



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

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SCAR
CWG SAP
workshop
18/19
October
2022

INRAE

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

B. Dumont, J. Aubin, S. Ingrand, G. Martin, V. Niderkorn,
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The 'Phase' division at INRAE (animal physiology & farming systems)

~1500 people

800 INRAE

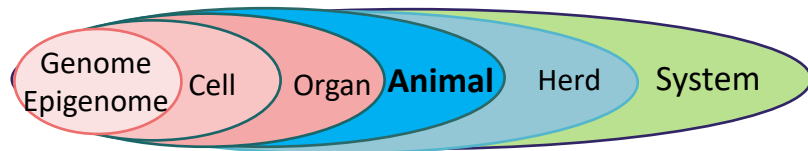
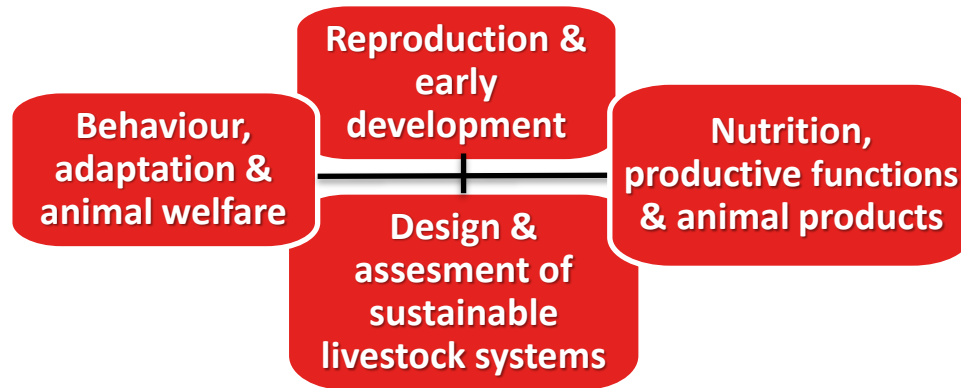
460 partners

220 docs + post-docs

Scientific domains:

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

4 thematic fields



SCAR CWG SAP workshop 18/19 October 2022



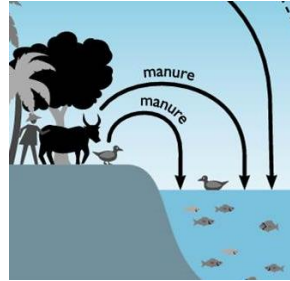
Diversity: which criteria? which organization? which goals?

Different components of diversity in LFS

❖ Resources

❖ Animals

❖ Systems



_01

DIVERSITY OF RESOURCES

Complementarity between plants in grasslands

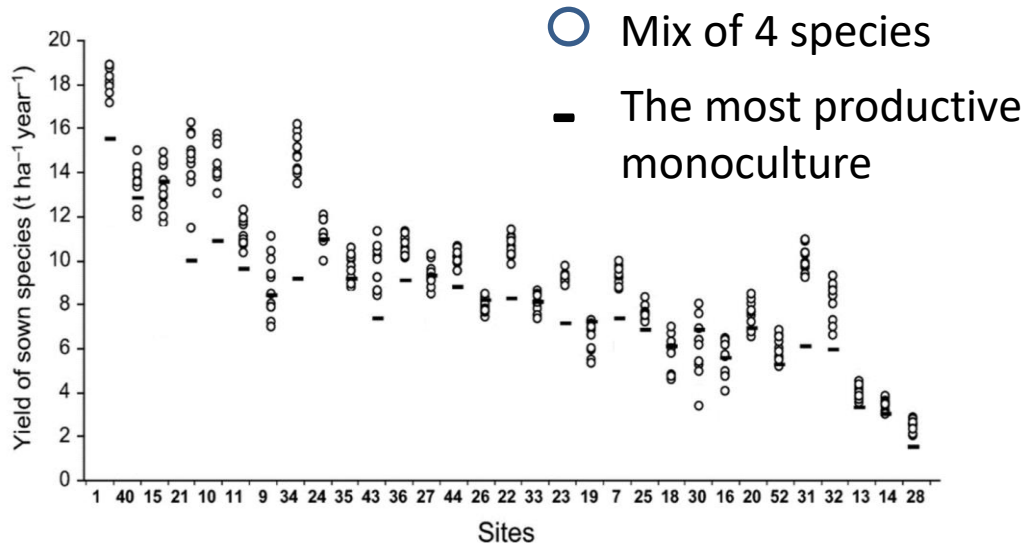
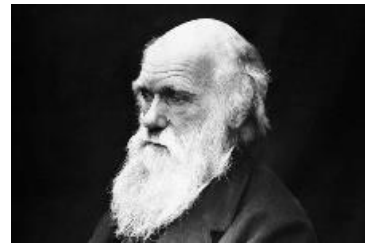
Not really a scoop...

