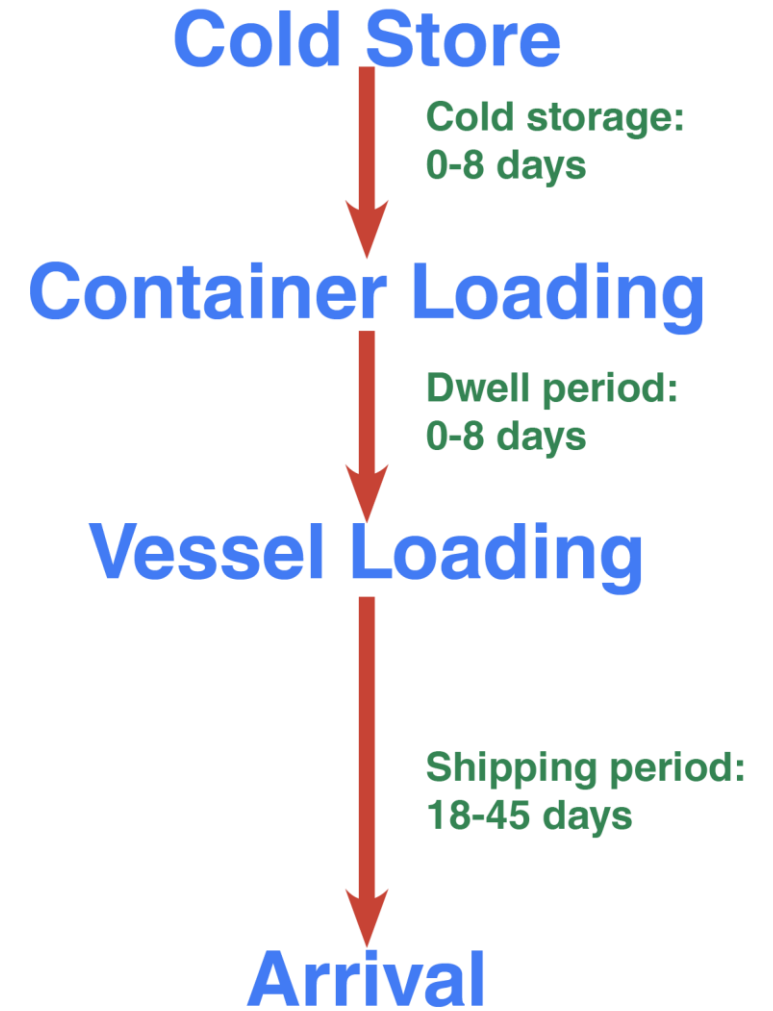
Over 2020, what was the mean duration between container loading and vessel departure (dwell)?

