

Diversification increases the resilience of European grassland-based systems but is not a one-size-fits-all strategy

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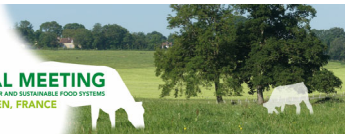
EGF 2022. Session 3

Diverging trends in European grasslands

In lowlands and on medium altitude plateaux, intensification / specialization has \nearrow the predominance of high-yielding swards and grass-legume mixtures that are increasingly vulnerable to CC (*Melts et al., 2018; Stampfli et al., 2018*)

In uplands, where animals graze on steep slopes and in more remote areas, grasslands are threatened by partial abandonment due to the lack of profitability (*López-i-Gelats et al., 2011*). May benefit from \nearrow in temperature, but more vulnerable to summer drought

Does (and how) diversification can enhance the resilience of grassland-based systems and preserve biodiversity and the range of ecosystem services they provide?



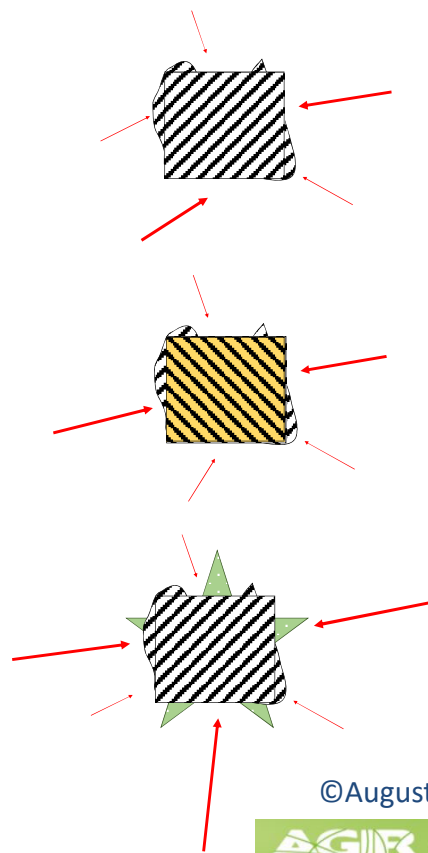
What is resilience?

Walker *et al.* (2004) defined resilience as the capacity of a system to absorb perturbations and reorganize while undergoing changes to maintain its function



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Buffer capability:

Buffer capability denotes the ability of a system to assimilate a perturbation without changing its structure or function

Adaptive capability:

Adaptive capability denotes the ability of a system to temporarily adjust to change while staying in the current stability domain

Transformative capability:

Transformative capability implies transition to a new system

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Darnhofer, 2014



A typology of resilience factors related to on-farm diversity

Production, ecosystem services and system resilience are grounded in grassland type and feed resource diversity, herd variability and farm scale interactions (Dumont *et al.*, 2020)

	Feed resource diversity	Herd variability	Farm scale interactions
Buffer capabil.	<ul style="list-style-type: none"> Benefit from plant species diversity to buffer drought events Preserve grassland diversity e.g. those of poor agronomic value on wet areas 		
Adaptive	<ul style="list-style-type: none"> Sow a drought resistant mixture (sainfoin, teff grass) Decrease mowing frequency in years of drought events Temporarily stock biomass 		
Transformative	<ul style="list-style-type: none"> Develop agroforestry: <i>Fraxinus excelsior</i>, etc. Cultivate cereals on farm & graze animals on cover crops 		

Andreas Lüscher's talk: using intra- and inter-specific plant diversity to ↗ drought resilience

Grassland-type diversification on farm
+ Management
+ Feed resource diversification

A typology of resilience factors related to on-farm diversity

Production, ecosystem services and system resilience are grounded in grassland type and feed resource diversity, herd variability and farm scale interactions (Dumont *et al.*, 2020)

	Feed resource diversity	Herd variability	Farm scale interactions
Buffer capabil.	<p>This talk: Investigating herd and farm- scale interactions</p> <p>Pointing out consequences for grassland management & biodiversity</p>	<ul style="list-style-type: none"> Use ≠ lines/breeds in mixed herds to benefit from the diversity of trade-offs and adaptive responses Keep a 'service herd' of a hardy breed 	<ul style="list-style-type: none"> Grazing cattle and horses (or sheep) together or alternately on the same plots to ↗ pasture use and ↘ parasite burden Make fodder stocks
Adaptive		<ul style="list-style-type: none"> Sell animals to ↘ stocking density 	<ul style="list-style-type: none"> Modify equilibrium between herds in multispecies farms Adapt type of product to market conditions Hire a worker
Transformative		<ul style="list-style-type: none"> Lengthen animal productive lifespan 	<ul style="list-style-type: none"> Add pigs or poultry (short production cycle) to cattle farms Diversification outside agriculture: off-farm employment, agritourism