“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

Higher yields

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



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

Reduction of concentrate

Reduction of veterinary products

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

Reduction of pollutions

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

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



_02

DIVERSITY OF ANIMALS

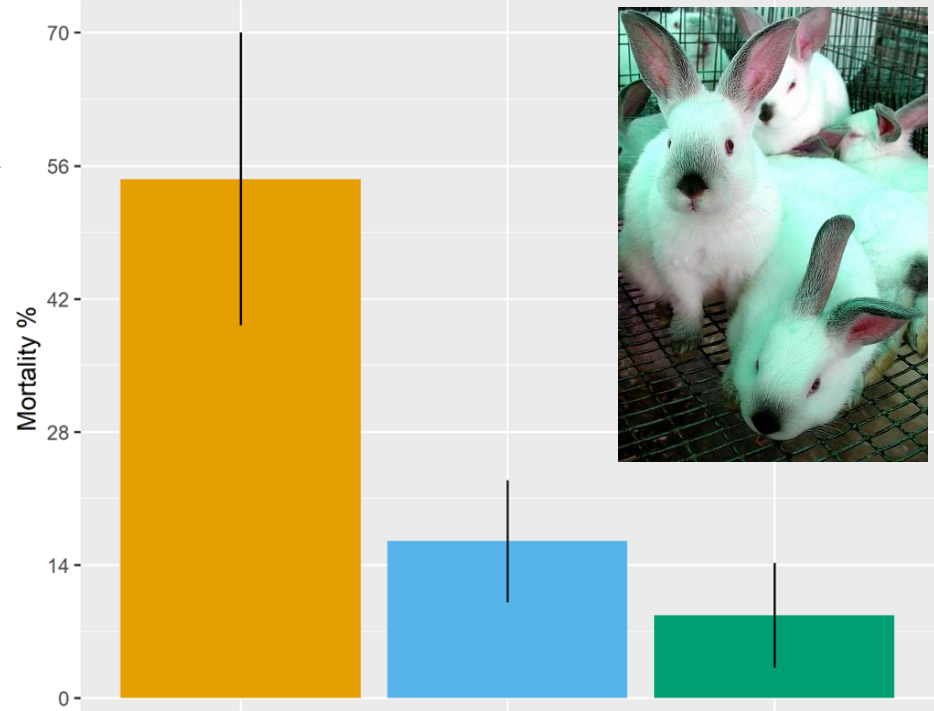
Rabbit breeding

Univ. Valence, epizootic rabbit enteropathy

