Modelling and experimentation

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An introduction to modelling, Poznan, 18 November 2008

Outline

1) Pros and cons of the experimental approach

2) Virtual experiments

3) Interactions between experimentation and modelling

4) Conclusion

1) Pro and cons of the experimental approach

- An experiment consists in testing an hypothesis

- Comparison of treatments, ANOVA (or other statistical tests)

- Pros: require little knowledge on the effets of the tested treatments, relatively simple, body of statistical knowledge, generally conclusive

Could we study this question experimentally?

- Concerns large area (several fields and margins). Hard to experiment.
- Many possible conditions
  - Different numbers of prey in margins
  - Different aphid infestations in wheat
  - Different geometries, climates
  - Etc.
  - Would require many treatments
- So use a model

1) Pro and cons of the experimental approach

- An experiment consists in testing an hypothesis

- Comparison of treatments, ANOVA (or other statistical tests)

- Pros: require little knowledge on the effets of the tested treatments, relatively simple, body of statistical knowledge, generally conclusive

- Cons: limited number of factors studied at the same time, money and time consuming, validity domain difficult to determine, not adapted to long term effects or to large spatial scales

2) Virtual experiments

- Use of a model to represent the behaviour of a system
- Interactive simulations
- Optimisation
- Planning

2) Virtual experiments: advantages

- Usually cheap and fast
- Fast exploration of scenarios
- Prediction of variables difficult to measure
- Exploration of unlikely scenarios

2) Virtual experiments: limits

- All models are false!
- Difficulty to manage a huge number of scenarios
- Simulations limited to the validity domain of the model
- Computational time (sometimes !)

3) Interactions between experimentation and modelling

Case 1. Classic experimental approach is not feasible

Case 2. The model helps design experiments

Case 3. Experiment and modelling are both feasible to answer a question

Exemple: Simulator for Integrated Pathogen Population Management-WOSR (Pelzer et al., submitted)

Resistant cultivars are important components of IPM and can help reduce pesticide use.

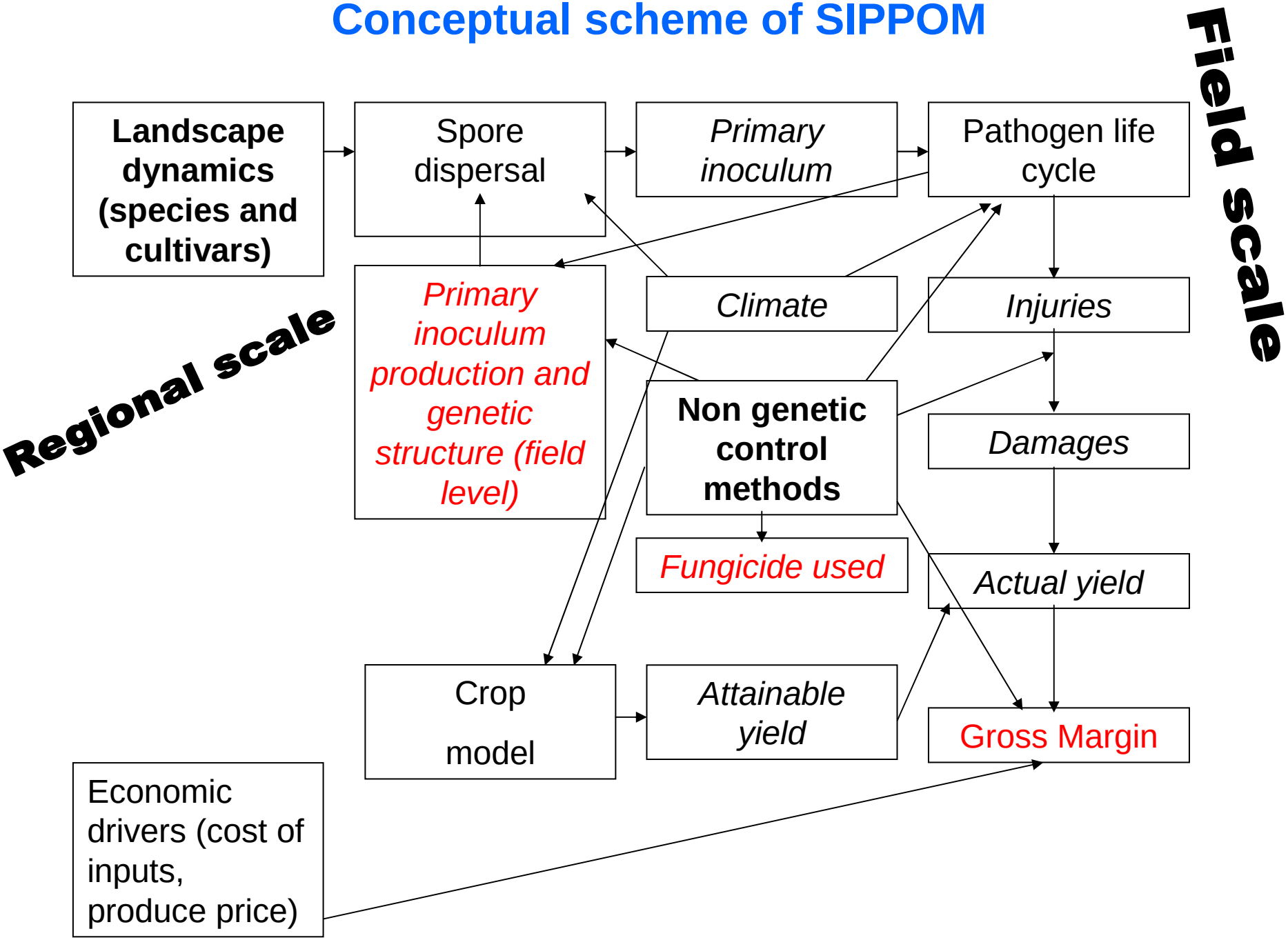
How to preserve their efficacy?

