Risk science to support systems approaches

CPM side session: The systems approach: principle, practical tools and an upcoming IPPC Workshop.

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- Thank you for the opportunity to present as part of this side session on systems approaches
- I am from CSIRO, the national scientific organisation in Australia
- I have a particular interest in how we can use science and technology to continue to improve how phytosanitary risks are managed
- Today I've been asked to explain the reasons and triggers for implementing systems approaches, provide an overview of what systems approaches are, and explain how systems approaches can be adaptable to change.

Why implement systems approaches?

- A holistic approach to managing phytosanitary risk recognizes the complexity of modern trade systems
- They can support the risk-based, least trade restrictive management of pests, including where single point treatments are not feasible or practical
- They are compatible with modern commercial production and trade practices
- New technologies offer exciting opportunities for managing phytosanitary risk

- Trade pathways are complex. They are also rapidly evolving through the application of new technologies, digitisation and, with time, climate change.
- This suggest that we should be taking a more holistic approach to managing phytosanitary risks. This, in my mind, is the philosophy behind phytosanitary systems approaches.
- There are a range of factors driving the global interest in systems approaches.
    - Phytosanitary risks need to be managed in a risk-based and least trade restrictive way. Systems approaches can support that, especially where alternatives such as single point treatments are either not feasible or practical.
    - Industry and regulators are also keen to find ways to manage phytosanitary risks that are compatible with modern commercial production and trade practices.
    - Also, new technologies can offer exciting opportunities for modernising how phytosanitary risks can be managed.

What is a systems approach?

A (phytosanitary) systems approach requires two or more phytosanitary measures that are independent of each other (ISPM 14)

ISPM 14
(adopted 2002)

- Systems approaches had its formal origins in the 1980s, with the systems approach ISPM being adopted in 2002.
- However, systems approaches continue to be an active area of research and application globally. Today I will therefore focus on how developments over the past 20 years could be used to build on how we understand and apply phytosanitary systems approaches.
- As defined in ISPM 14, a phytosanitary systems approach is where two or more phytosanitary measures are used that are independent of each other.
- I'll focus on 2 aspects of this definition: the use of the term "phytosanitary measures", and how we can tell whether measures are working independently of each other.

What is a phytosanitary measure?

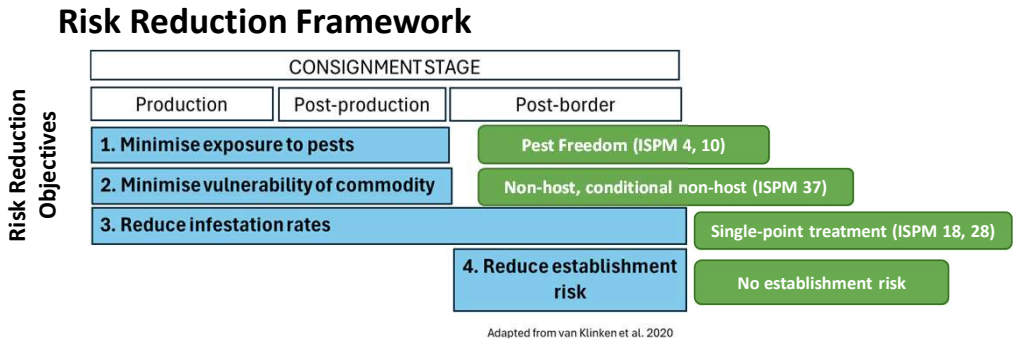
- **Clearly defined**
- **Efficacious (needs to demonstrably reduce risk)**
- Officially required (mandatory)
- Able to can be monitored and controlled by the responsible NPPO

} "Commercial measures"

A (phytosanitary) systems approach requires two or more phytosanitary measures that are independent of each other (ISPM 14)