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

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

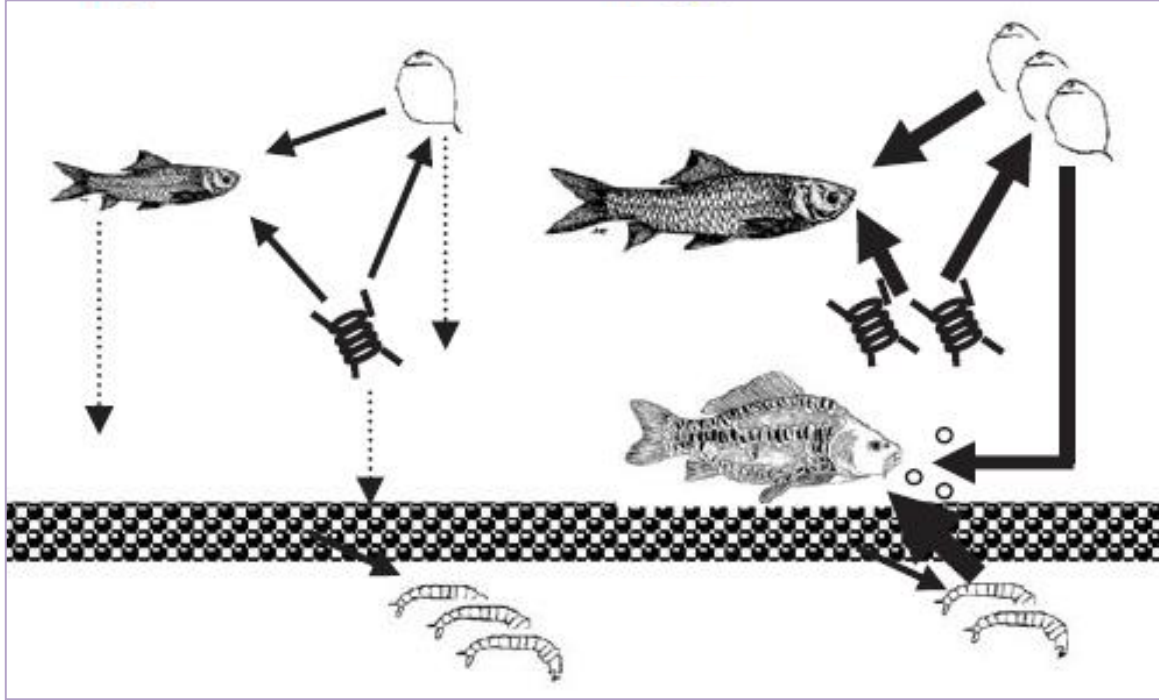
Exp.3 : Introduction of a resistant line among theses \neq lines (*Garcia-Quiros et al., 2014*)



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

2 territoires

40 enquêtes

PhD thesis Louise Forteau



11 élevages



10 élevages



Sward management



Parasitology

Massif Central



10 élevages



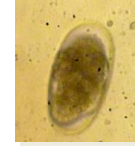
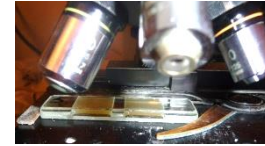
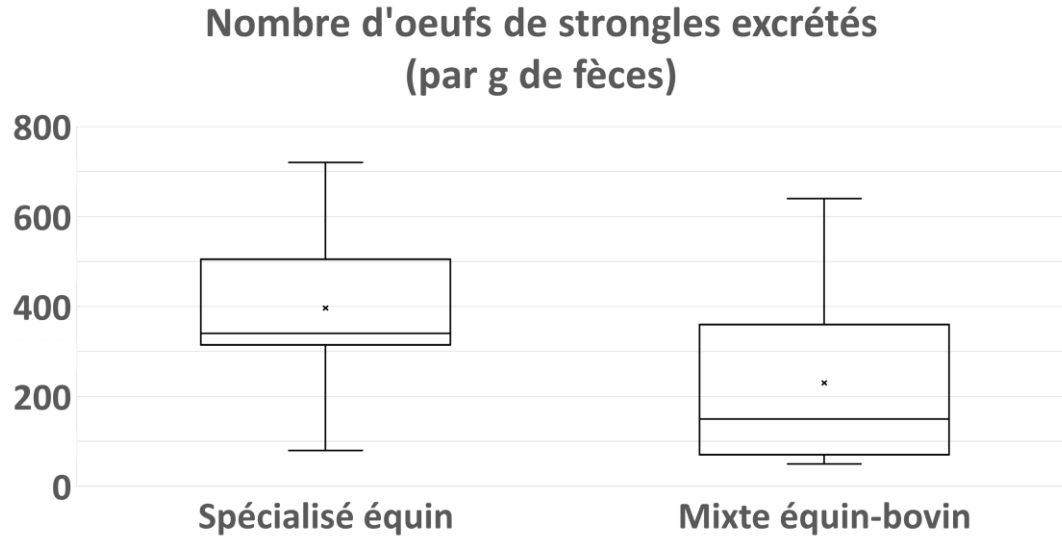
10 élevages

