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Livestock grazing and biodiversity in semi-natural grasslands

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Grasslands

- Climatically-determined
 - Savannah and shrub steppe
 - Natural grassland
- Successional/agricultural
 - Maintained by grazing and other agronomic practices
 - Semi-natural grassland
- Not as clear division as previously thought
- Natural grasslands often proved to have a more anthropogenic background

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A GENERALIZED MODEL OF THE EFFECTS OF GRAZING BY LARGE HERBIVORES ON GRASSLAND COMMUNITY STRUCTURE

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Submitted December 19, 1986; Revised June 8, 1987; Accepted November 18, 1987





European grasslands

- Mainly successional/agricultural grasslands
 - Middle and south Europe
 - Agriculture has conquered most of the landscape for the last 9000 years
 - Northern Europe and Scandinavia
 - Pre-industrial agriculture (6000 yrs) based on animal husbandry and grazing of semi-natural grasslands
 - Iceland
 - Shorter grazing history: settlement during the 9th century
 - A long-held view that sheep grazing is the culprit for land degradation and soil erosion
 - Grazing exclusion & re-seeding for ecosystem restoration
 - → Different views on grassland conservation

European grasslands

- Provide a large proportion of animal proteins
- Host a wide diversity of plants, animals and microorganisms of functional or patrimonial interest
- Face new social expectations
 - Support for other agricultural systems (pollination)
 - Landscape production





 How to conciliate production and other ecosystem services, while reducing the environmental footprint of livestock farming systems?

Threats on biodiversity

- Intensification in land use
 - Cultivation and fertilization
- Abandonment of marginal areas
 - Shrub encroachment
- Fragmentation of habitats





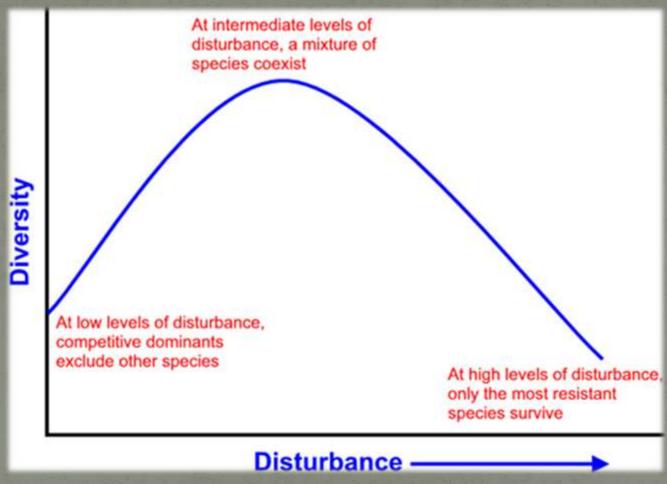


Grazing by livestock can be seen as a conservation tool with positive effects on biodiversity, but the quality of the management regime and grazing history are decisive

Grazing as nature conservation tool

- Grazing
 - One of the main drivers of global vegetation dynamics
- The effect of grazing
 - Grazing history
 - Livestock species and breed
 - Pasture productivity
 - Grazing intensity
 - Grazing period
 - •
- The connection between grazing and biodiversity

