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A Risk Assessment Framework for Seed Degeneration: Informing an Integrated Seed Health Strategy for Vegetatively Propagated Crops

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CGIAR RESEARCH PROGRAM ON Roots, Tubers and Bananas

CIP INTERNATIONAL POTATO CENTER
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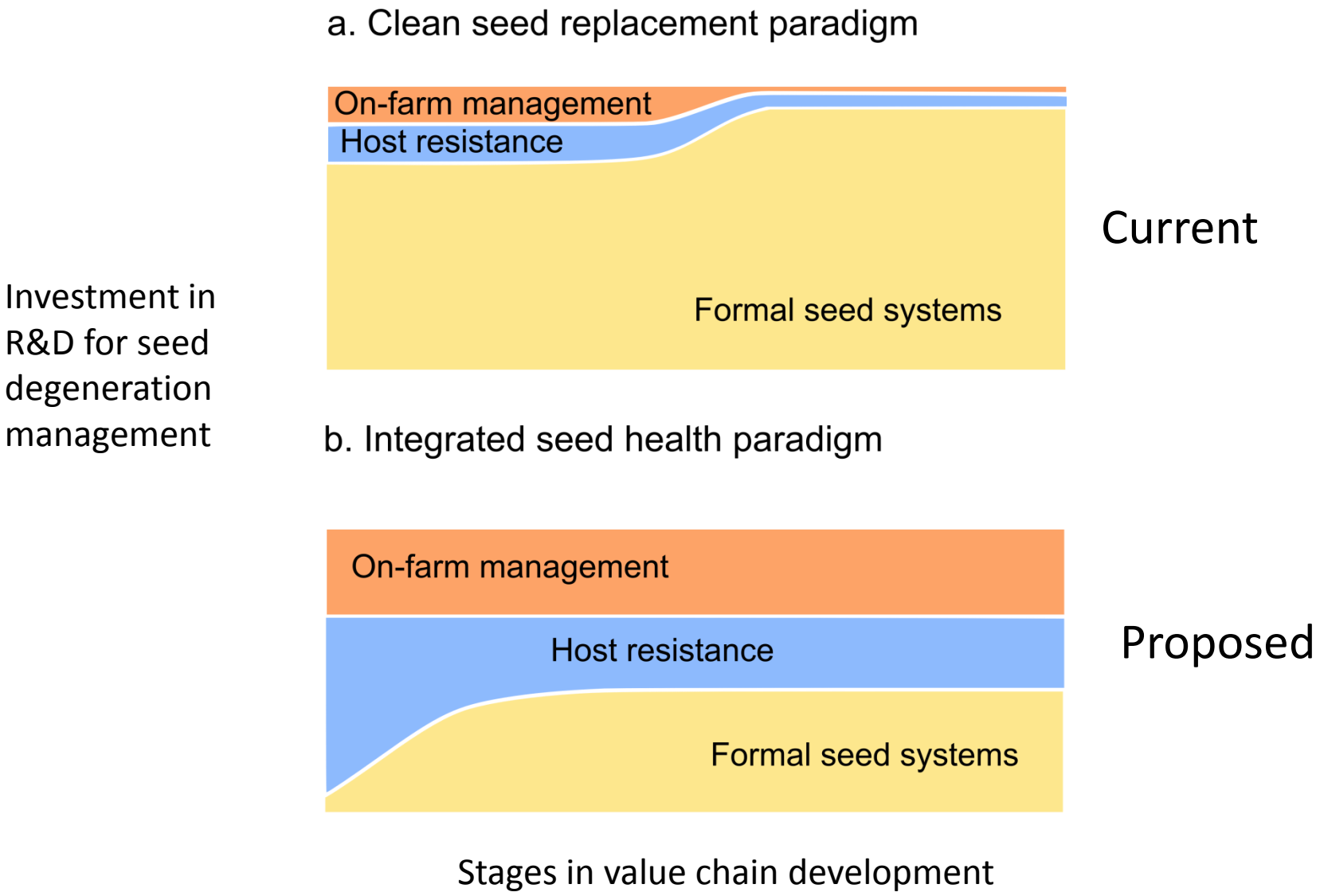
Presentation based on:

