Weed suppressive rotations

A modelling framework for sustainable weed control

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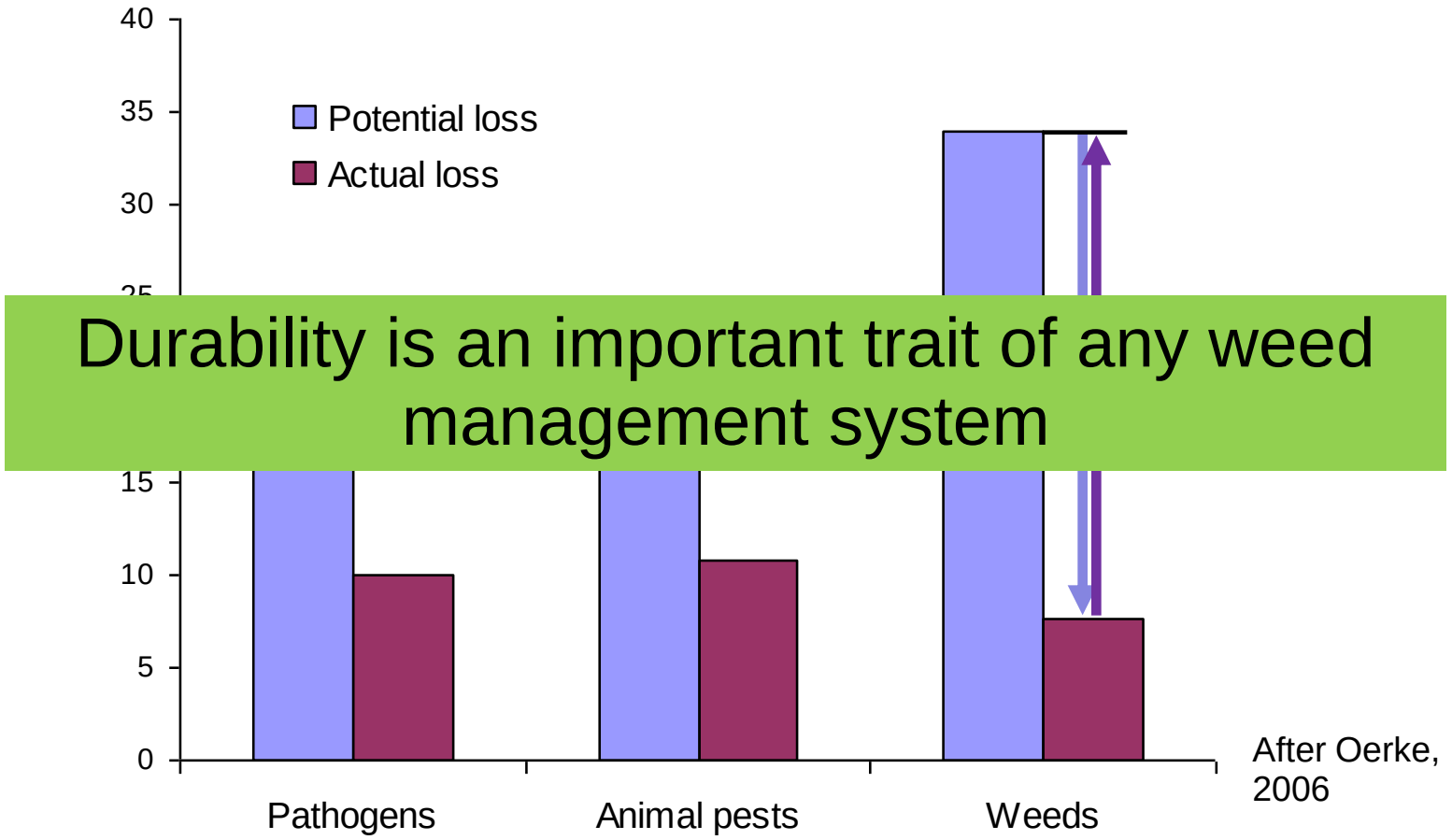
Weeds a permanent problem

- Competition and yield loss
- Persistence (despite control)

Potential and actual yield loss



Durability is an important trait of any weed management system

Durable weed management

- Harper defined weeds as:

‘*species which have been selected by the very cultural practices which were originally designed to suppress them’*

- Minimize selection pressure:

  Diversify weed management

  →Avoids selection of a few difficult to control weed species

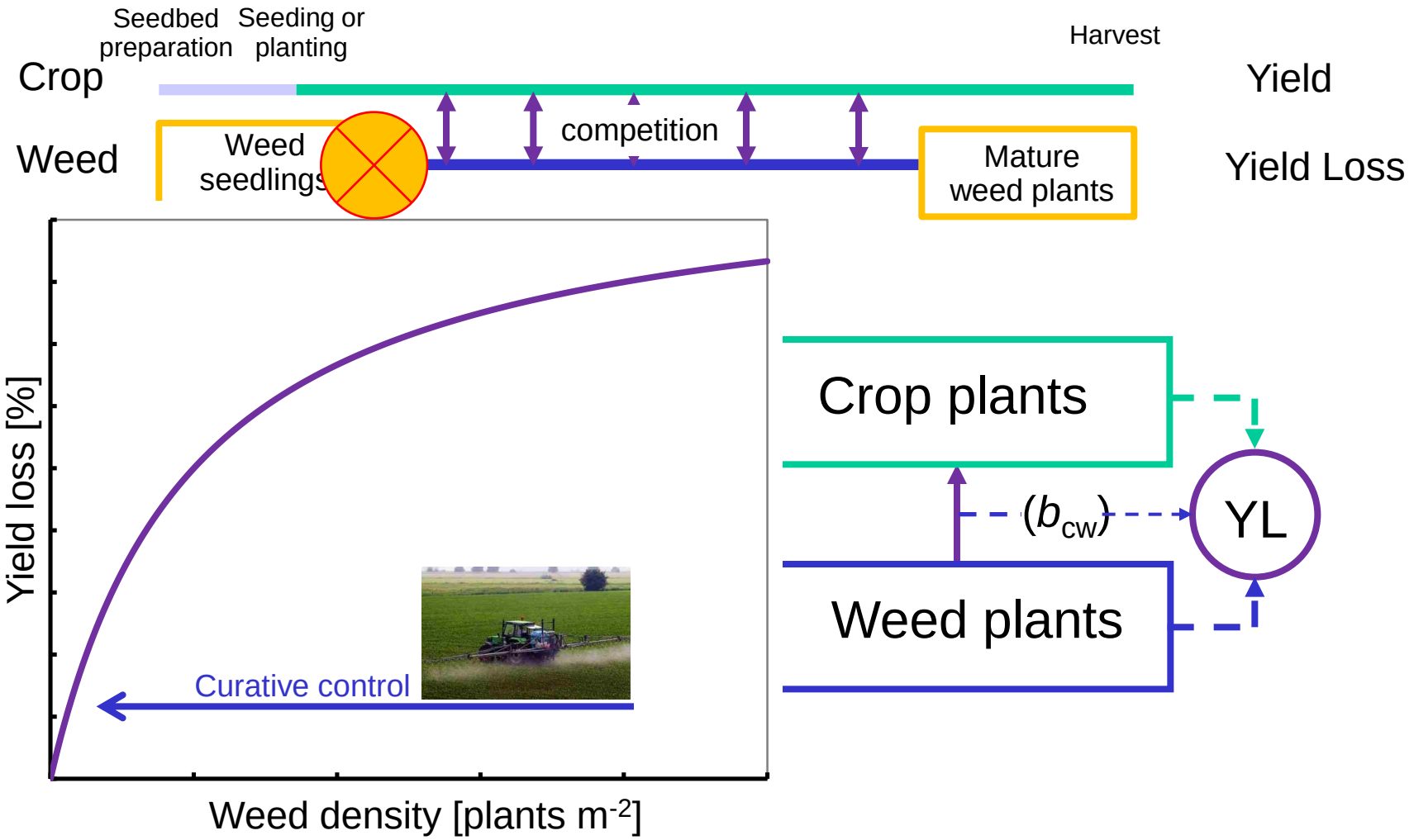
  Specific case: herbicide resistance

Is our weed management diverse?

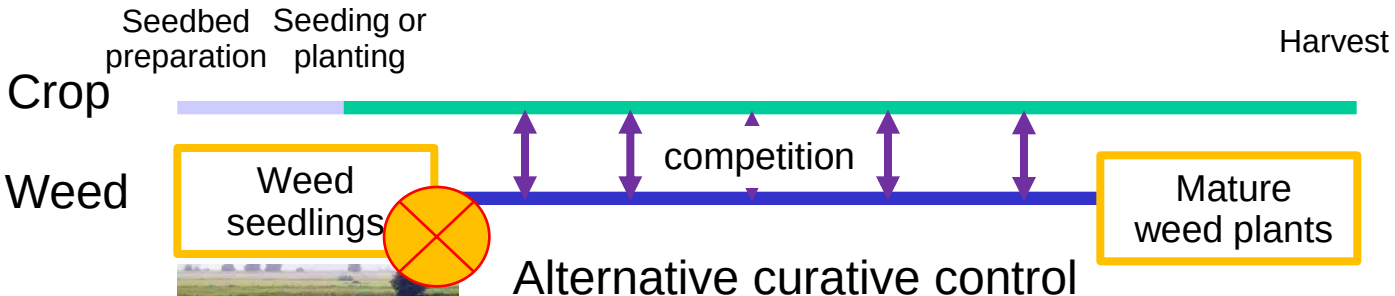
- Various curative weed control measures are available, but often a heavy reliance on chemical control exists

- Additionally:
  - the number of active compounds has dramatically reduced:
    → increased selection pressure
    → particularly in monocultures

Curative weed control



Diversify weed control



Continuous use of the same herbicide will result in herbicide resistant weed populations

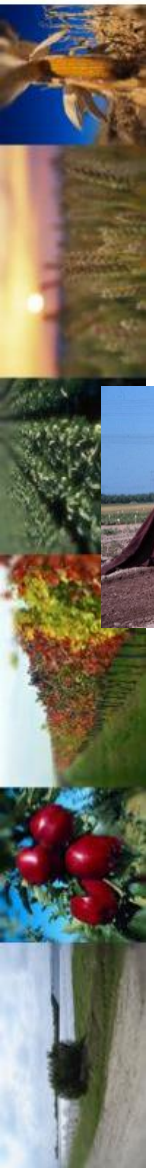
Alternative curative control

- Other herbicide

- Mechanical weed control

- Hand weeding

Cultural control options



Seedbed preparation

Seeding or planting

Harvest

Crop

Yield

Weed

competition

Yield Loss

Weed seedlings

Mature weed plants

Weed seed bank

New produced seeds

Diversify over time

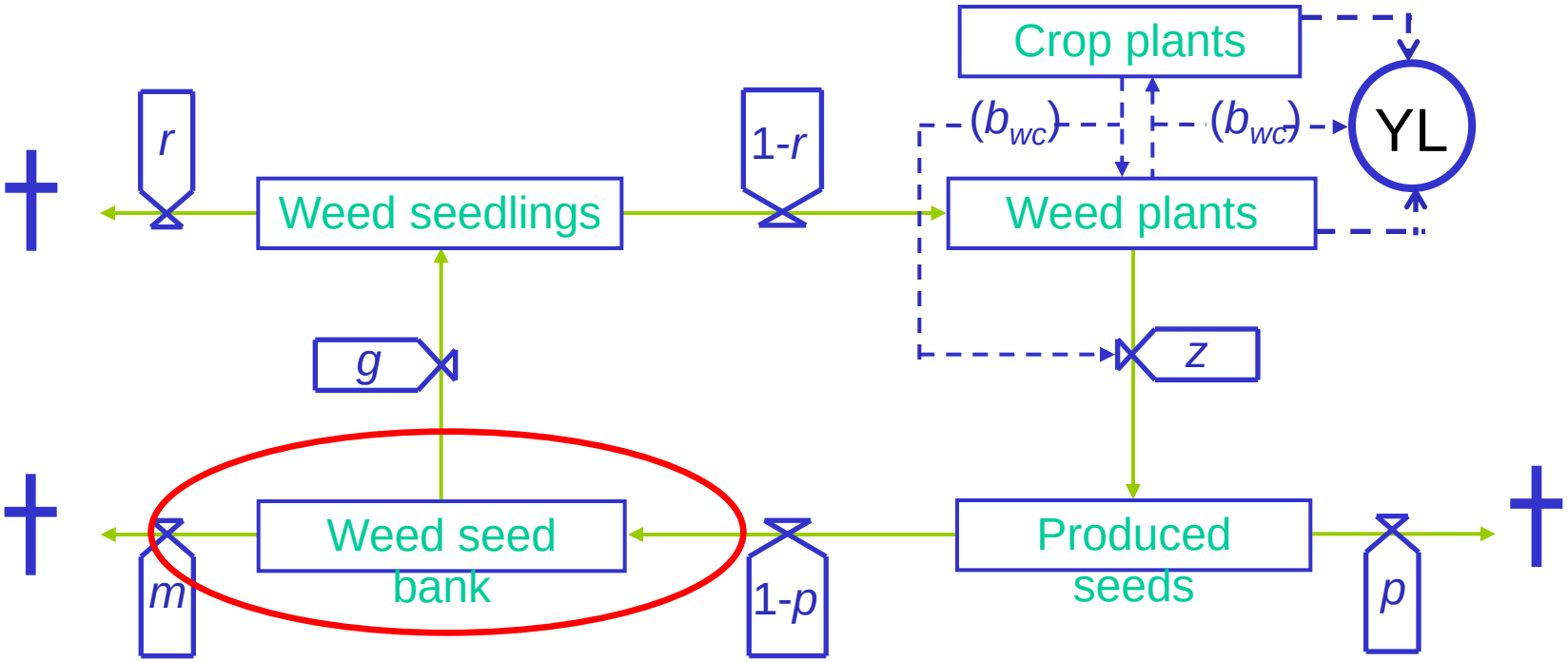
- Crop rotation
- Basis:
  - Each crop has its own effect on a weed species, due to:
    - (A-)synchronicity between crop and weed
      - Winter annuals - Autumn sown crop
      - Summer annuals - Spring sown crops
    - Ability to apply curative control
      - Use of specific herbicides
      - Interrow cultivation in row crops
    - Competitive ability of the crop
      - Slow growing crop with an open canopy
      - Highly competitive or smother crop