From inter-individual variability to multi-breed herds

At herd level the diversity of trade-offs and adaptive response of animals is assumed to buffer the effect of random environmental perturbations in the long-term (*Blanc et al., 2013; Magne et al., 2016; Ollion et al., 2016*)

Moreover, pasture management and resilience can be improved by keeping a 'service herd' of a hardy breed, as these animals show a number of adaptive traits

Light and big-footed highland cattle cause less pressure to the ground. They increase grassland resistance against erosion and allow site adapted use of steep slopes

They can consume thistles and woody plants



Keep a 'service herd' of a hardy breed

Thereby, Highland cattle increase plant species richness, increase pasture quality, and reduce shrub encroachment and workload needed for pasture management

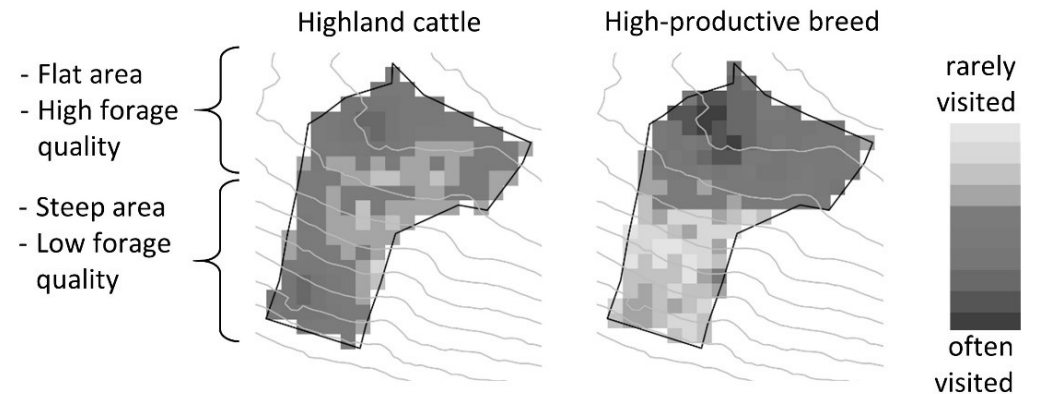
Products of the service herd can benefit from the system 'positive image' and can be sold on-farm

Robust cattle valorise ecosystem services of marginal grassland

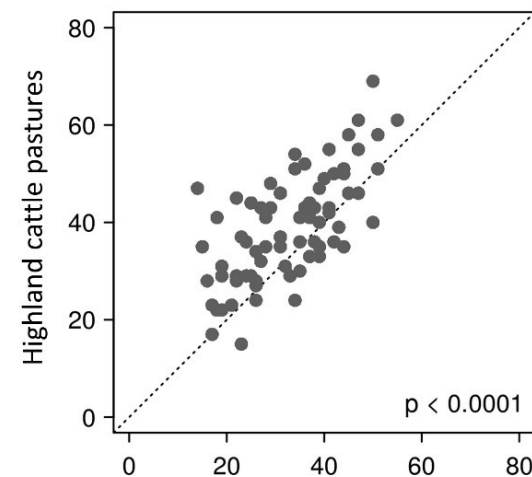
Talk by C.M. Pauler and M.K. Schneider

Today 14:30 – 16:00, Amphitheater Vauquelin

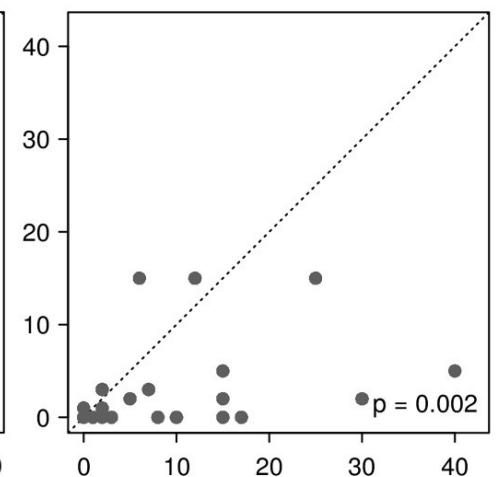
a) Space use of different cattle breeds



b) Plant species richness



c) Woody plants (cover %)



