

Challenges of grassland farming in mountain areas

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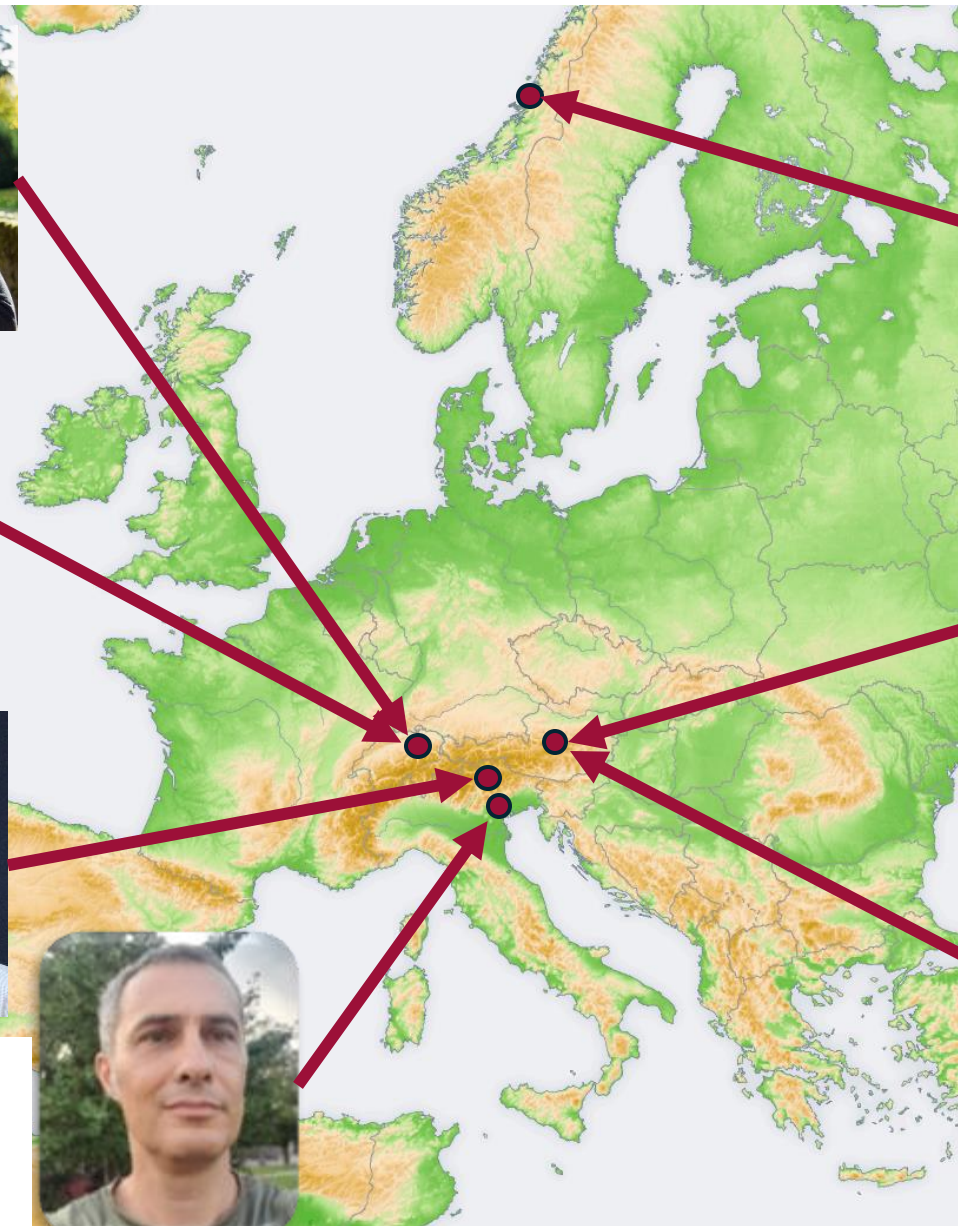
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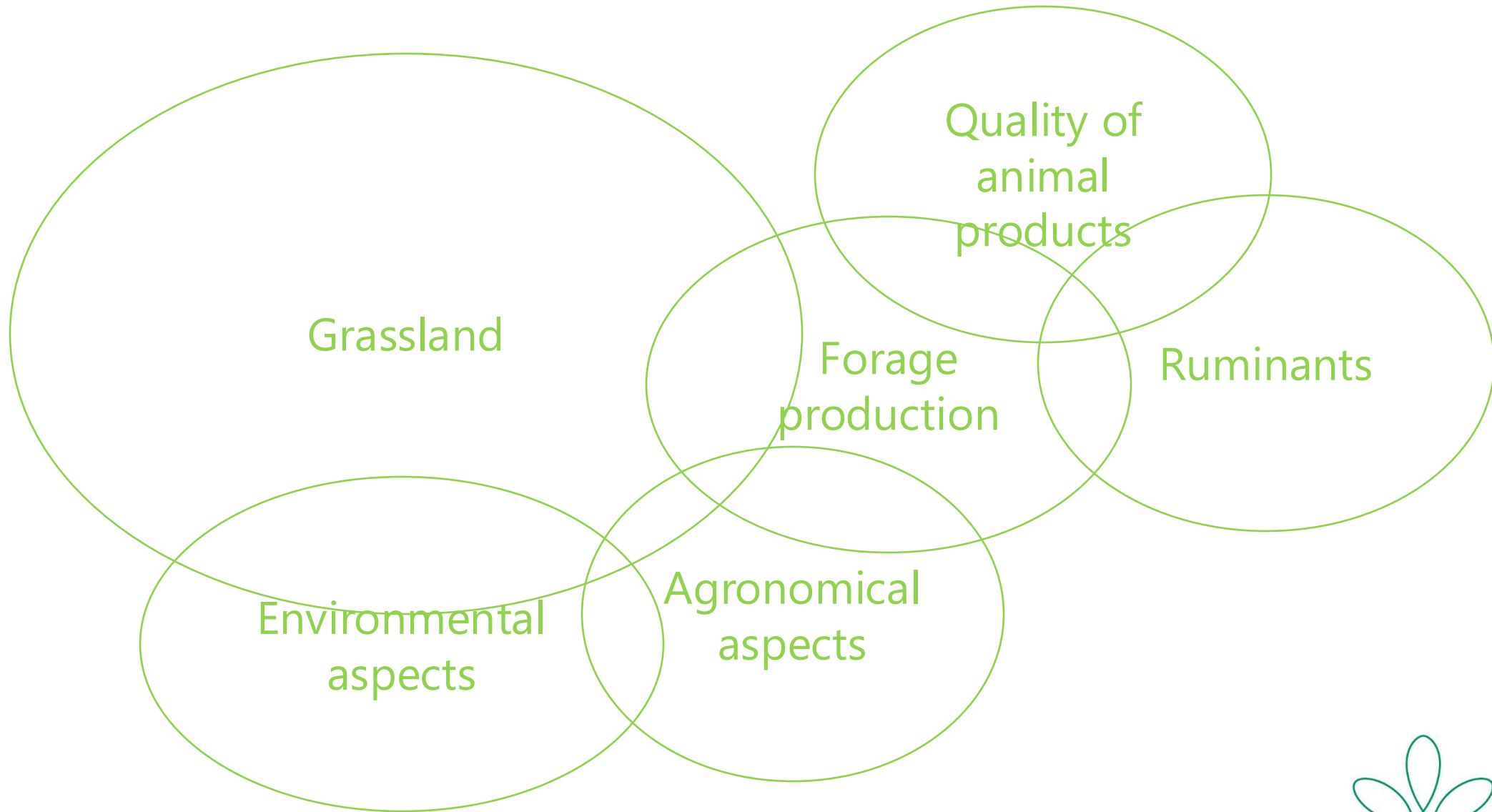
Andreas
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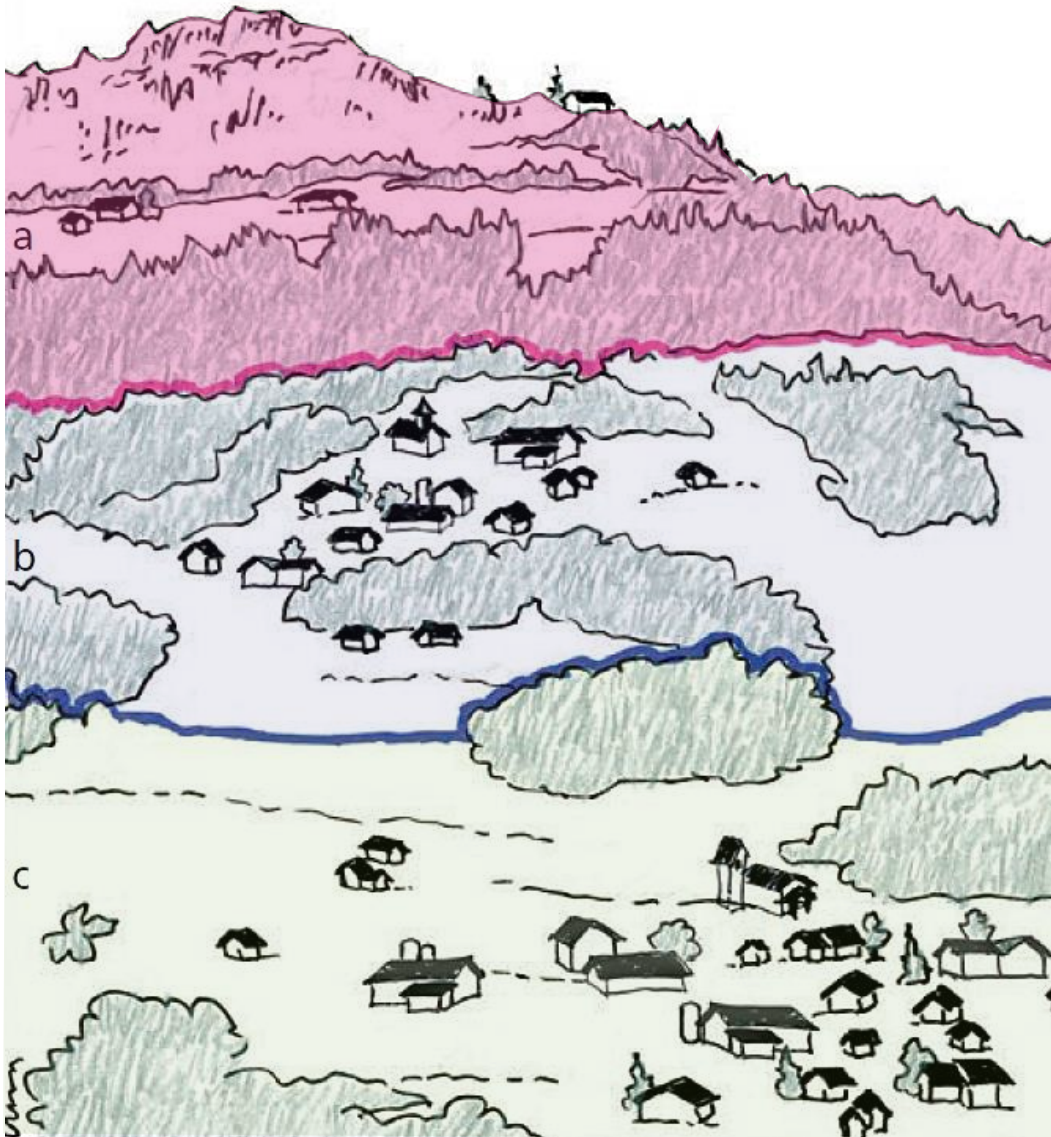
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What is related to grassland farming?