Thomas-Sharma, S., J. Andrade-Piedra, M. Carvajal Yepes, J. F. Hernandez Nopsa, M. J. Jeger, R. A. C. Jones, P. Kromann, Legg, J., Yuen, J., Forbes, G. A., and Garrett, K. A. 2017. A Risk Assessment Framework for Seed Degeneration: Informing an Integrated Seed Health Strategy for Vegetatively Propagated Crops. Phytopathology 107: 1123-1135. https://doi.org/10.1094/PHYTO-09-16-0340-R.

Outline

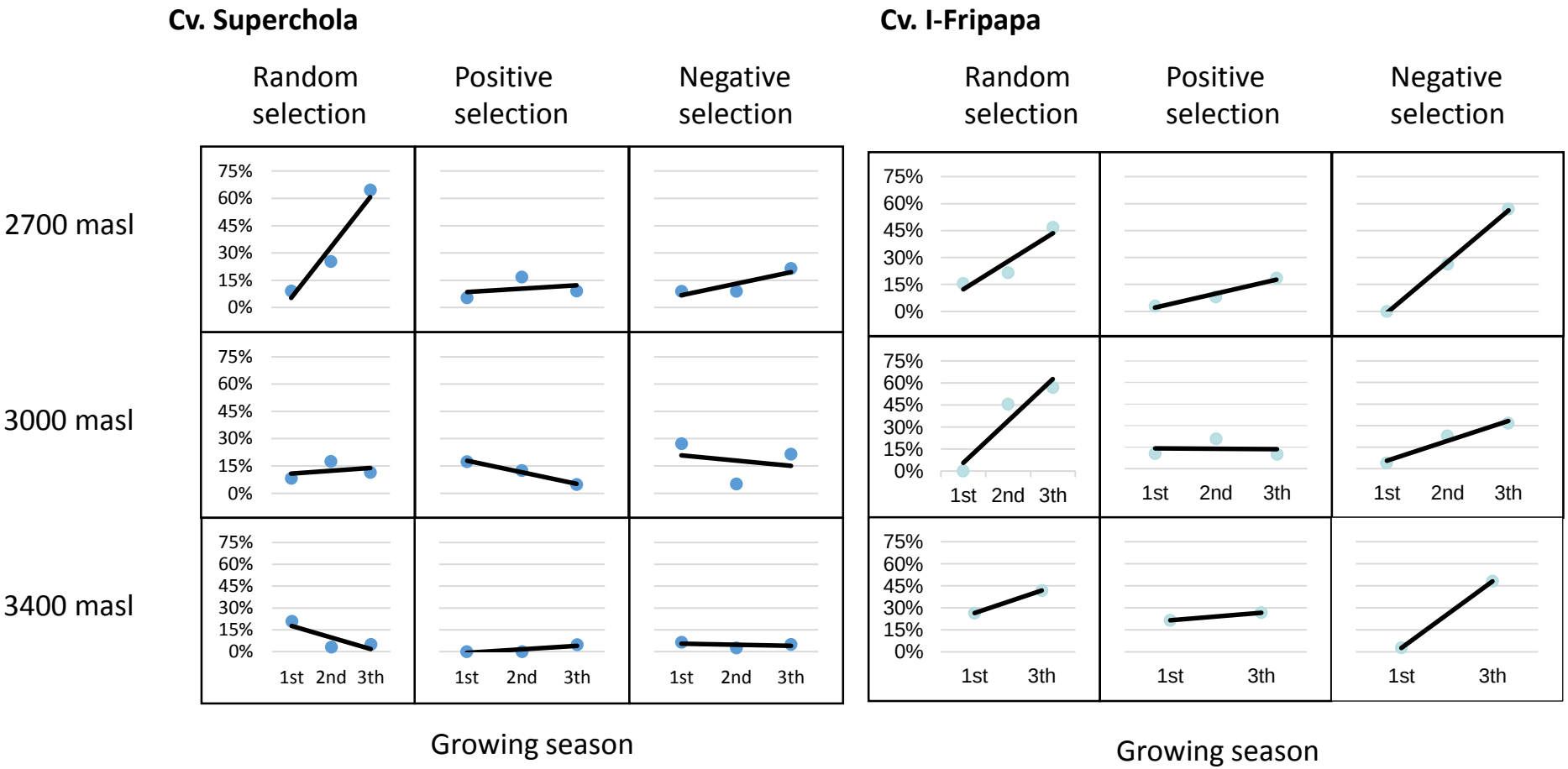
- Recap from seed degeneration presentation
- Factors affecting seed degeneration
- An example from Kenya
- Why simulation is needed?
- Framework for seed degeneration
- Parameters
- Examples of key questions
- Main messages

