More diversity within livestock farming systems: an improvement of performances at all scales

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INRAE

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The ‘Phase’ division at INRAE (animal physiology & farming systems)

~1500 people

800 INRAE

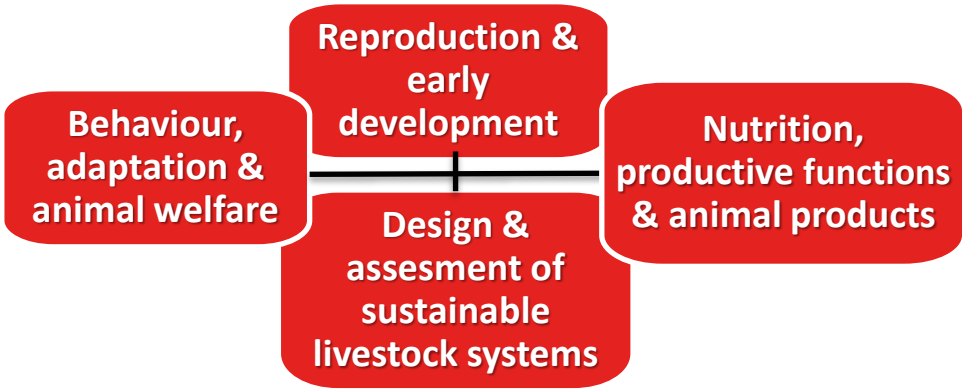
460 partners

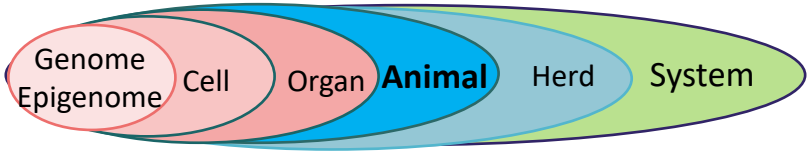
220 docs + post-docs

Scientific domains:

reproduction, nutrition, development, ethology, neurosciences, zootechnie, bio-informatic, stat. & modelisation

4 thematic fields

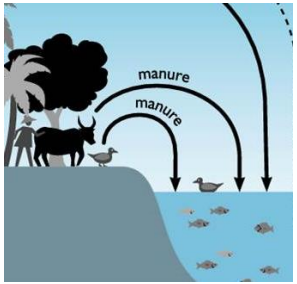




Diversity: which criteria? which organization? which goals?

Different components of diversity in LFS

- Resources
- Animals
- Systems



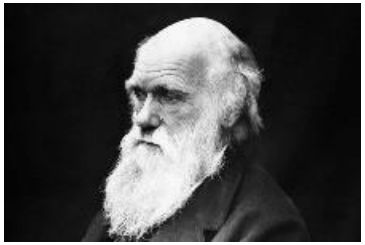
_01
DIVERSITY OF RESOURCES

Complementarity between plants in grasslands

Not really a scoop…

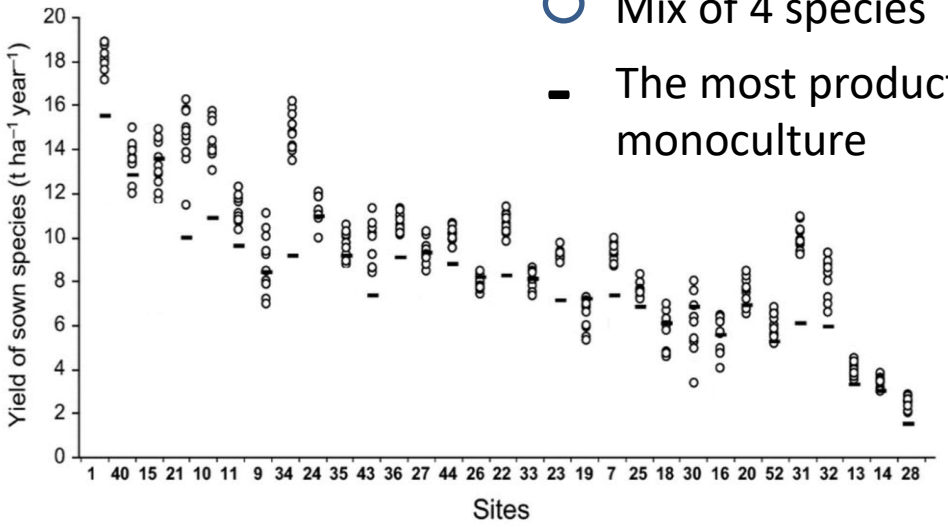
"It has been experimentally proved, if a plot of ground be sown with one species of grass, and a similar plot be sown with several distinct genera of grasses, a greater number of plants and a greater weight of dry herbage can be raised …"

Darwin (1872), On the Origin of Species by Means of Natural Selection, ch IV.