- 0 day?
- 1-2 day?
- 3-4 day?
- 5-8 days?
- Longer



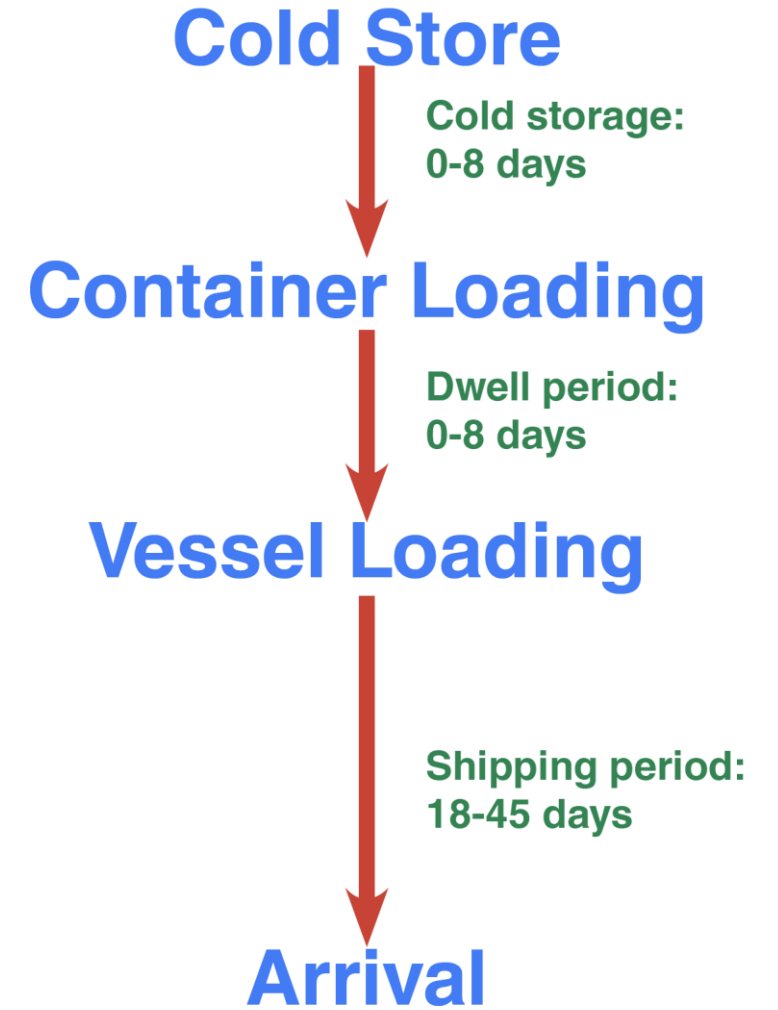
Cooling duration

- Shipping durations: the components:
 - Shipping period: 18-50 days
 - Inland dwell period: 0-8 days
 - Cold storage:
 - Temperature and durations combinations unknown
- Extend cooling if you are expecting a short shipping duration
 - Precooling
 - Longer cold store holding periods
 - Increase container dwell period prior to vessel loading
- Cape Town often has similar cooling durations to Durban
 - Durban has longer shipping durations
 - Cape Town has longer cold storage durations



A note on short shipments (e.g. Spain)

- Some voyages can be <18 days
 - E.g. between Cape Town and Spain
 - Take care here
- If a voyage is expected to be uncharacteristically short
You need to:
 - Extend the cold store period
 - Precool to set-point
 - Extend dwell periods (to reach acceptable containerized cooling periods)



Temperature considerations

- Minimum cooling durations calculated:
 - Warmest fruit temperatures are equal to **set-point + 1°C**
 - This is not always true
 - Multiple factors can increase temperatures
 - i.e. longer durations
- Factors include
 - Container setup
 - Packaging



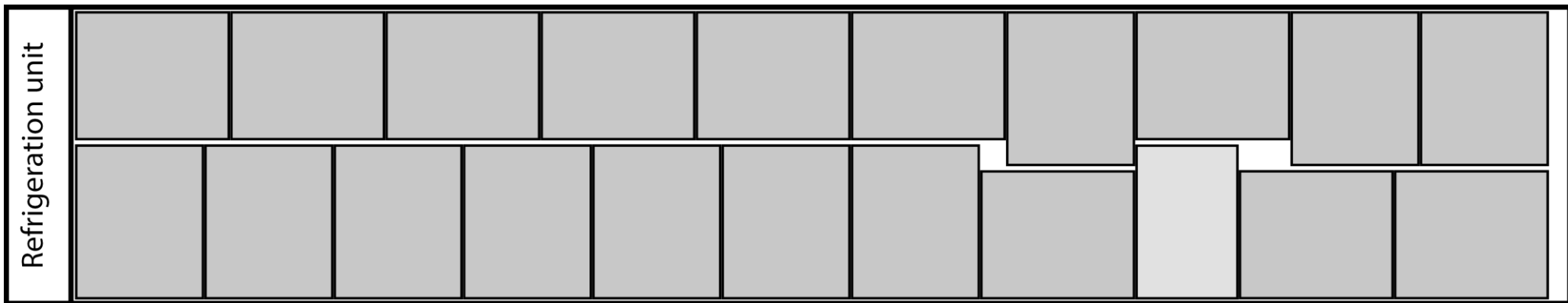
Container factors:

That can increase the set-point + 1°C estimate



New FMS regulation: 21 pallet loadout

- Airflow compromised in containers using 21 pallet load-outs
 - Experiments showed airflow bypassed pallets near the door
 - Resulting in unacceptably high airflow temperatures
- 21 pallet loading configuration only permissible through a dispensation
 - Granted via PPECB
 - Conditional to:
 - Inter-pallet chimney blocking in accordance with PPECB procedure.
 - Installation of additional temperature monitoring as instructed by PPECB
 - Compulsory reporting of the recorded shipping temperatures to PPECB within 24h of arrival at port of destination