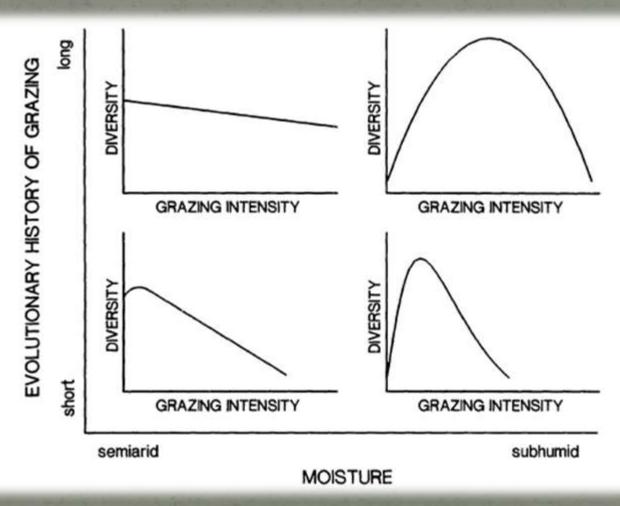
Intermediate disturbance hypothesis



i.e Connell 1978; Wilkinson 1999

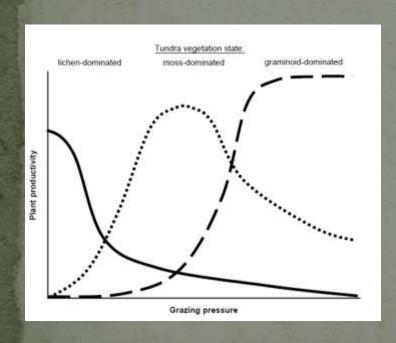
Grazing is disturbance

Relationship between grazing and biodiversity is a function of environment moisture and grazing history



Further development

- Moisture gradient generalized to a productivity gradient
- Incorporation of the state and transition model (Westoby et al. 1989) predicts that grazers can create alternative equilibria



- According to grazing pressure, we get different sward composition
- An example of different alternative stable stages in tundra ecosystems: the most productive and resilient grassland is created and maintained by large herbivores

Grazing creates mosaic of habitats

- Defoliation
- Trampling
- Dung deposition

- Animals select for short rather than tall patches (patch grazing, Adler *et al.* 2001)
- Patch stability...

Creating mosaics of short and tall patches, contrasting growth forms and competitive interactions



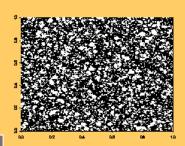




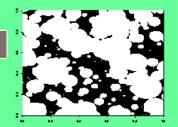
Inter-annual patch stability

Poor grasslands

Fine-scale stability patterns explained by Δ in plant palatability and local abundance



Large-scale stability patterns favour functional divergence



Mesophile grasslands

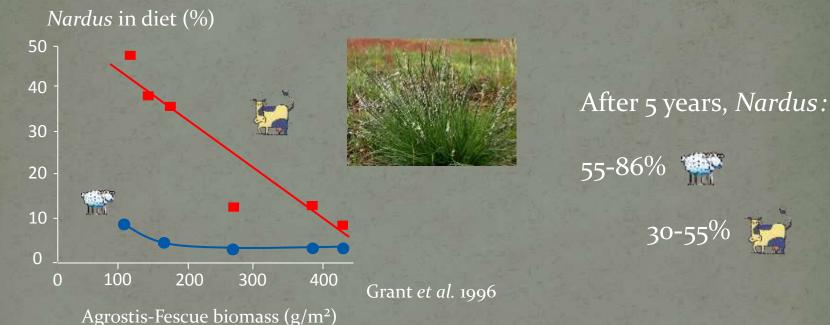
Large stable patches more frequent in lightly-grazed, productive swards



Rossignol et al. 2011; Dumont et al. 2012

Livestock species and breed

- Size matters !!!
 - Differences in requirements / gut capacity, in the ability to sort out preferred items and graze short swards, in digestive capacities

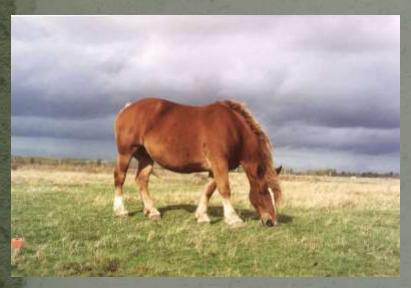


• In temperate grasslands, ≠ in size and experience in the young age explain most breed effects; stronger effects in constraining environments (Sæther et al., 2006)

Horse grazing

Two rows of teeth → Grazing short lawns









→ Stable patches in horse-grazed pastures

Different digestive regulation → Roughage consumption

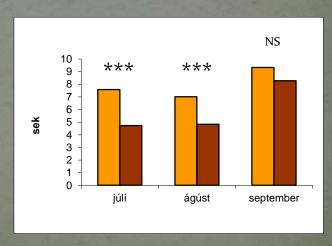
→ Impact on sward composition

Biodiversity affects foraging behaviour

- Grazing horses in W-Iceland
- Two areas
 - High biodiversity 30 species
 - Low biodiversity 10 species
- Time at each feeding station (Marginal Value Theorem as a reference model)
 - Gain at each station
 - Traveling time between stations
- Stay shorter at each feeding station in high biodiversity
 - More to gain at the next station...