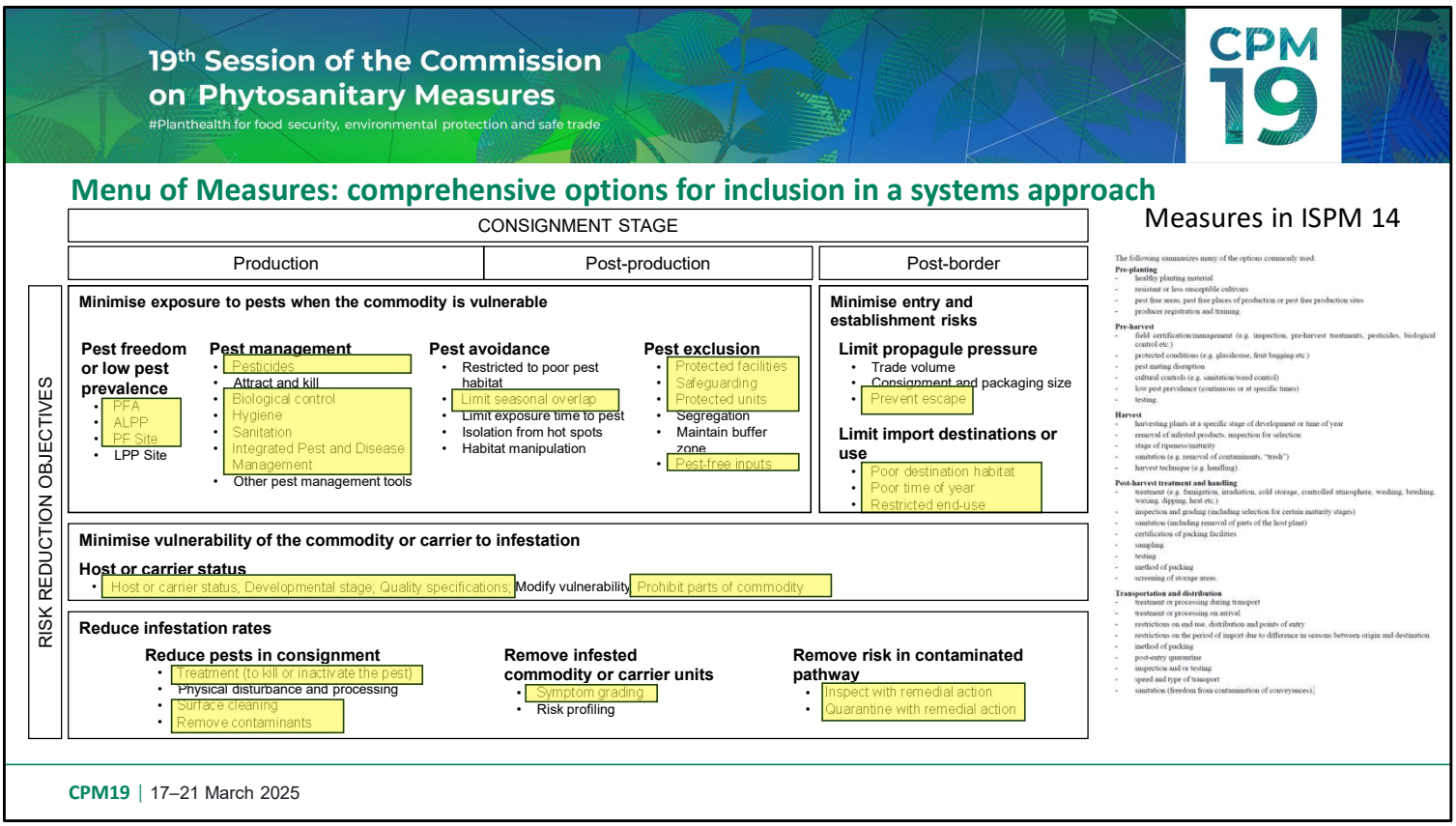
- First of all, what is meant by a phytosanitary measure?
- According to ISPM 14, phytosanitary measures must be clearly defined, be effective, be mandatory and be under NPPO oversight. However, I will be taking a broader perspective of systems approaches to include both phytosanitary measures as well as commercial measures. Here, commercial measures also reduce risks but are not necessarily officially required and monitored. We will see why this distinction can be important shortly.

