Coping with risks by enhancing adaptive capacities of biological components in the system: research strategy in the livestock sector

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Stéphane Ingrand, Inra, « Animal physiology and livestock farming system » PHASE Department

PHASE's strategic plan, 2016-2020

Objective: **to contribute to the shift towards multi-effective livestock farming systems, by producing knowledge at different scales and by associating :**

❖ The principles of **agroecology**: stimulation of natural processes

❖ Predictive approaches in biology: models and decision-support tools

4 thematic fields (TF)
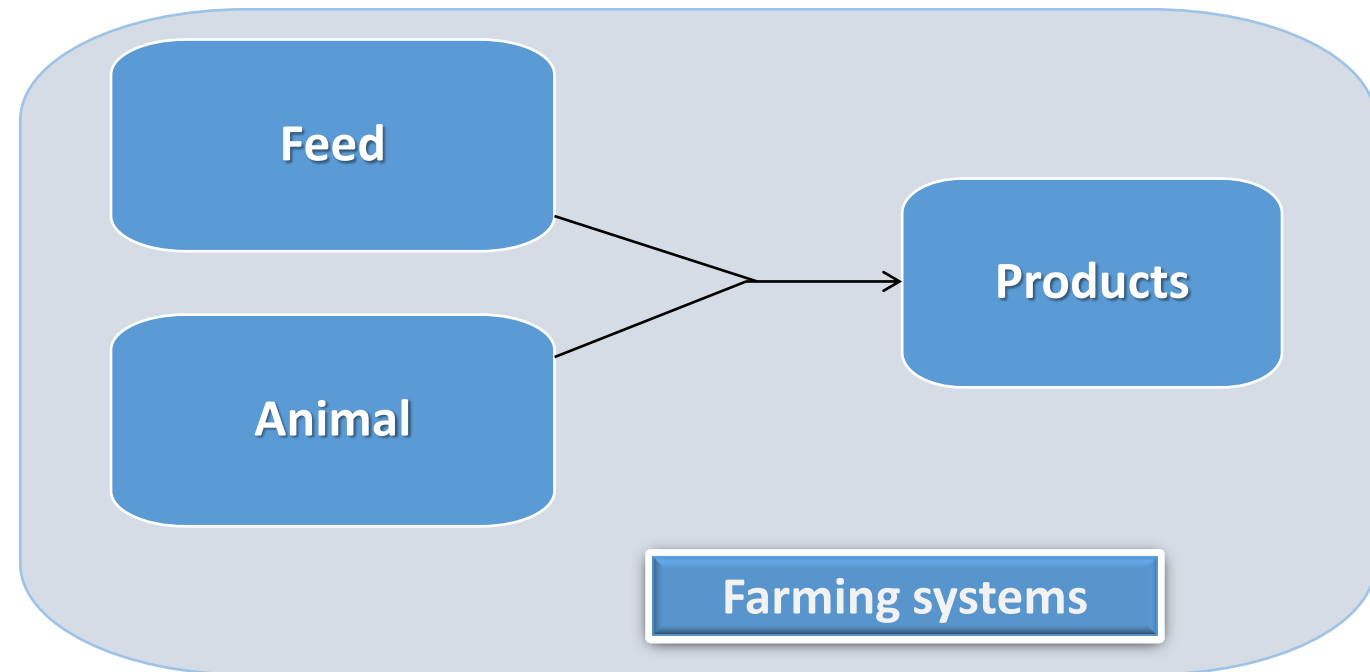
Thematic field: farming systems

Objective: to define combinations of resources, animals and farming practices, taking the environment into account, to conciliate productive, economic and environmental performances, while maximizing animal welfare and health.

Priorities

❖ **Identification of bottle-necks** to design innovative systems to cope with climatic hazards (milk/agroforestry), water quality (aquapony), economic volatility (hitech organic pig), health status (zero antibio), animal welfare (fat liver without forced feeding, no castration in pigs).