Mountain farming – the context



(Sub-)alpine zone:

- Harsh environmental conditions
- Grazing (or very expensive and labour-intensive forage production) are the only agricultural options
- Transhumant use in summer only

Montane zone:

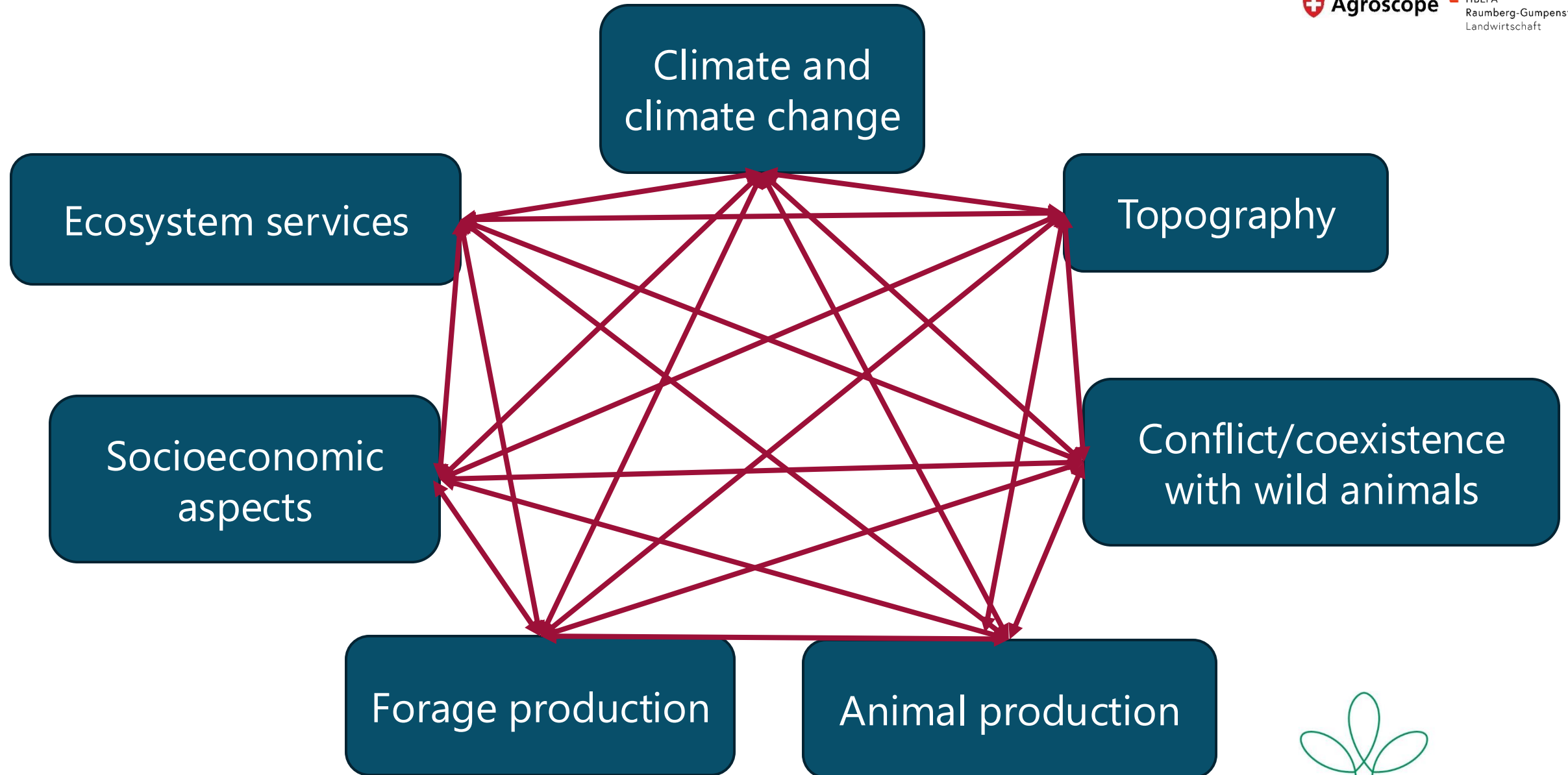
- Less favourable environmental conditions
- Ruminant livestock important
- All-year settlements

Colline zone:

- Most favourable environmental conditions
- Arable farming possible
- All-year settlements



Which are the main topics characterising mountain grassland farming?