Measure options: How do they reduce risk?



van Klinken et al. 2020 (Crop Protection)
van Klinken et al. 2023 (Biological Invasions)

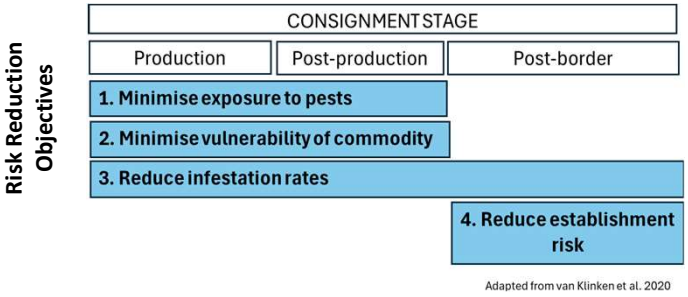
- So what measure options are there for including in a systems approach?
- Our first step to answering that question was to review 1800 phytosanitary measures that have been applied across all pathways, and to ask one question: “how do they each reduce risk?”
- From this work we found that these measures reduced risk in one of only four ways. These 4 risk reduction objectives are: to minimise exposure to pests, minimise vulnerability of the commodity, reduce infestation rates and reduce entry and establishment risks.
- Importantly these risk reduction objectives largely align to stand alone measures described in existing ISPMs
- This risk reduction framework is important because it provides us with a structured way to think about and apply systems approaches.



- Measures identified in our review were further classified under each of the 4 risk reduction objectives according to how they reduce risk
- This resulted in a comprehensive menu of measures which contains 41 different measures classified under 10 measure categories
- Now let us check in to see what happened to the measures mentioned in ISPM 14, when we map them according to how they reduce risk.
- Importantly, the ISPM measures map well to our Menu of Measures. There were also quite a few measures that were not mentioned in ISPM 14.
- This works shows that there is a diverse tool kit, or menu, of measures that could be incorporated into a systems approach.

Using the Risk Reduction Framework to define independent measures

Risk Reduction Framework



Adapted from van Klinken et al. 2020

A (phytosanitary) systems approach requires two or more phytosanitary measures that are independent of each other (ISPM 14)

- **Dependent measures** work together towards the same risk reduction objective
- **Independent measures** address different risk reduction objectives

- The second aspect of the ISPM 14 definition of systems approaches that I wanted to address today was independent measures.
- The requirement for measures to work independently of each other lies at the heart of systems approaches. In ISPM14, independent measure are defined as having a multiplicative effect on each other. However, I find this definition very challenging to interpret and apply.
- An alternative, and I think much simpler, approach is to use the Risk reduction framework to define independence.
- Here, measures that work together to reduce the same risk reduction objective are considered to be dependent. Likewise, measures that address different risk reduction objectives are considered independent.
- Next, I will provide examples of how the risk reduction framework and Menu of measures can be applied to develop a set of dependent measures, and a set of independent measures.

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An example of combining dependent measures: Pest Free Area

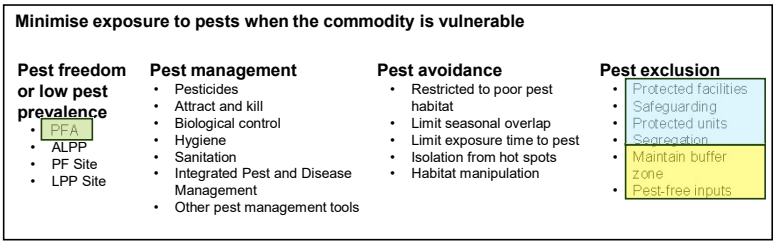
Dependent measures work together towards the same risk reduction objective