Normandy

Horses for leisure + cattle (priority to generate income)

Horses for sport, more productive swards

Management of parasitism in mixed systems

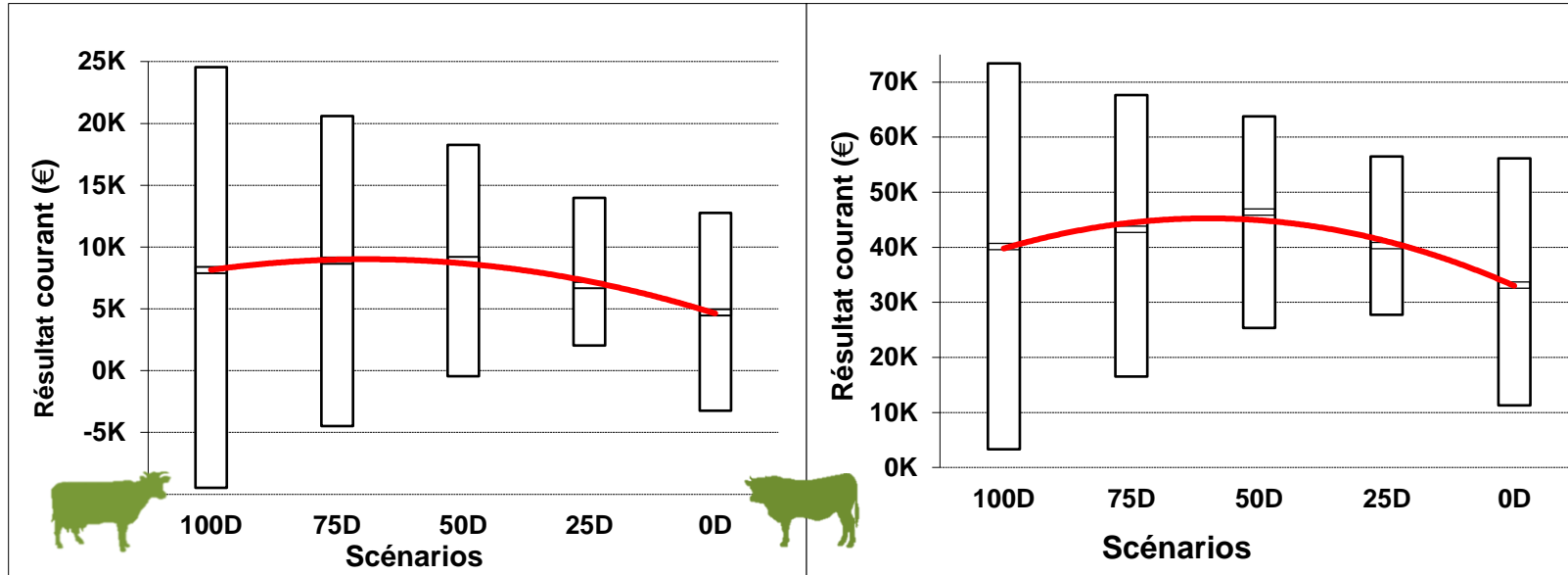


(Forteau et al., 2019)

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



Income mixed dairy (D) + beef cattle farms



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

(Diakité et al., 2019)

