



Biodiversity and animal breeding: friends or foes for infectious diseases?

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➤ Biodiversity and animal breeding : friends or foes for infectious diseases?

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➤ Animal production since 1960

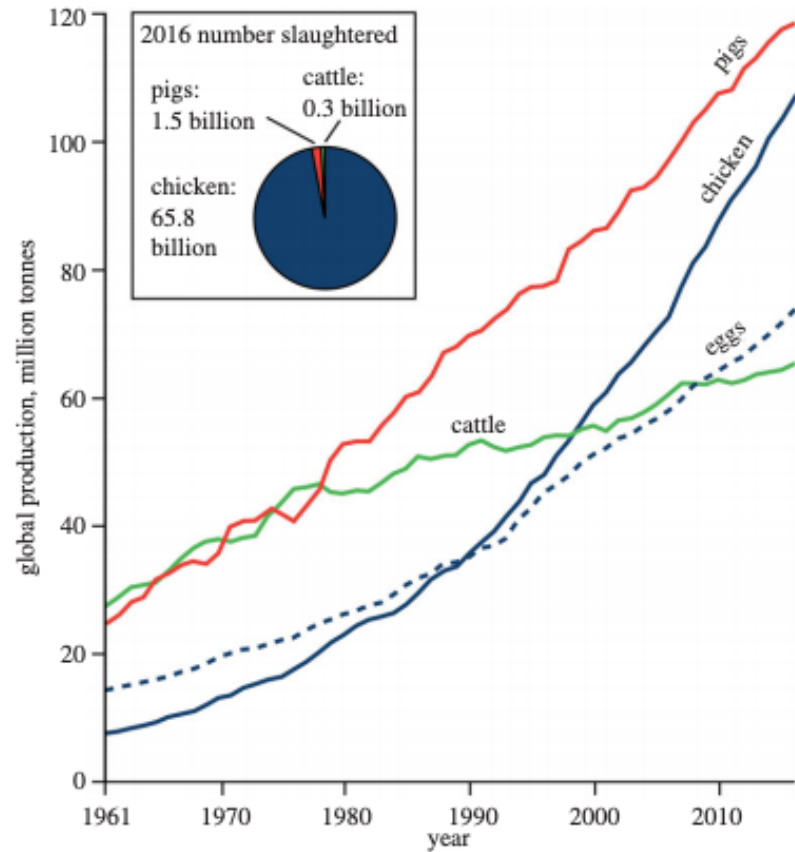


Figure 1. Global consumption of domesticated chicken, pig and cattle from 1961 to 2016. Chicken is the most common meat consumed, with a standing population in 2016 of over 22.7 billion. The number of chickens slaughtered per year is an order of magnitude larger than that of pigs or cattle. Data compiled from UN Food and Agriculture Organization, FAOSTAT, at faostat.fao.org, accessed November 2018.



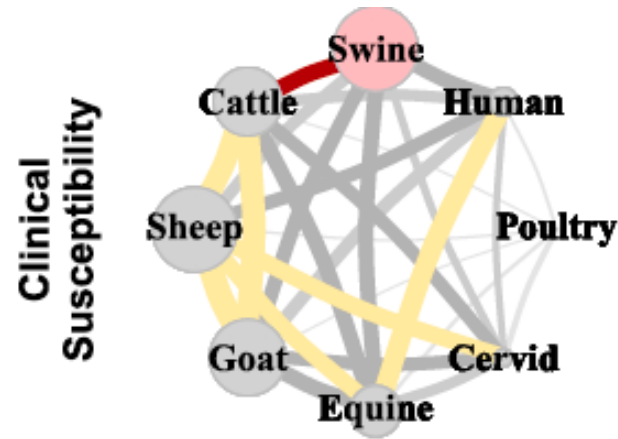
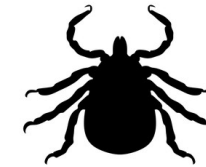
Photo : INRAE / NICOLAS Bertrand