Green: The primary measure

Yellow: Dependent or supporting measures to help ensure pest freedom is maintained in the designated area

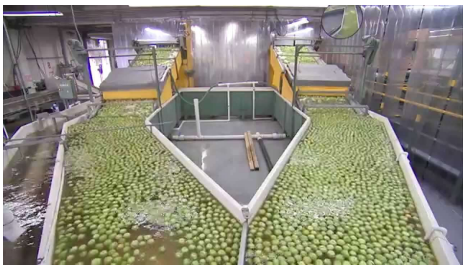
Blue: additional measures to manage risk of post-harvest infestation

Inspection and remedial action (e.g. 600 fruit inspection) used as an assurance and compliance step.



- First, I will start with an example of how multiple dependent measures can be combined. This would not meet IPSM 14s definition of systems approaches.
- In this case the primary phytosanitary measure is Pest Free area (highlighted in green). The PFA measure provides confidence through surveillance, and management responses if thresholds are exceeded, that the pest does not occur in the designated area
- This measure is then supported by other phytosanitary measures (highlighted in yellow). These contribute to giving confidence that the pest is absent within the designated area. For that reason, they would be considered “supporting” or “dependent” measures. This could include conditions to prevent entry of infested produce into the PFA, and a requirement to maintain a buffer zone around the Pest Free Area.
- Additional measures (in blue) may also be needed if the produce can become infested when it is moved outside of the PFA and prior to export. These might include secure storage and segregation.

An example of a systems approach (combining independent measures)



Protected cropping → Picked and graded → Refrigerated storage & transport

- My second example is of a systems approach that includes independent measures. I use this example to look at how a systems approach could be developed, evaluated and applied.
- In this hypothetical example, we are considering a quarantine pest of fruit that is grown in glasshouse facilities before being picked and graded in a pack-house and then stored and transported under refrigeration to maintain quality and shelf life.

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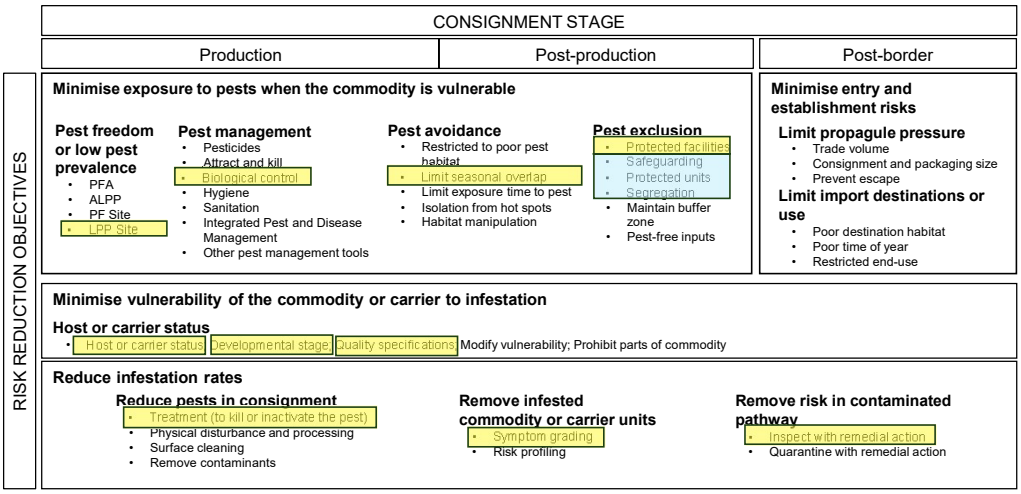
An example of a systems approach: Identifying potential measures

Independent measures address different risk reduction objectives

- Yellow: Potential measures
- Blue: post-harvest infestation measures



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- Again we start with the Menu of Measures
- The first step is to identify all possible measures across the four risk reduction objectives that could be used to reduce risk
- Here we have identified potential measures from three risk reduction objectives. They include measures that minimise exposure to the pest, minimise host vulnerability, and reduce infestation rates.
- Again, these include measures (in blue) to manage post-harvest or post-treatment infestation risks. Although important, these are common even to single point treatments such as fumigation. I believe that they can therefore be considered separately from the phytosanitary systems approach. I won't discuss those further today.