Expected impact of increasing mountain character on different aspect of grassland farming

Impact of **increasing
elevation = decreasing
temperature** on...

Impact of **increasing slope**
on...

Impact of **increasing
remoteness** on...

Climate change in the Alps



- Clear temperature increase and increase of heat waves
- Increase of growing season length
- Clear decreasing trend of snow cover (-8.4% on average) and glacier retreat -> loss of water reservoirs
- Climate projections -> increase in summer droughts by more than 50% in the Alps. This means that droughts could occur more than every second summer

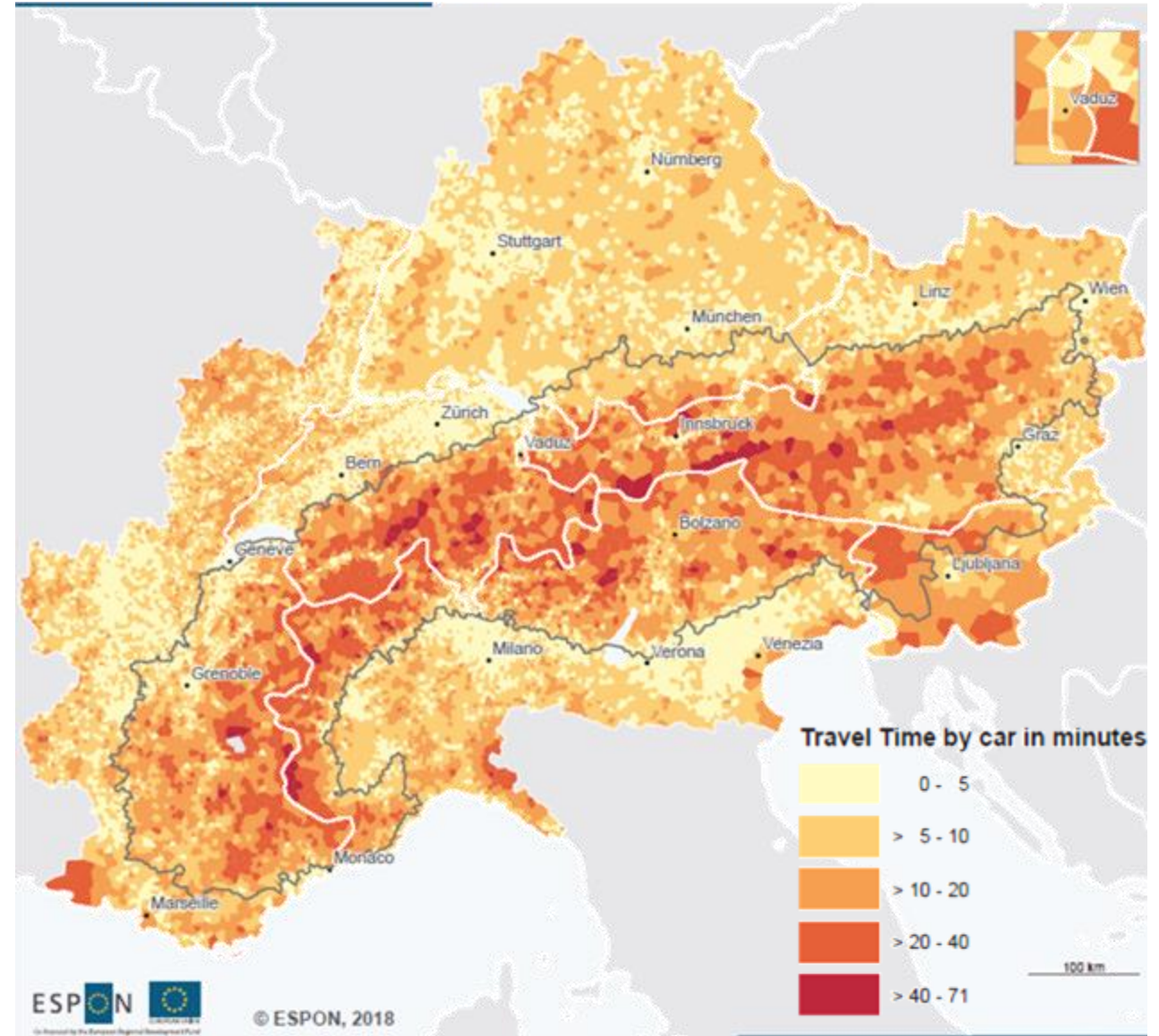


Socioeconomic aspects

In the mountains everything requires more time:

