

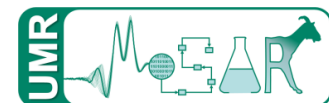


# Tools for evaluating trade-offs between robustness to price and yield variations in dairy goat farms

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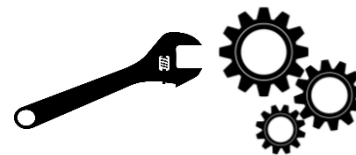


# Context and research question

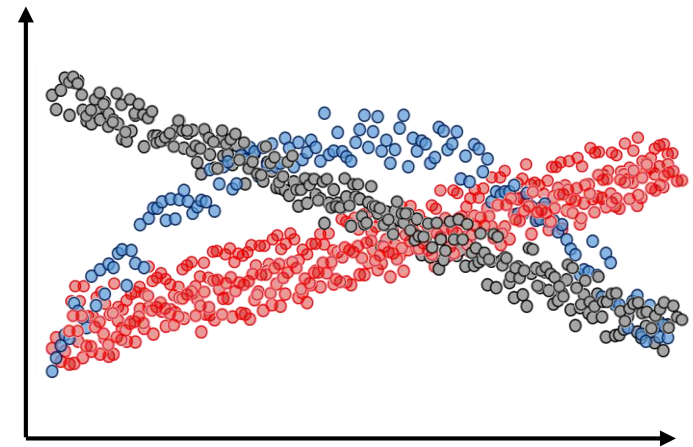
- Complex systems, properties and environment
  - ↗ constraints, perturbations, uncertainty
- Promoting grass-based diets in dairy goat farms
  - Less dependence to feed price fluctuation
  - More exposure to variability in plant yield



- How to address trade-offs?
  - Q1: how to capture relationships?



Indicator 2



Indicator 1

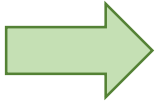
- Q2: how to deal with the situation?

# Material and methods

## Addressing trade-offs and synergies

- Q1: how to capture relationships and identify trade-off?
  - By using computer simulations to test scenarios of perturbations
- Q2: how to deal with the situation? What are the drivers?
  - By implementing global sensitivity analysis