Photo : INRAE / VASSEUR DELAITRE Gilles

Bennett et al 2018. <https://doi.org/10.1098/rsos.180325>

➤ Introduction of pathogens



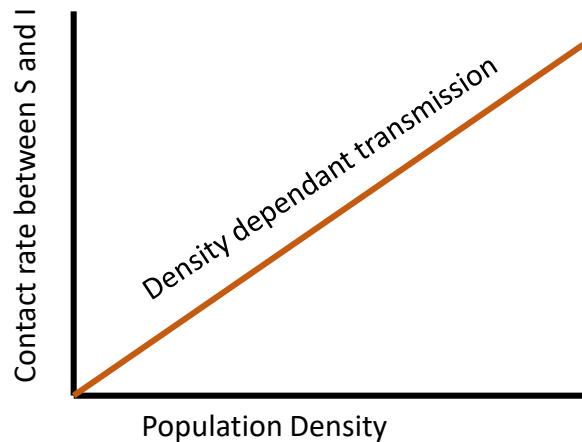
Study on 39 terrestrial pathogens that can affect (wild) pigs

→ 34 (87.2%) caused clinical or sub-clinical disease in at least one other species

➤ Pathogen spread within facilities

- High density

→ higher transmission rates



- One species, low genetic variability – low biodiversity

→ higher virulence

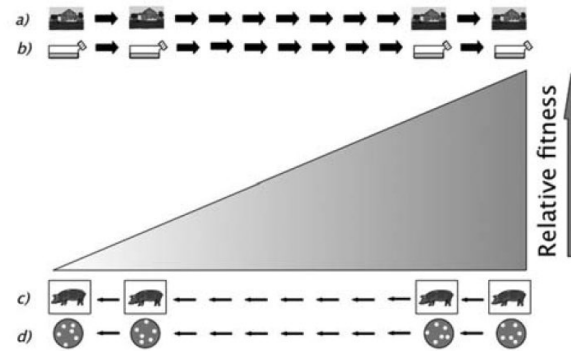
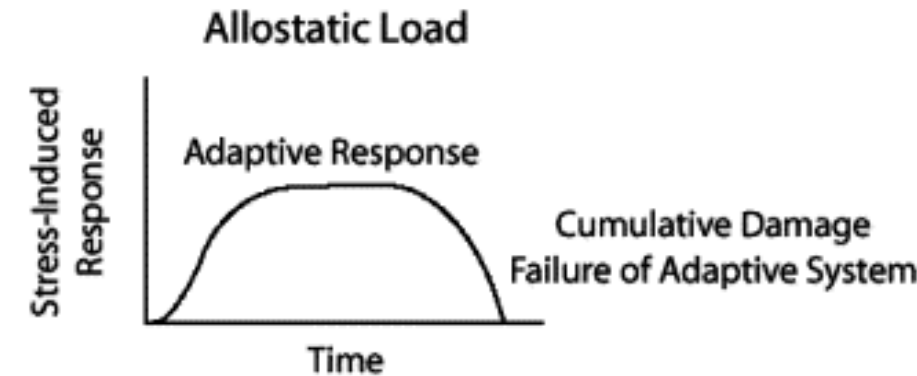


Fig. 1
A simplified schematic of fitness variation of a virus following replication in a constant environment

- Chronic stress

→ lower immune response



from:
<https://parasiteecology.wordpress.com/2013/10/17/density-dependent-vs-frequency-dependent-disease-transmission/>

Drew et al 2011. Rev Scien Tech OIE

Pruett 2003. [https://doi.org/10.1016/S0928-4680\(03\)00003-8](https://doi.org/10.1016/S0928-4680(03)00003-8)