Concept of IAM: Integrated Avirulence Management

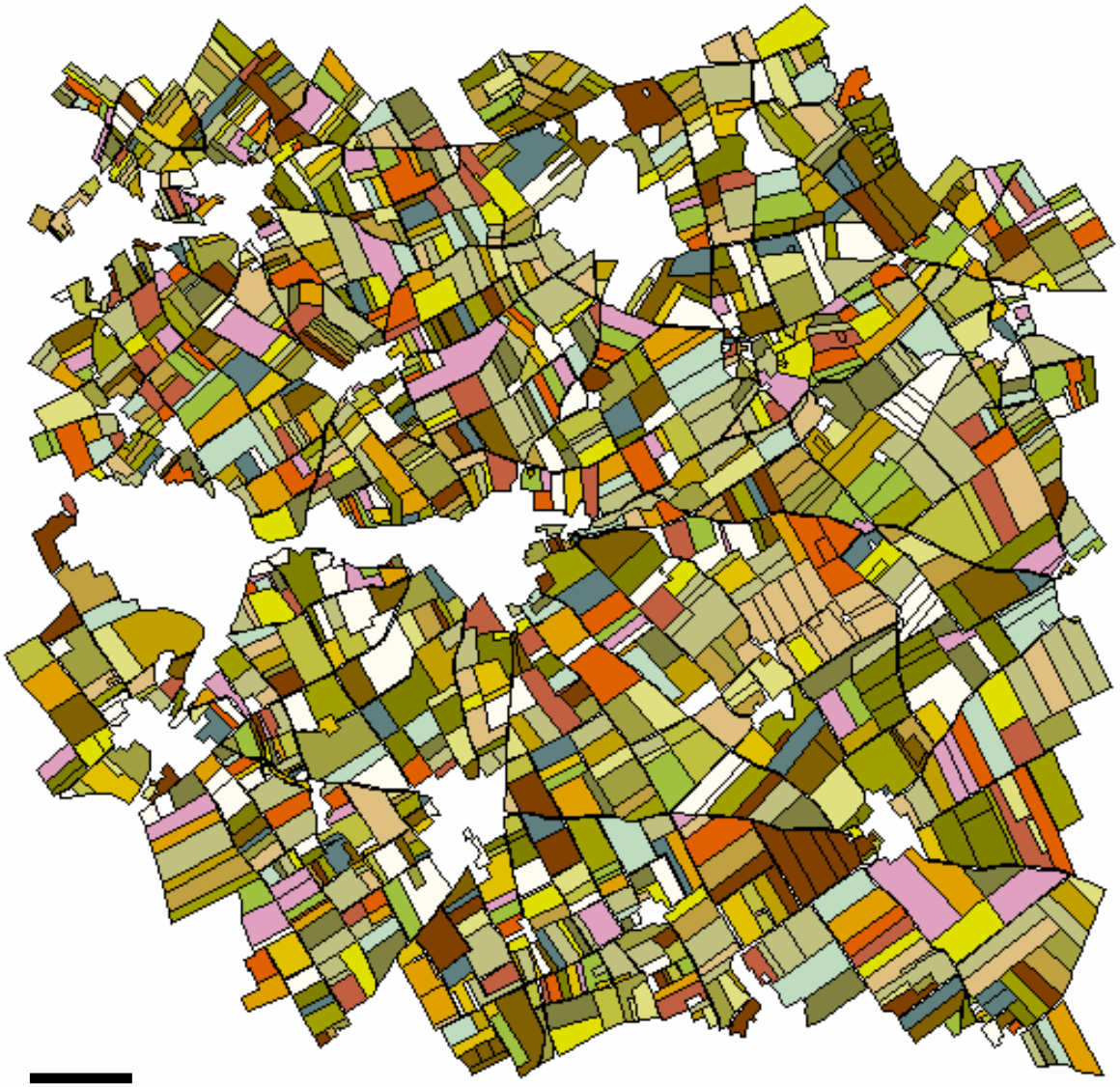
Integrated Avirulence Management involves a strategy to limit the selection pressure exerted on pathogen populations and, at the same time, reduce the size of pathogen populations by combining cultural, physical, biological or chemical methods of control".