An example of a systems approach: assessing efficacy of potential measures

Risk reduction objective & measure	Description	Reduce risk on its own?
Reduce exposure		
Low Pest Prevalent Site	Trapping with corrective actions	Yes
Protected facilities	Partially secure glasshouse	Limited
Pest Management (e.g. biological control)	Inundative biological control	Limited
Limited seasonal overlap	Harvest is completed before pests build up	Limited
Minimise host vulnerability		
Host quality specifications	Supply chain has fruit quality requirements (no surface damage)	Yes
Poor developmental stage	Fruit transported at immature stage for shelf- life requirements.	Yes
Reduce infestation rate		
Kill treatment	Cold storage or treatment	Yes
Symptom grading	Automated grading in packhouse	Limited

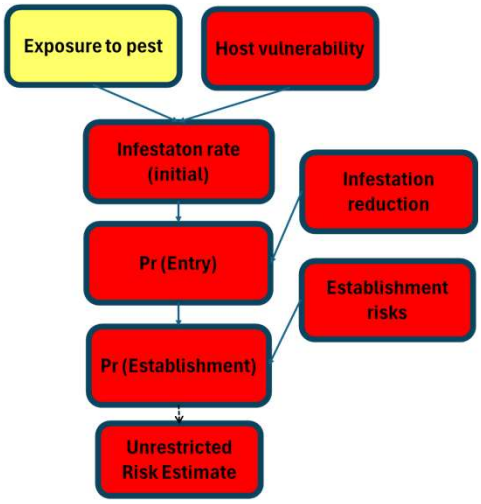
- The next step is to individually assess how effective each potential measure is at reducing risk. It was concluded that 4 of the 8 measures had limited effect. For example,
  - The physical barrier provided by the glasshouses was not as effective as expected in reducing risk.
  - Nor was limiting production to time when the pest was least active. Biological control was applied inconsistently and was difficult to apply at scale.
  - Furthermore, infested fruit weren't consistently removed during the fruit grading process because pest symptoms were difficult to detect.

An example of a systems approach: short-listed measures

Risk reduction objective & measure	Description	Reduce risk on its own?
Reduce exposure		
Low Pest Prevalent Site	Trapping with corrective actions	Yes
Minimise host vulnerability		
Host quality specifications	Supply chain has fruit quality requirements (no surface damage)	Yes
Poor developmental stage	Fruit transported at hard stage for shelf-life requirements.	Yes
Reduce infestation rate		
Kill treatment	Cold storage or treatment	Yes

- That leaves us with four short-listed measures for further consideration
- Together they include measures that address three different risk reduction objectives (independent measures), and two different measures that work together to minimise host vulnerability (dependent measures)
- We have worked out that each of these measures are good at reducing risk
- The next step is to work out which combination of these are needed to meet ALOP