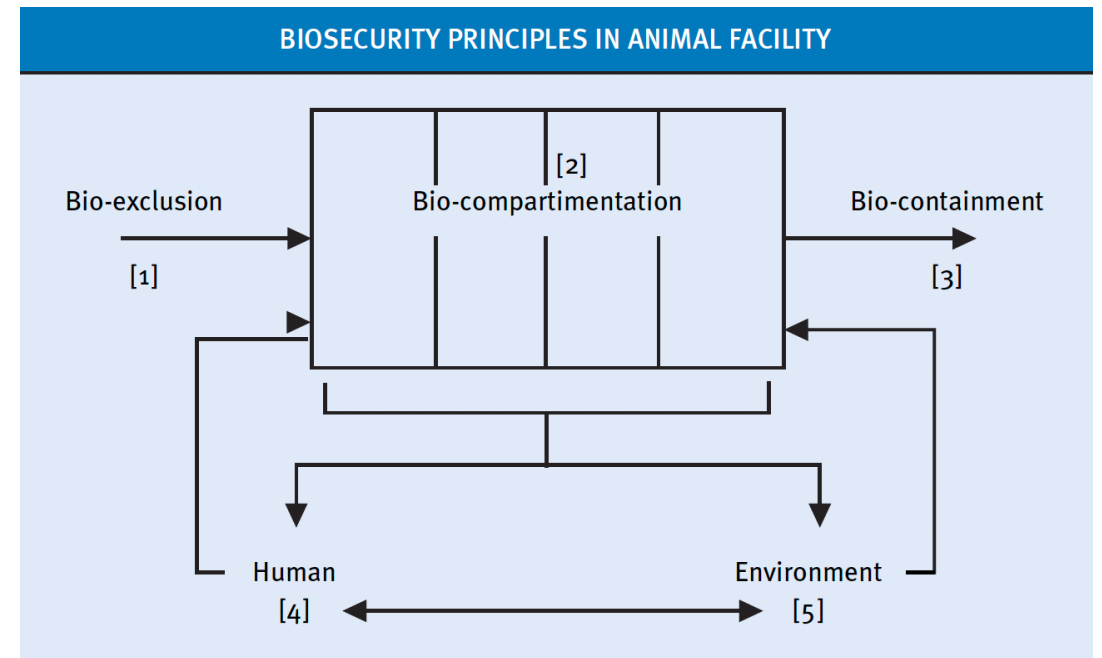
➤ High-yield animal breeding

Biosecurity measures

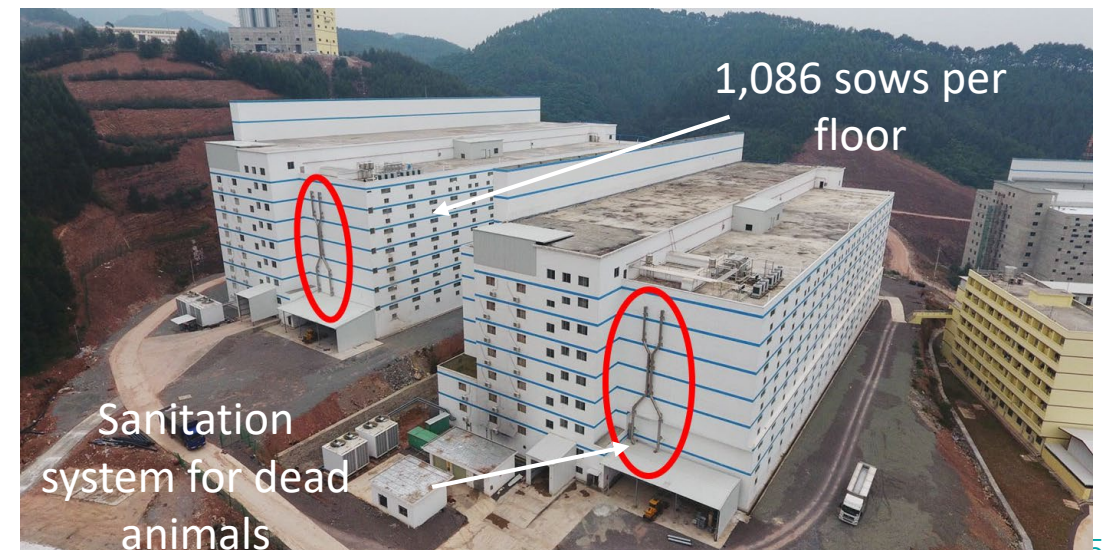
1. Limit the risk of pathogen introduction, no contact with outside
2. Limit the spread of pathogen within the same facility
- 3-5. Limit the spread of pathogen and contamination outside facility

Massive culls if introduction of highly contagious pathogen

The Guifei Mountain Sow Farm (Guigang region, China)



