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

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
Reproduction & early development
Behaviour, adaptation & animal welfare
Design & assessment of sustainable livestock systems
Nutrition, productive functions & animal products

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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 …”

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

Mix of 4 species
- The most productive monoculture

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

Higher yields

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Complementarity between plants in grasslands (mechanisms)

Gains due to legumes / symbiotic fixation $N_{atm}$
- $N = \text{improve growth of grass}$
- Presence of grass = improve N fixation by legumes
  
  \text{\cite{Nyfeler2011}}

Functional diversity reduces propagation of weeds

\text{\cite{Suter2016}}

Improvement of resilience
- Portfolio effect \text{\cite{Figge2004,Volaire2014}}
- Functional redundancy \text{\cite{Biggs2012}}

\text{\cite{SCARCWG2022}}
Zootechnical added-values: both ecological & economic

Better performances when animals graze mixed grasslands
- Roca-Fernández et al., 2016
- Grace et al., 2019

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

Reduction in CH₄ emission with some species (in vitro; Macheboeuf et al., 2017)

Increase of income / ha (2946 => 3062 $/ha; Romera et al., 2017)
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 these 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)
DIVERSITY OF SYSTEMS
Diversity of species in mixed livestock systems

PhD thesis Louise Forteau

- Sward management
- Parasitology

Massif Central: Horses for leisure + cattle (priority to generate income)

Normandy: Horses for sport, more productive swards

2 territoires

40 enquêtes

11 élevages

10 élevages

10 élevages

10 élevages

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Management of parasitism in mixed systems

The hypothesis of dilution is validated: *Marley et al. 2006; Mahieu 2013*

- Only 35% of mixed farmers surveyed were aware of this property

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Income mixed dairy (D) + beef cattle farms

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

*(Diakité et al., 2019)*

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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*
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
  - Assessment 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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