- Yield = 30% > average of the same species alone
- In 60% of sites = yield > to the best monoculture

Higher yields



Complementarity between plants in grasslands (mechanisms)

Gains due to legumes / symbiotic fixation N_{atm}

- N = improve growth of grass
- Presence of grass = improve N fixation by legumes

(Nyfeler et al. 2011)

Reduction of the use of fertilizers

Functional diversity reduces propagation of weeds

(Suter et al. 2016)

Reduction of the use of herbicides

Improvement of resilience

- Portfolio effect *(Figge, 2004; Volaire et al., 2014)*
- Functional redundancy *(Biggs et al., 2012)*

Zootechnical added-values: both ecological & economic

Better performances when animals graze mixed grasslands

- *Roca-Fernández et al., 2016* *Grace et al., 2019*

Reduction of concentrate

Reduction of veterinary products

- Greater motivation to eat *(Ginane et al., 2002; Niderkorn et al., 2017)*
- Anthelminthics properties of tannin plants : *Hoste et al. 2006; Collas et al. 2018*

Reduction of pollutions

Reduction of N leaching *(61 => 34 kg N/ha; Romera et al., 2017)*

Reduction in CH_4 emission with some species *(in vitro; Macheboeuf et al., 2017)*

Increase of income *l* ha *(2946 => 3062 $/ha; Romera et al., 2017)*

_02
DIVERSITY OF ANIMALS

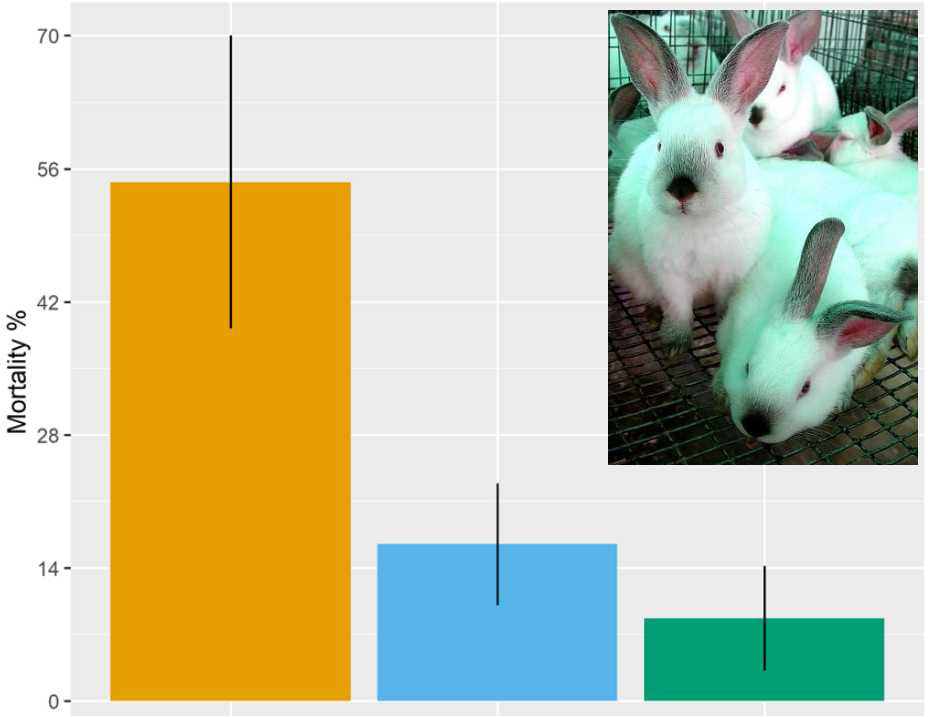
Rabbit breeding

Univ. Valence, epizootic rabbit enteropathy

Exp.1 : 1 single line *(Martinez-Vallespin et al., 2011)*

Exp.2 : 3 simultaneous lines *(Savietto et al., 2012)*

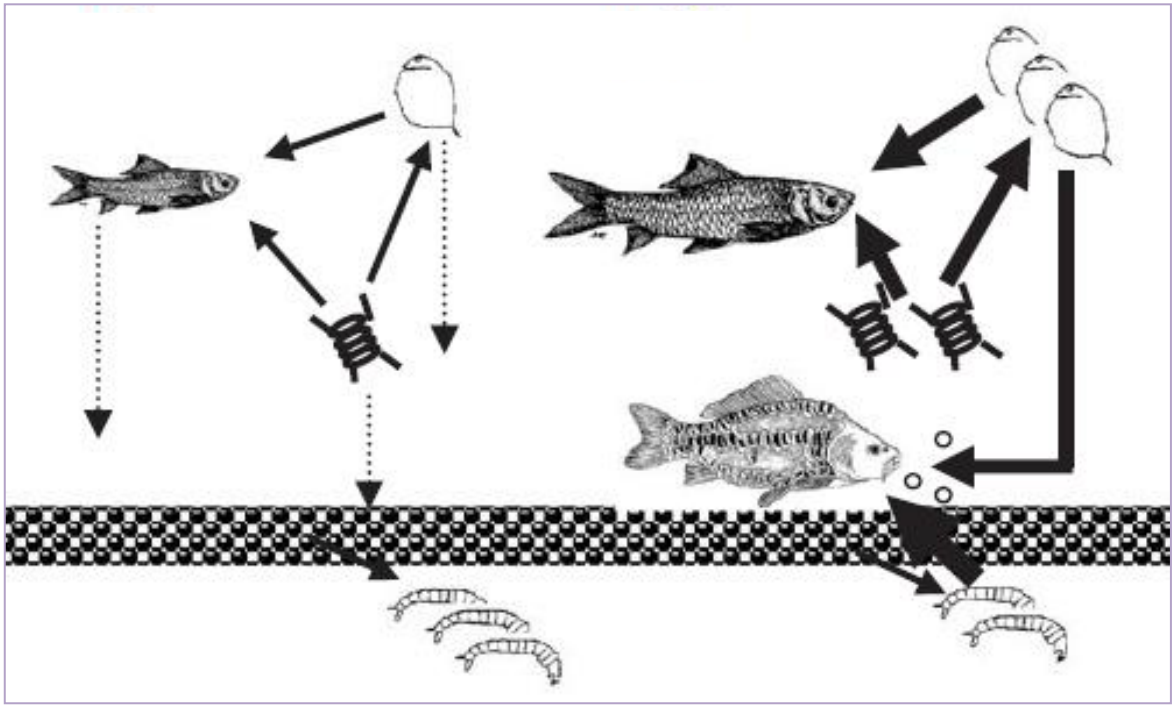
Exp.3 : Introduction of a resistant line among theses ≠ lines *(Garcia-Quiros et al., 2014)*



Towards herd immunity

Aquaculture

Favour multi-species systems to take advantage of the complementarity of the trophic niche of each one



Yield increase = 40%
(Rahman et al., 2006; Wahab et al., 2011)

… to which are added facilitation phenomena via the resuspension of nutrients, which favors plankton
(Milstein et al., 2006)

_03
DIVERSITY OF SYSTEMS

Diversity of species in mixed livestock systems

PhD thesis Louise Forteau

2 territoires

40 enquêtes

11 élevages

10 élevages

★ Sward management

★ Parasitology

Massif Central

Horses for leisure + cattle (priority to generate income)