Sagerman et al 2012. IJPH 9: 13-24



➤ Agroecology for animal breeding

Animal breeding sector poses increasing environmental and ethical challenges

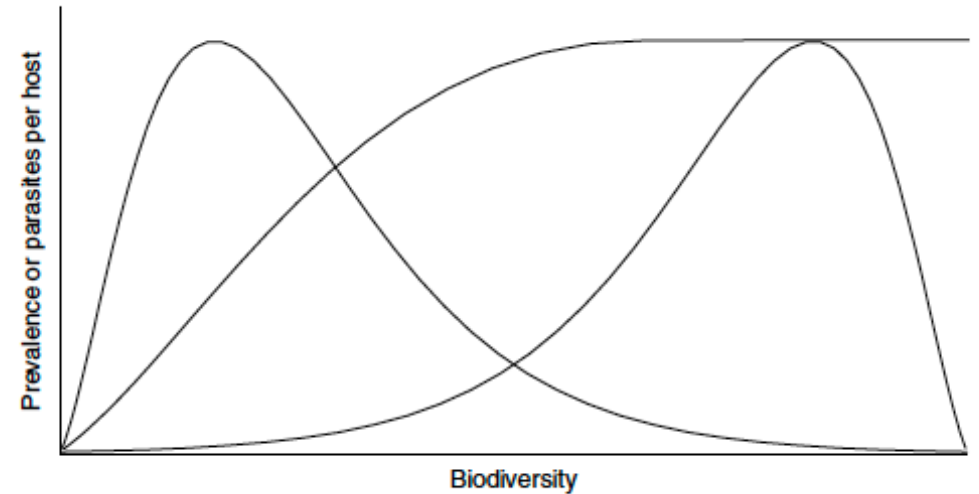
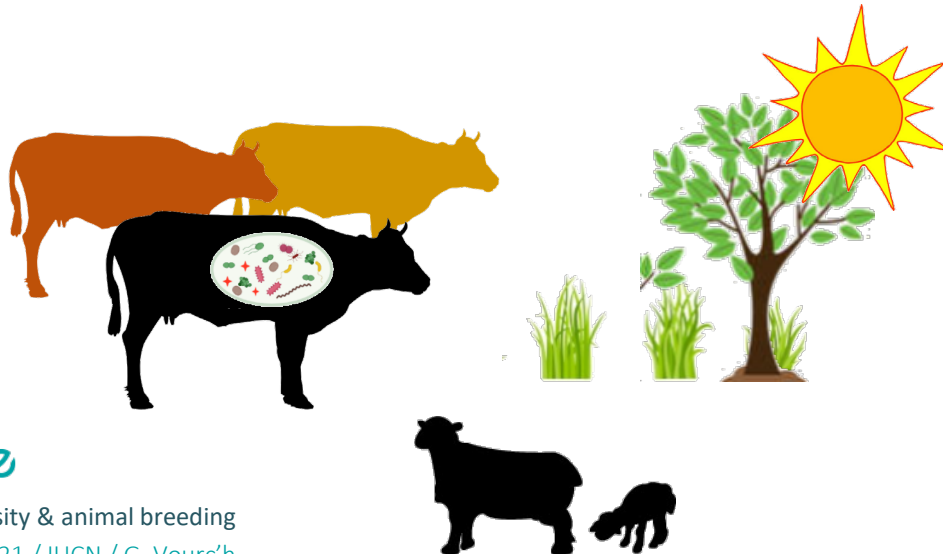
--> Demand to:

- ✓ Lower environmental impact
- ✓ Increase resilience
- ✓ Preserve of biodiversity

Apply ecological principles to produce sustainable systems

- ➔ Integration animal breeding in its ecosystem
- ➔ Increase biodiversity

Dumont et al 2013. <https://doi.org/10.1017/S1751731112002418>



Rohr et al 2020. <https://doi.org/10.1038/s41559-019-1060-6>

➤ Increase the diversity of the environment and food

- ✓ Livestock feeding on plants with tannins show lower nematode burdens (eg, sulla *Hedysarum corarium*)
- ✓ Self medication has been observed in herbivores
- ✓ Agroforestry provide interesting service including plants with tannins (such as willow)



Xavier Remongin / Agriculture.gouv.fr

Vandermeulen et al 2018 <https://doi.org/10.1071/AN16434>
Mupeyo et al 2011 <https://doi.org/10.1016/j.anifeedsci.2010.11.015>
Lisonbee et al 2009 <https://doi.org/10.1016/j.beproc.2009.06.009>