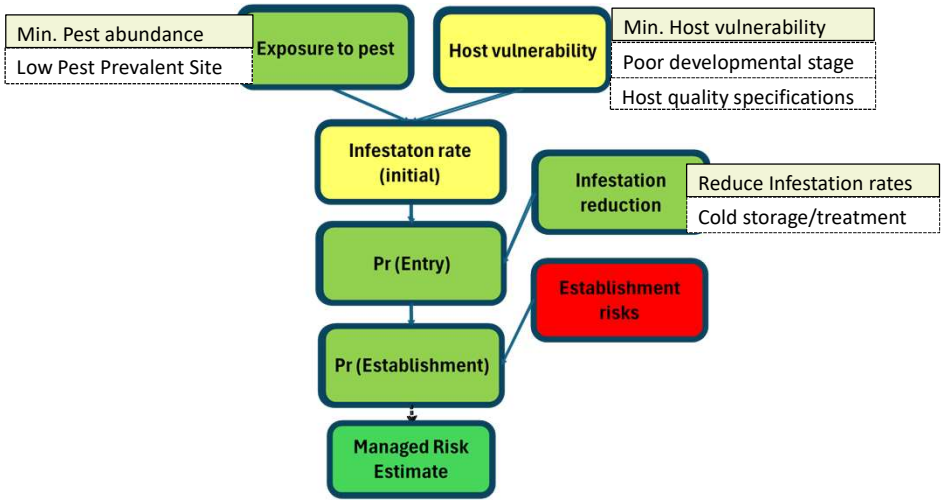
Assessing combined efficacy of measures: a qualitative approach



Managed by a systems approach

- A qualitative approach can be taken to assess how our short-listed measures can combine to reduce overall phytosanitary risk
- Our original risk assessment has identified that the unmanaged risk of establishment is unacceptably high (red). This is because pest exposure is high, and the fruit is a good host. This will result in high infestation rates.

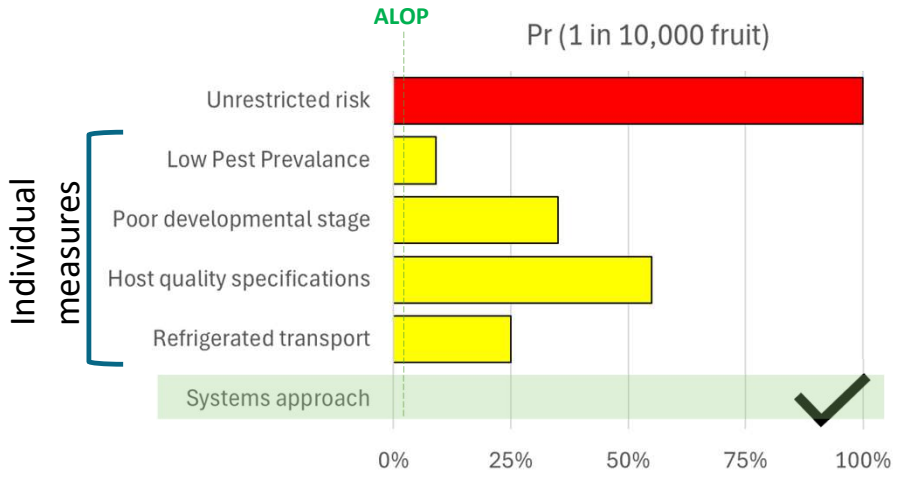
Assessing combined efficacy of measures: a qualitative approach



Managed by a systems approach

- However, qualitative analysis shows
  - That keeping pest levels on the site to low levels will greatly reduce the pest exposure risk, and therefore the likelihood that fruit will become infested
  - That host vulnerability will be greatly reduced by restricting trade to fruit that is not yet fully mature and that is free from external damage
  - And that storage and transportation under refrigeration will result in substantial in-transit pest mortality
  - It also shows that when these measures are combined they will bring the risk of entry and establishment to acceptably low levels.

Assessing combined efficacy of measures: a quantitative approach



PRReSTo

(Pest Risk Reduction Scenario Tool)

The Pest Risk Reduction Scenario Tool (PRReSTo) for quantifying trade-related plant pest risks and benefits of risk-reducing measures

Jens G. Froese, Justine V. Murray, Nicholas J. Beeton, Rieks D. van Klinken

Froese et al. 2024 (Crop Protection)
PRReSTo Risk Tool

- Quantitative approaches can also be applied to determine the effect of combining measures. This can be particularly useful if we need to estimate how effective a measure needs to be within a systems approach.
- Here we used a publicly available quantitative tool that we have developed called PRReSTo. The Pest Risk Reduction Scenario Tool.
- By using this tool we can estimate how effective each measure will be in reducing the likelihood of pests being present in the consignment. For example, imposing host quality specifications will almost halve the infestation risk. We can see that each measure reduces infestation risk by quite a lot. However, all four are needed in combination to meet ALOP.