_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

le: 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

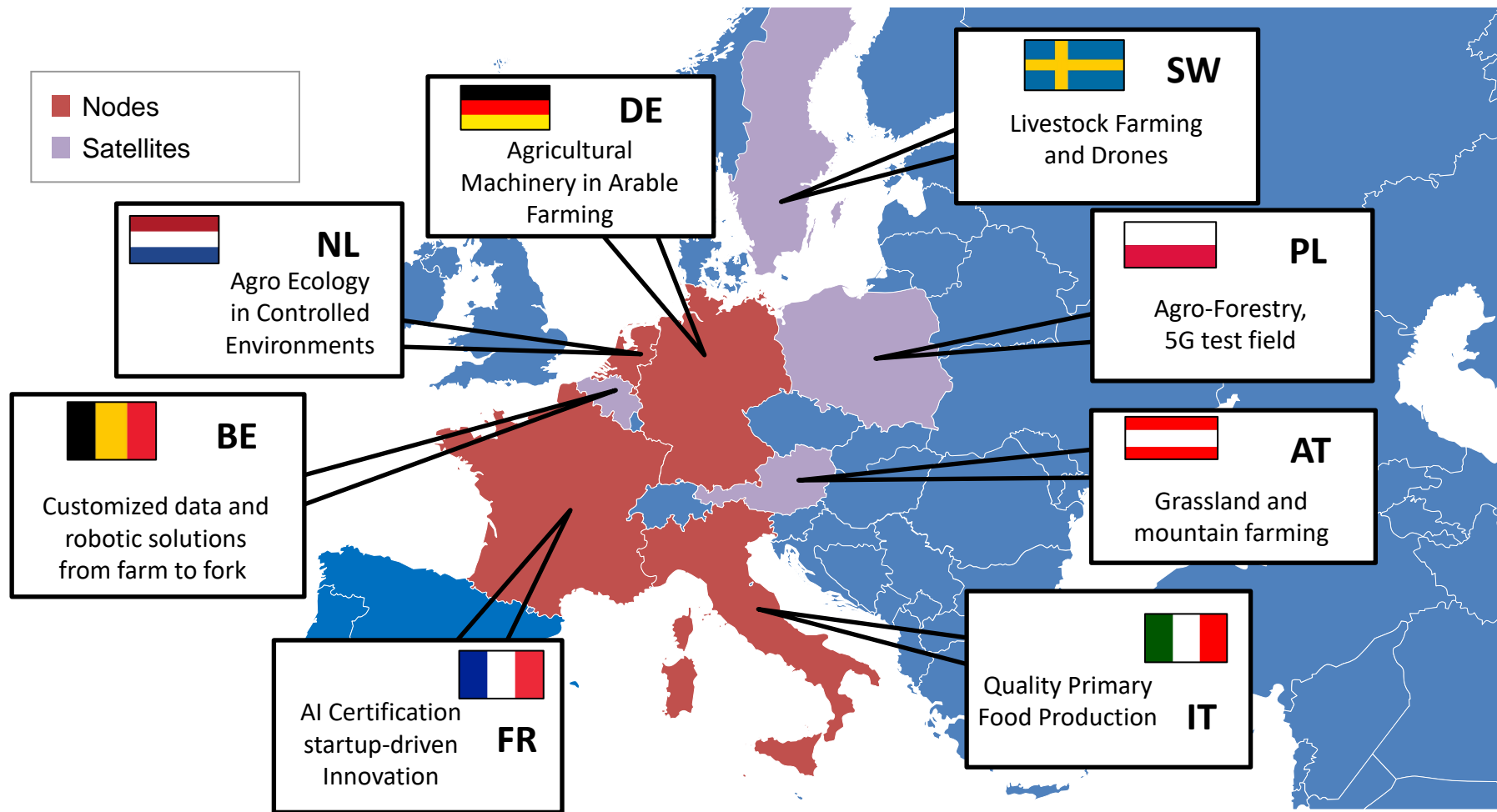
To be able to act and to adapt practices in real time

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 \neq organisation levels**
- ❖ **Diversity is vital for geneticists**: 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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