Pastures grazed by high-productive cattle breeds

Pauler et al., 2019; 2020

Grazing different species on the same plots increases pasture use

The case of mixed grazing by cattle and horses

Horses are less affected by ruminants by digestive constraints and thus have high voluntary intake on roughages

- Control competitive grasses and sedges in wet areas
- Open pastures, which facilitate species coexistence (*Köhler et al., 2016; Garrido et al., 2019*)



Horses are poorly selective on flowering plants (unable to detoxify plant secondary metabolites)

- Benefit plant diversity and flower-visiting insects (*Stewart & Pullin, 2008; Öckinger et al., 2006*)

Horses select short lawns (two sets of teeth) and exclude cattle from these short lawns

- Direct benefits for grazing tolerant plant species
- Indirect benefits as cattle graze tall competitive grasses in horse latrine areas

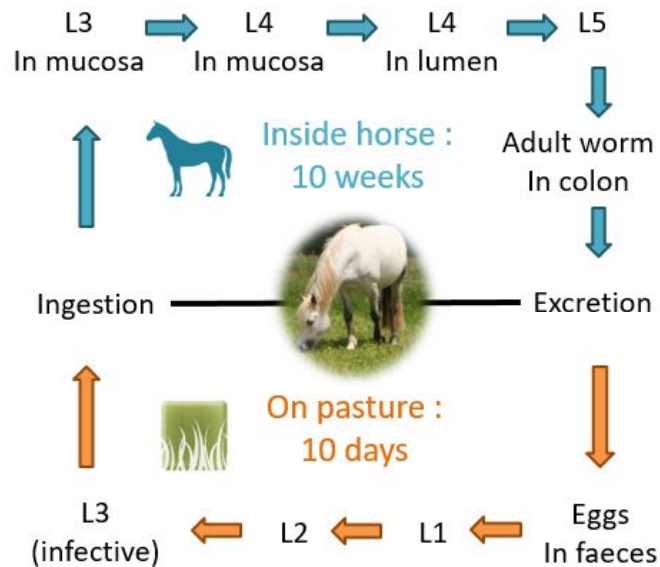


Loucougaray et al., 2004

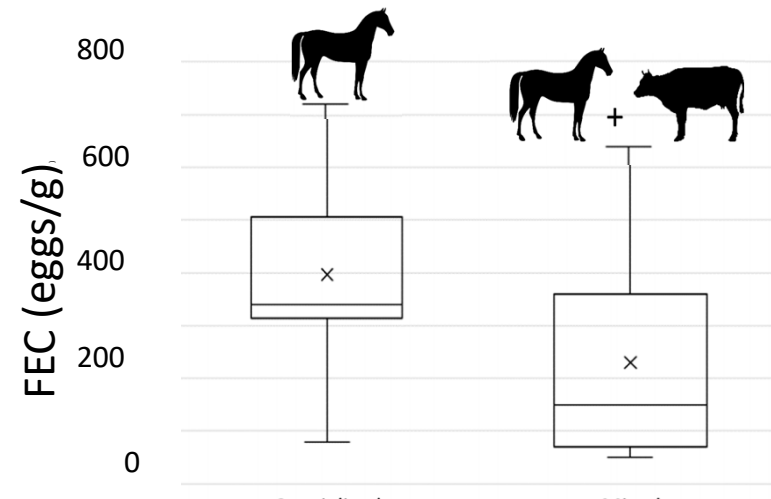
Grazing different species on the same plots increases pasture use



In diversified farms associating beef cattle and saddle horses, we observed a 15% increase in pasture use, a clear reduction in purchased fodder, and less use of rotary slashers to clean pastures (*Forteau, 2019*)