Investing in seed degeneration management as a function of value chain development



Factors affecting seed degeneration

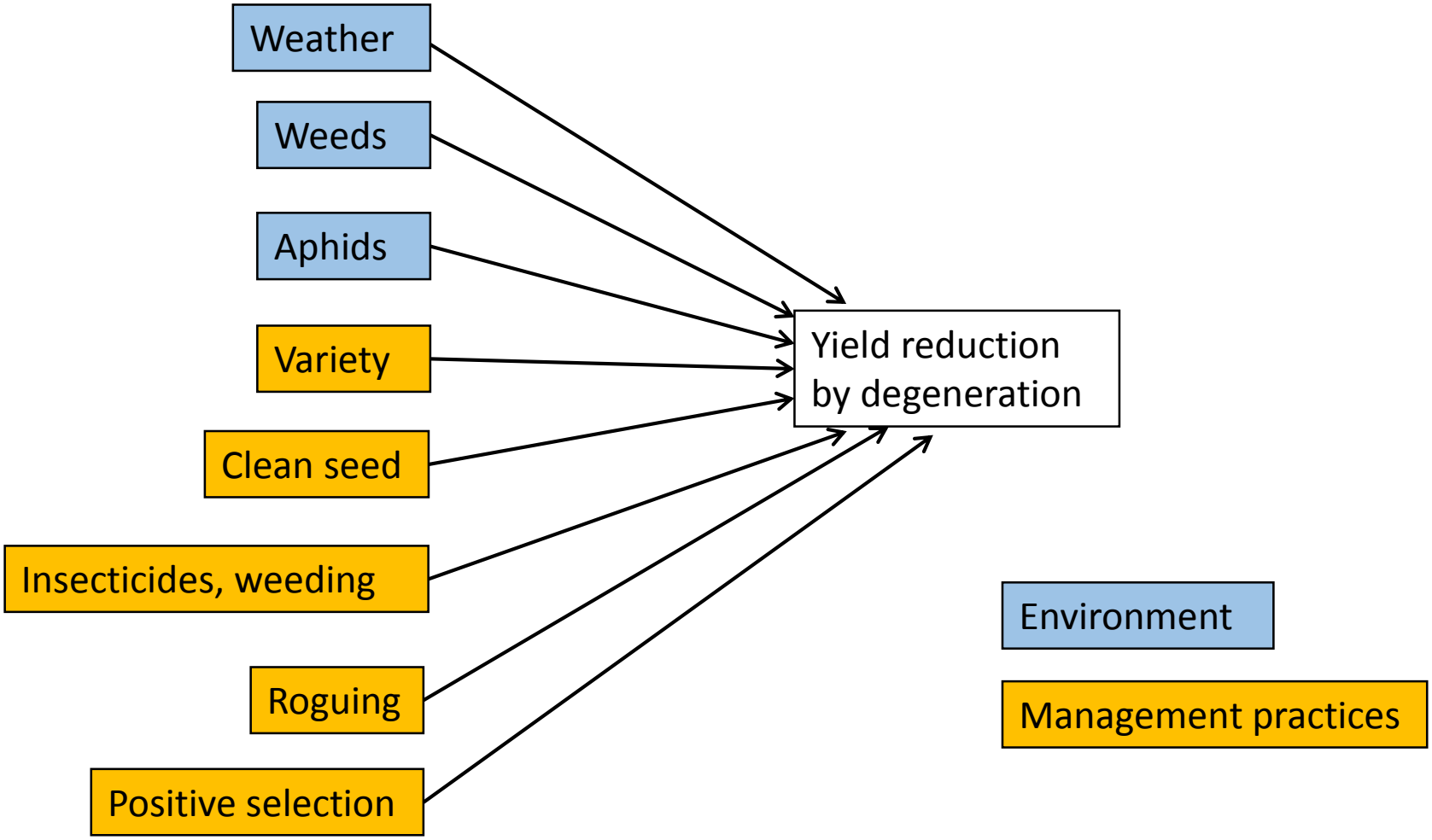
Effect of environment, management practices and host genotype on virus incidence in 3 growing seasons in Ecuador