Questions that come up

- How effective are these measures?
- Are they able to reduce the dependency on chemical weed control?
- Do they contribute to the avoidance of herbicide resistance?

→ Modelling framework

Modelling framework



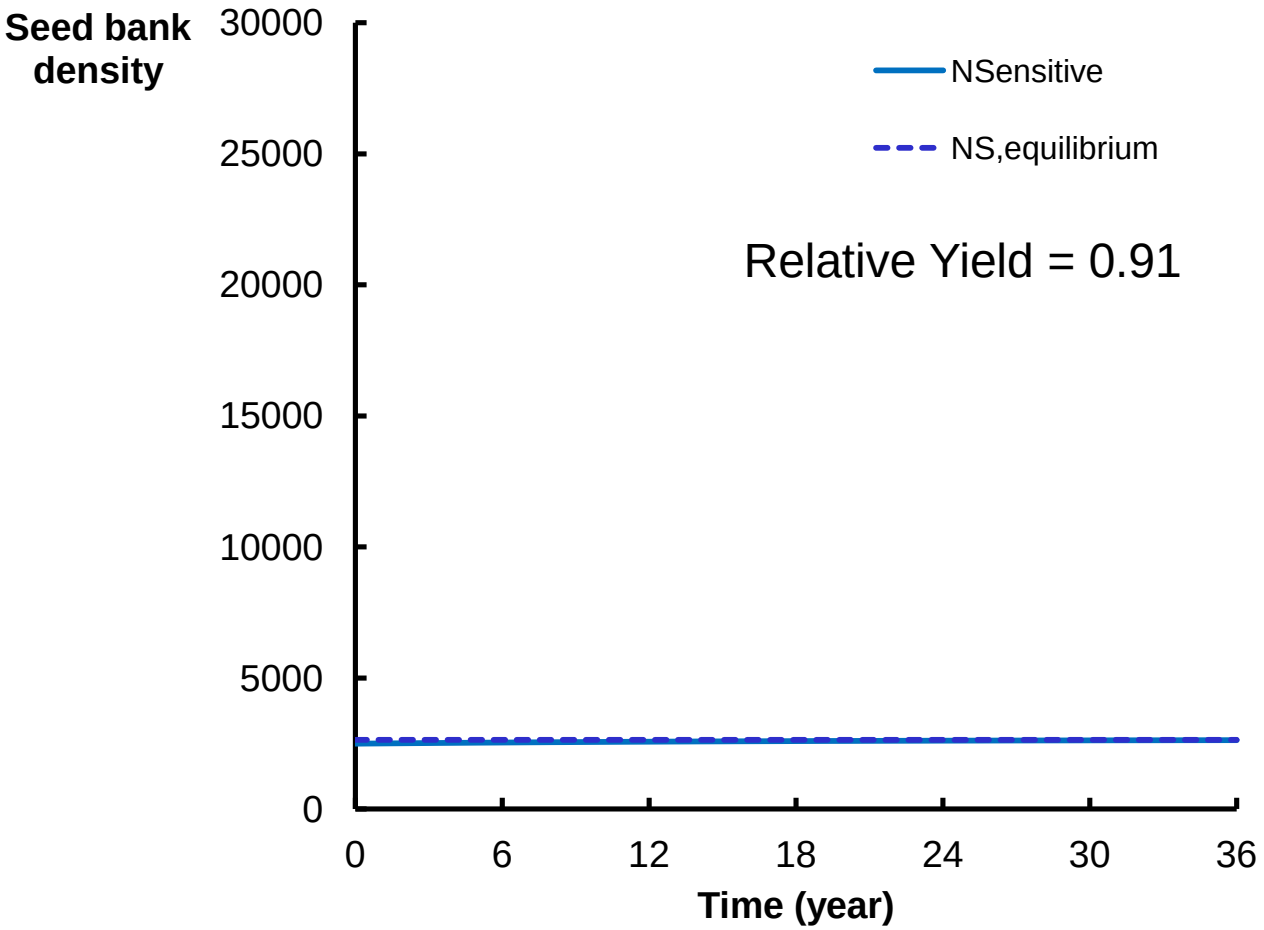
Model parameters

- Life history captured in parameters
  - g – fraction germinating seeds
  - b_{wc}, b_{cw} – relative competitiveness
  - z – seed production
  - p – fraction seed removal
  - m – fraction seed mortality
  - r – control efficacy
  - weed species specific
  - influenced by:
    - environment
    - (weed) management