Container air manipulation equipment/devices

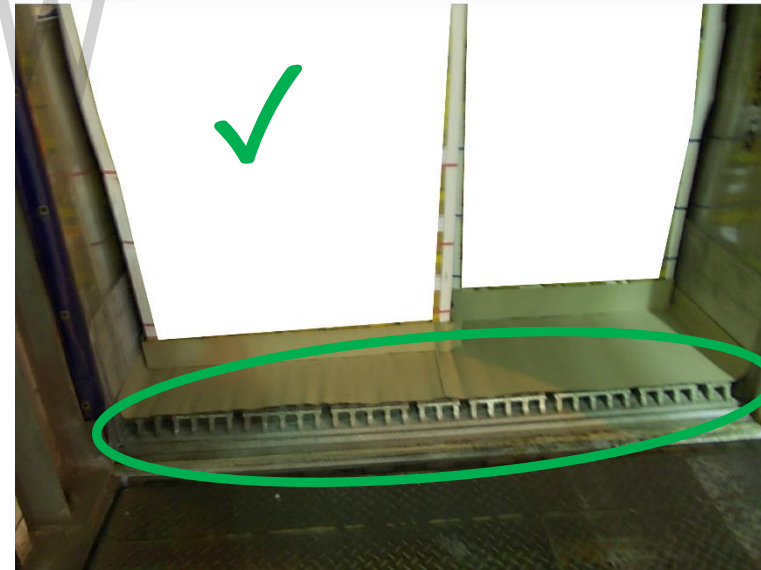
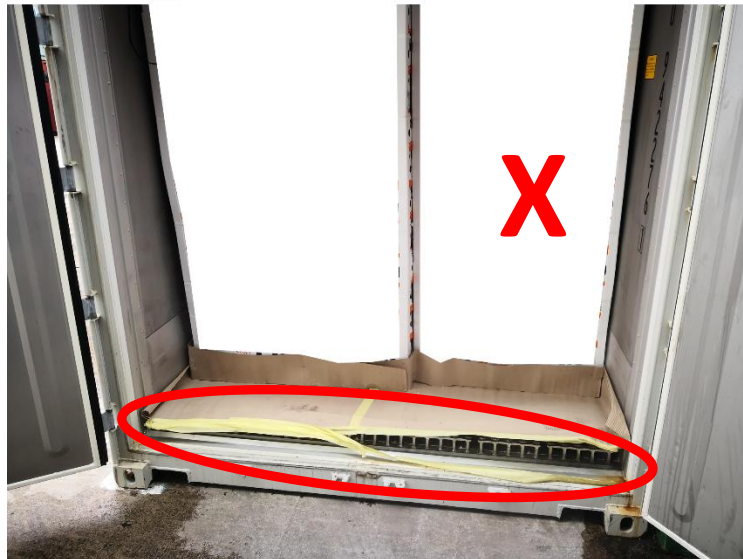
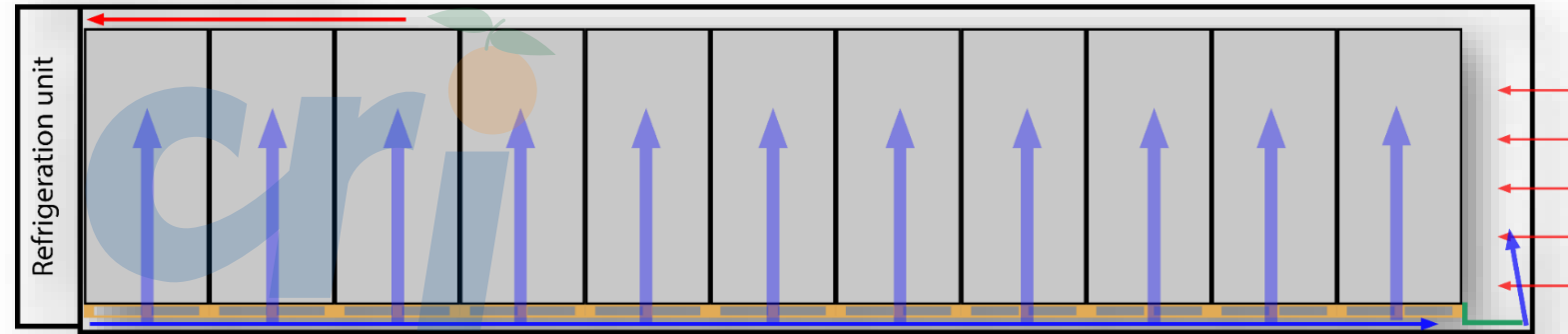
- FMS: No air manipulation equipment/devices can be placed on either the container floor or on top of the pallets.
- Outflow (as an example)
 - No benefit in either ambient loaded containers or cold treatment
 - Avoid Outflow for all markets
- Please notify me (Tarl Berry) if new devices become available.
 - They will be tested