❖ **Identifying some indicators for robustness, resilience and efficiency (animal, group, system)**

❖ **Understanding synergies/antagonisms between elements within the system**

❖ **Producing methods for multicriteria assessment of new systems**

1- Achieve an integrated animal health management

2- Recouple the CNP cycles in animal production

3- Reduce external inputs for animal production

4- Increase resilience of production by increasing diversity

5- Preserve and use biodiversity in animal production

Agroecology in livestock farming systems: 5 principles

Dumont et al, 2013
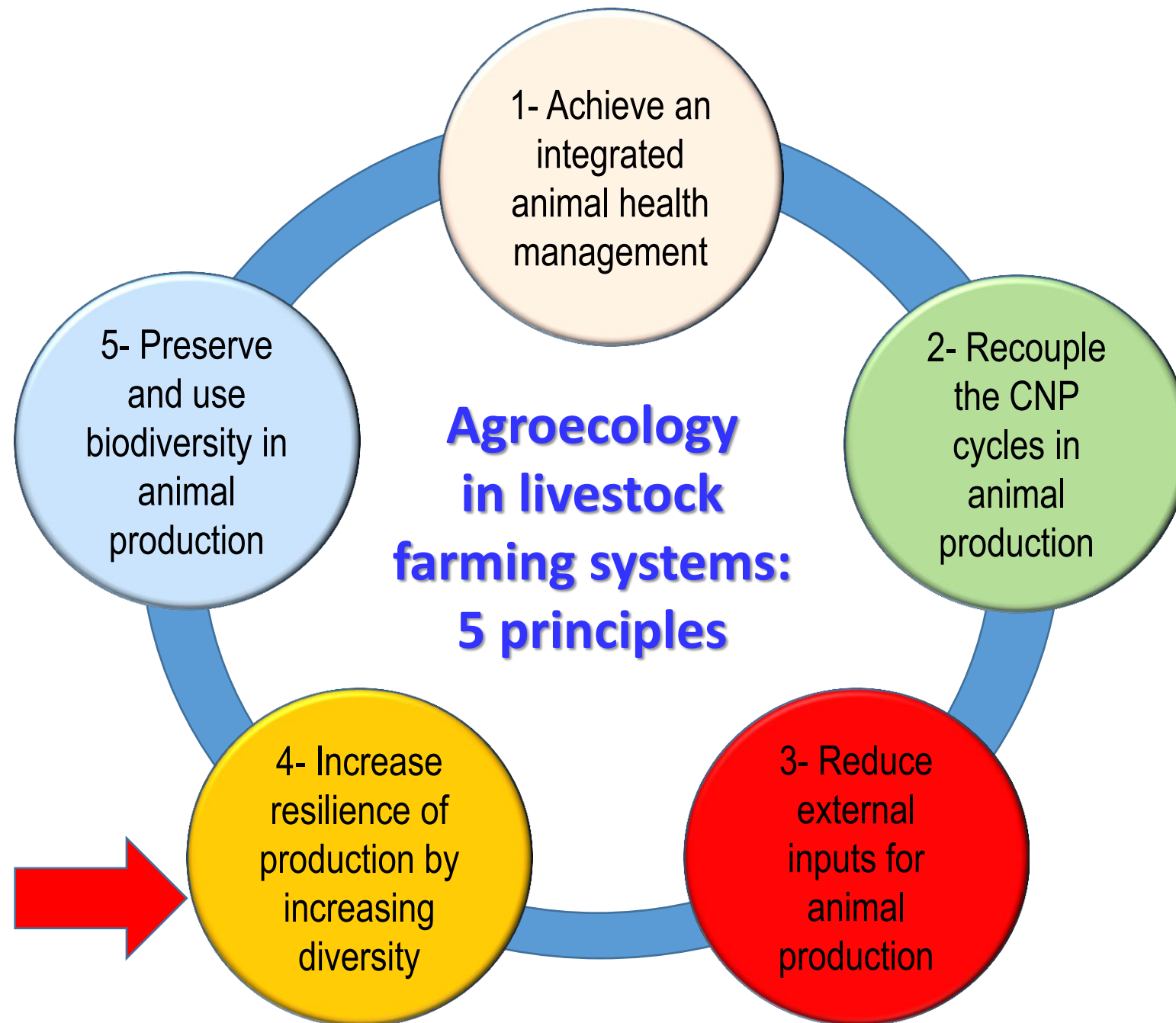
3 scientific + 1 « societal » challenges

❶ **Early levers to drive phenotypes** and products and favour coadaptation between animals and the environment

❷ **Models and biomarkers to anticipate and drive processes**
  - Model the dynamic interactions between levels of organization and between functions
  - Produce validated biomarkers of efficiency, robustness, product quality
  ➔ To improve high-throughput phenotyping, precision livestock farming

❸ **Diversity to enhance** efficiency, robustness et resilience
  Assuming that "diversity of items (resources, animal, products) within a system increases its capacity to face unpredictable events »
  ➔ Propose rules for managing farming systems, which are based on the diversification of biotechnical elements.