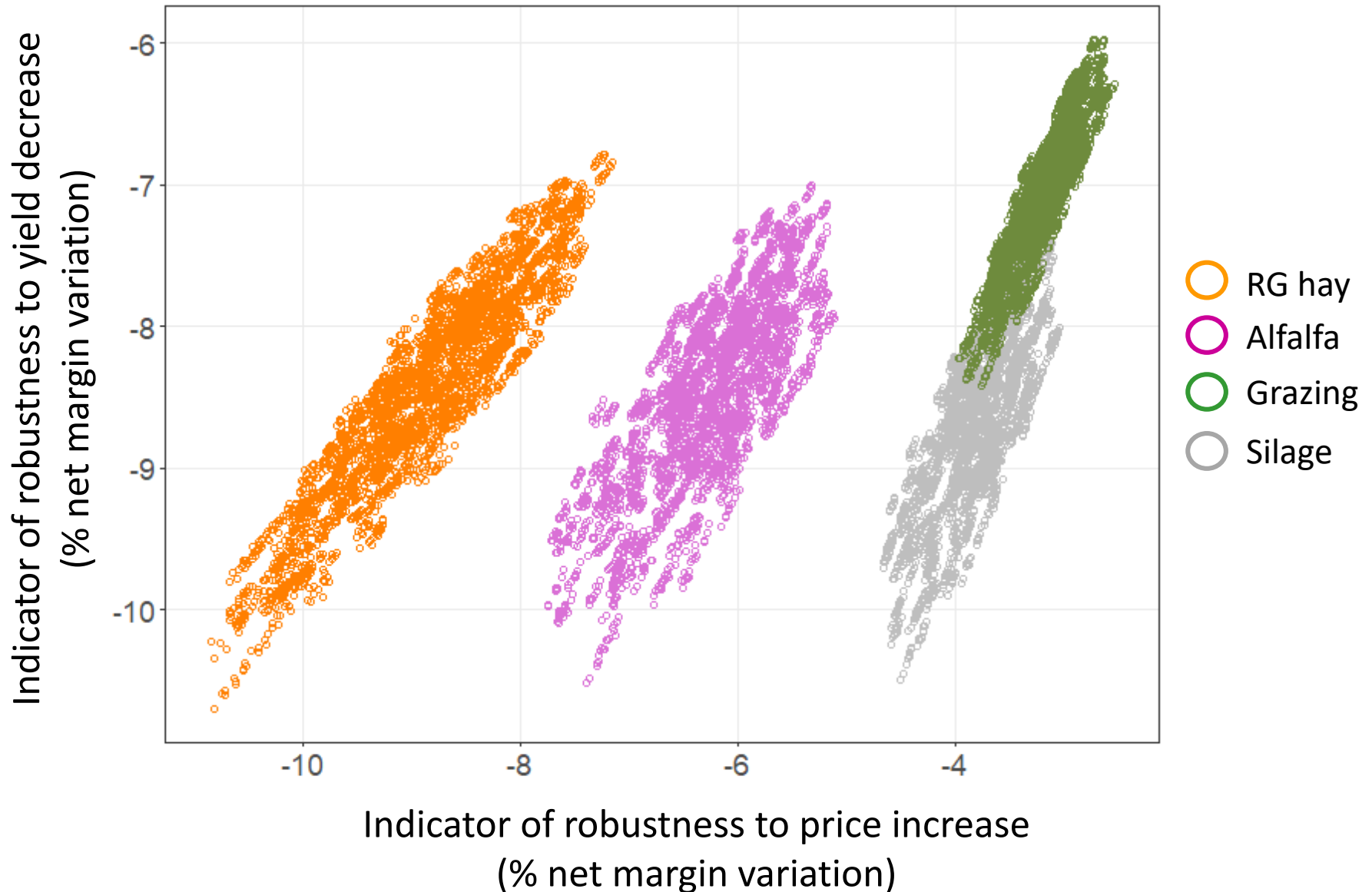
## Computer simulations

- Individual-based model for simulating herd performance
  - Animal building block → biological responses to feed
  - Management practices → 7 key parameters  
Reproductive success, breeding season length, culling criteria, replacement rate, production potential, extended lactation, supplementation level
- Feeding systems → alfalfa hay | rye-grass hay | corn silage | grazing
- Simple farm module
  - Link herd feed consumption to crop and forage areas
  - Compute economic indicators
- Perturbed situations
  - + 25% feed prices
  - - 25% crop and forage yield

**Robustness indicators**

Herd net margin variation  
(reference vs perturbed )

## Computer simulations



# Material and methods

## Addressing trade-offs and synergies

- Q1: how to capture relationships and identify trade-off?
  - By using computer simulations to test scenarios of perturbations
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  - By implementing global sensitivity analysis

# Global sensitivity analysis

- Formal definition

“How the uncertainty in the output of a model can be apportioned to different sources of uncertainty in the model input ?”

*Saltelli et al., 2000*

- Practical definition

- How model parameters contribute to variation of robustness indicators?
- What are the key management parameters?

- Quantitative approach → Sensitivity indices

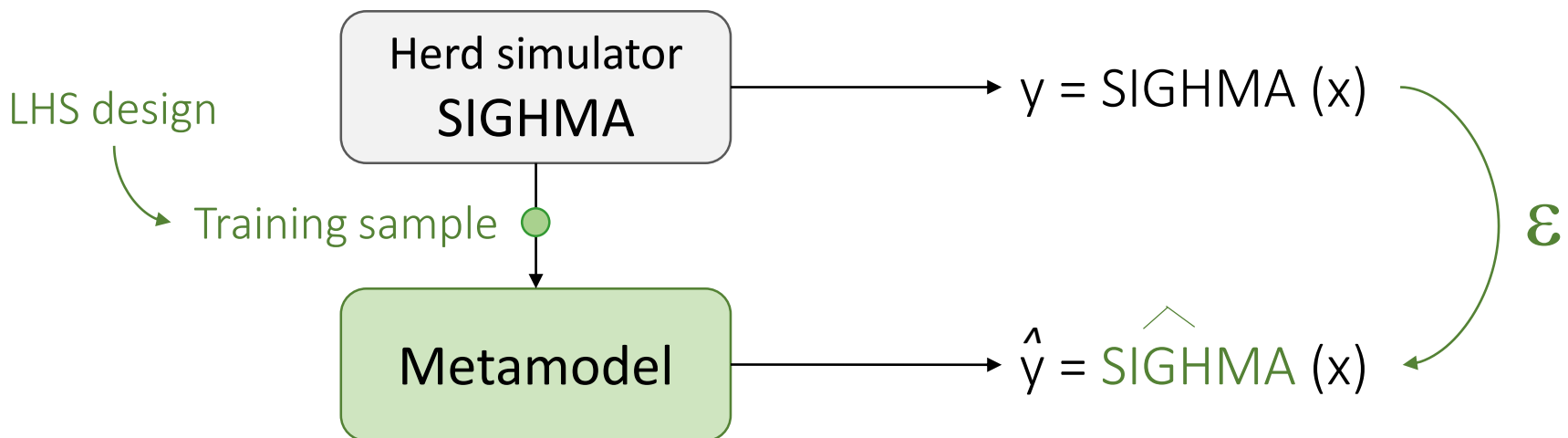
- Decomposition of output variance (% of variance explained by)
- Estimation based on a large number of model runs

7 parameters \* 1000 runs \* 10 replicates \* 20' = 1400000' ≈ 972 days

How to save time?