Container cooling performance: Void-plugs

- Void-plugs stop airflow from bypassing pallet stacks
- Use corrugated-board to seal along both the pallet base sides and floor
- Important to leave ends of T-bar floor open so that heat gain from the less insulated door is removed.
- Don't be creative (and take risks!)
We are exploring alternative/better approaches and techniques

Container: Side view



Packaging factors:

That can increase the set-point + 1°C estimate



QUESTION 2

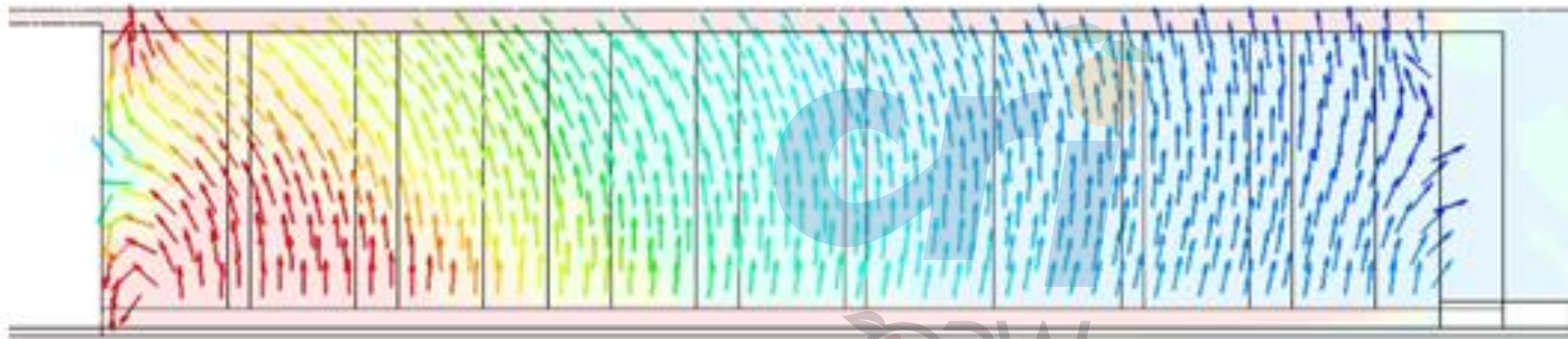
Are you concerned about poorly ventilated packaging?

- Yes very!
- Yes, but I'm worried about meeting market requirements
- Yes, but I just take what the carton manufacturers provide
- No, I have more problems with mechanical failures
- No, just give me the cheapest one!



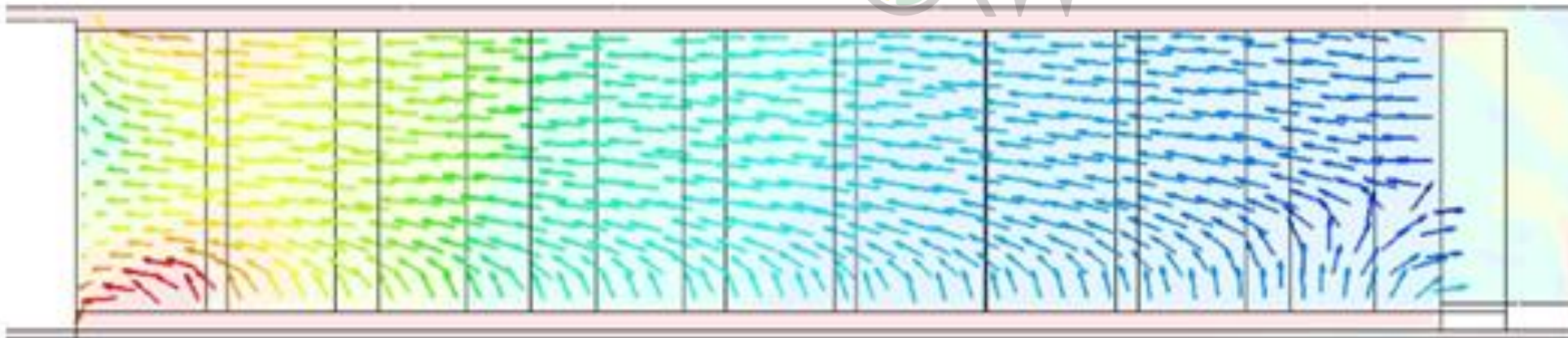
Poor ventilation can disable container cooling