Implementation of "phytosanitary systems approach"

- The *poor developmental stage* measure is not required as no additional assurance is needed

Scenario 1 (phytosanitary systems approach): combines three independent phytosanitary measures

Scenario 2 (low pest prevalent site measure): assumes no additional assurance is needed for poor developmental stage and extended cold storage.

Risk reduction objective & measure	Description	Phytosanitary measures	
		Scenario 1	Scenario 2
Reduce exposure			
Low Pest Prevalent Site	Trapping with corrective actions	Yes	Yes
Minimise host vulnerability			
Poor developmental stage	Fruit transported at hard stage for shelf-life requirements.	Not required to be mandated	
Host quality specifications	Supply chain has fruit quality requirements (no surface damage)	Yes	No
Reduce infestation rate			
Kill treatment	Cold storage or treatment	Yes	No

- The final step when developing a phytosanitary systems approach is to work out how to have confidence that the short-listed measures will be applied effectively.
- In this example, trade is already restricted to immature fruit stages to maintain shelf life. It is therefore decided that this measure does not require NPPO oversight as a phytosanitary measure
- We are now left with 3 potential phytosanitary measures.
- In one scenario all three remaining measures require NPPO oversight. This would result in a phytosanitary systems approach, with three independent measures.
- In the other scenario the importing NPPO has confidence that host quality specifications will be consistently applied for commercial reasons, and that cold exposure during transit will always cause the required pest mortality. In this case, we are left with only one phytosanitary measure that is under the direct oversight of the NPPO. This would technically not be a phytosanitary systems approach.
- In one scenario we have three phytosanitary measures and one commercial measures, whereas in the other we have only one phytosanitary measure and 3 commercial measures. However, the resulting risk reduction would be the same.

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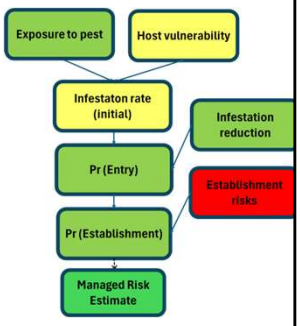
Systems approaches can be adaptable to change

- Pest risk and efficacy of management options can change for many reasons
  - Changes in pest risk profile (distribution shift, climate change, new industries)
  - Changes in production and supply chains
  - New phytosanitary measures (e.g. see Menu of Measures)
  - New technologies
- Applying "systems thinking" allows changes in risk profiles and the effectiveness of a set of measures to be assessed and updated
- Phytosanitary systems approaches can accommodate flexibility in what measures are included, and their required strength



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- As we have seen, systems approaches requires understanding how risks can be both created and managed through production and supply chains. One advantage of taking this holistic approach to managing phytosanitary risks is that it is adaptable to changes in both pest risks and the options for managing those risks.
  - Many factors can change pest risk over time. For example, the way that apples are grown has changed dramatically over the past 100 years, which change both the risk of different pests and the options for managing those risks. Similarly, climate change will also impact phytosanitary risks and they can be managed.
  - New management options can emerge. Our Menu of Measures highlight the wide range of possible measures that are available, many of which may be underutilised.
  - New technologies are being adopted by the agriculture sector. For example, the use of advanced, optical grading technologies provide new opportunities for detecting and removing infested fruit.
- A strength of systems approaches is that they are versatile. The approach to developing systems approaches that we've worked through today can be used to consider changes in the pest or the agricultural system that might affect phytosanitary risk, and how best that risk should be managed. And the frameworks and tools that I've introduced today allows this to be done more easily.