> Mixed species farming

Strongyle eggs per gram of feces in sheep

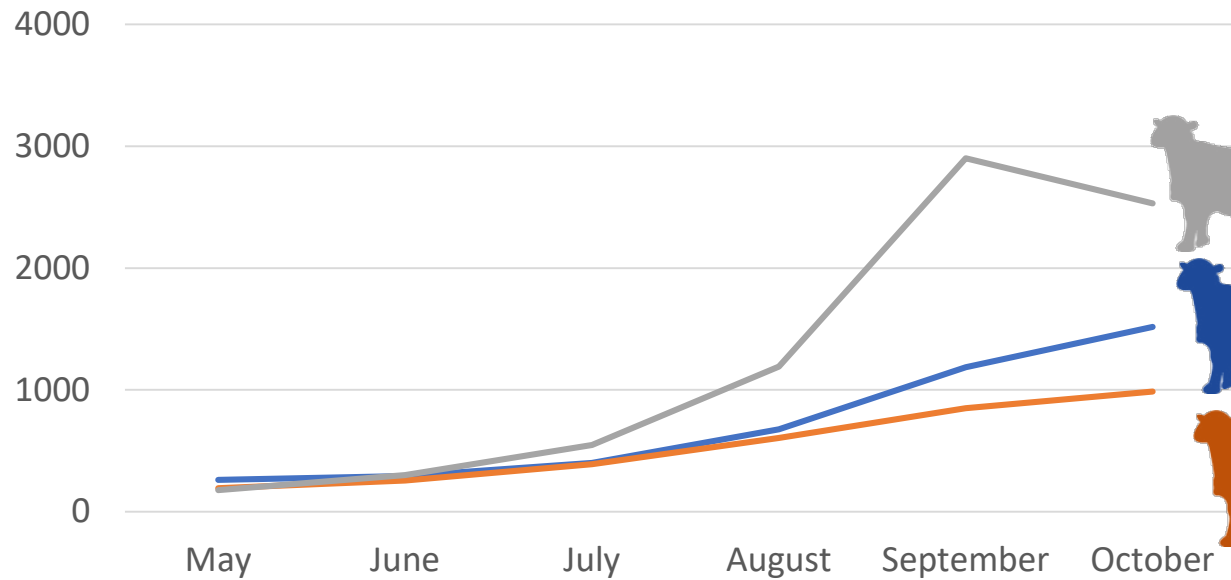
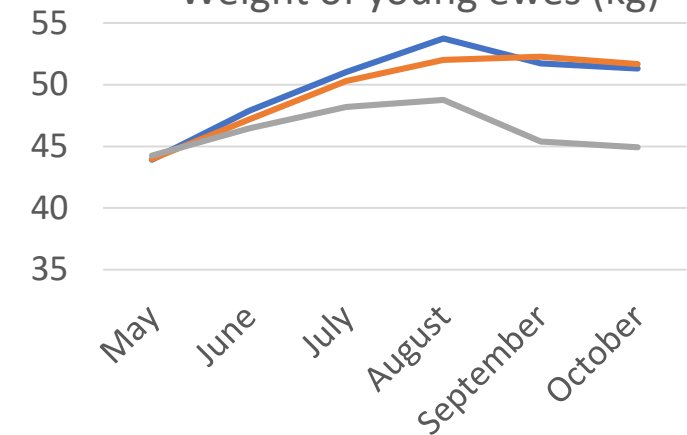


Photo credit: Frédéric Joly

Weight of young ewes (kg)