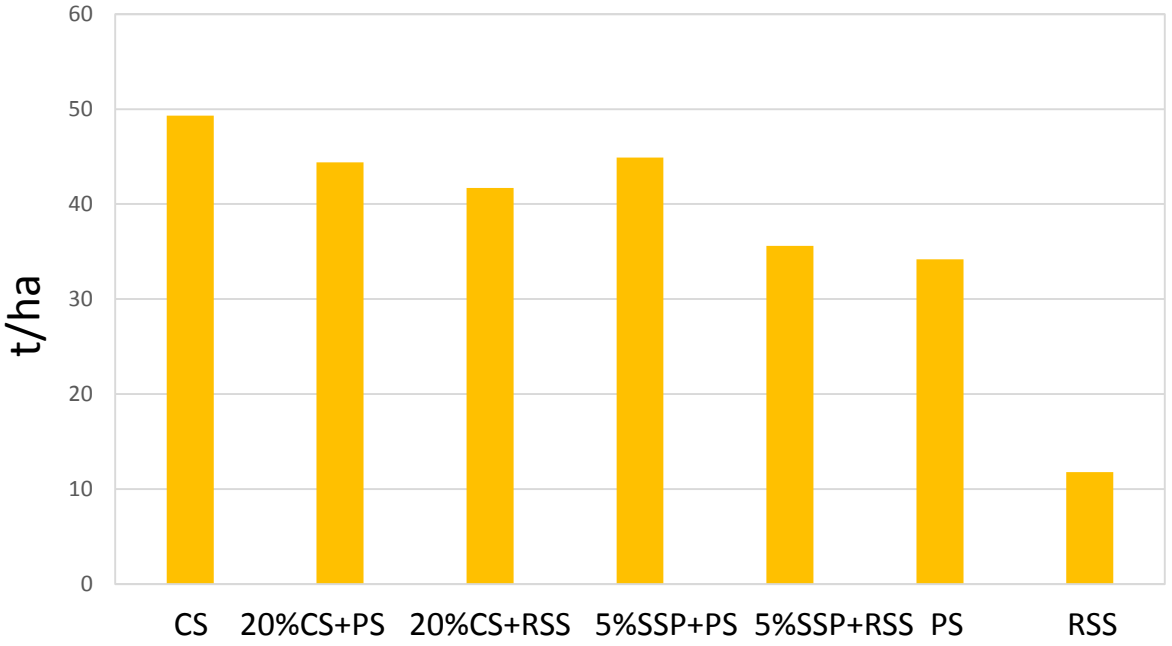
Kromann et al., in preparation

Buddenhagen et al., in preparation

Factors affecting seed degeneration

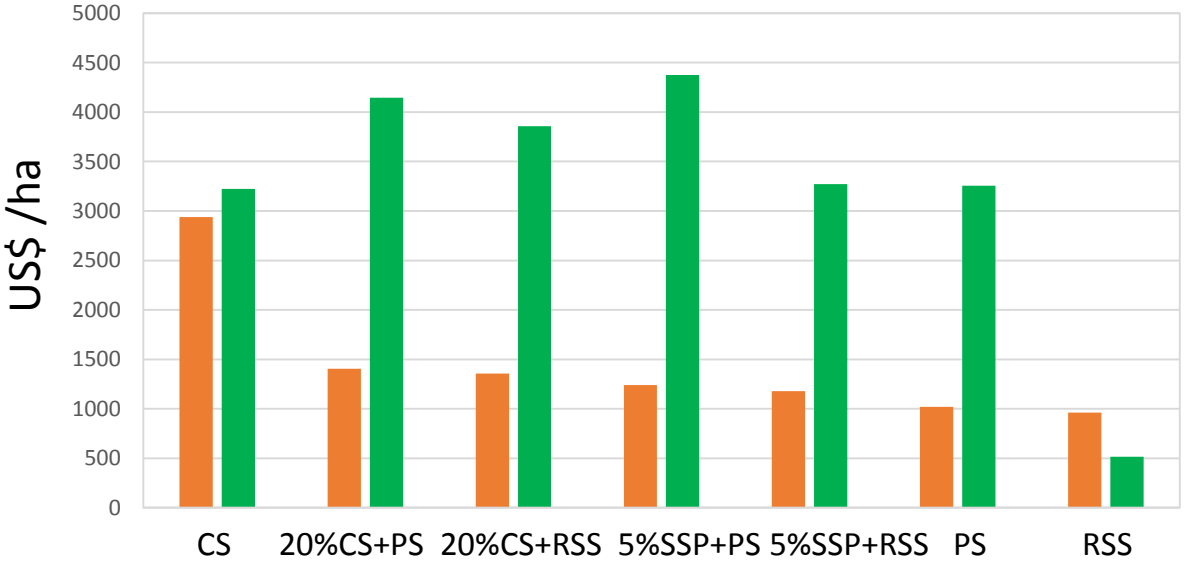


Field experiment to define best tactics for managing seed degeneration



Yield

CS: Certified seed
RSS: Randomly selected seed
PS: Positive selection seed
SSP: Seed from small seed plot