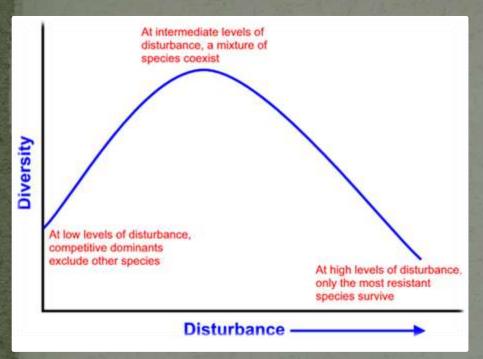


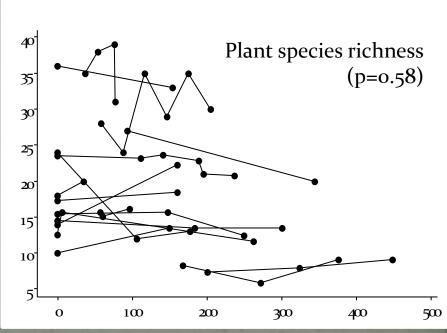
Feeding station



Time at each feeding station

Grazing intensity





Grazing intensity (LU.day/ha)

Grazing intensity (LU.day/ha)
Scohier & Dumont 2012

Observations did not fit predictions of the theoretical model !!!!

Need to be tested with other species

Shifts in functional group abundance more rapid than changes in sp. richness

Grazing intensity

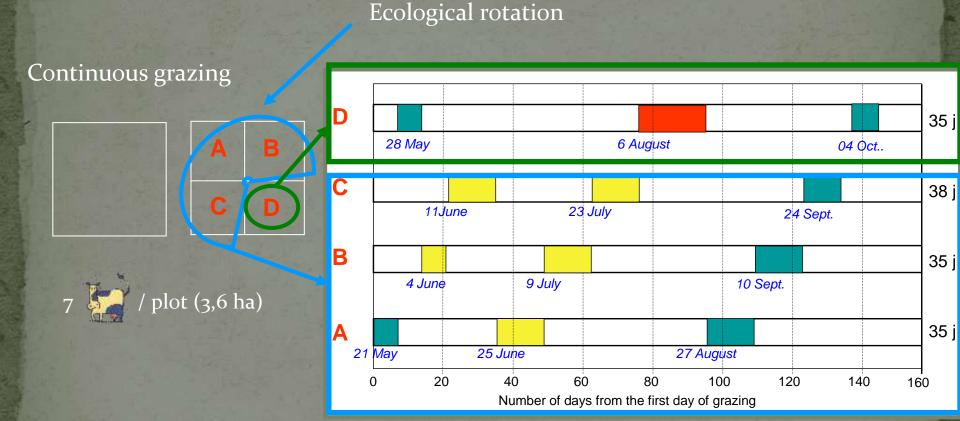


Butterfly dynamics matches that of flowering plants
Trophic hypothesis (Loertscher *et al.* 1995; Collinge *et al.* 2003; Öckinger *et al.* 2006)

Sward heterogeneity provides more diverse habitats and microclimate > Habitat heterogeneity hypothesis (Dennis et al. 1998; Wallis De Vries et al. 2007)

Less risk of negative direct effects (Lenoir & Lennarston 2010)