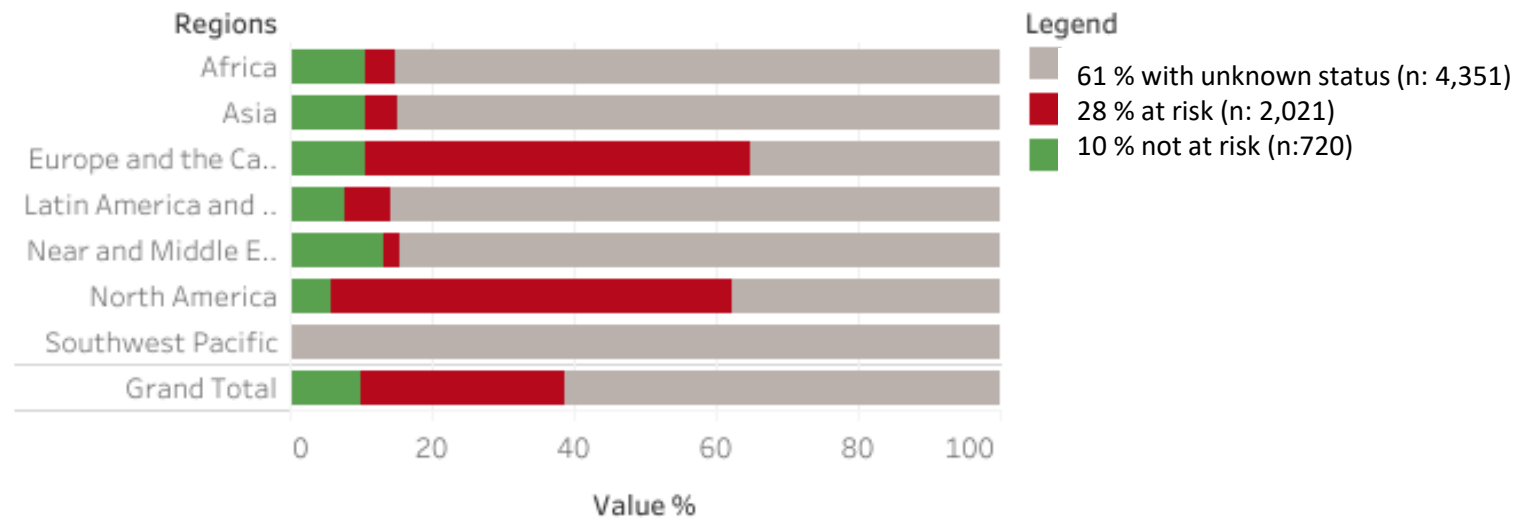


Joly F., Benoit, M. Note, P. and Dumont B. 2021. Sheep/cattle mixed grazing: parasitism dilution improves sheep growth more than grazing facilitation. Book of abstract of EAAP conference 2021, Davos (Switzerland)

➤ Genetic diversity



Status of local animal breeds (7092 breeds) – source FAO



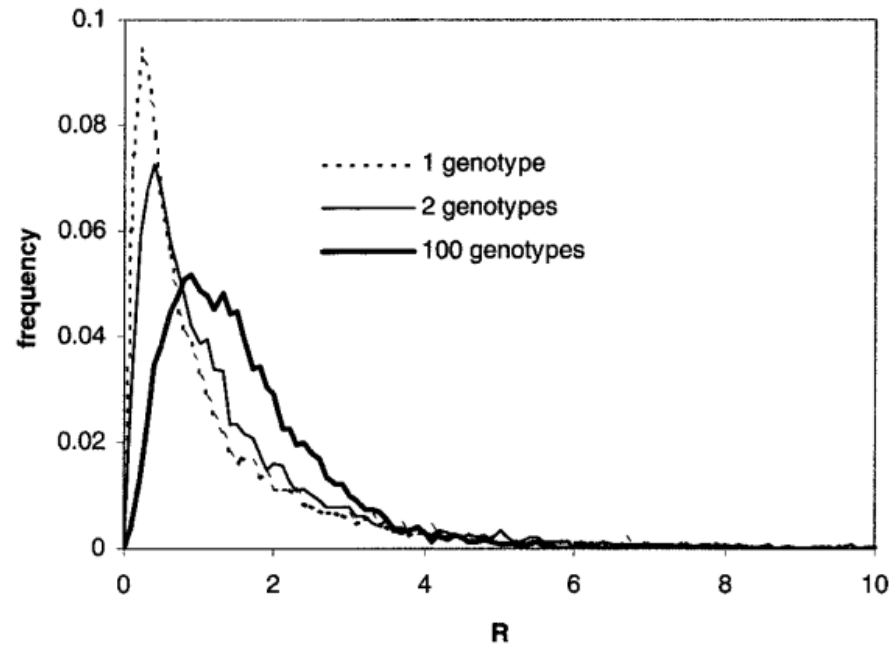
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➤ Genetic diversity