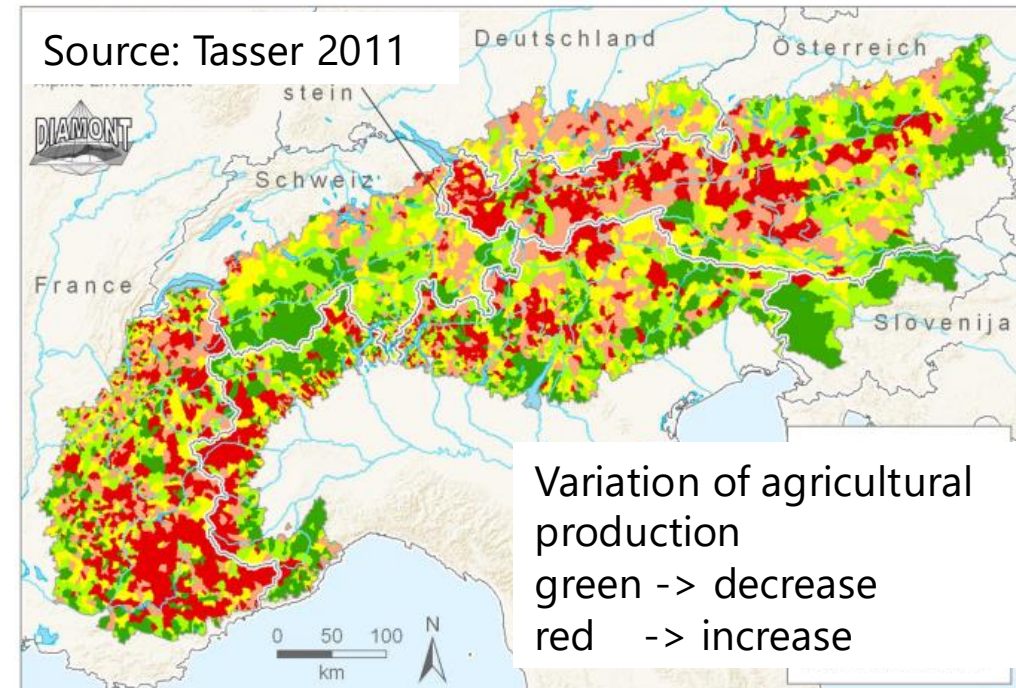
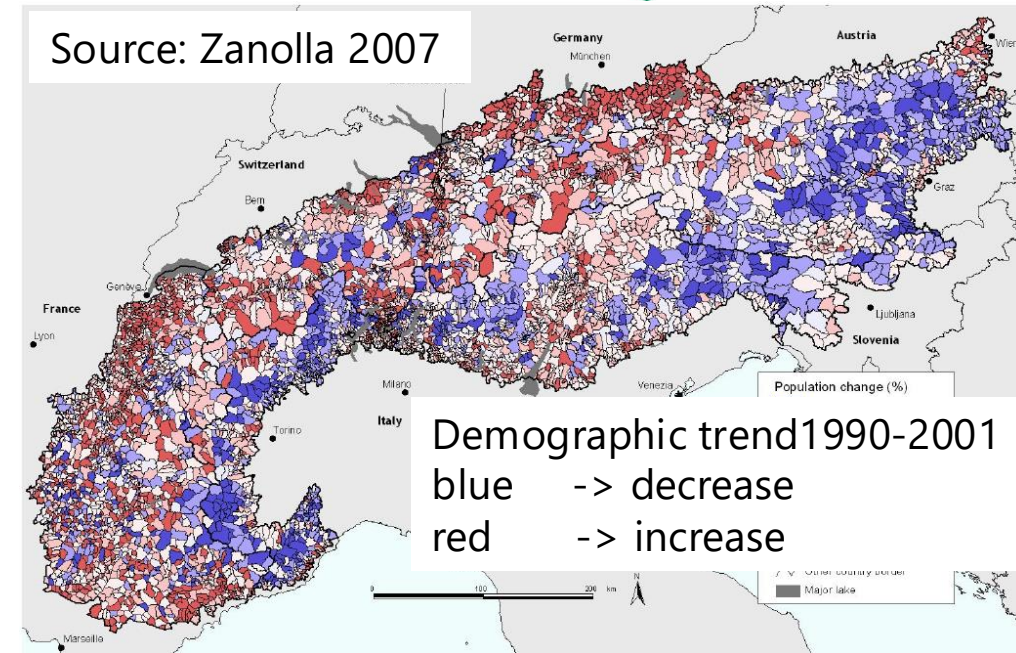
- Transport costs for forage and manures
- At high slopes at high elevations, grazing becomes advantageous
- For the management of remote pastures, additional (off-farm) personnel is needed
- Collective properties play a positive role, but the decisional processes becomes more complex

Travel time to primary schools by car

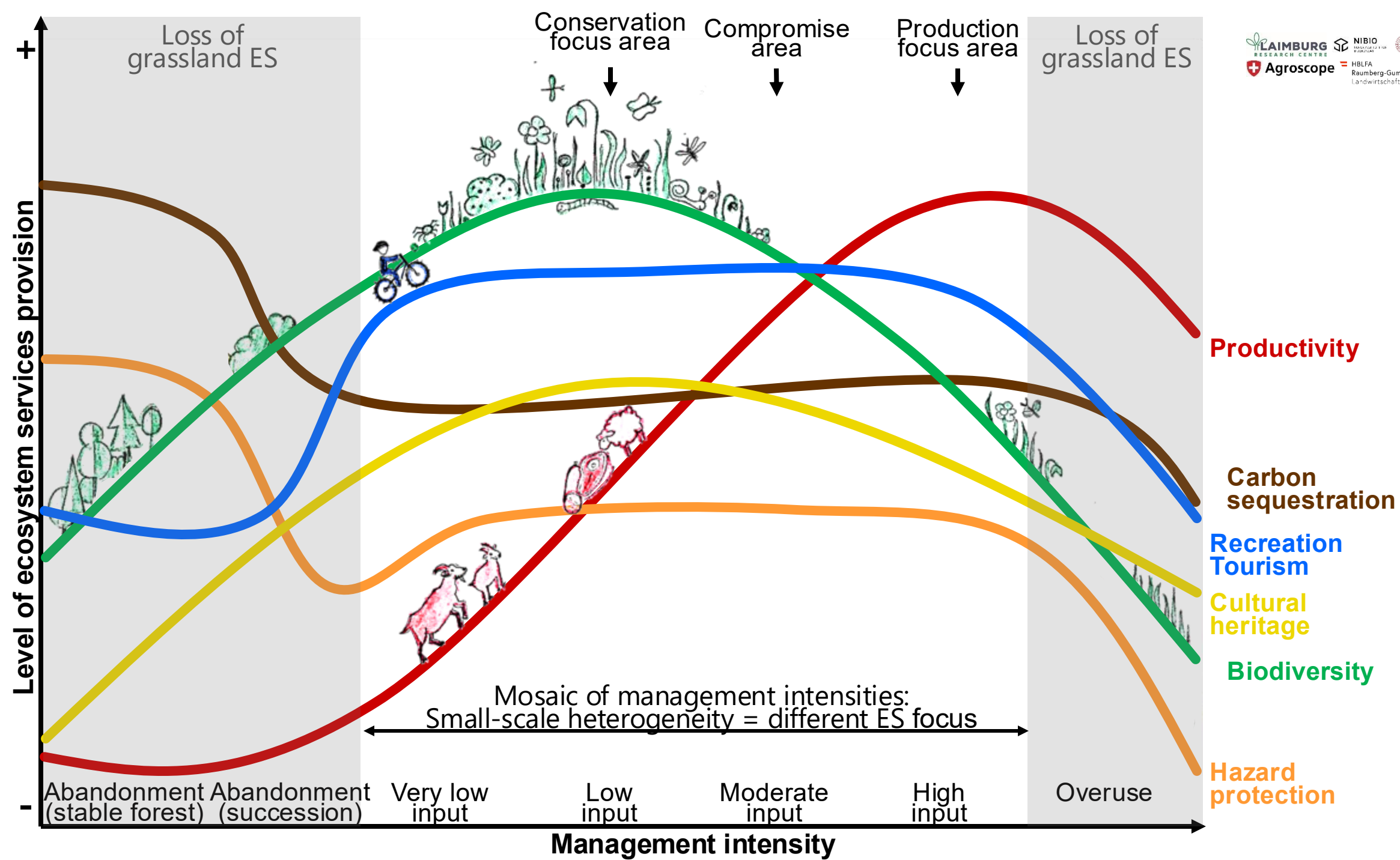


Socioeconomic aspects

- Processes of demographic concentration:
 - Inhabitants increase in well connected central locations
 - Population decrease in remote areas (with large regional differences)
- Strong reduction of the number of farms & moderate reduction of the agriculturally used area
 - Frequent increase of farm size
 - Decrease of available manpower
 - Specialisation of farm management (forage conservation, animal genetics, infrastructures and mechanisation)
 - Concentration of production in mechanisable areas



Source: Peratoner et al. 2025 (mod.. artwork: C. Pauler)



Site-specific forage production

Adapting the management intensity to site conditions -> graded management intensity

Intensive management of areas with high potential

- Harvesting at an early phenological stage and nutrient supply tailored to plant uptake to optimise forage yield and quality
- Promoting high forage production and forage quality

Extensive management of areas with low potential

- Reduced defoliation frequency and moderate fertilisation
- Promotion of biodiversity and feeding of forage to animals with lower performance requirements
- **Aim:** Optimisation of yield and biodiversity at farm level through a site-specific, efficient and sustainable use of resources