- High emphasis on vent holes on top and bottom of cartons
 - Low vent hole area or obstructions limit cooling!



Vertical flow

Container with **good** vertical ventilation



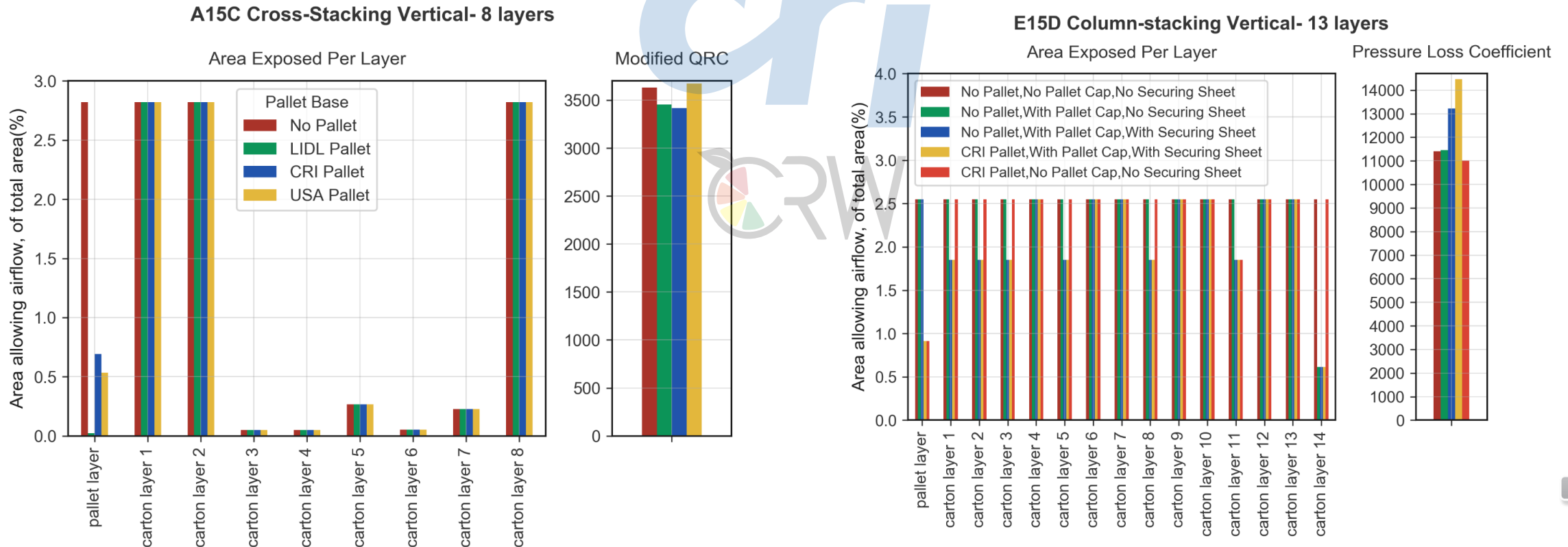
Horizontal flow

Packaging with **poor** vertical ventilation



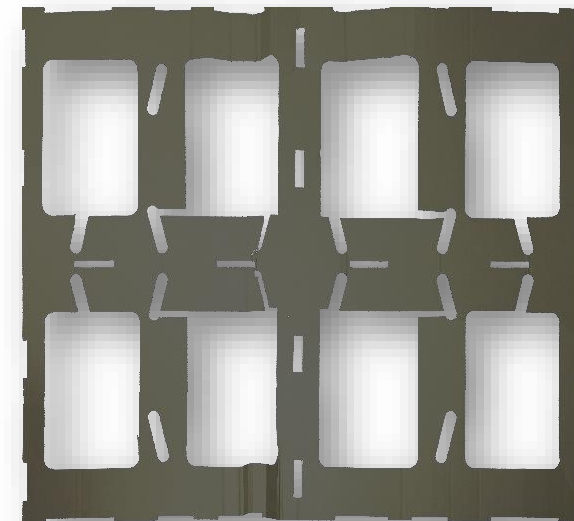
Packaging design

- Beware of display cartons
 - Flow rates can be 4 × lower than A15C!
 - Securing sheets are a big factor
 - Active research area



Packaging: Ventilation and vent alignment

- Cartons should have 5-8% ventilation at the top and bottom of cartons
 - Vent holes should align when stacked
 - Pallet sheets openings should compliment carton vent holes
 - Pallet base should not obstruct vent holes
- Pallet build
 - Pallet base – only CRI recommended
 - Correct placement on pallet + use of corner pieces to ensure square pallet (vent alignment)