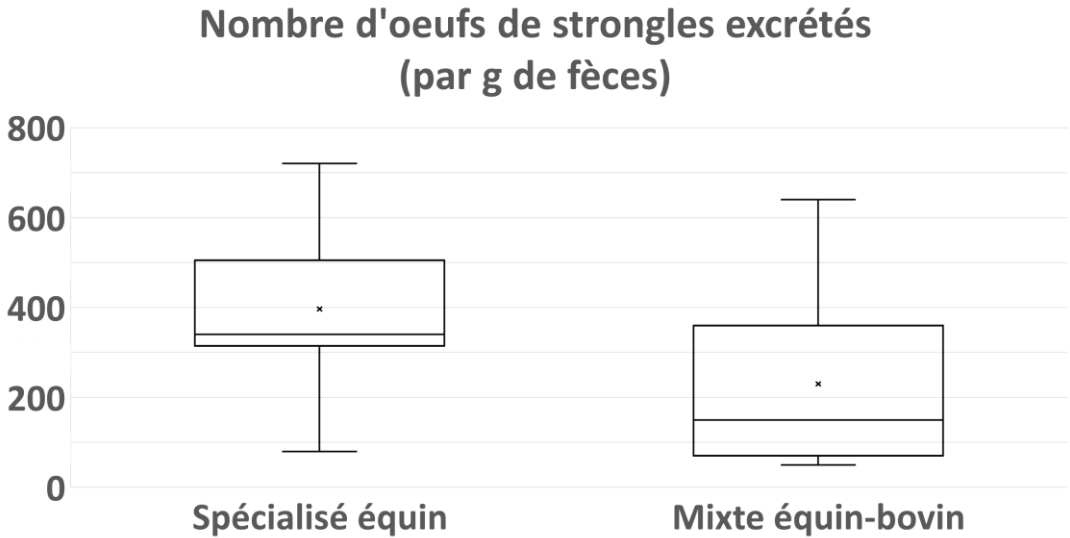
10 élevages

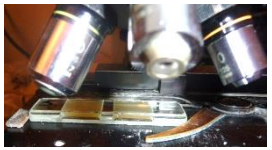
10 élevages

Normandy

Horses for sport, more productive swards

Management of parasitism in mixed systems

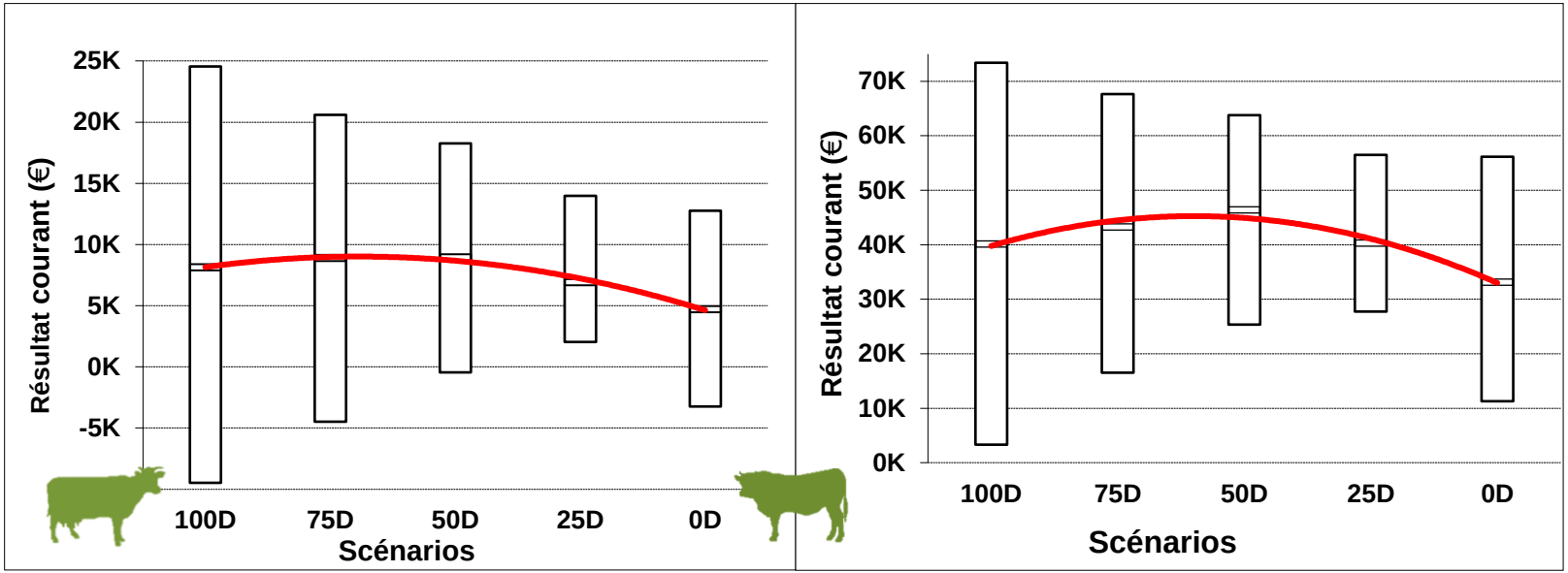




(Forteau et al., 2019)

- The hypothesis of dilution is validated: *Marley et al. 2006; Mahieu 2013*
- Only 35% of mixed farmers surveyed were awared of this property

Income mixed dairy (D) + beef cattle farms



(Diakité et al., 2019)

- **Maximum income** for scenario 50D
- **Lowest variability** / market fluctuations for scenario 25D