# Global sensitivity analysis

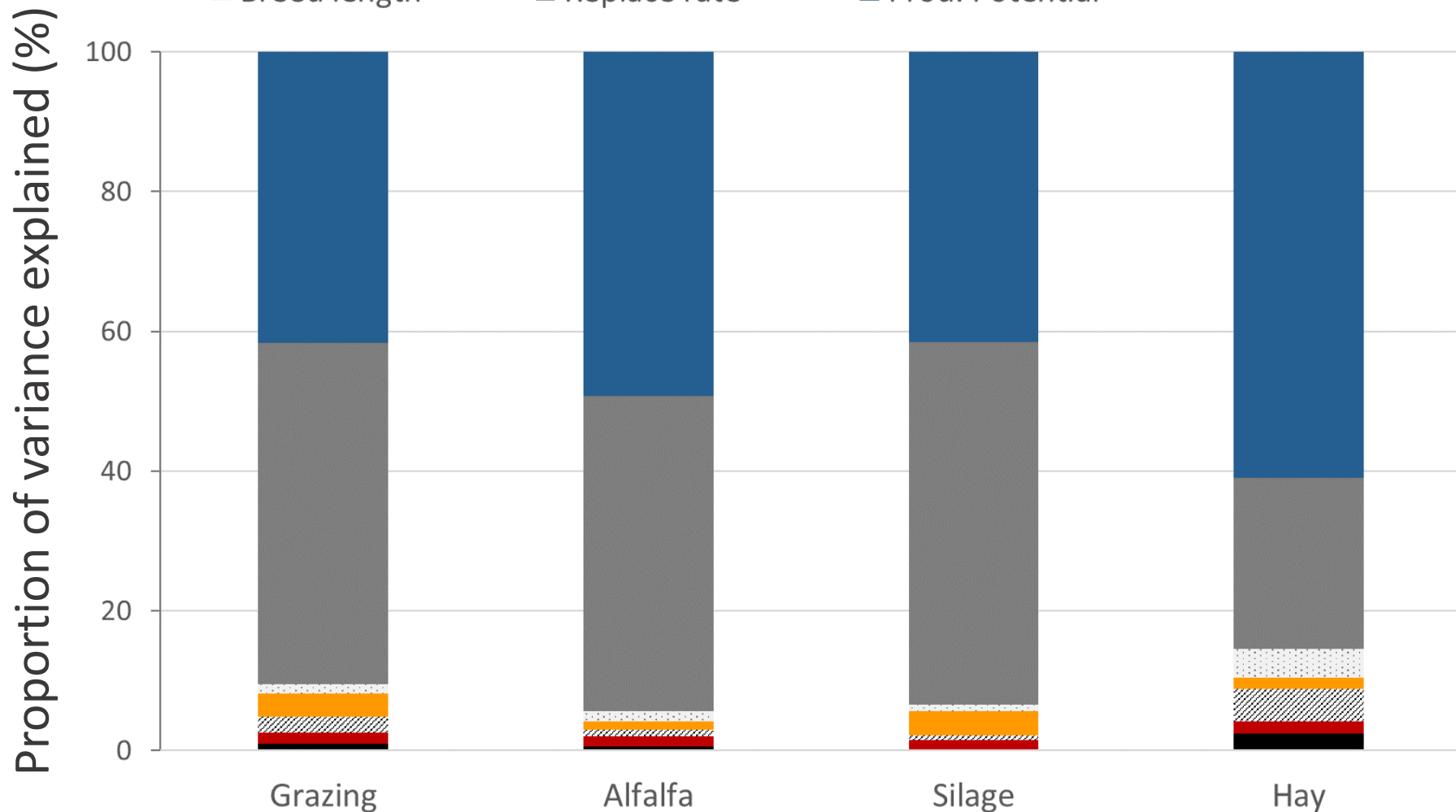
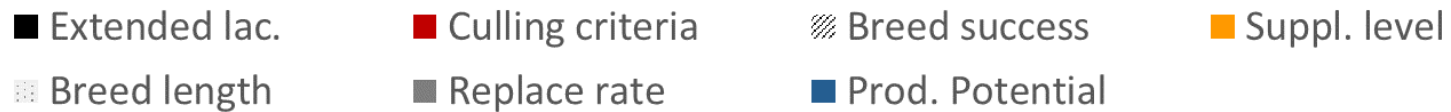
- Using computing cluster
- Reducing number of runs
  - Design of experiments → Latin Hypercube Sampling
    - Exploring parameters space with a limited nb of points
  - Metamodelling (Kriging) → cheap-to-evaluate surrogates
    - Approximation of the real model for obtaining large nb of runs
    - Computation of sensitivity indices based on these runs





