Livestock grazing and biodiversity in semi-natural grasslands

Dumont B., Thórhallsdóttir A.G., Farruggia A., Norderhaug A.

INRA – Agricultural Univ. of Iceland – Norwegian Inst. for Agriculture and Environmental Res.
Grass-dominated ecosystems

Approximately one-third of the Earth's vegetative cover is savannah, grassland and other grass-dominated ecosystems.
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
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

Grazing is disturbance

i.e. Connell 1978; Wilkinson 1999
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

Milchunas & Lauenroth 1993; van der Wal 2006; Blinnikov et al. 2011
Grazing creates mosaic of habitats

- Defoliation
- Trampling
- Dung deposition

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

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

**Poor grasslands**

*Fine-scale stability patterns explained by $\Delta$ in plant palatability and local abundance*

**Mesophile grasslands**

*Large-scale stability patterns favour functional divergence*

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

  *Nardus in diet (%)*  

  ![Graph showing Nardus in diet (%) against Agrostis-Fescue biomass (g/m²)](image)

  *After 5 years, Nardus:*

  - 55-86%  
  - 30-55%

- 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
  - Gain at each station
  - Traveling time between stations
- Stay shorter at each feeding station in high biodiversity
- More to gain at the next station...
Grazing intensity

Grazing intensity (LU.day/ha)

Plant species richness
(p=0.58)

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
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)
Preserving flowering intensity and sward heterogeneity is assumed to benefit nectar-feeding insects.
Ecological rotation increased flowering intensity and sward heterogeneity.

Farruggia et al. 2012

-19% grazing d. a year of poor spring growth
Grazing period

Benefit was lesser in sheep-grazed pastures

CG = ER

Same daily liveweight gain

Context affects the success of grazing practices!
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)

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
A simple way to express services provided by each sward type

- **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 flexibilidade**

- **Allowed milk production**

- **Provisioning services**
A simple way to express services provided by each sward type

**Provisioning services**

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**Cheese quality**

- **Organoleptic potential**
  - Colour: 4/4
  - Flavour: 1/4

- **Nutritional potential**
  - Antioxydes: 3/4
  - Insaturated fatty acids: 3/4
A simple way to express services provided by each sward type

<table>
<thead>
<tr>
<th>Provisioning services</th>
<th>Regulating/cultural services</th>
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</thead>
<tbody>
<tr>
<td>▶ Yield</td>
<td>▶ Carbon sequestration</td>
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<tr>
<td>▶ Production seasonnality</td>
<td></td>
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<td></td>
<td>▶ Botanical patrimonial interest</td>
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<td></td>
<td>▶ Colour diversity</td>
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<td>▶ Pollinisation impact</td>
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Basis for a multifunctional diagnosis tool to characterise services at farm scale

Designed for farmers and extension services

System description

Farm plots
- Diversity of vegetation types, practices, grazing intensity

Herd
- Animal requirements, milk yield, calving dates, concentrate

Analysis
(4 aggregated criteria)

- Forage system ‘consistency’
- Ecosystem services
- Quality of dairy product (cheese)
- Forage autonomy (PDO rules)
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
3 reasons 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.)