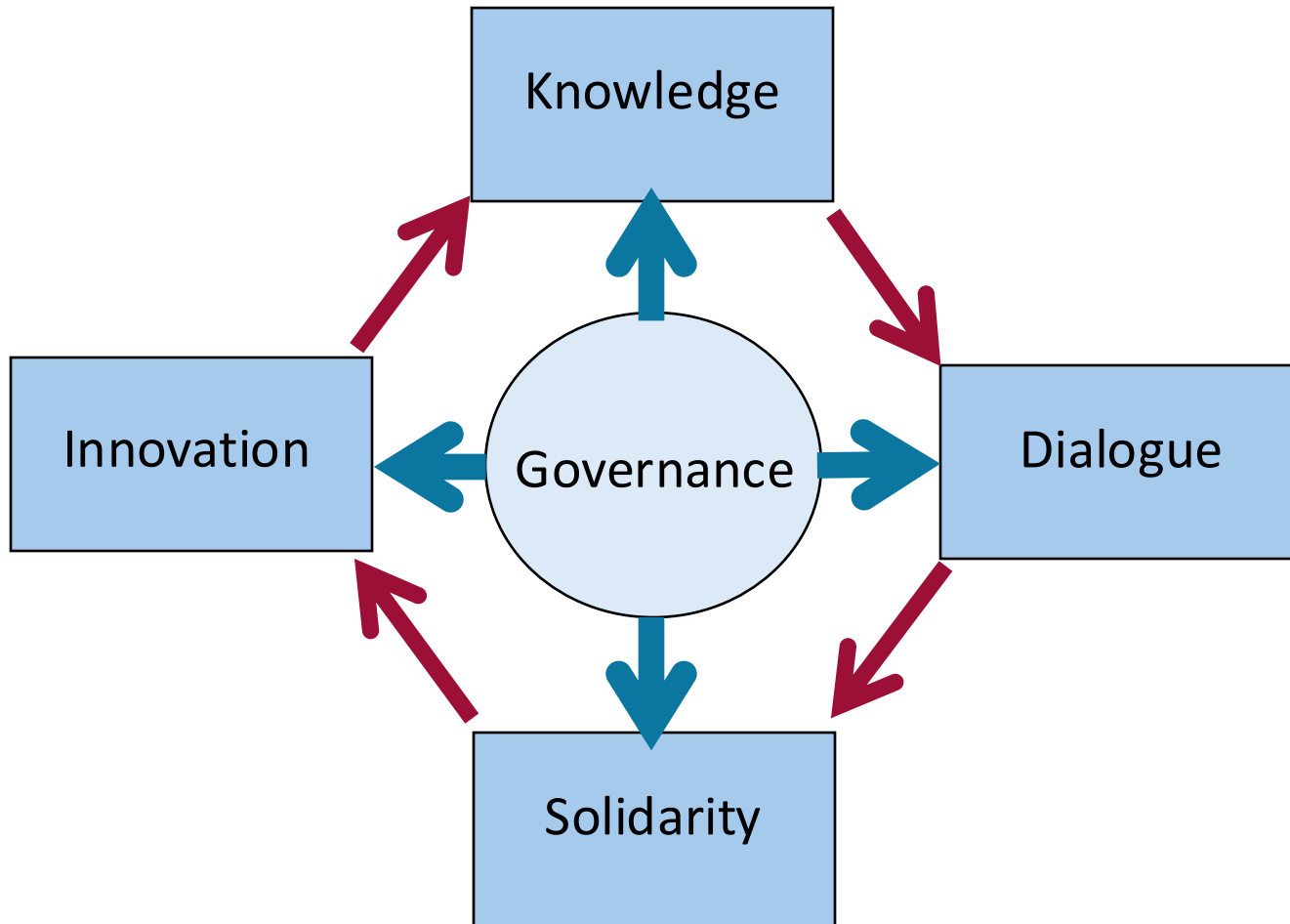
Animal production



Photo: NIBIO

- Need for consistency between animal species/breed and the characteristics of the production site
- The diet of highly productive animals requires supplementation with off-farm concentrates
- Decline in the number of farms (issue of generational turnover)
- Contribution to the creation of a cultural landscape desired by the general public
- The certifications required are often based on large lowland farms and make it difficult to certify small mountain farms

Interaction with wildlife - how to manage the conflicts?



- Successful coexistence of large carnivores and humans depends on the effective mitigation of their impact on humans, especially through livestock predation
- Lack of scientific evidence of the effectiveness of the different prevention measures
- Urgent need to conduct studies of intervention effectiveness to support for the implementation of policies and strategies aiming at reducing conflicts between carnivores and livestock



Adaptation and optimisation strategies of grassland farming systems

- Continuous adaptation of plant species/varieties to climate change, including also the targeted use of functional diversity in seed mixtures
- Selection of livestock species/breeds adapted to mountain conditions -> exploration of the genetic basis
- Establishment and use of systems making use of the potential of digitalisation and technological advances to increase the efficiency of mountain farming systems and to decrease the costs of production under disadvantaged conditions
- Development of approaches to solve or mitigate the conflicts of interest between agricultural production, tourism, predators and energy production
- Development and evaluation of sustainable mountain farming systems (with regard to ecological, economic and social dimensions)