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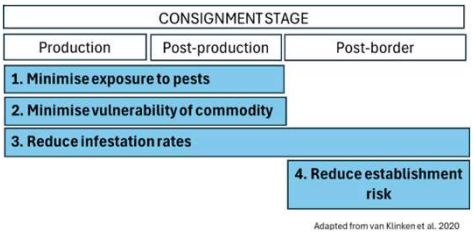
Conclusions

- There are many reasons and opportunities to continue to apply, evolve and adapt systems approaches
- ISPM 14 remains an important guide to how to do this, but the supporting science, trade systems and pressures on regulators continue to evolve.
- Today we explored two opportunities for progressing how we apply systems approaches
  - Using the risk reduction framework and Menu of Measures to help apply systems approaches.
  - Extending systems approach thinking to apply to both commercial and phytosanitary measures
- We can accelerate progress by continuing to strengthen international collaborations



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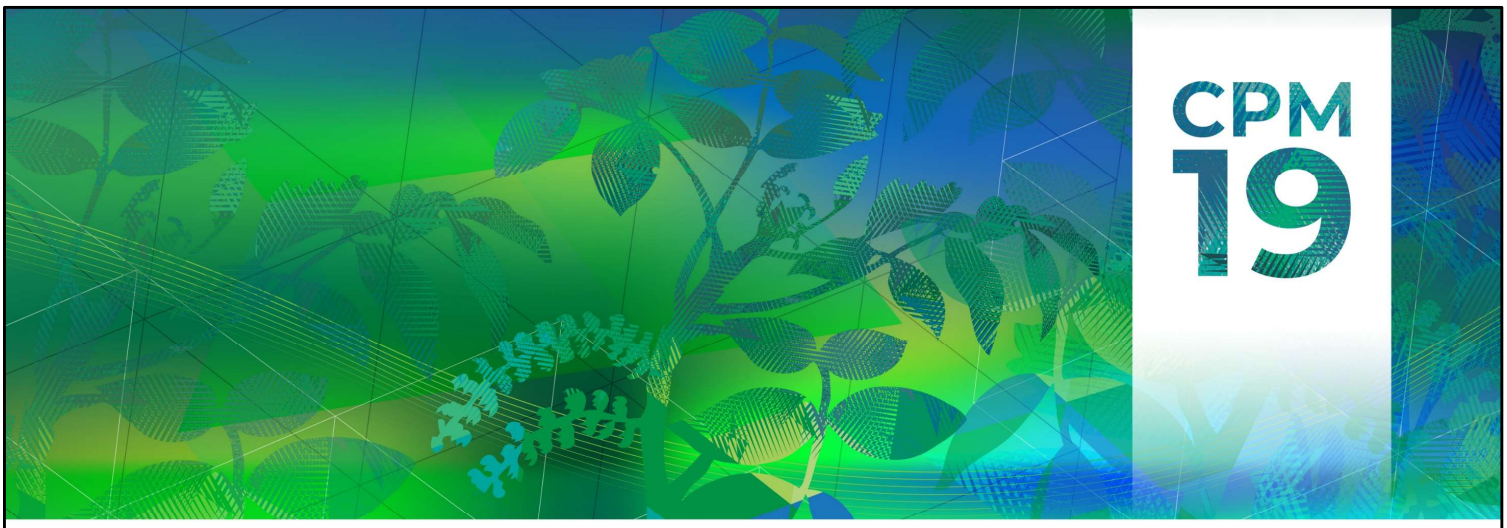
- I hope that I have left you with a sense of the potential opportunities that systems approaches present for managing phytosanitary risks
- ISPM 14 remains an important guide as to how systems approaches are to be applied.
- However, the way we undertake systems approaches needs to continue to evolve and adapt.
- Today we looked at how the risk reduction framework and menu of measures can be used to help implement systems approaches. We also looked at how the strict definition of systems approaches could be extended to consider both phytosanitary and commercial measures.
- International collaboration will be critical if we are to realise the potential of systems approaches, which is why I'm so excited to be a part of todays session.



Thank you