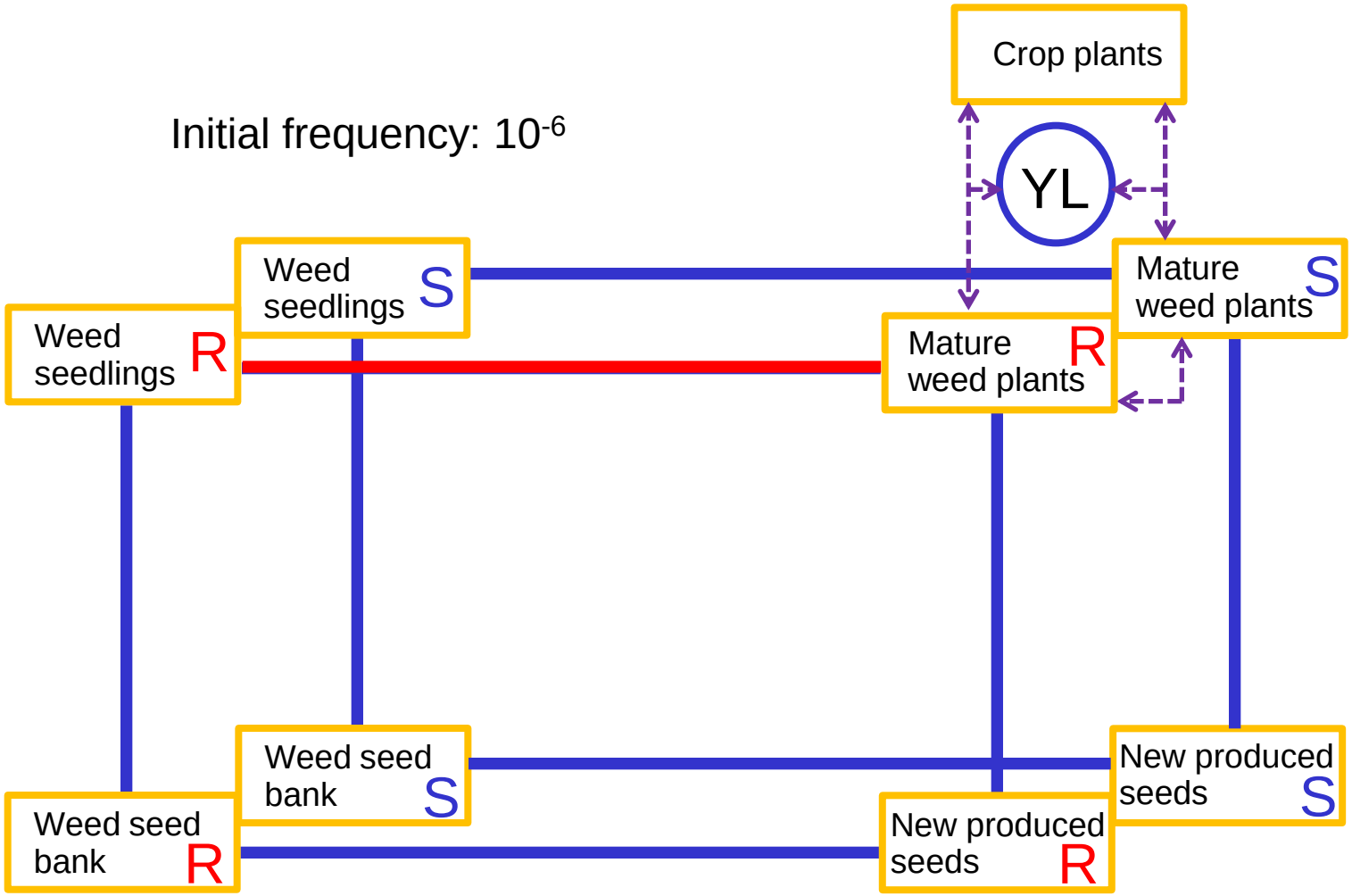
Simulation results

- Starting point
  - Crop in monoculture
  - Herbicidal control
  - No herbicide resistance