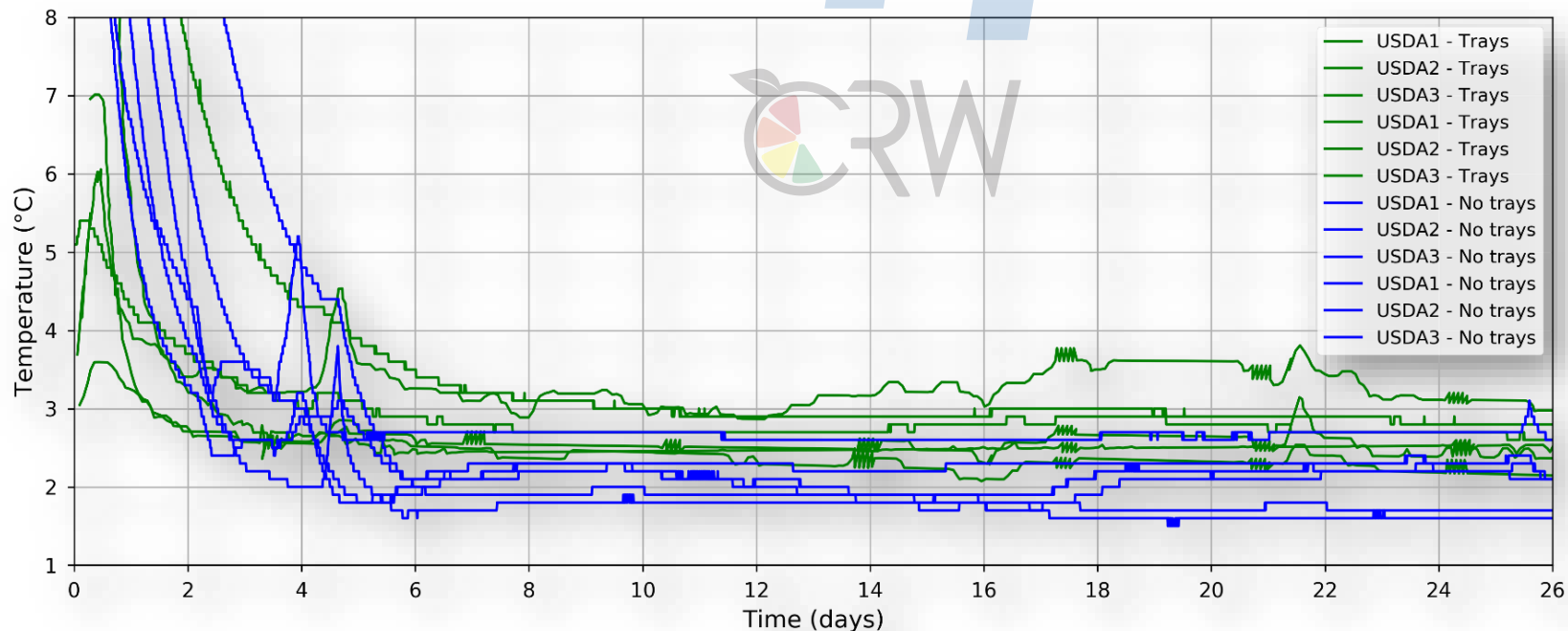


Example of a well-ventilated securing sheet



Packaging: Trays

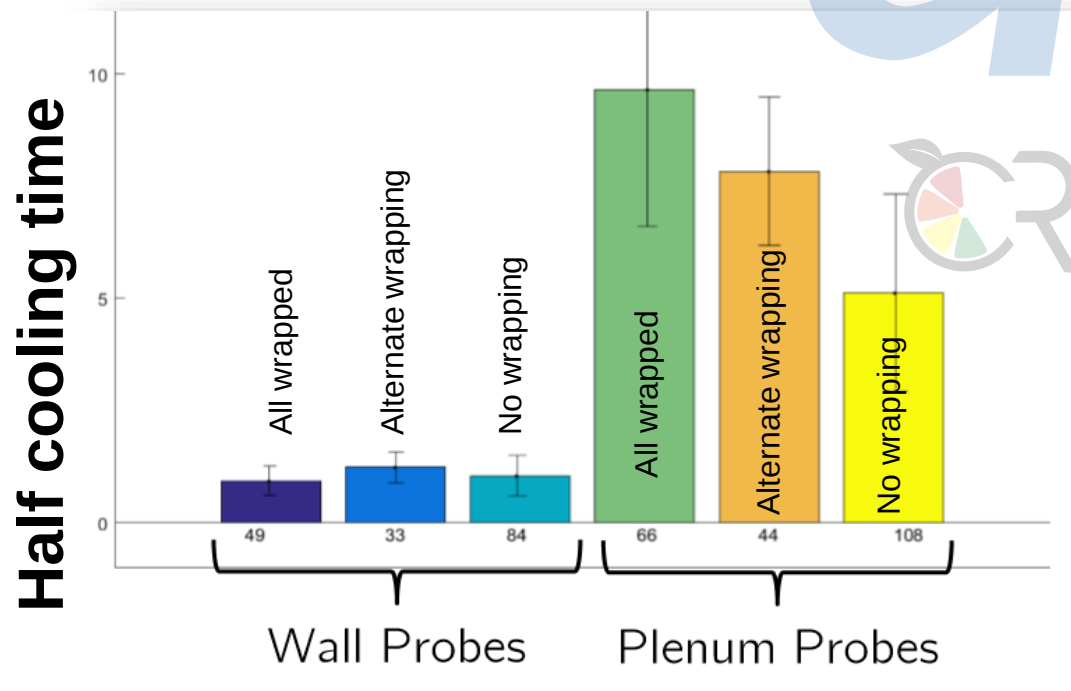
- Trays restrict airflow and reduce cooling rates
- Cooling rates of ambient loaded fruit (containers) were decreased
 - Tray-packed containers reach 3°C after 8 days
 - Control containers reach 3°C within 6 days
- Trays not permitted for FMS markets
- Should be avoided for steri markets as well



Packaging: Fruit wrapping

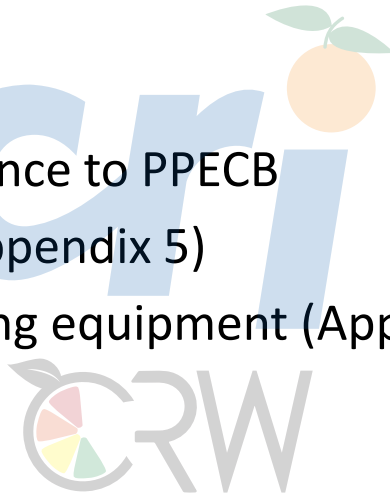
- Greatest effect in middle of pallet stack
 - Wrapped fruit cool 88% slower
 - Alternative layers wrapped cool 53% slower
 - Cooling homogeneity negatively affected
- No wrapping for FMS fruit
 - Exception is made for wrapping of alternate rows on top layer
 - Wrapping should be twisted tight around fruit (if used)

Incorrect wrapping of fruit: Poor cooling!