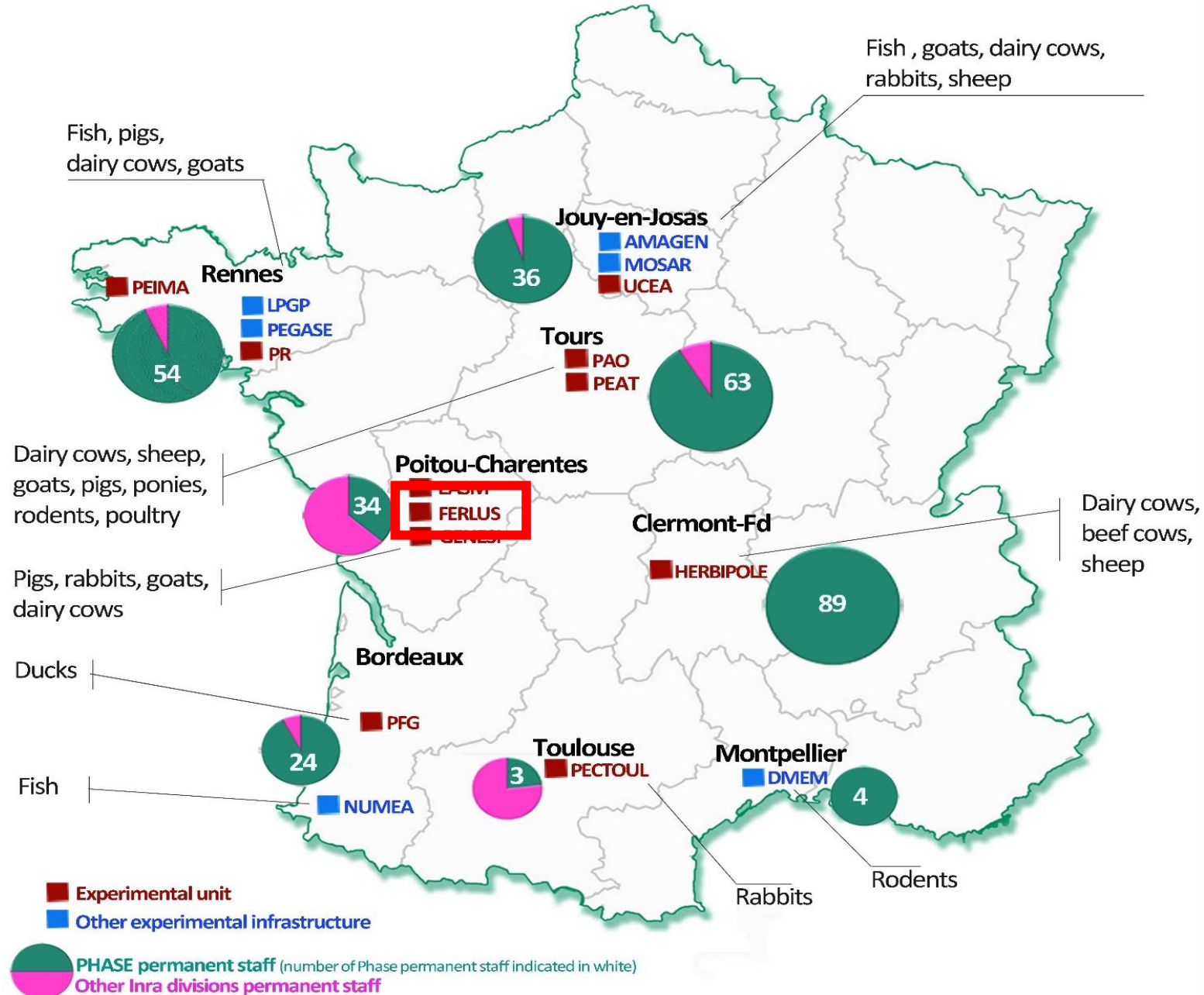❹ **Perception of livestock farming systems and research involving animals**