The LegacyNet network

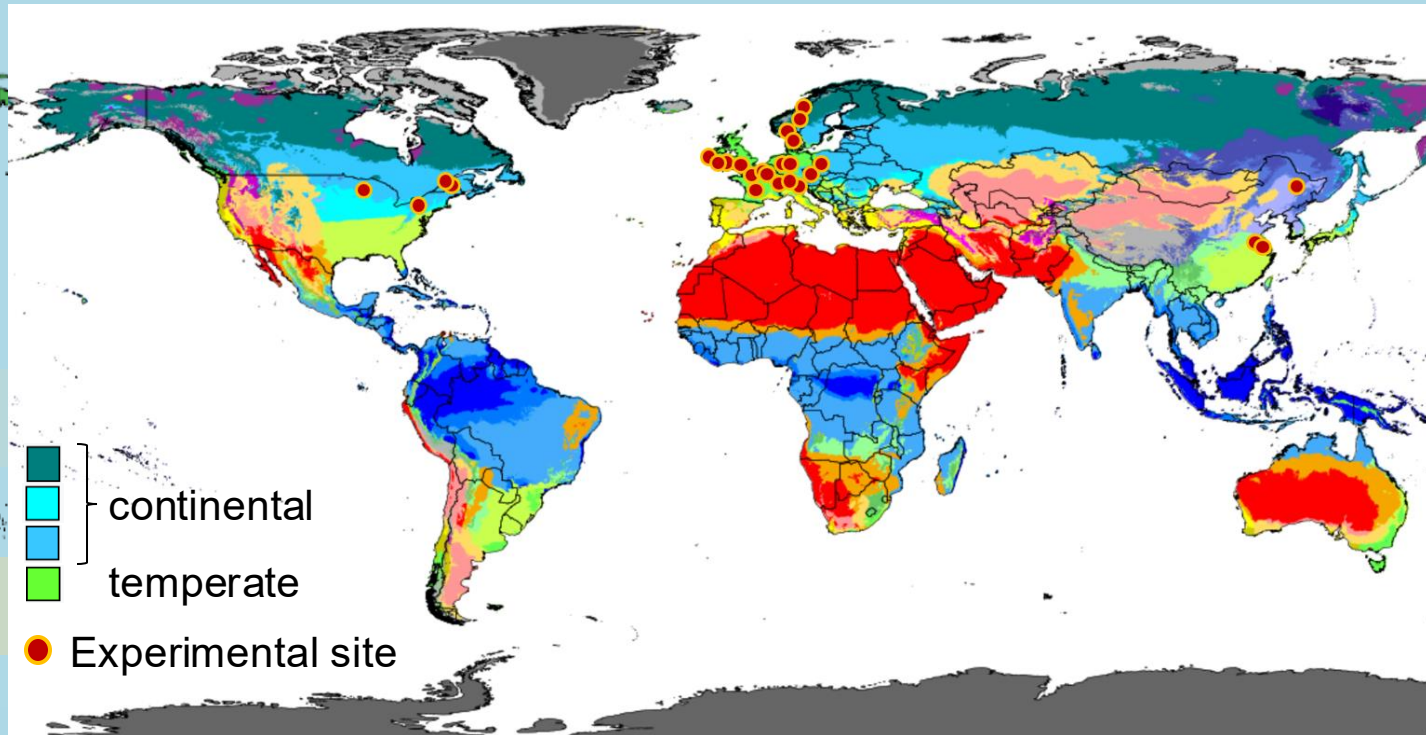


Co-ordination: C. Brophy - Trinity College Dublin (IE)/J. Finn – Teagasc (IE)/C. Malisch - Aarhus University (DK)

26 sites

15 countries

1 design



Map sources: Peel et al. (2007): Köppen-Geiger climate (mod.)

6 Species:
2 grasses
2 legumes
2 forbs

Most frequent species:
Lolium perenne
Phleum pratense
Trifolium pratense
Trifolium repens
Cichorium intybus
Plantago lanceolata

A brown bag with a green leaf icon.

109
kg N ha⁻¹
on average

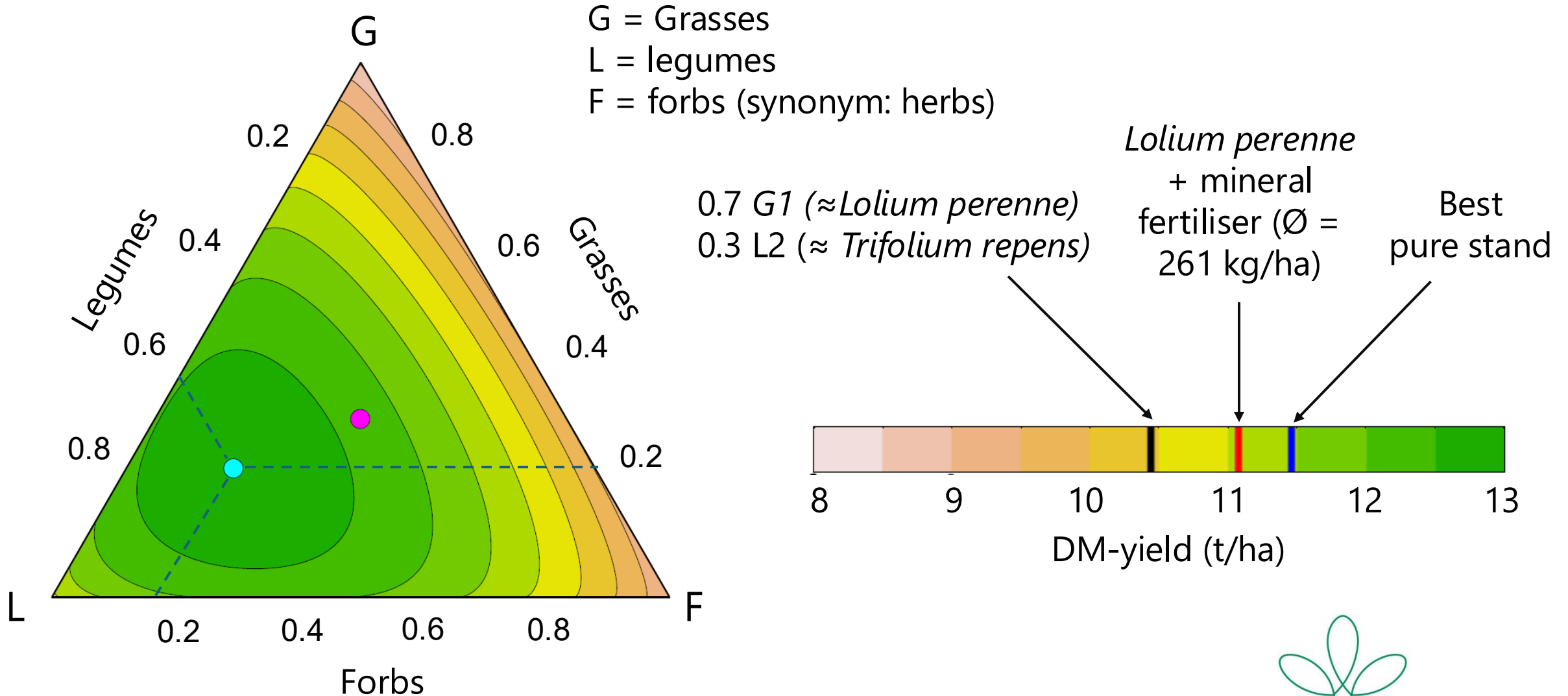
47 plots:
Pure stands and mixtures
up to 6 species