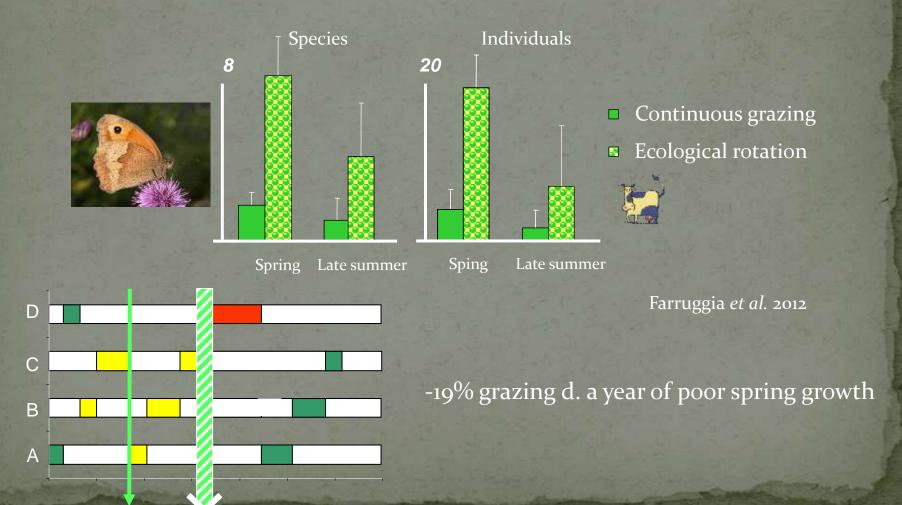
Grazing period



Preserving flowering intensity and sward heterogeneity is assumed to benefit nectar-feeding insects

Grazing period

Ecological rotation increased flowering intensity and sward heterogeneity



Grazing period

Benefit was lesser in sheep-grazed pastures

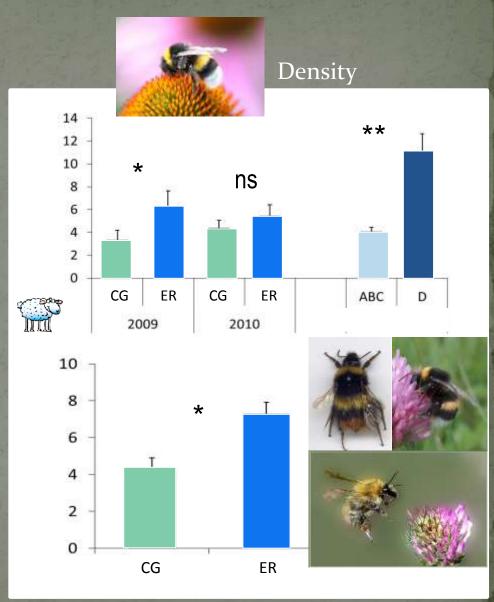




CG = ER

Same daily liveweight gain

Context affects the success of grazing practices!

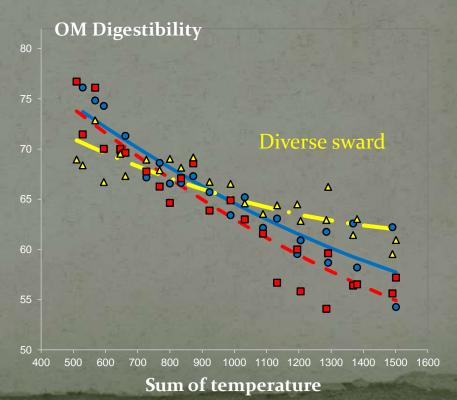


Scohier et al. 2013

Biomass, dynamics of sward production

• Greater stability of biomass production in diversified grasslands due to variability in plant species response to abiotic conditions, and asynchronicity of these responses (Yachi & Loreau 1999; Tilman *et al.* 2006)

 Greater stability in the digestibility of diverse swards
 (Michaud et al. 2011)



Milk from diverse pastures is richer in fatty acids (benefit to human health)



Maize silage -----

C18:3*n*-3 (omega 3) +1,0 CLA-*c*9*t*11 +0,6

(Ferlay *et al.* 2006, 2008)



Lowland pastures



Diverse upland pastures

+0,8 (g/100 g AGT) +1.3

(Lucas et al. 2006; Chilliard et al. 2007)

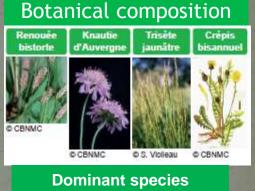
The abundance and diversity of dicotyledonous plants reduce ruminal biohydrogenation, which leads to a weaker transformation of omega 3 and CLA in the rumen

Grassland typology: a tool to evaluate multiple services provided by diverse grasslands

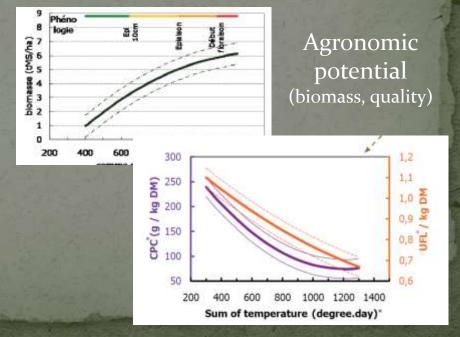
 23 vegetation types defined based on altitude, practices, moisture and fertility gradients