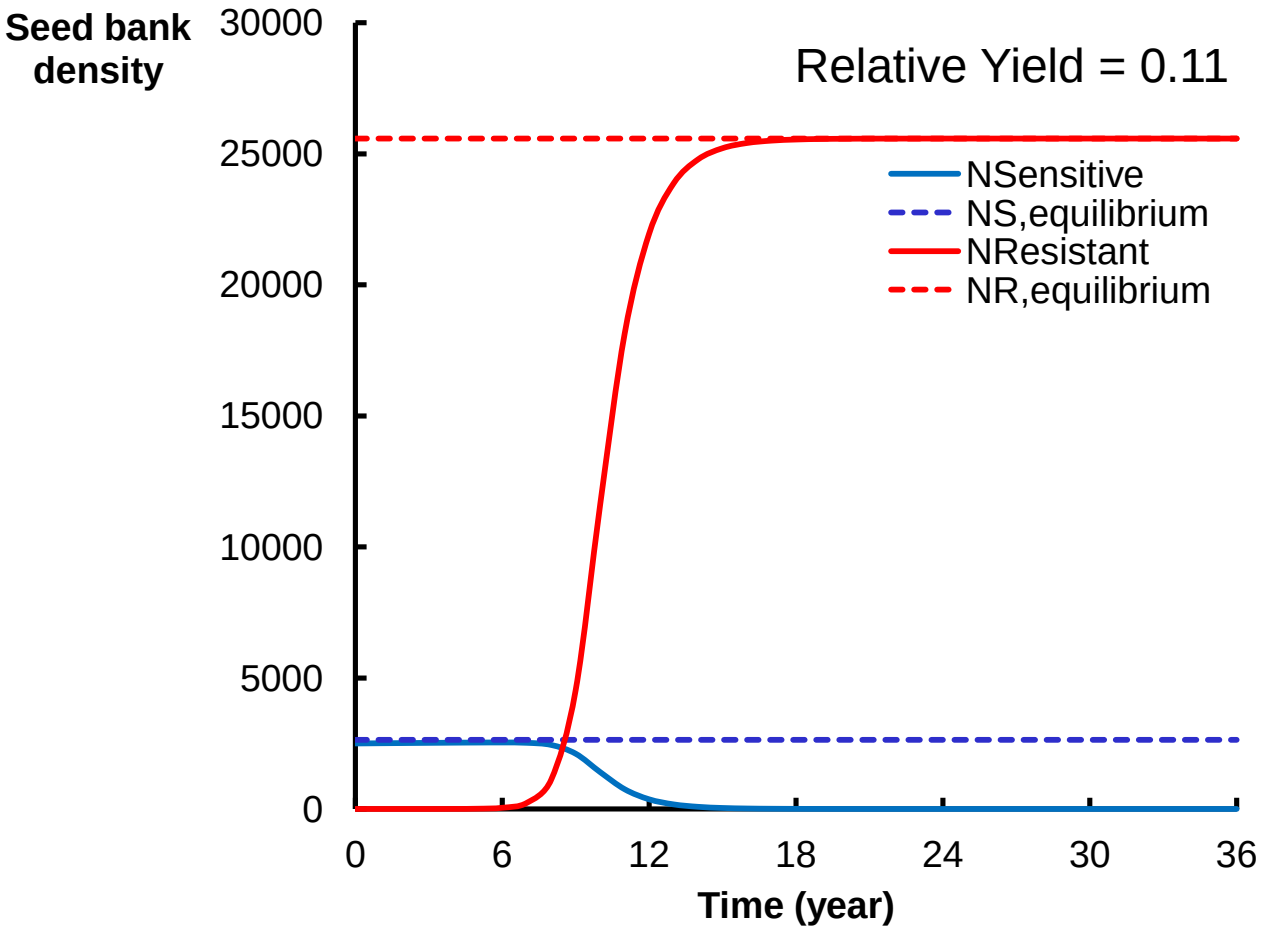
Monoculture



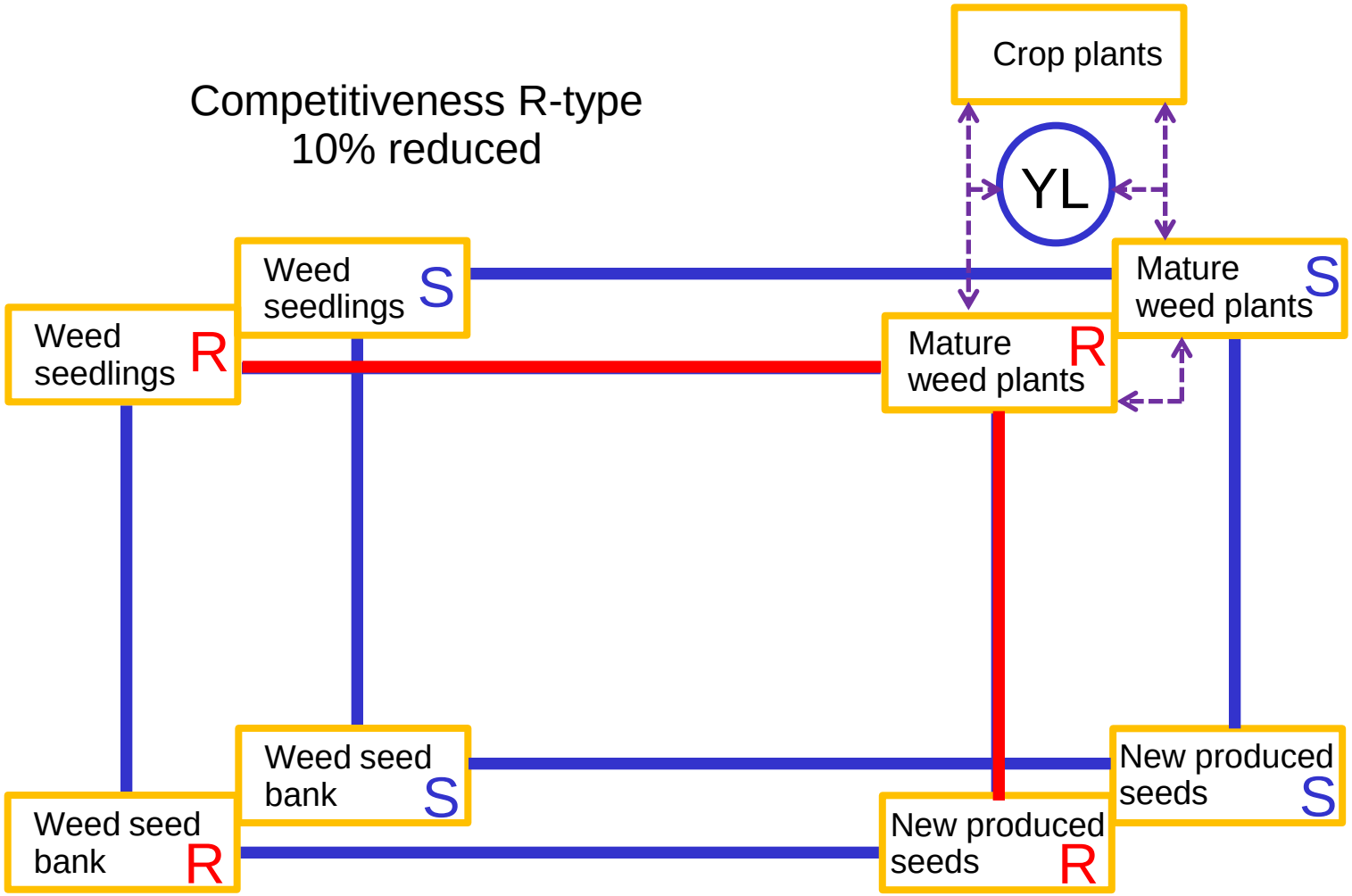
Resistant biotype



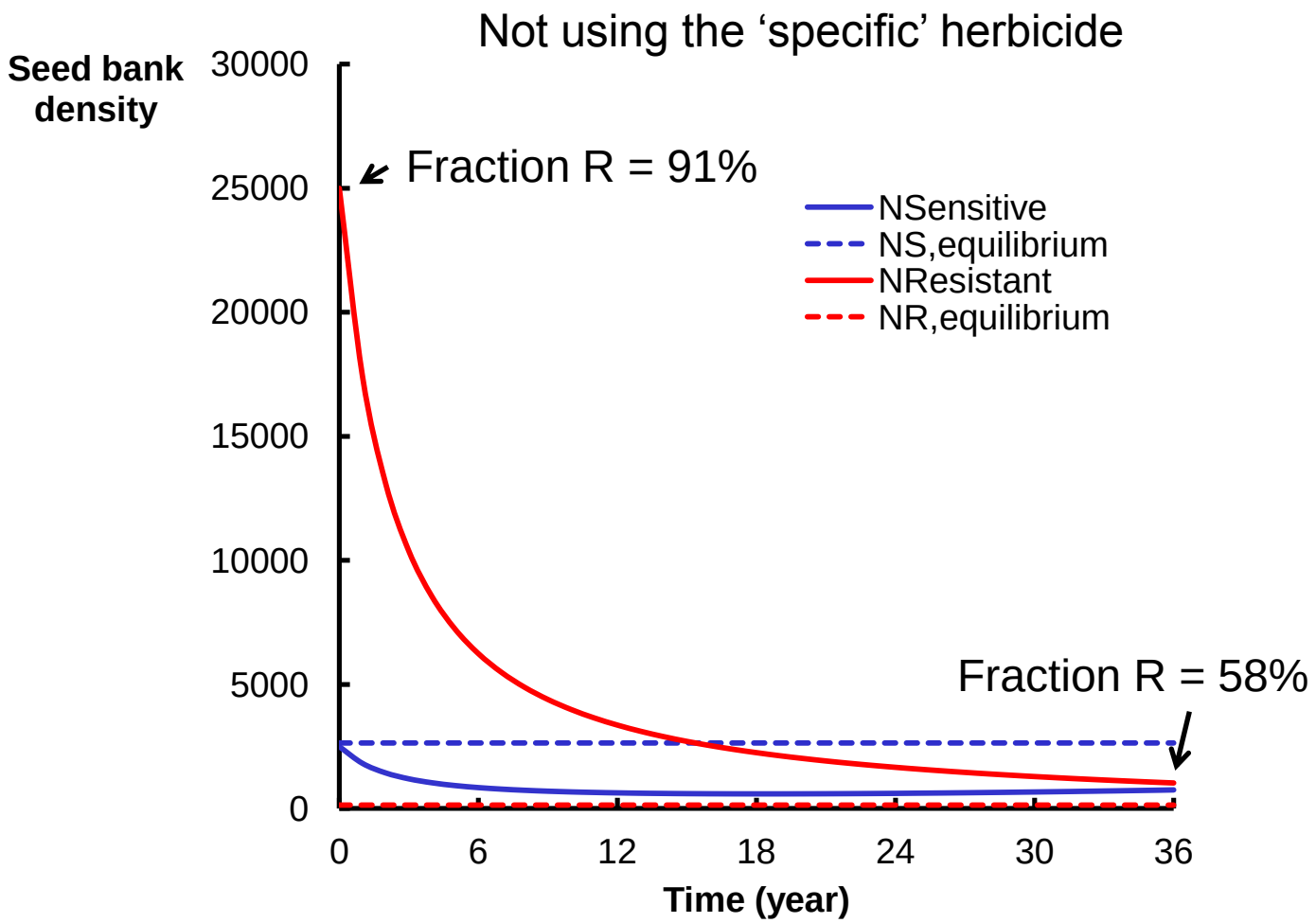
Resistant biotype