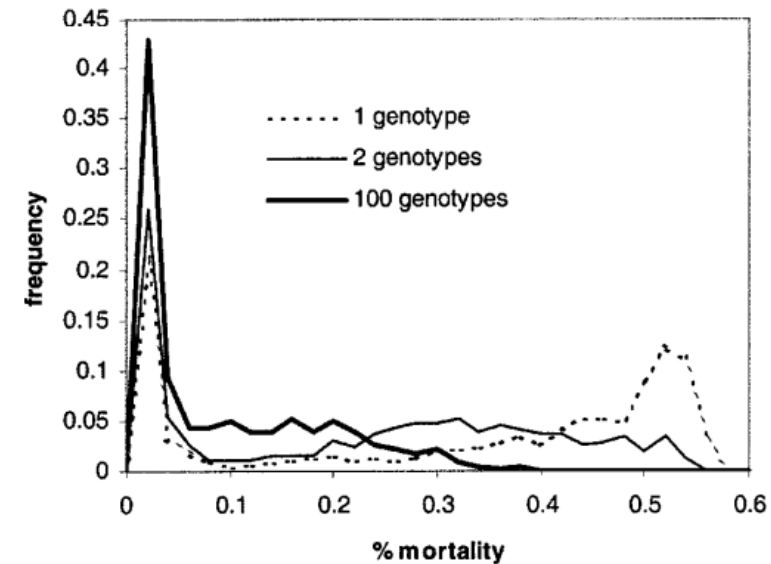


Simulation study of infectious disease spread in livestock populations (one species)