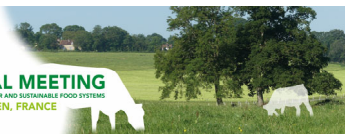


↘ egg excretion in horses grazing with cattle



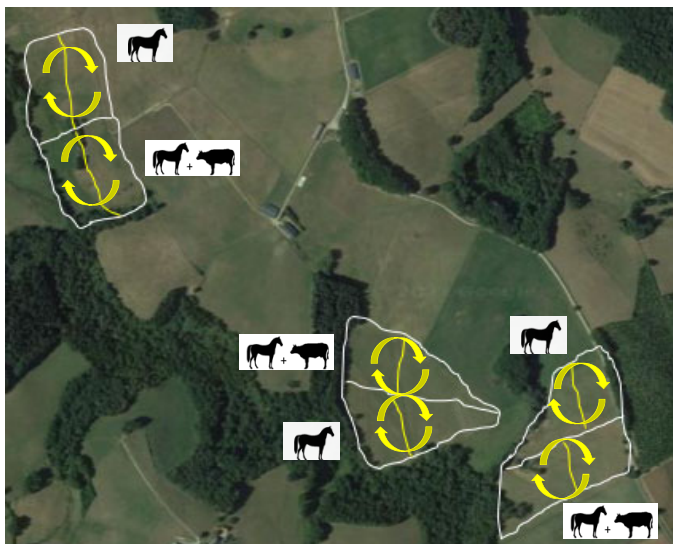
Forteau et al., 2020

Herbivore species have specific parasites
 → clearing pastures of parasites with a non-susceptible species



... but grassland management matters!

- Experiment over three grazing seasons in a hill-range mesophile grassland (central France)
- Co-grazing saddle horses-beef cattle vs horse grazing at the same stocking rate (1.4LU/ha)



Animals in both treatments alternately stocked on 2 subplots

Fleurance et al., 2022



Alternate stocking let short swards regrow (3.9cm) before animals entered the subplots again

High selectivity of Limousin breed (*D'Hour et al. 1995*)



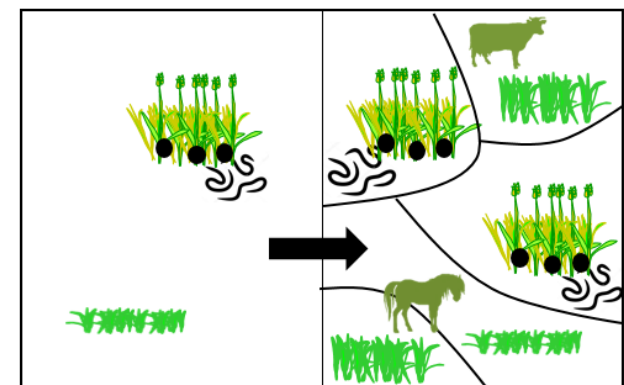
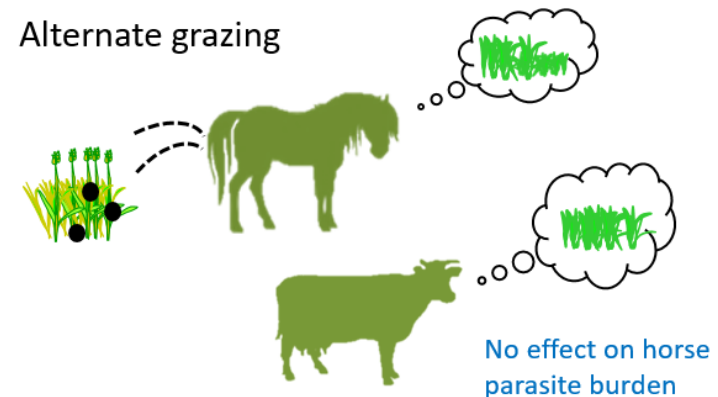
... but grassland management matters!



Complementarity of horse and cattle grazing was not revealed when the two species grazed together in a rotational system

Heifers 'behaved as horses'

Avoiding reproductive and dead herbage areas, they did not \nearrow herbage quality

Mixed grazing did not homogenize sward structure



			
CV sward surface height (%)	58.5 ± 1.7	60.1 ± 2.3	p = .324
CP (g/kgDM)	116.0 ± 4.8	113.7 ± 5.2	p = .147
NDF (g/kgDM)	594.4 ± 11.6	604.5 ± 13.6	p = .319
DM digestibility horse diet (%)	57.5 ± 0.4	57.7 ± 0.4	p = .846

Avoiding reproductive and dead herbage areas, heifers did not clear pastures of parasites

Diversify farm products by adding pigs/poultry to cattle farms

This diversification allows a more regular cash inflow (short production cycles), \nearrow farm income and stabilize income as cattle and monogastric meats are sold on different markets

Diversifying products facilitates the use of short-distribution channels. High willingness to pay for beef-pork-legume 'baskets' produced on-farm (Vollet & Said, 2018)



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	Mixed beef-sheep	Beef-monogastrics	Specialized beef
Nb of farms	78	61	573
Forage area / farm area	93%	78%	87%
Final work income (€/ha)	357	447	364