Indicator species



A simple way to express services provided by each sward type

Provisioning services

❖ Yield



Production seasonnality

At 400 °C 60% of grass are vegetative
At 800 °C 80% of grass culms above 10 cm soil level

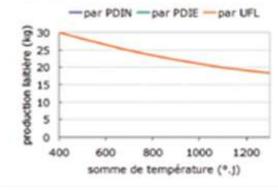
❖ Forage nutritive value



❖ Management flexibilty



❖ Allowed milk production





A simple way to express services provided by each sward type

Provisioning services * Yield

❖ Production seasonnality

At 400 °C 60% of grass are vegetative
At 800 °C 80% of grass culms above 10 cm soil level

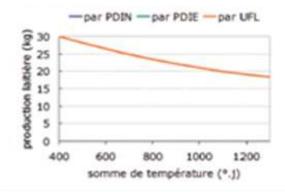
❖ Forage nutritive value



❖ Management flexibilty



❖Allowed milk production



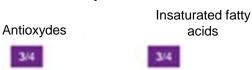
Cheese quality



❖ Organoleptic potential

Colour	Flavou	
4/4	1/4	

❖ Nutritional potential





A simple way to express services provided by each sward type

Provisioning services

❖ Yield



Production seasonnality

At 400 °C 60% of grass are vegetative

At 800 °C 80% of grass culms above 10 cm soil level

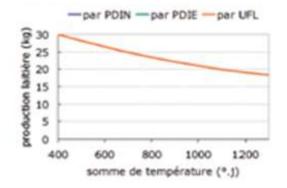
❖ Forage nutritive value



Management flexibilty



❖ Allowed milk production



Regulating/cultural services

Carbon sequestration



❖ Botanical patrimonial interest



Colour diversity



❖ Pollinisation impact



❖ Fauna



Cheese quality



Organoleptic potential

Colour







Nutritional potential

Antioxydes

Insaturated fatty acids







OUTIL

Basis for a multifunctional diagnosis tool to characterise services at farm scale



Designed for farmers and extension services



System description

Farm plots



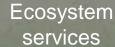
Herd

Diversity of vegetation types, practices, grazing intensity

Animal requirements, milk yield, calving dates, concentrate

Analysis (4 agregated criteria)

Forage system 'consistency'





Forage autonomy (PDO rules)

Quality of dairy product (cheese)

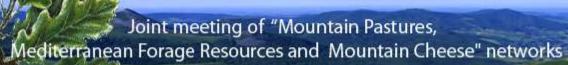
Take-home messages

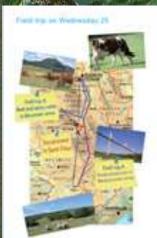
- Grazing history led to different views of the role of livestock grazing with regard to grassland biodiversity
- Cows, sheep and horses have a role to play
- Taking account of fertility, grazing intensity, grazing period allows to define proper management
- Highlight the benefits of sward diversity and heterogeneity
- Diverse swards provide a wide range of ecosystem services
- New tools need to be developed to assess sward and forage system multifunctionality

Thanks for your attention

24-26 June 2014, Clermont-Ferrand, France

Forage resources and ecosystem services provided by Mountain and Mediterranean grasslands and rangelands





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JOINT MEETING
OF THE "MOUNTAIN
PASTURES, MEDITERRANEAR
FORAGE RESOURCES
(TADIESCONTAA - CHEAM)
AND MOUNTAIN
CHEESE" NETWORKS

24-26 June 2014
Clement-Ferrand, France
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3 other resaons to come to Clermont

- Nice landscapes and the only other place in Europe where you can find andosols (Helgadóttir *et al.*, 2013)
- Akureyri is the most beautiful town in the World and where you can eat the best lamb...

... but Clermont-Fd is the second most beautiful town in the World and where you can eat the best cheese!

« Clermont-Ferrand has the best rugby team in Europe, second best is Munster » (J.D. Murphy, pers. comm.)