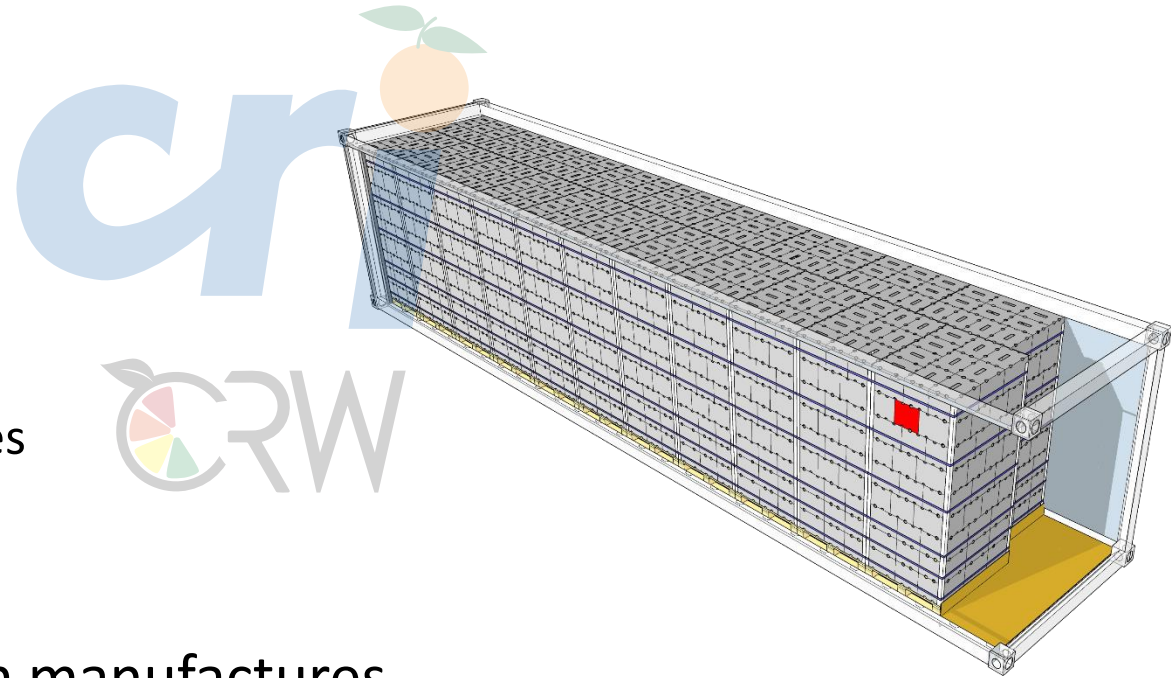
New FMS regulation: Loading facilities

- From 2021, all loading facilities used for FMS must register with DALRRD via Phytclean
- New responsibilities will include:
 - Comply with FMS protocol
 - Report any detected FMS non-compliance to PPECB
 - Only handle appropriate packaging (Appendix 5)
 - Correctly install temperature monitoring equipment (Appendix 6)



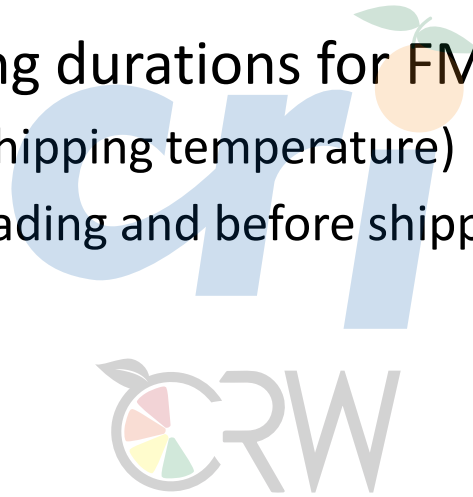
Where should the cellular logger be placed

- Several instances of non-compliance!
- Key monitoring position
 - Near the side wall
 - Second carton from the top
- Position in carton
 - **Inside** carton (cut hole)
 - Place logger away from vent holes
 - **In between fruit**
- Do not follow instructions from manufactures
 - Only use the FMS instructions



Take home message

- Begin preparing for new regulations
 - Could happen this year!
- This would mean regulated cooling durations for FMS
 - Extend period at cold store (at the shipping temperature)
 - Extend period during dwell (after loading and before shipping)
- Invest in cold storage
- Note, cooling is only effective if:
 - The container is setup correctly
 - The packaging is designed and applied correctly



A close-up photograph of numerous dried orange slices scattered across a white background. The slices vary in color from bright yellow to deep orange and brown, showing the internal structure of the fruit.

Thank you!

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