5 plots:
Lolium perenne

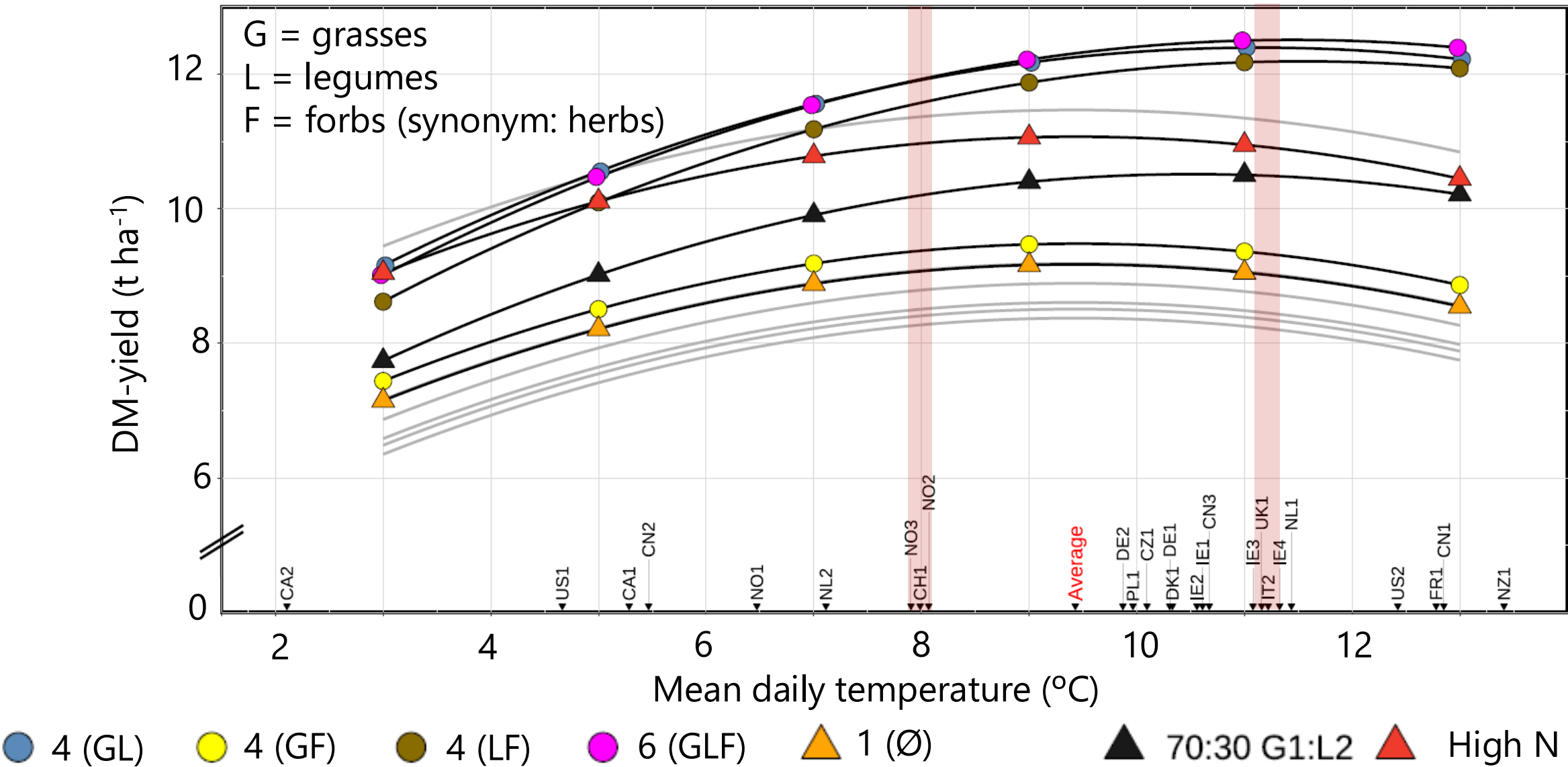
261
kg N ha⁻¹
on average

A brown bag with a green leaf icon.

Including small proportions of forbs increases forage yield



Mixtures of functional groups achieve higher yields than reference treatments at increasing temperatures

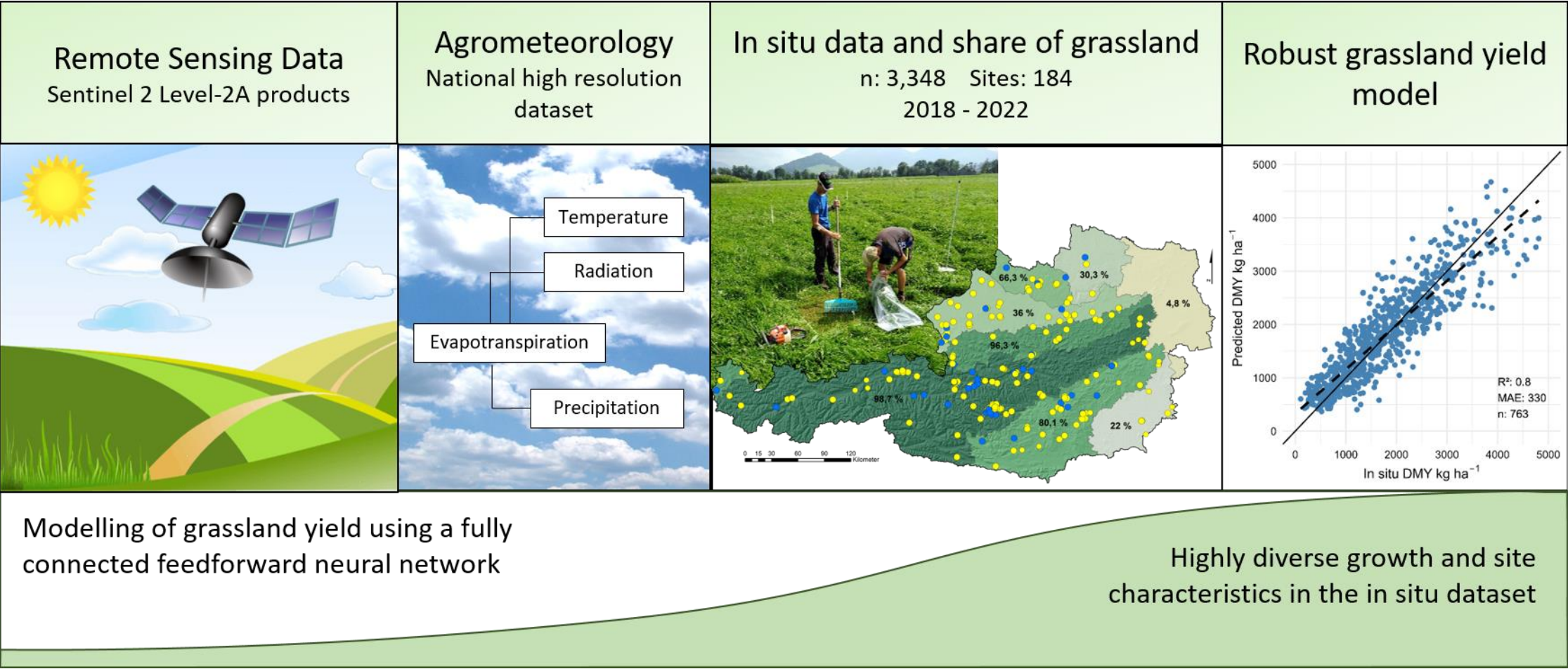


Potential of digitalisation and use of modern technologies

- Satellite imagery, AI and real-time monitoring enable more accurate assessments and forecasts in real time
- Applicable at various spatial scales to optimise grassland management
 - **Remote sensing-based insurance against drought** (yield loss) (France/Trentino-South Tyrol)
 - **Remote sensing-based grassland monitoring** (SATGRASS, Austria)
 - **Sensor-based, on-demand grassland irrigation** (Wasser-Pilot, South Tyrol)
 - **Virtual fencing**