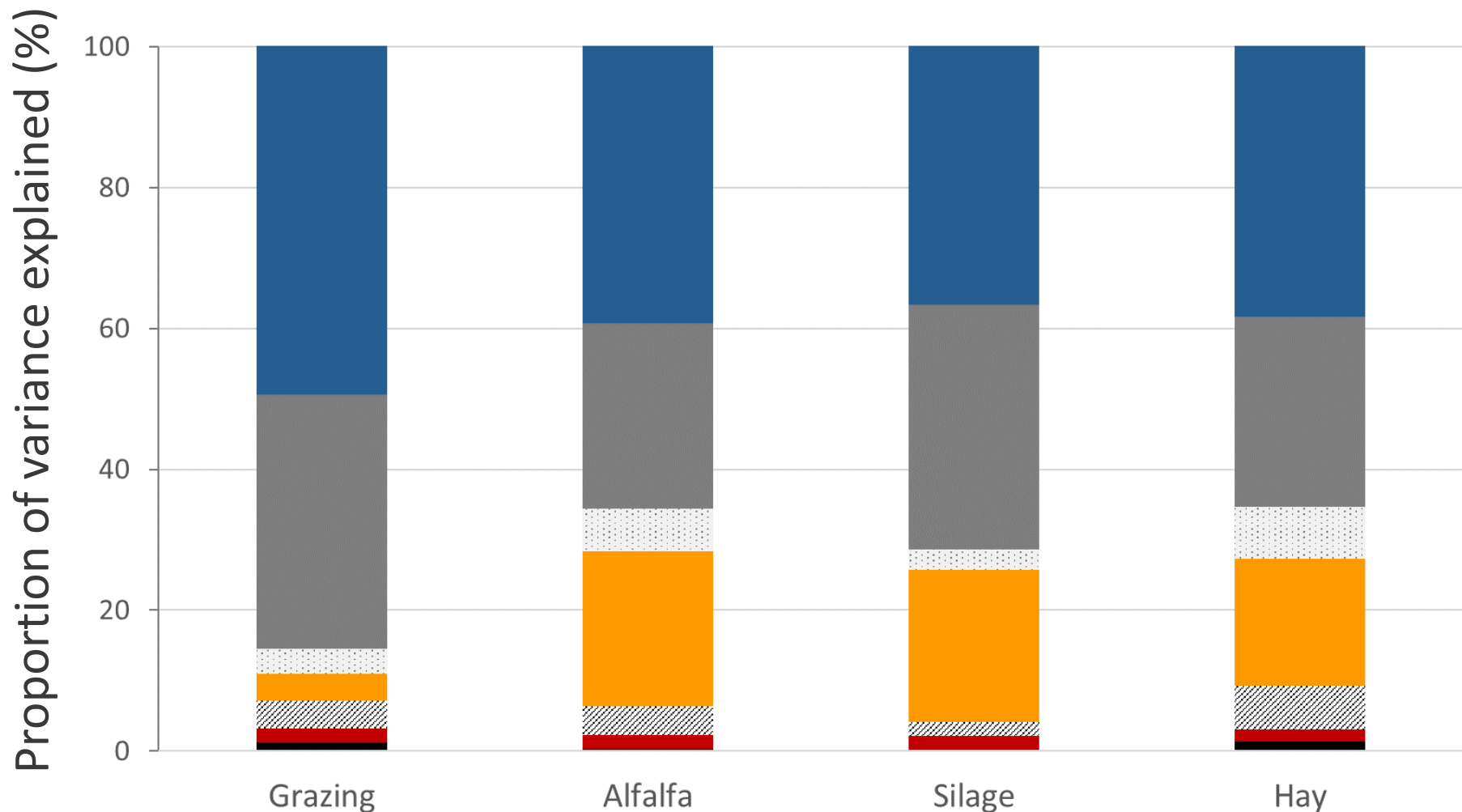
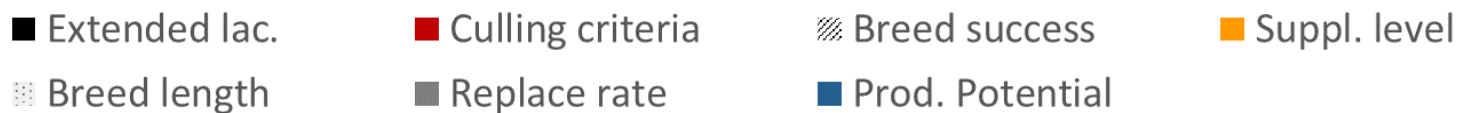
# Global sensitivity analysis