More probability to get $R > 1$, but R lower



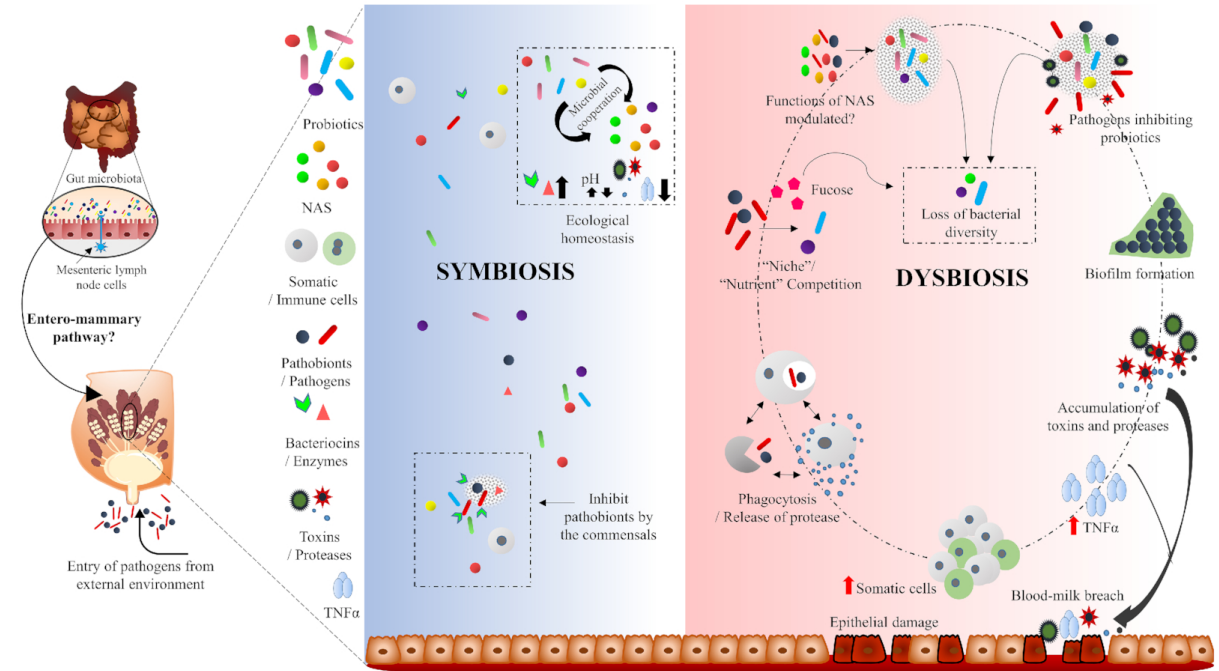
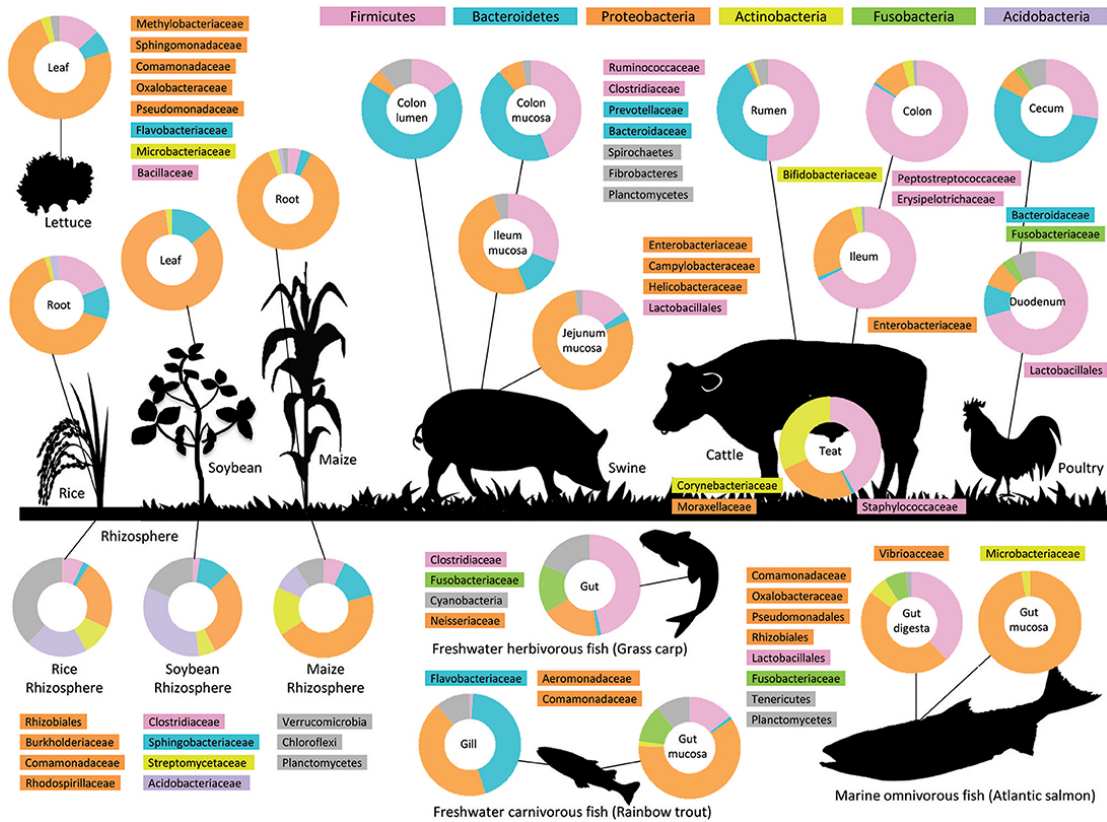
Mortality is lower



More diverse populations would face smaller epidemics

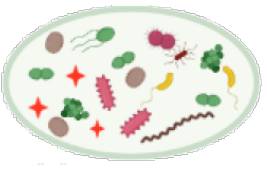


➤ Microbiotic diversity



Maity and Ambatipudi 2020. FEMS Microb. Ecol.
<https://doi.org/10.1093/femsec/fiaa241>

Ikeda-Ohtsubo et al 2018. <https://doi.org/10.3389/fnut.2018.00090>



➤ Microbiotic diversity



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- « (...) *experimental evidence is accumulating that the health and zootechnical performances of cultured aquatic species can be improved by the prophylactic use of probiotics* »

Verschuere et al 2000. Microbiol Mol Biol Rev. doi: [10.1128/mmb.64.4.655-671.2000](https://doi.org/10.1128/mmb.64.4.655-671.2000)

➤ Conclusions



- ✓ Necessity to adapt breeding practices in the context of environmental crisis
- ✓ Increasing biodiversity and ecological relationships raises many challenges
 - Understand the mechanisms linking biodiversity and pathogens in animal breeding systems
 - Understand the short and long-term effect
 - Adapt to the local conditions, with no unique standardised model
 - Lead to modify and rethink food production systems in a globalised world



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➤ Thank you for your attention



Photo : INRAE / Gwenaél Vourc'h



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