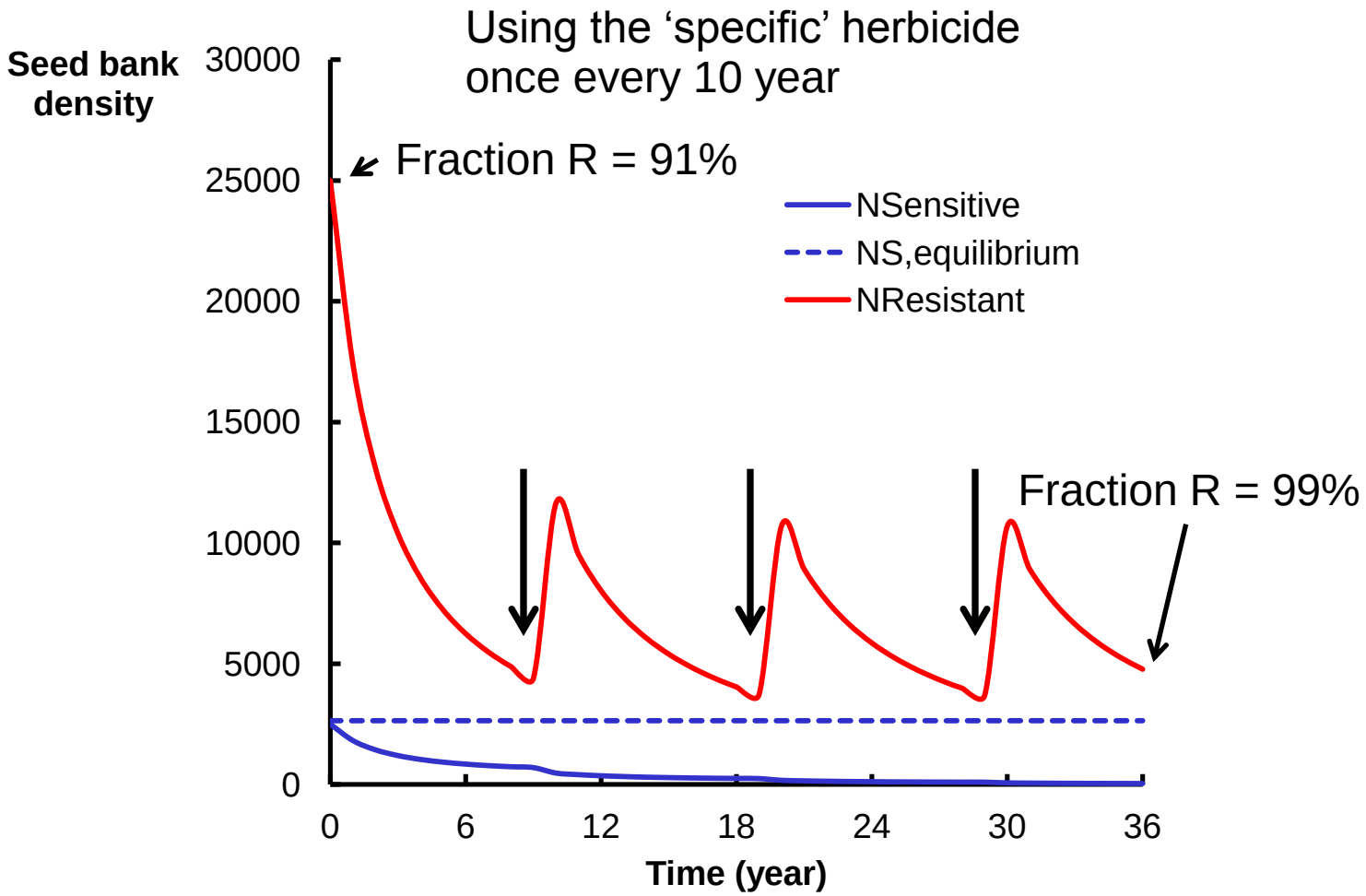
Fitness cost of resistance



Fitness costs included



Fitness cost included



Cultural control measures

- Effect of a measure translated into change in relevant parameter