## Indicator of robustness to price increase



# Global sensitivity analysis

## Indicator of robustness to yield decrease



# Global sensitivity analysis

- What are the key drivers [variable 1, variable 2] ?
  - Formal answer → implement global sensitivity analysis
  - Practical answer → play with the data and visualize effects



## SIGHMA-WEB : outil d'exploration des résultats technico-économiques de l'atelier caprin laitier



(Bis repetita) L'outil SIGHMA-WEB permet d'accéder aux résultats techniques et économiques d'un atelier de production caprin laitier en fonction du système d'alimentation du troupeau et des pratiques de conduite de la reproduction, du renouvellement et de la réforme.

Grâce à l'outil, il est possible de comparer les résultats du troupeau pour différents systèmes de conduite de l'alimentation (foin de graminées, ensilage, pâturage...) et visualiser comment les pratiques de conduite (durée de la période de reproduction, taux de renouvellement...) modulent ces résultats.

SIGHMA-WEB valorise les résultats obtenus dans le cadre du projet FLECHE grâce au simulateur informatique SIGHMA développé par l'INRA.

### MODE EXPLORATION

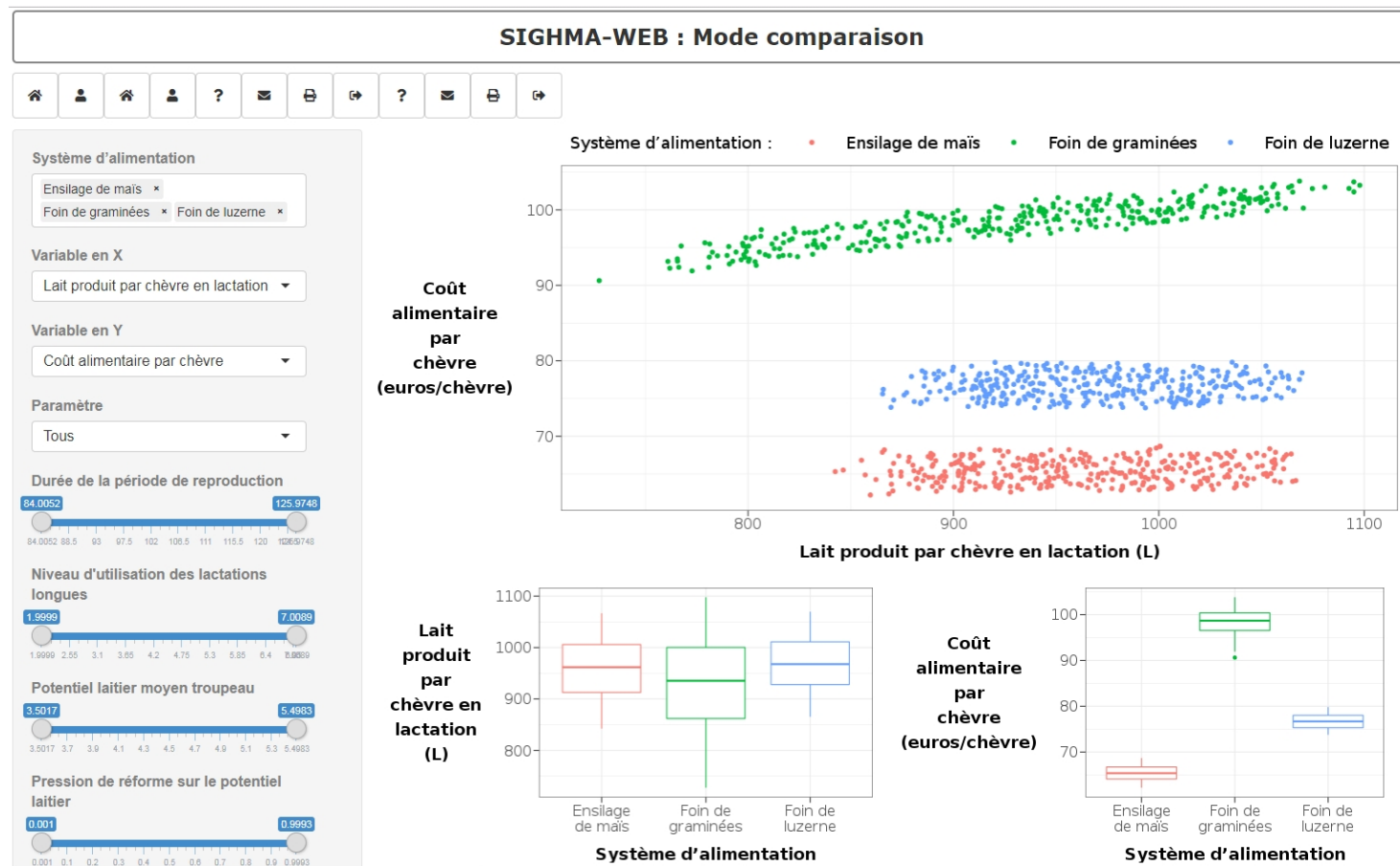
Analyse détaillée  
d'un seul scénario  
d'alimentation