Example n°1:
A long-term experiment

OasYs : a dairy system designed to have a low sensitivity to climatic hazards

Experimental facilities of PHASE Department

INRA SCIENCE & IMPACT

Fish, pigs,
dairy cows, goats

Fish , goats, dairy cows,
rabbits, sheep

Jouy-en-Josas
- AMAGEN
- MOSAR
- UCEA

Rennes
- PEIMA
- LPGP
- PEGASE
- PR

36

Tours
- PAO
- PEAT

63

Poitou-Charentes
- EASM
- FERLUS
- GENESI

Dairy cows, sheep,
goats, pigs, ponies,
rodents, poultry

34

Clermont-Fd
- HERBIPOLE

Dairy cows,
beef cows,
sheep

89

Pigs, rabbits, goats,
dairy cows

Bordeaux
- PFG

Ducks

24

Toulouse
- PECTOUL

Montpellier
- DMEM

3

4

Fish

- NUMEA

Rodents

Rabbits

- Experimental unit
- Other experimental infrastructure

PHASE permanent staff (number of Phase permanent staff indicated in white)
Other Inra divisions permanent staff

The main innovations in the « OasYs » system

Diversification

Species, mixed crops

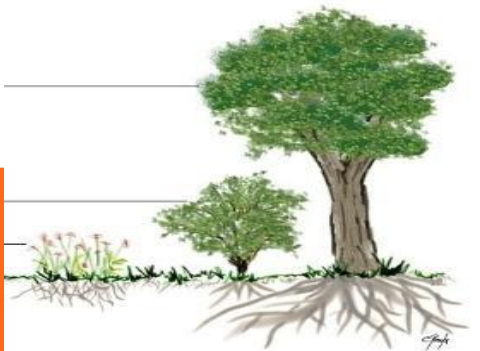**Breed, calving period**
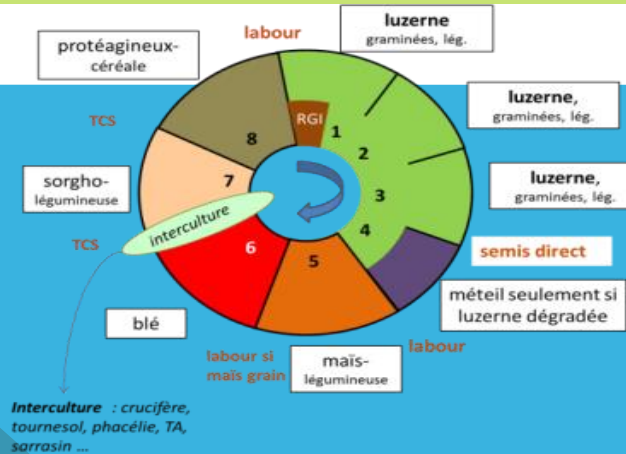
Functions

Valorisation in all dimensions

verticale 3D

Time 4D

Crops succession

Lactation duration

Fodder trees: future pollards to be browsed

pollarded to increase the foliar biomass

Alnus cordata
italian alder

Ulmus minor
field elm

Morus alba
white mulberry

Fraxinus excelsior
ash

Objectives: to be browsed during periods of low grassland production (summer and autumn).