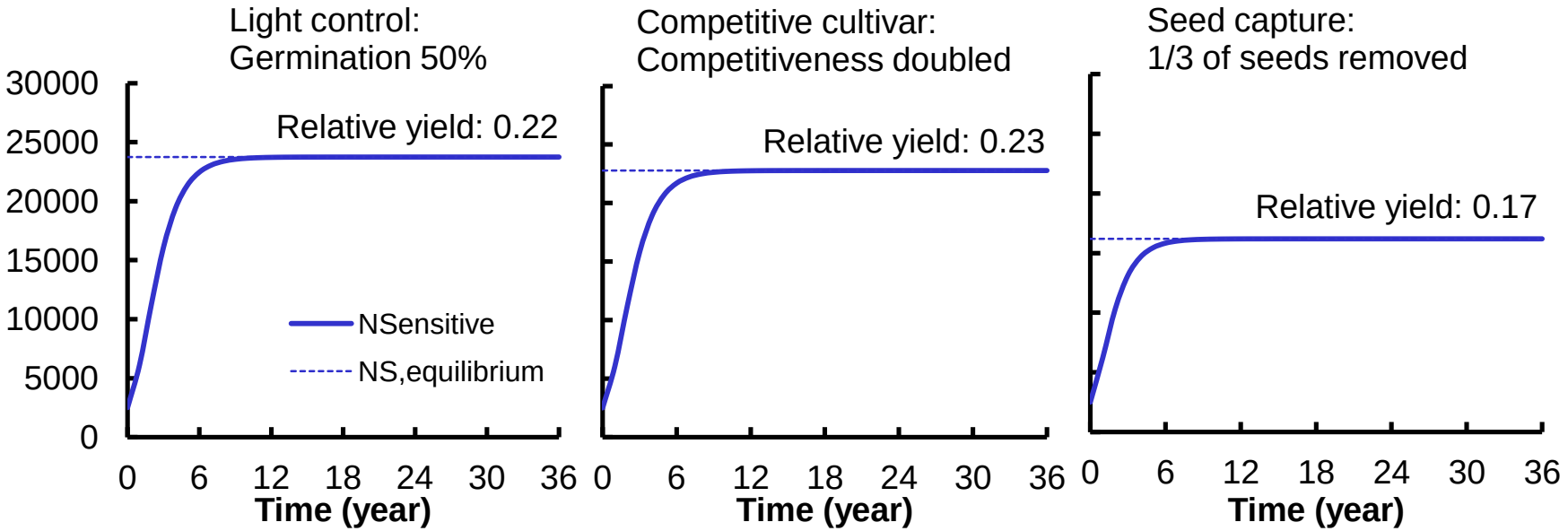
» *g* - fraction germinating seeds

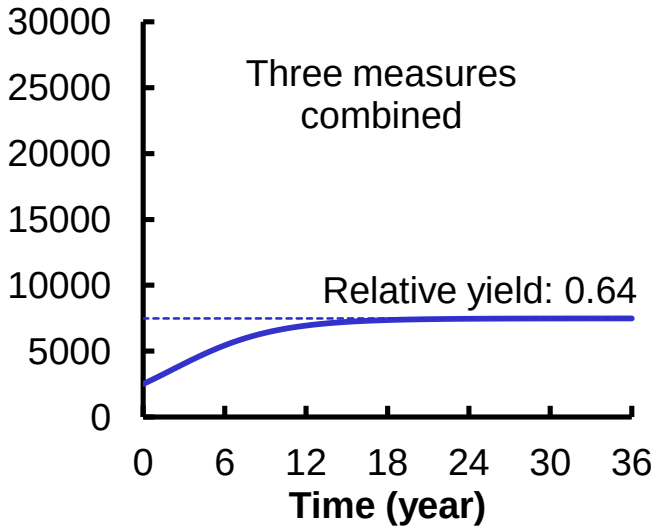
» $b_{w,c}$ and $b_{c,w}$ – competition parameters