Cost

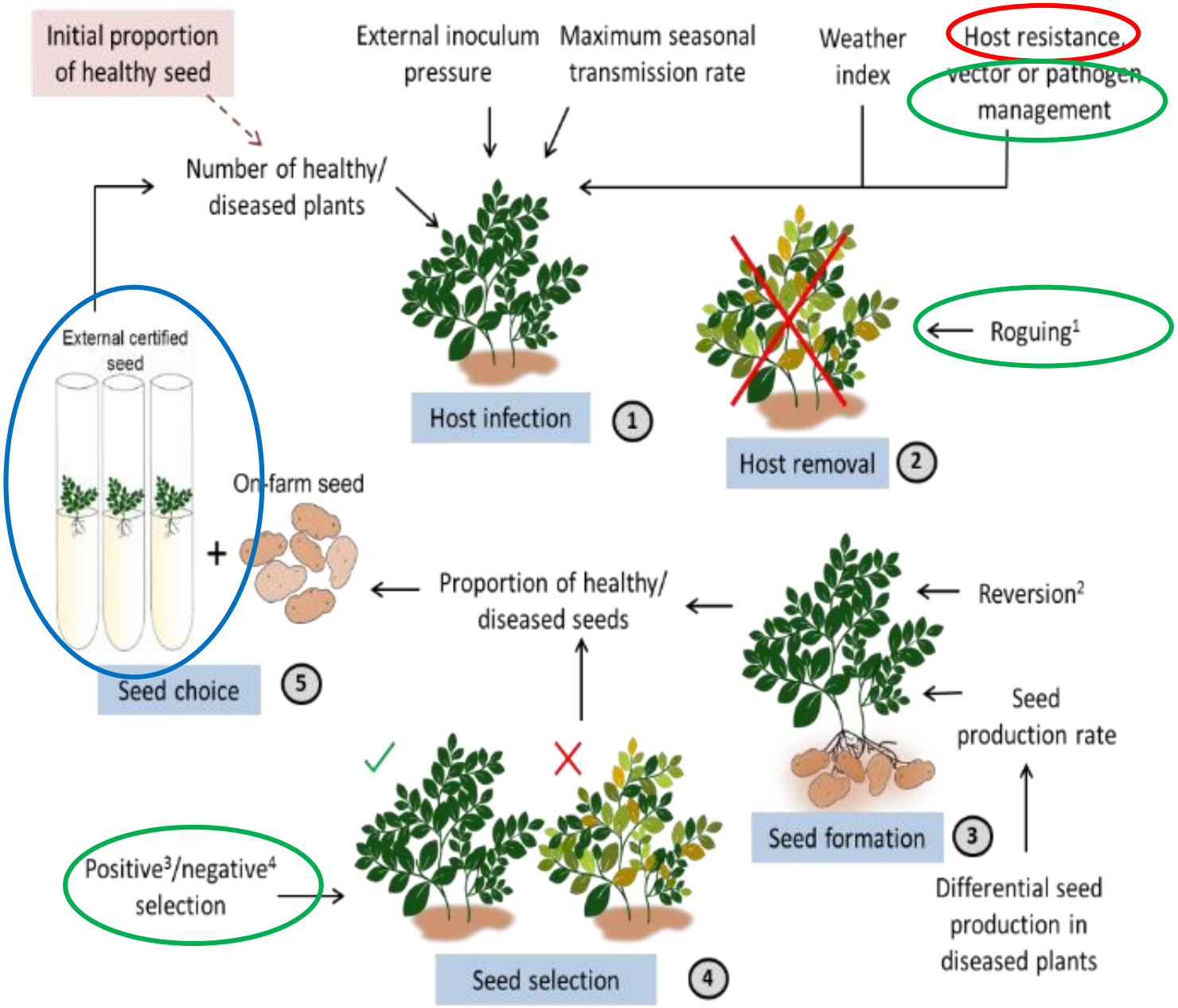
Benefit

Obura et al., 2016

Why simulation is needed?

- Field experiments are expensive and take years to conduct.
- Conditions in developing countries are highly variable. Many field experiments are needed to define the best tactics.
- We can run simulation experiments evaluating many combinations of tactics (host resistance, on-farm management and clean seed) under different scenarios and then select the best to be validated in field conditions.
- Also, simulation models help to understand complex processes and identify knowledge gaps.

Framework for seed degeneration



Parameters

No.	Parameter
1	Initial proportion of healthy seed
2	External inoculum around the farm
3	Maximum seasonal transmission rate
4	Weather conduciveness
5	Host susceptibility
6	Vector and weed management
7	Roguing
8	Seed production rate in healthy plants
9	Plant (seed) selection
10	Differential seed production
11	Reversion in infected plants
12	Certified seed usage
13	Rate of yield decline

Parameters (constants for this exercise)

No.	Parameter	Value
3	Maximum seasonal transmission rate	During the season when there are no limitations for disease to spread 0.02
8	Seed production rate in healthy plants	Number of seed produced per healthy plant 4
10	Differential seed production	1=no difference in seed production between healthy and infected plants 0=no seed production in diseased plants 0.9
11	Reversion in infected plants	1=only healthy seed produced by an infected plant, 0=only infected seed produced by an infected plant 0.1
12	Certified seed usage	1=only certified seed used 0=no certified seed used
13	Rate of yield decline	0=constant rate of yield decline (straight line); for 0 to 0.5,yield declines slowly as disease incidence increases (concave); for -1 to 0, yield declines rapidly as disease incidence increases (convex) 0.2