Objective: to provide shade

Quercus ilex

Example n°2: a PhD thesis

Assessing robustness of dairy cows
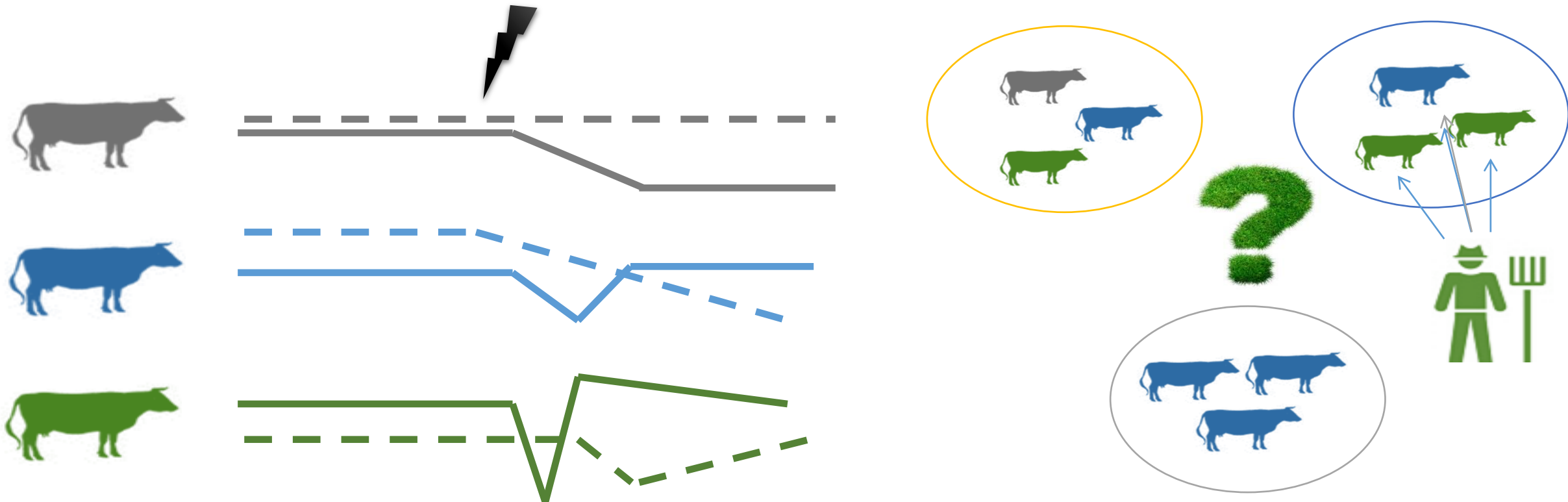
Emilie Ollion (2015)
Fabienne Blanc & Stéphane Ingrand, supervisors
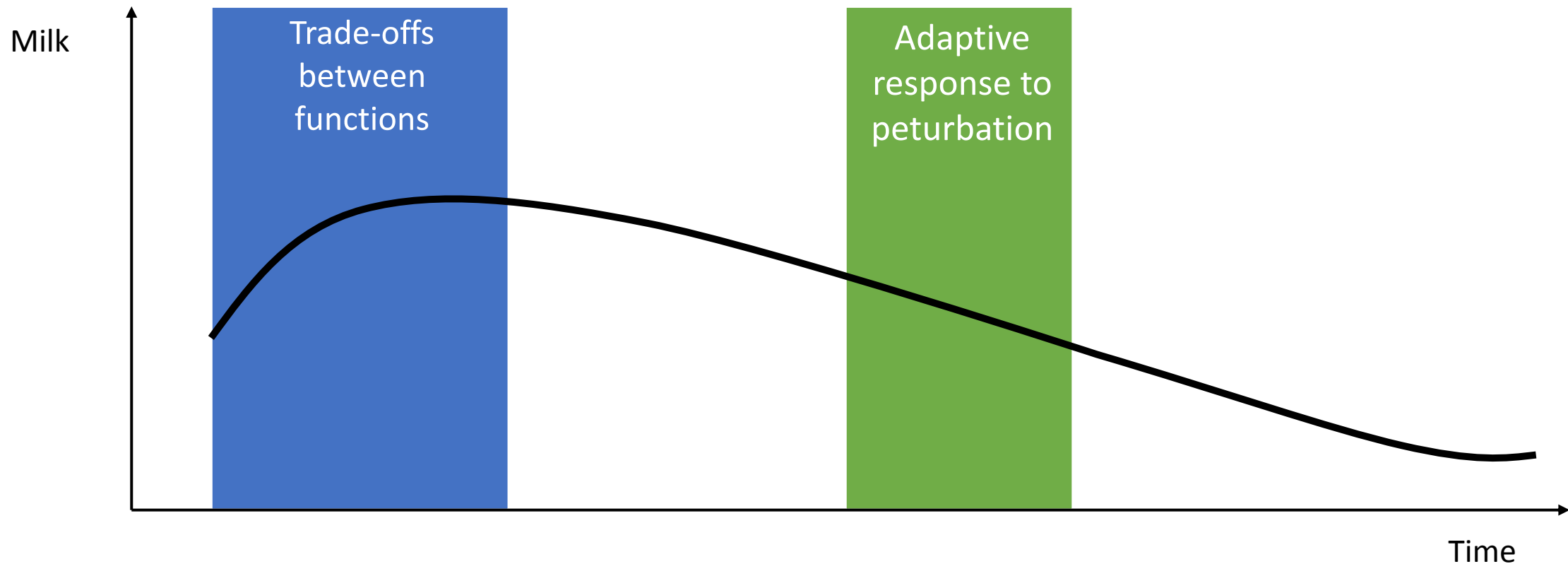
Scientific context