Inosys farm, organic sub-network: Mischler, 2019

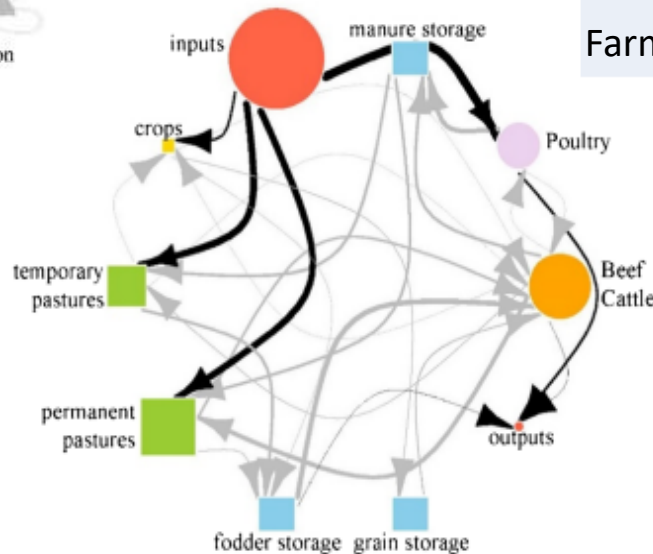
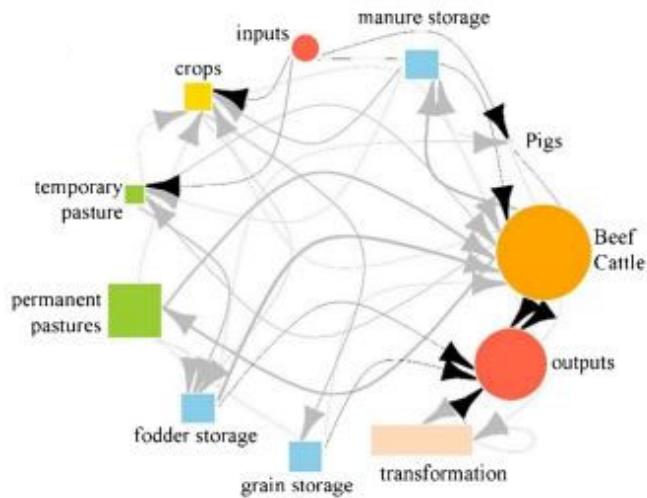
Pigs, poultry, but also cattle, consumed more of the cereals produced on-farm \rightarrow \nearrow feed-food competition



Size of monogastric production unit matters!

Ecological network analysis → Among 17 French organic mixed farms, the two economically most efficient farms associated beef cattle to a small monogastric production unit and had a processing enterprise on-farm (Steinmetz et al., 2021)

Beef farms with large monogastric prod. units highly depend on external inputs, which led to a high excess of N/ha without gaining economic efficiency



	Mixed beef-sheep	Beef-Monogastrics	Specialized beef
N balance	+0.4	+34.9	+2.3
Farm size	100	112	105

Mischler, 2019

- Risk of poor pasture management:
- High levels of organic fertilization
 - Simplification of practices