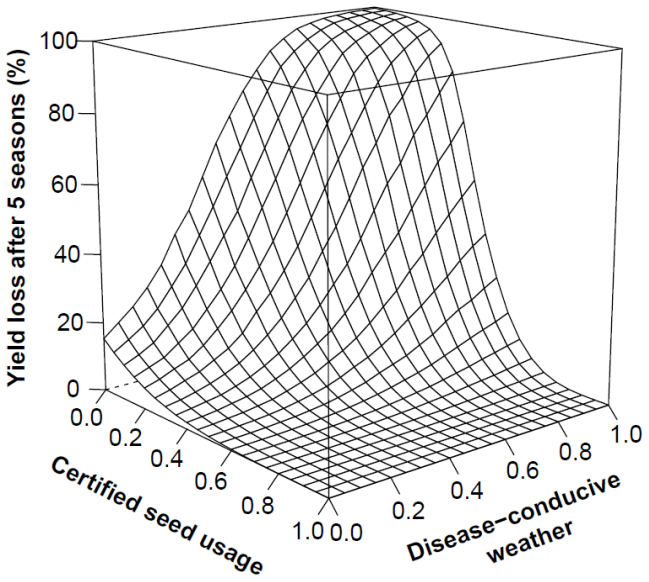
Parameters (values will be changed)

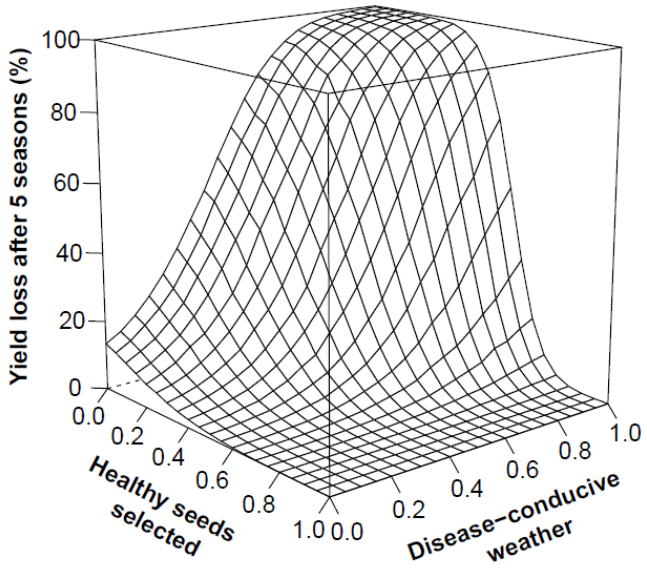
No.	Parameter	Value
1	Initial proportion of healthy seed	1=only healthy seed used 0=only infected seed used
2	External inoculum around the farm	50=high level of external inoculum 0=absence of external inoculum
4	Weather conduciveness	1=highly disease conducive weather 0=weather completely restricts disease spread
5	Host susceptibility	1='completely' susceptible 0=immune
6	Vector and weed management	1=no management of vectors/weeds 0=vector/weed eradication
7	Roguing	1=no symptomatic plants removed 0=all symptomatic plants removed
9	Plant (seed) selection	1=random selection 0=complete selection against diseased plants

Risk assessment framework: Examples of key questions

- For what scenarios can on-farm seed management perform as well as certified seed?
- Which management components would perform better in the presence or absence of initial inoculum?
- Can combining management components increase the effectiveness of seed degeneration management?

Can on-farm management perform as well as certified seed use?





Seed selection can perform as well as certified seed use, if the rate of success in selecting healthy plants is high

Can you think in a question about seed degeneration that can be addressed with our framework?

Main messages

- Simulation models are used to:
  - Evaluate management tactics and combinations, and define the best ones to be tested in the field
  - Predict potential effects of new technologies, climate, etc. (“what if” questions)
  - Identify knowledge gaps
  - Inform decision makers and train scientists
- The framework integrates the effect of 13 parameters on seed degeneration.
- These parameters include host resistance, on-farm seed management, and clean seed, i.e., the tactics of the integrated seed health strategy.
- The framework is being used now as a training tool – Validation with field data is underway.

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Thank you!

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