- Herd scale

➔ Individual diversity + accurate practices: stabilisation of production and revenue

(Puillet et al. 2011, Cournut et al. 2012, Blanc et al. 2013)

Method

To develop a method for characterising adaptive responses to perturbations based on the identification of trade-offs between biological functions in early lactation
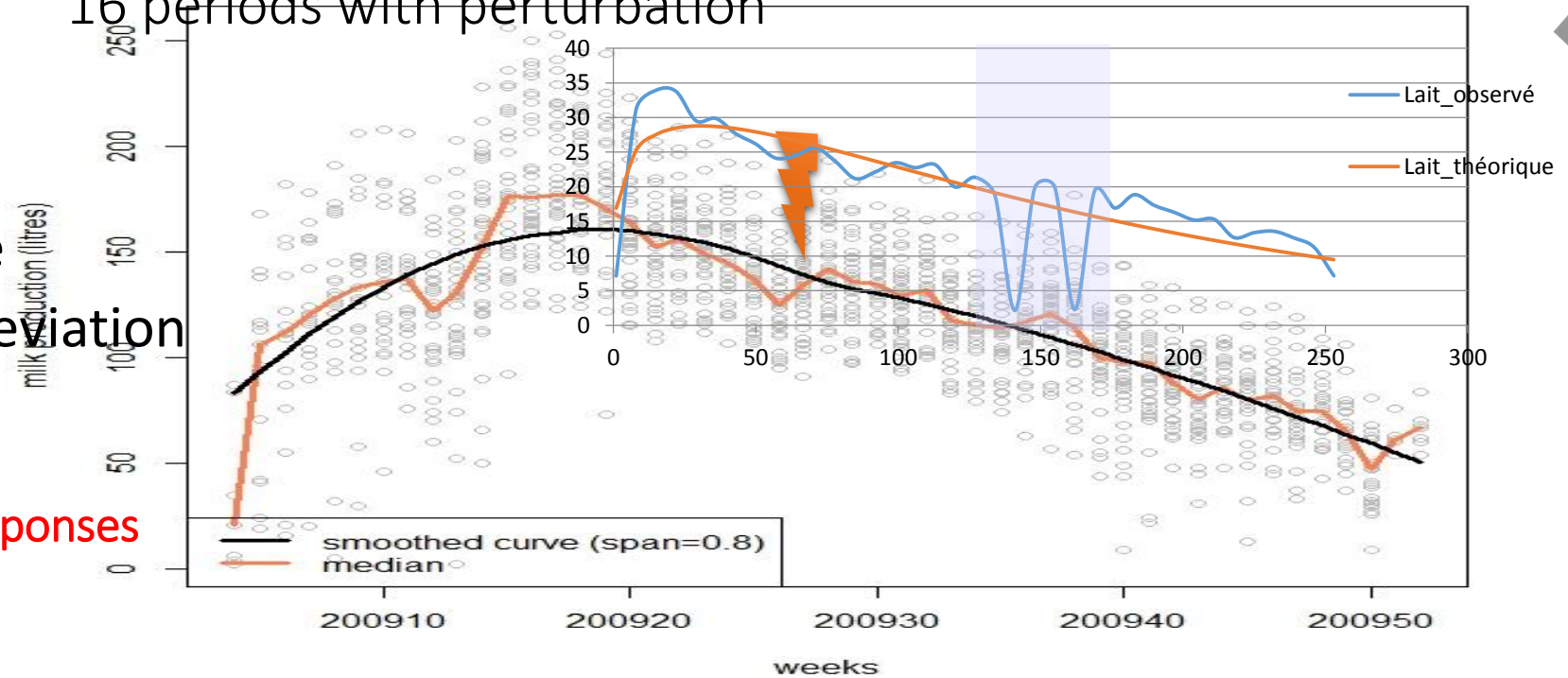
Characterisation of adaptive responses

- Detection of perturbations at herd's scale:

- At animal scale:
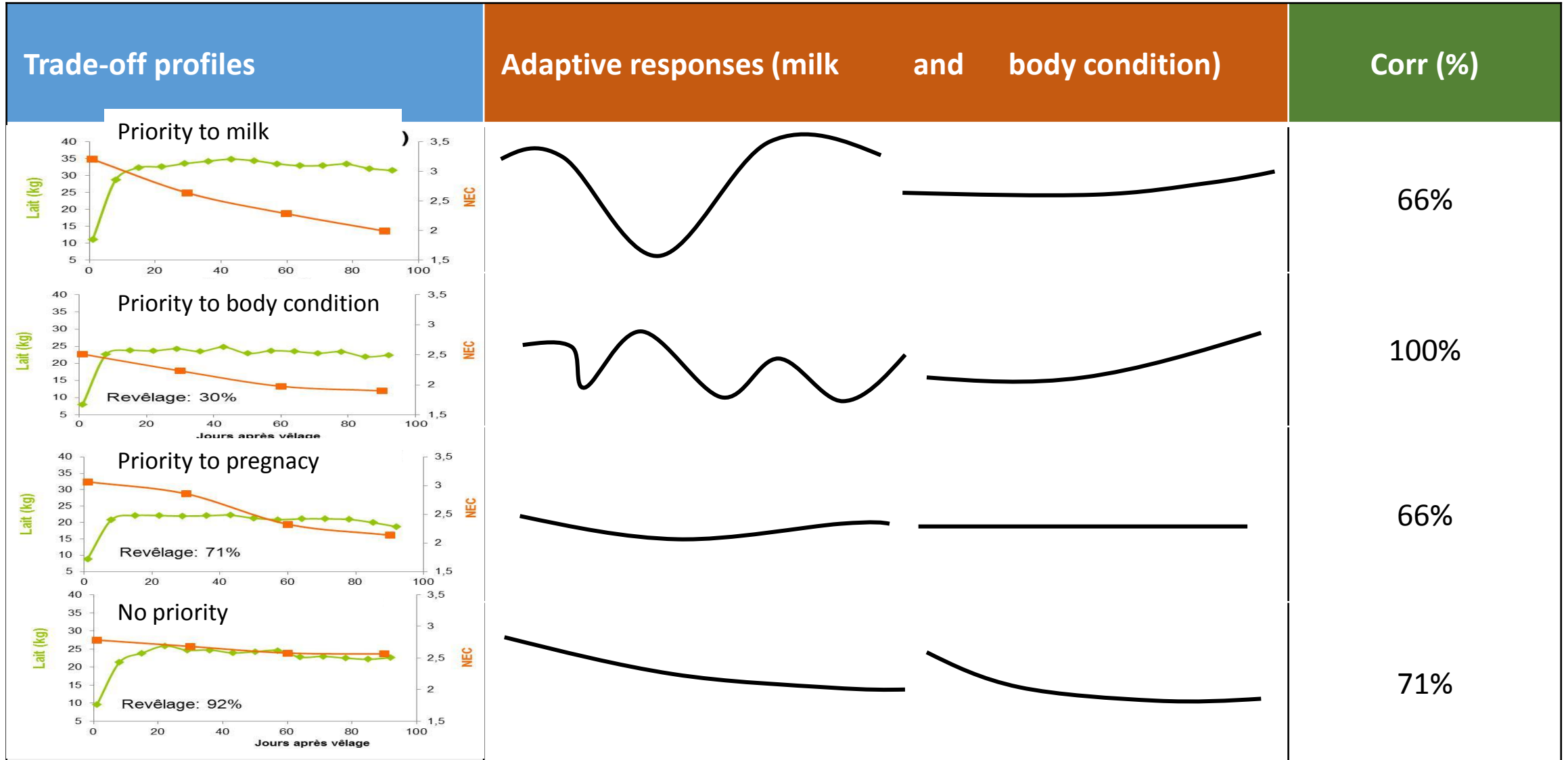 - Reference curve
  - Indicateurs of deviation

➔ 4 profiles of adaptive responses

16 periods with perturbation

Données Inra Mirecourt, 2009

Relationships between adaptive responses to perturbation and trade-off between functions

Trade-off profiles	Adaptive responses (milk and body condition)	Corr (%)
Priority to milk		66%
Priority to body condition Revêlage: 30%		100%
Priority to pregnacy Revêlage: 71%		66%
No priority Revêlage: 92%		71%

Concluding remarks…

Need to monitor systems in hazardous environment

→ precision farming as a tool for agroecological transition

Diversity as a lever to cope with risks:

→ what are the conditions?

- « position paper » in progress

(another paradigm for researchers in animal science)

- a PhD thesis concerning crossbreeding in dairy herds