### MODE COMPARAISON

Analyse comparative  
des différents scénarios  
d'alimentation

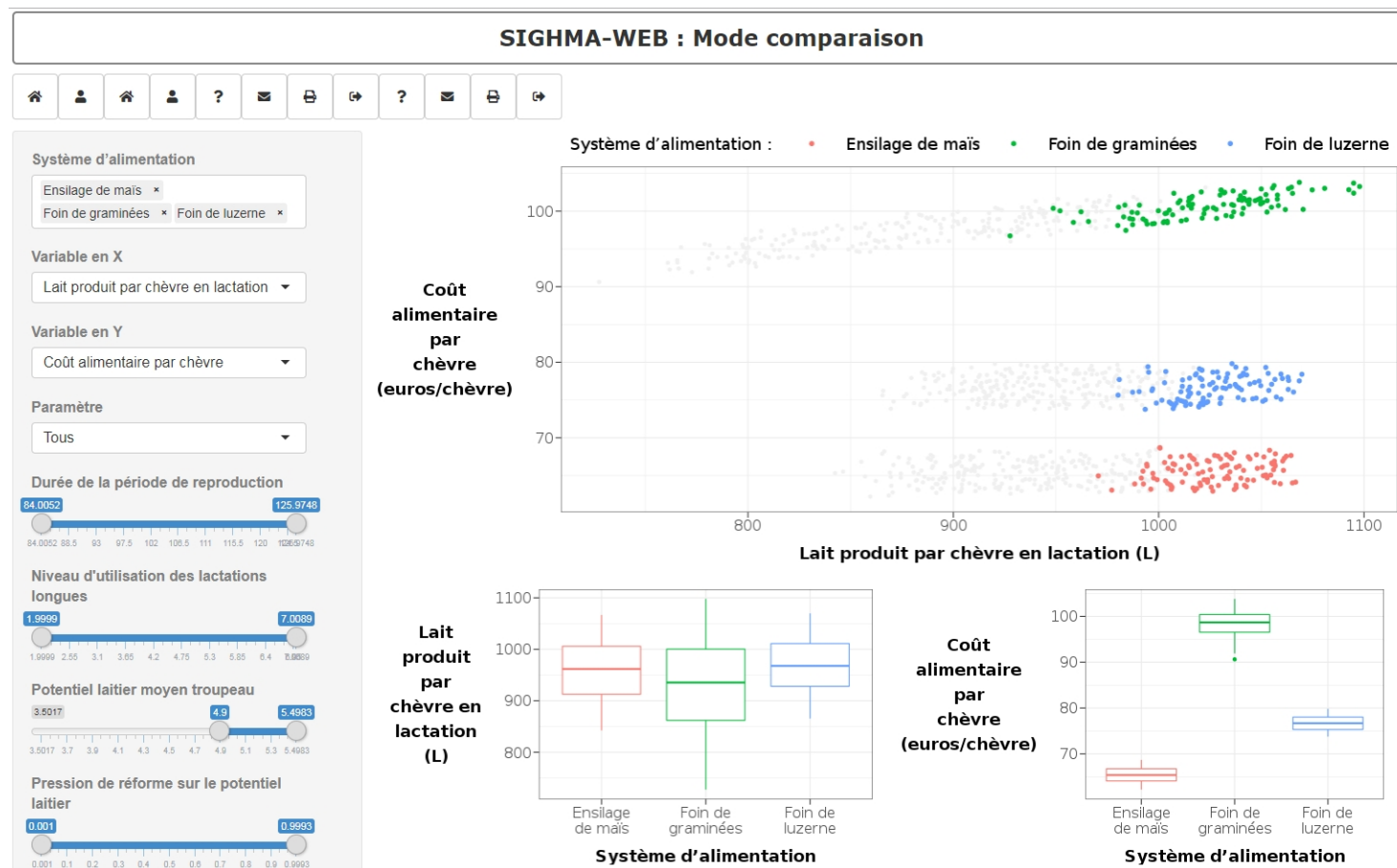
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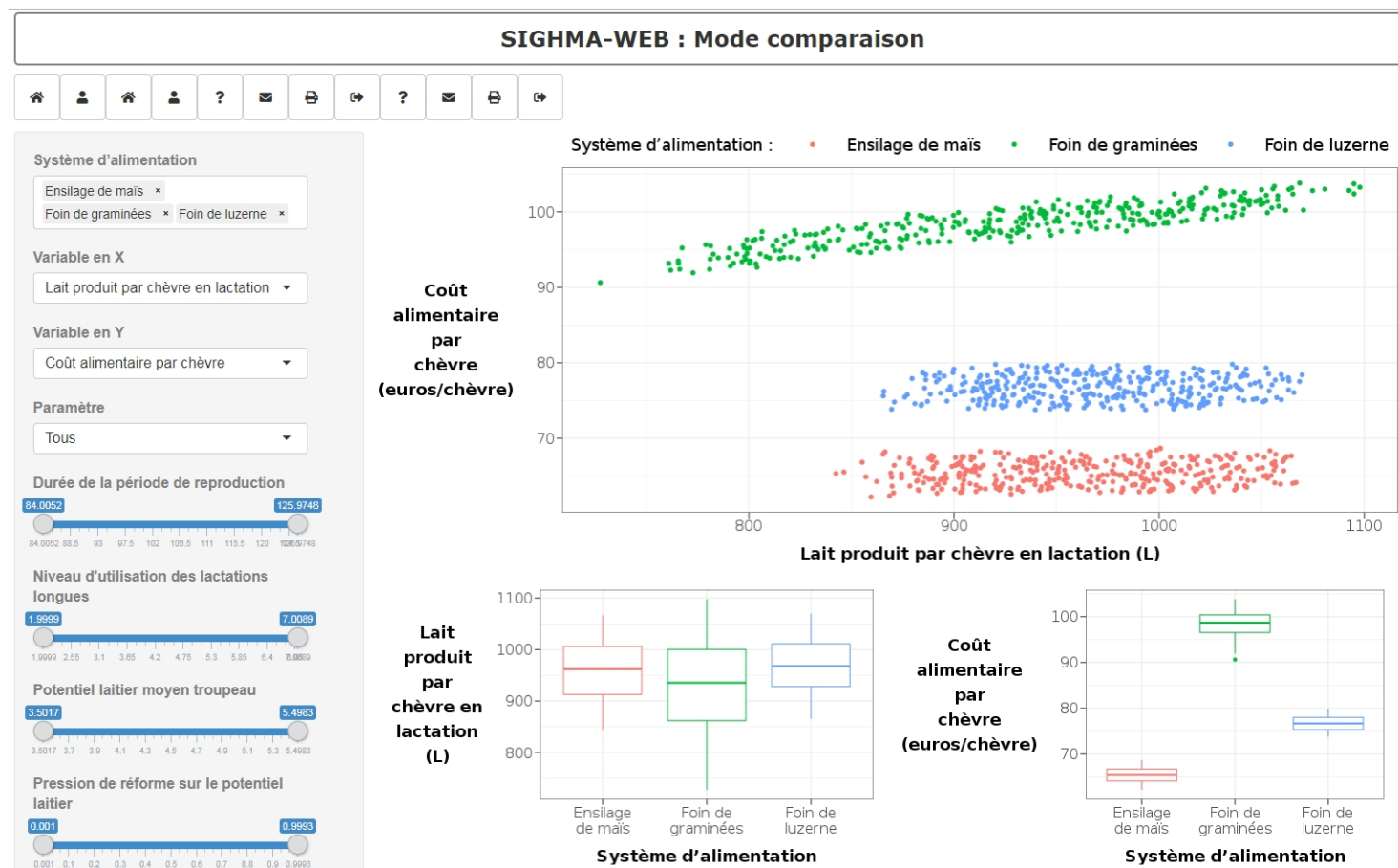
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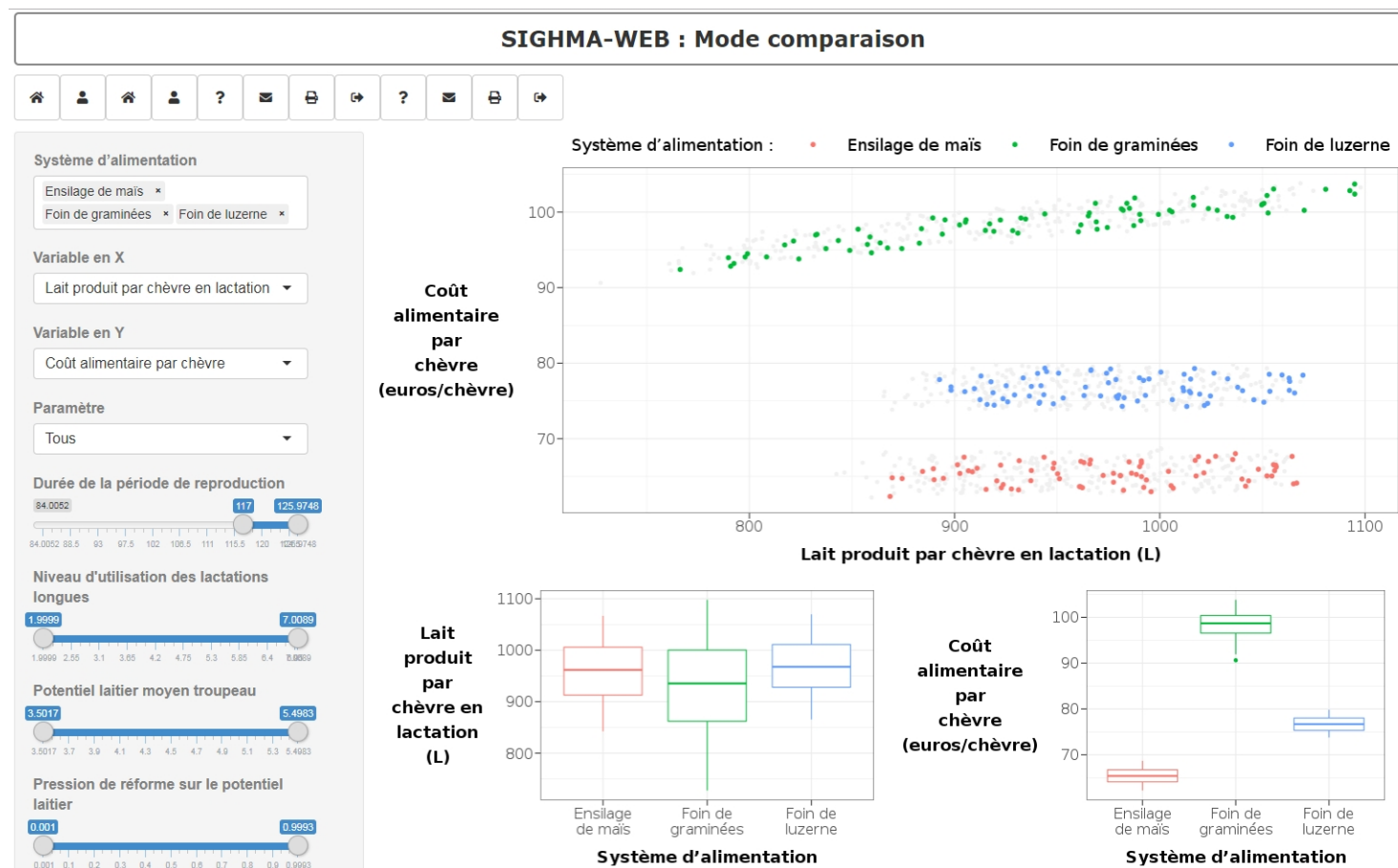
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# Conclusion and perspectives

- Work in progress on farm module
  - Robustness indicators @ farm level
  - Intrinsic mechanisms of regulation
    - Dynamics of crop and forage production and stock
- Complex models produce complex information
  - Synthetic view, indicators, visual display
- Computer sc. and applied maths provide useful tools
  - Reap the benefits from our models



Thanks for your attention



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