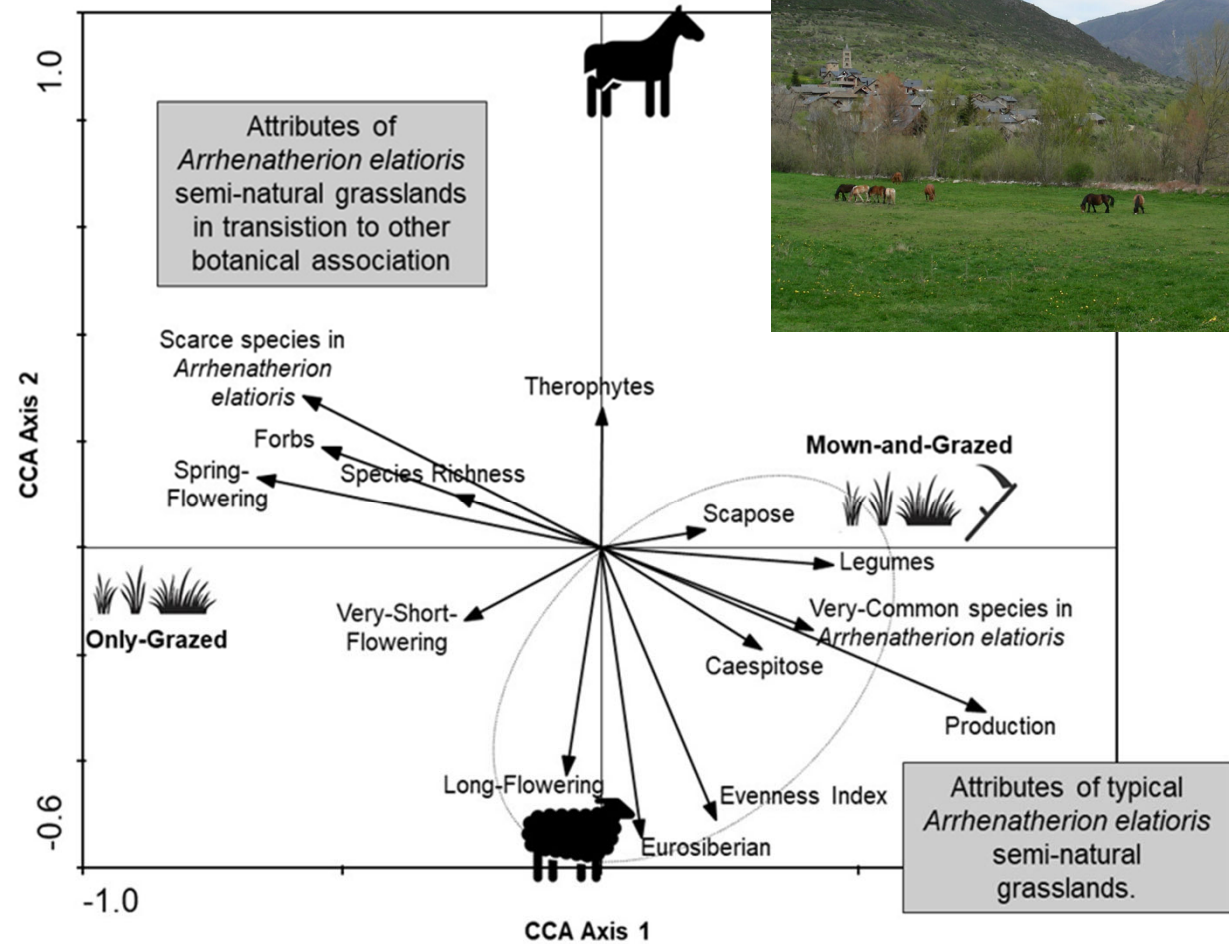
Diversification outside agriculture: off-farm employment, agritourism

This kind of diversification disconnects farm income from climatic and economic risks

But, it leads to management simplification and may \nearrow land abandonment if the additional income is not reinvested into pastoral farming activities

Diversification of labour:

- Enhanced the resilience of pastoral households
- Threatened grasslands of high ecological value



López-i-Gelats et al., 2015

Take-home messages

Numerous benefits arise from the diversification of grassland-based systems for economic viability and environmental goals such as input reduction (*Forteau, 2019; Mosnier et al., 2021*) and habitat conservation

Some efficient leverages will transform the system: adding monogastrics, processing enterprise and selling products on-farm (*Vagnoni & Franca, 2018; Mischler, 2019*)

System resilience and grassland biodiversity can benefit from:

- Preserving 'poor' but diverse grasslands on wet areas
- Keeping a 'service herd' of a hardy breed
- Mixed grazing species that have complementary feeding habits

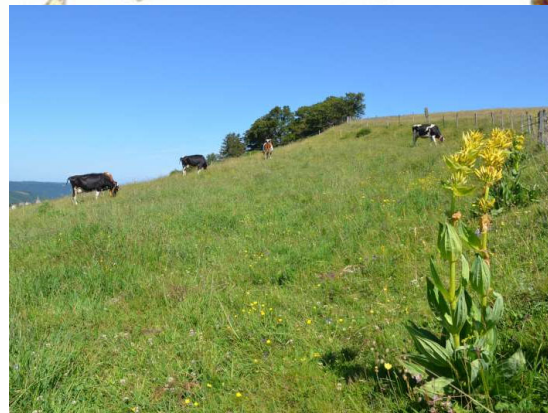


But diversification is not a one-size-fits-all strategy and there is a need to understand processes & adapt grazing management to obtain the expected benefits (*Fleurance et al., 2022*)

Moreover, there are **trade-offs** and levels of substitution between different levels of diversification: workforce dilution can lead to system simplification that can threaten grasslands of high ecological value (*López-i-Gelats et al., 2015*)

TRANS-disciplinary approaches for systemic Economic, ecological and Climate change Transitions

7/11 IH with grazing ruminants



Stay tuned!  @ag_transect