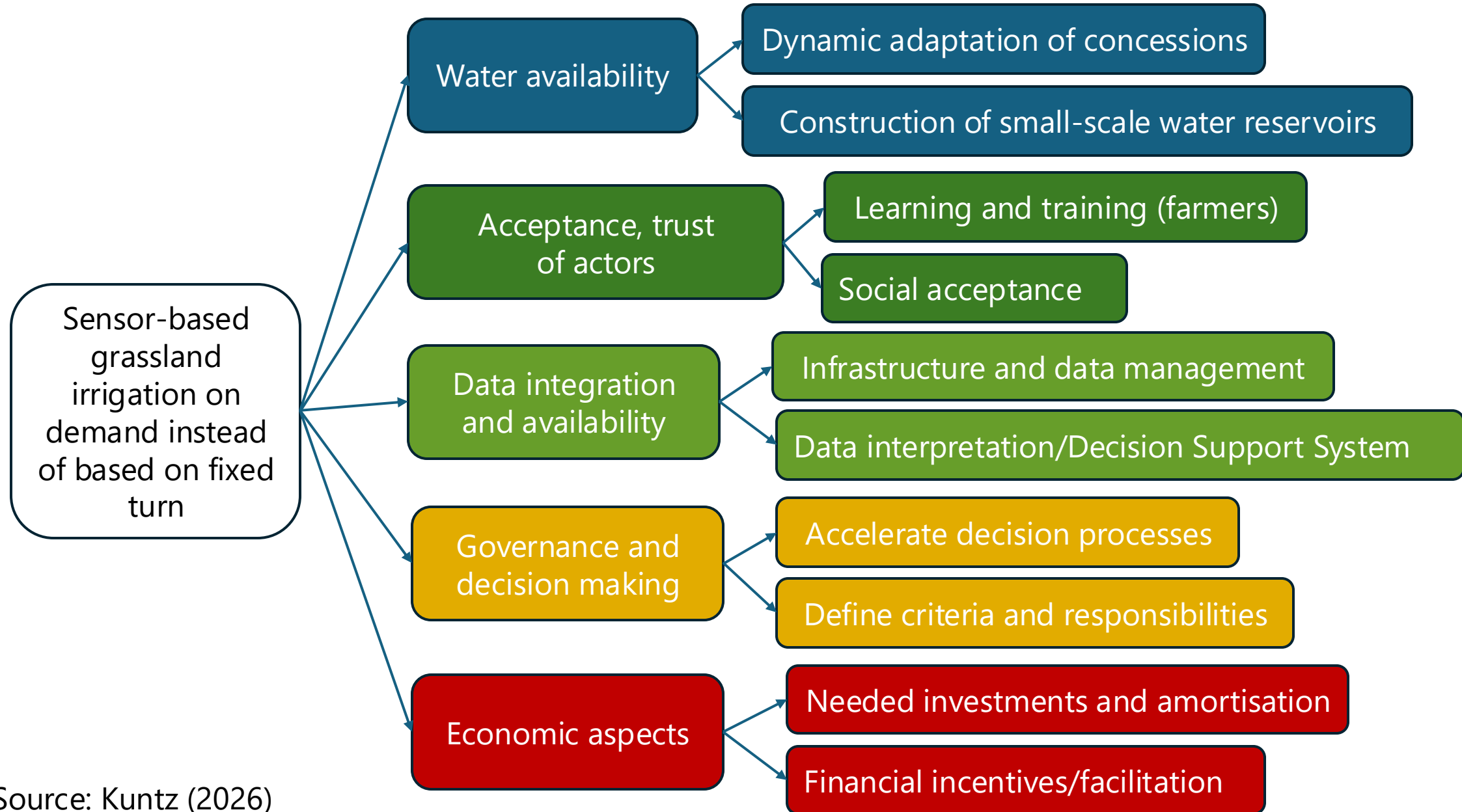
SatGrass



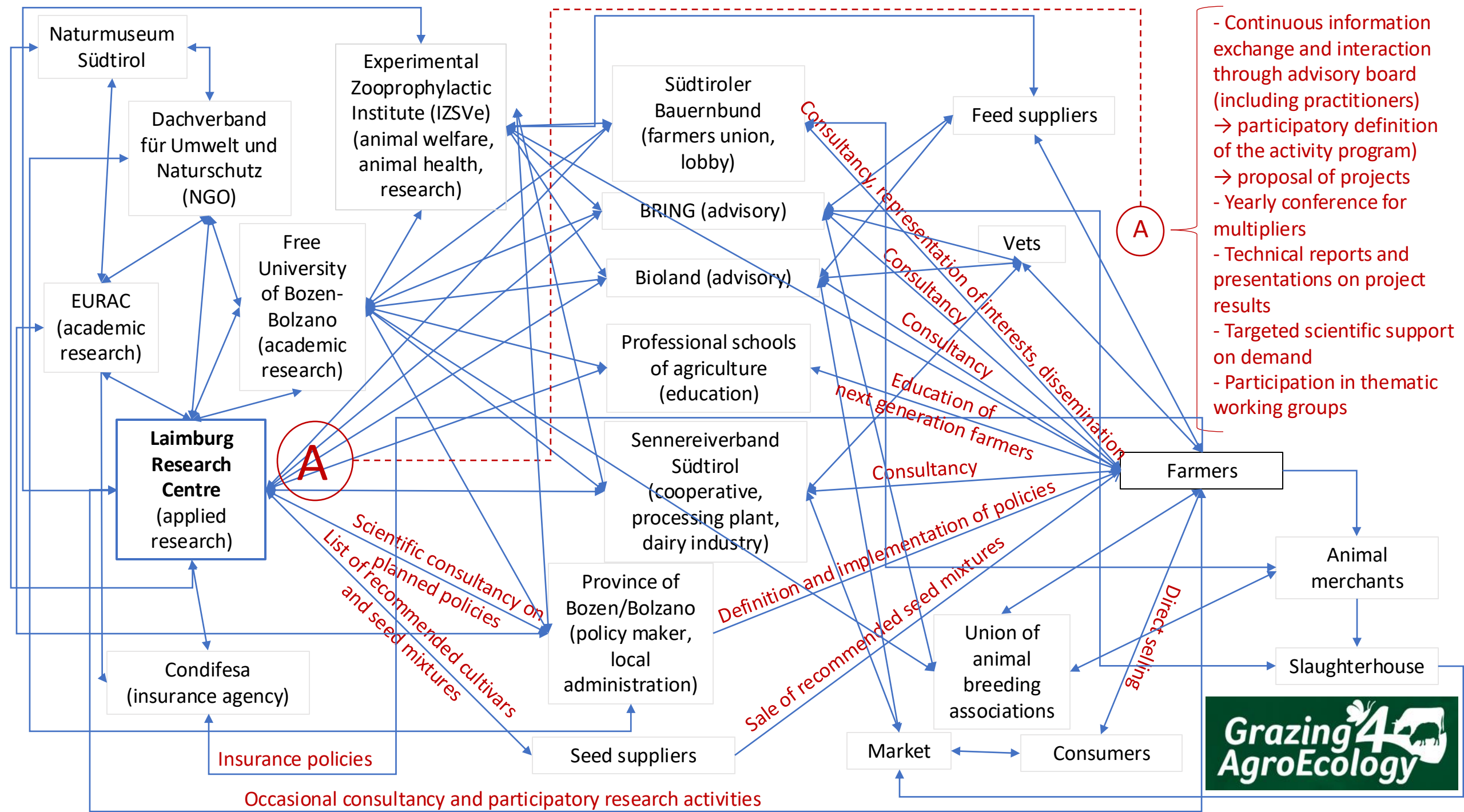
Further details on Wednesday 17.06.2026 – Theatre session 9 at 10:45



Implementation of innovations in the context of climate change: more complex than it may seem



Source: Kuntz (2026)



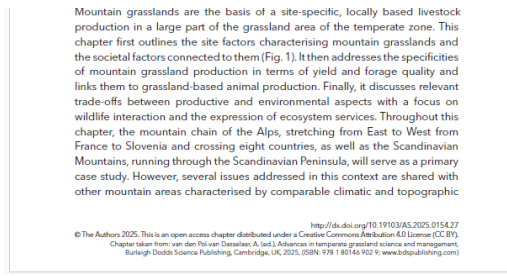
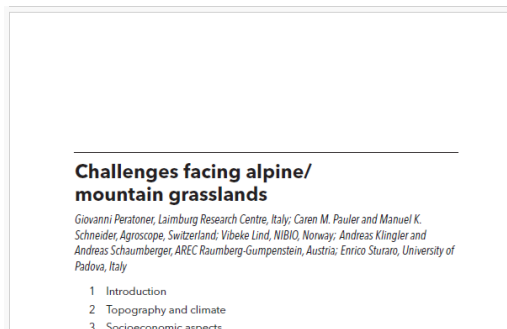
Conclusions

- Research and knowledge transfer -> networks and collaborations (including informal ones) are a key element
- Recognition of the benefits to society and/or the particular quality (whether in the form of public funding or a fair price for animal products) is necessary to ensure economic viability
- Loss of ecosystem services and the contribution to food security if grassland farming declines, but a balance between site potential and differentiation of management (gradation) is necessary
- In the case of trade-offs, research is pivotal to provide sound knowledge to support the decision-making process
 - Dialogue with stakeholders and with society -> My vision: conscious, fact-based decisions
 - Education and training on agricultural topics – also for the general public – is key



Chapter online
available
(open access)

Thank you for your attention!



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