» *p* – fraction seed removal

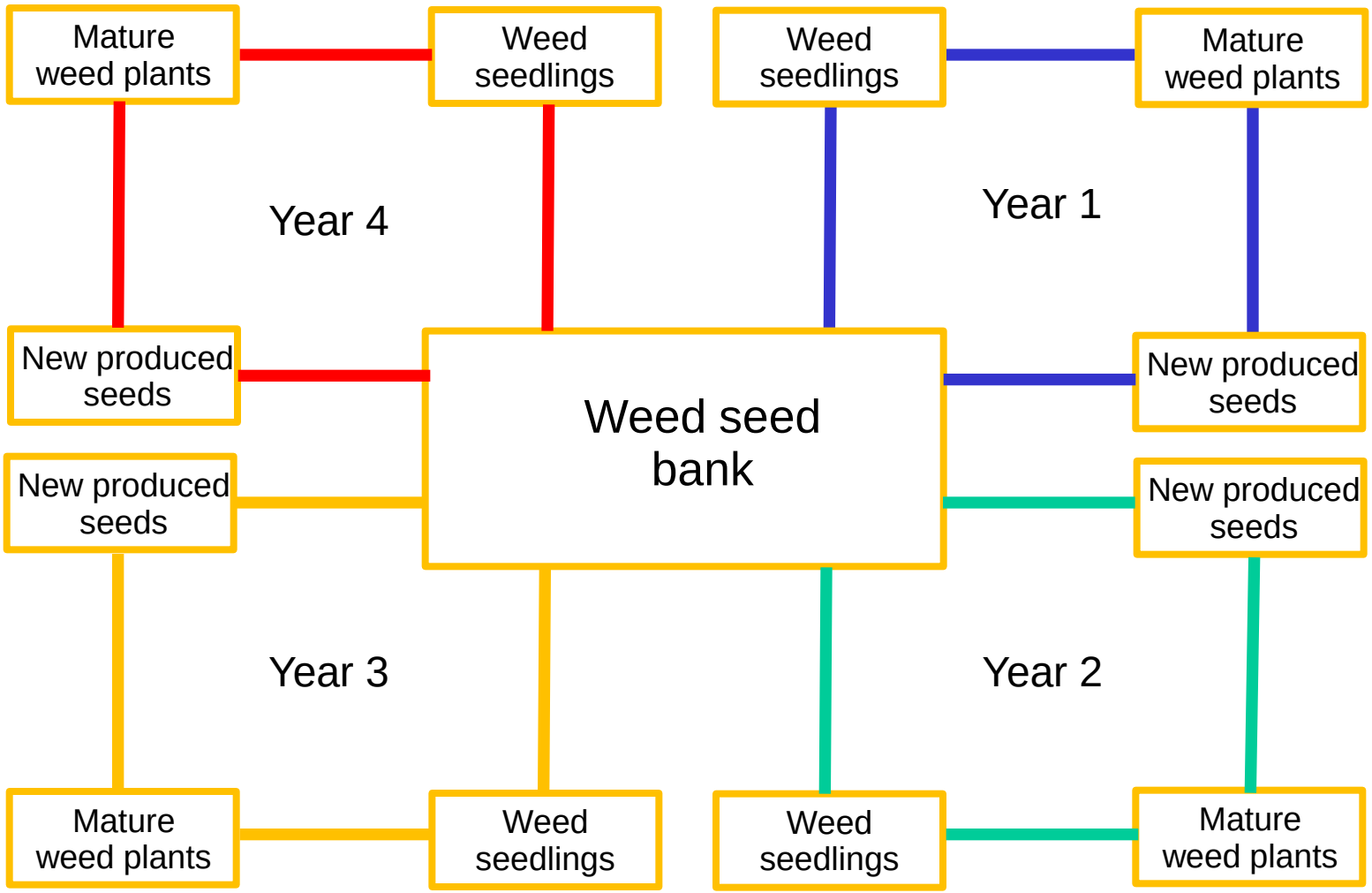
» *m* – fraction seed mortality

Cultural control

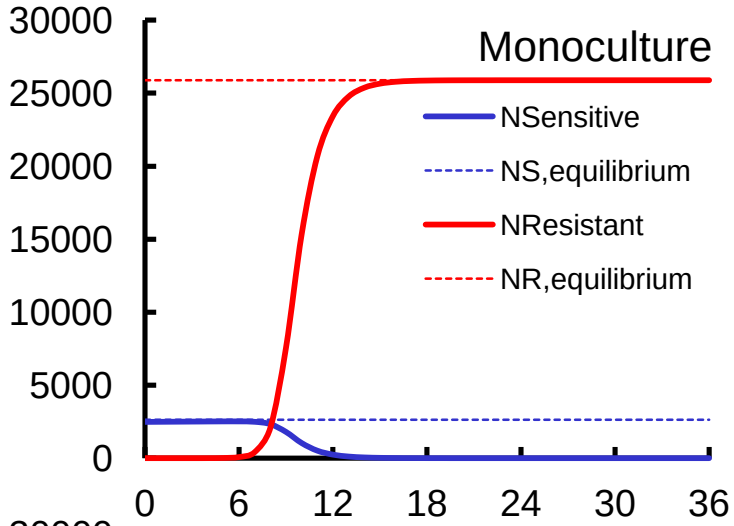


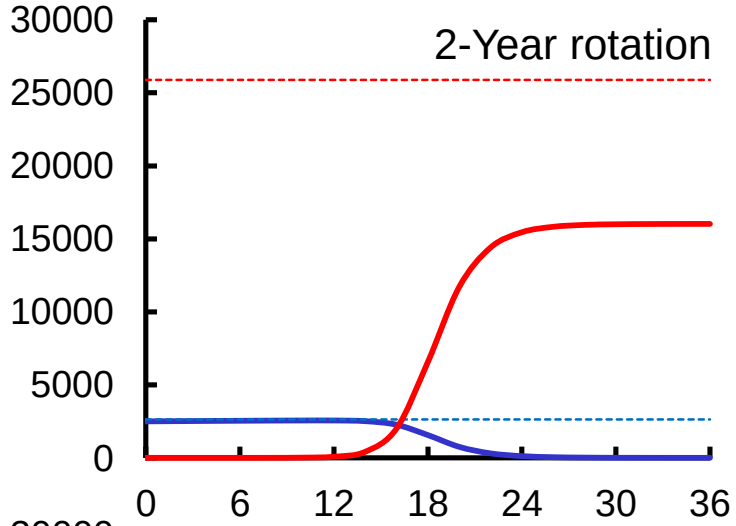


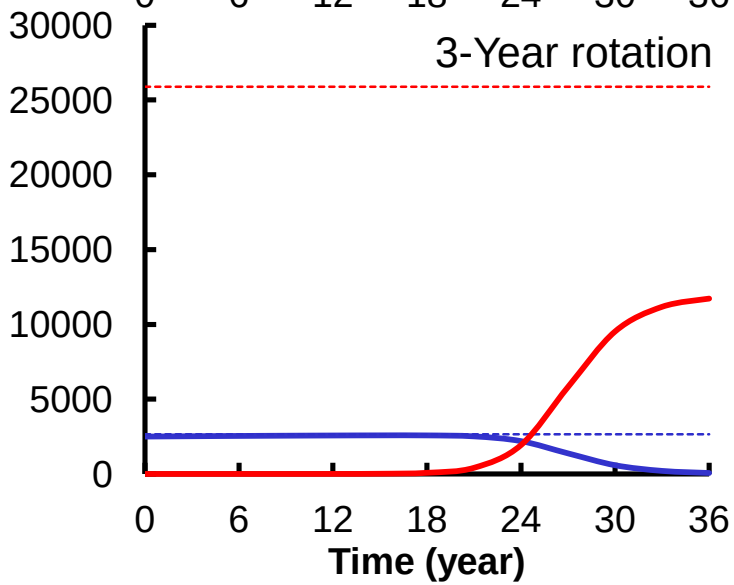
Crop rotation

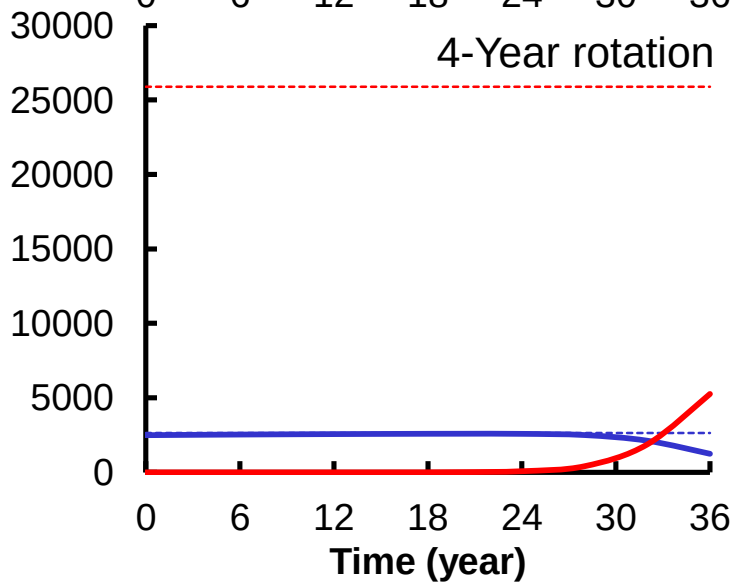


Crop rotation









Concluding remarks

- Model is an oversimplified representation of reality
- Still it provides clear insight of what might be expected of certain measures and strategies
- A tool to generate longer term consequences of findings from short term experiments

Next step

- Two case studies within PURE
  - Maize-based crop rotations
    - *Echinochloa crus-galli*
    - Italy
  - Wheat-based crop rotations
    - *Alopecurus myosuroides* (black grass)
    - Denmark
  - Workshop in Padova (early February) to link experiments and simulation

Thank you for your attention!

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Outline

- Weeds and current control
- Diversity key for sustainability
- Cultural control and crop rotation
- Modelling framework
- Simulations: Herbicide resistance
- Linking model to experiments