_04

MY VIEW: DIVERSITY IS AN ADDED VALUE WHEN WE HAVE THE MEANS TO MANAGE IT

To be able to track and to assess the status of the system

Ie: to mobilize ecological processes, we need to know them

Proxies, biomarkers, high throughput phenotyping, sensors

→ *the dramatic expansion of digital sciences in farming systems*

→ *monitoring devices*

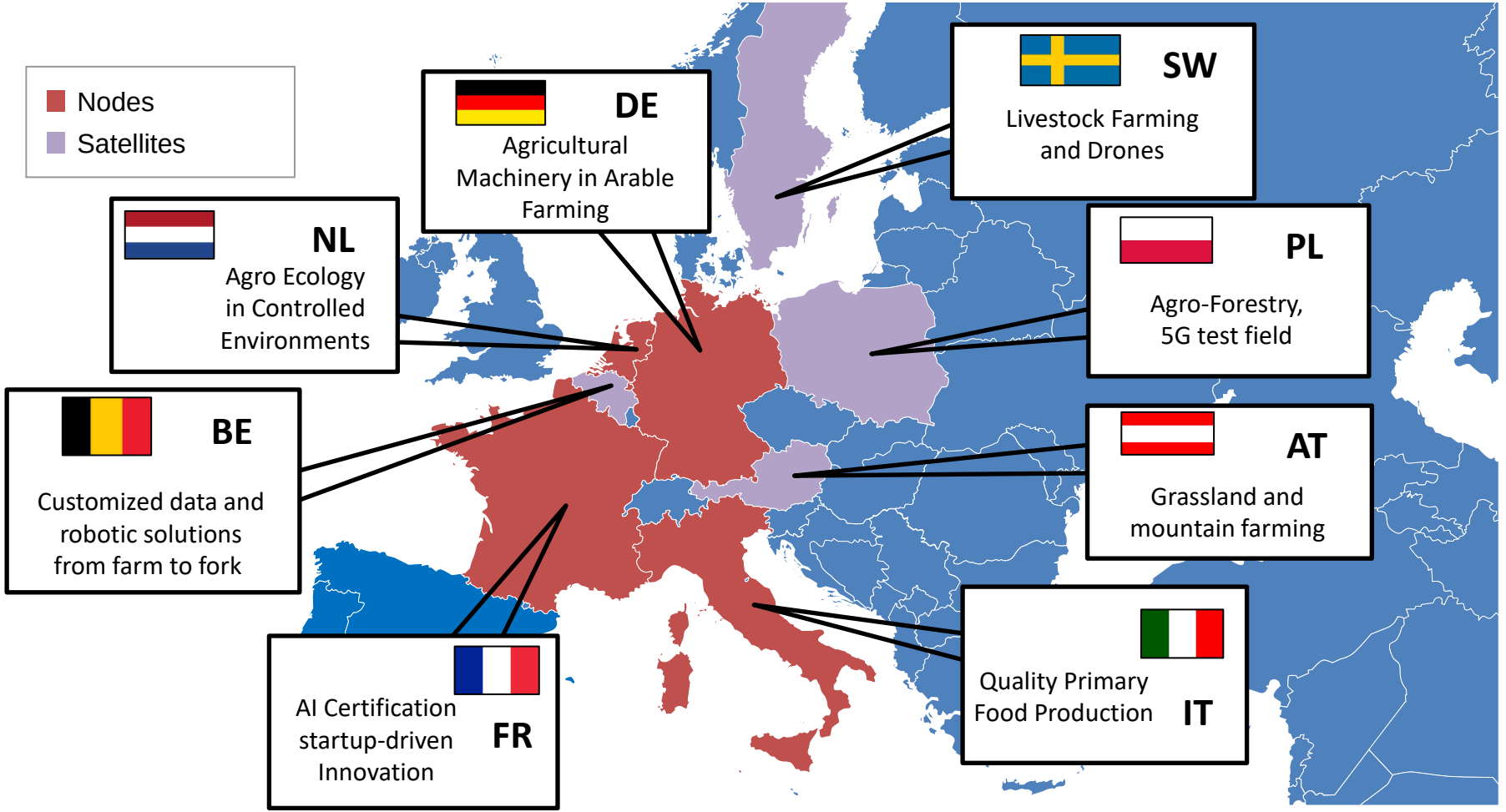
To be able to act and to adapt practices in real time

Decision-making tools, rules, thresholds, adaptive management

→ *artificial intelligence and modelling*

→ *robotics*

TEF Project (Testing and Experimental Facilities)



Conclusion

- **Diversity** has to be considered **at ≠ organisation levels**
- **Diversity is vital for geneticians**: no diversity = no possible selection
- **The clone fashion is over**
- Not only for extensive systems, **but also for intensive indoor systems** (rabbits, dairy goats, poultry)
- 3 steps are necessary:
  - Identification of the relevant parameters
  - Assesment of the relevant level of diversity for each parameter, according to the others
  - Definition of the management means & rules to drive the system throughout time

THANK YOU!

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