Aubertot et al., EJPP 2006.

Conceptual scheme of SIPPOM



Selomme (Centre), France (UPS-CETIOM-INRA)

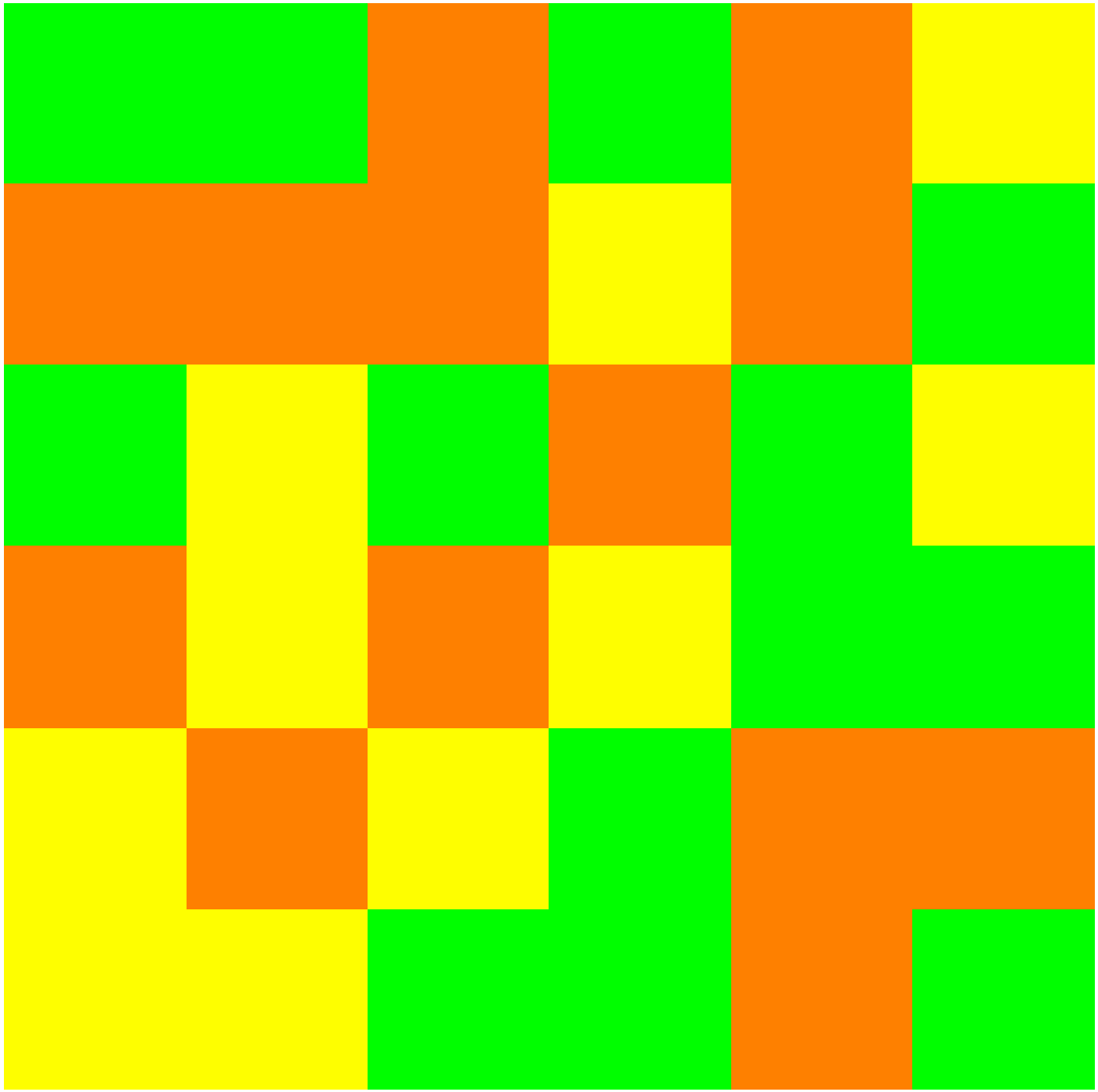


1 km

First simulations on a much less realistic region…

3 km * 3 km with 36 square fields (500 m long). Each field is composed of 10*10 pixels (50*50 m^2). A canola (green)-wheat (yellow) –barley (orange) rotation is simulated.

Pixels that receive spores are coloured in grey. The darker, the more spores. Only spores landing on canola fields will generate inoculum for the following year.



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3) Interactions between experimentation and modelling

- Setting up experiments requires conceptual models
- Models can help understand experimental results
- Experiments can help define model structures
- Experiments are used to estimate model parameters
- Experiments are used to estimate the predictive quality of models
- Models can identify hypotheses to be tested experimentally

4) Conclusion

- Modelling consists in representing a system. Experimenting consists in observing and analysing a system for which one or several components are modified.

- In addition to predictions, analysis and control of systems, modelling helps define ways to experiment. Experiments permit to estimate parameters and to confront simulations and observations.

- Experimentation and modelling are highly complementary and are dynamically linked.

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