



Università degli Studi di
Udine
Dipartimento di Biologia e Protezione
delle Piante

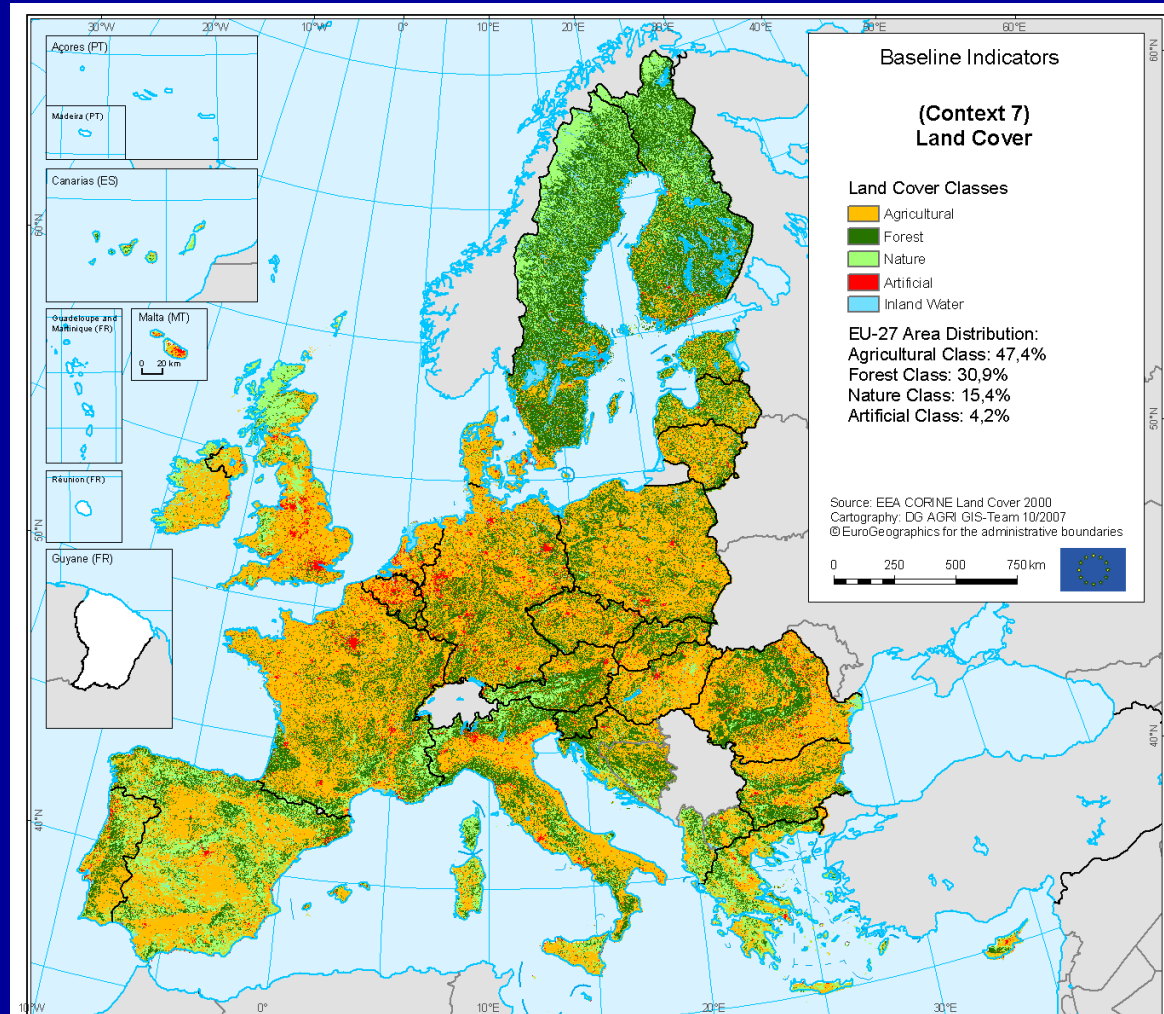
Giuseppe Parente

The multifunctional role of grasslands in Europe. Challenges and perspectives for the future

Brno, 5 may 2011



Land cover in EU



EC 2008. Rural development in the EU



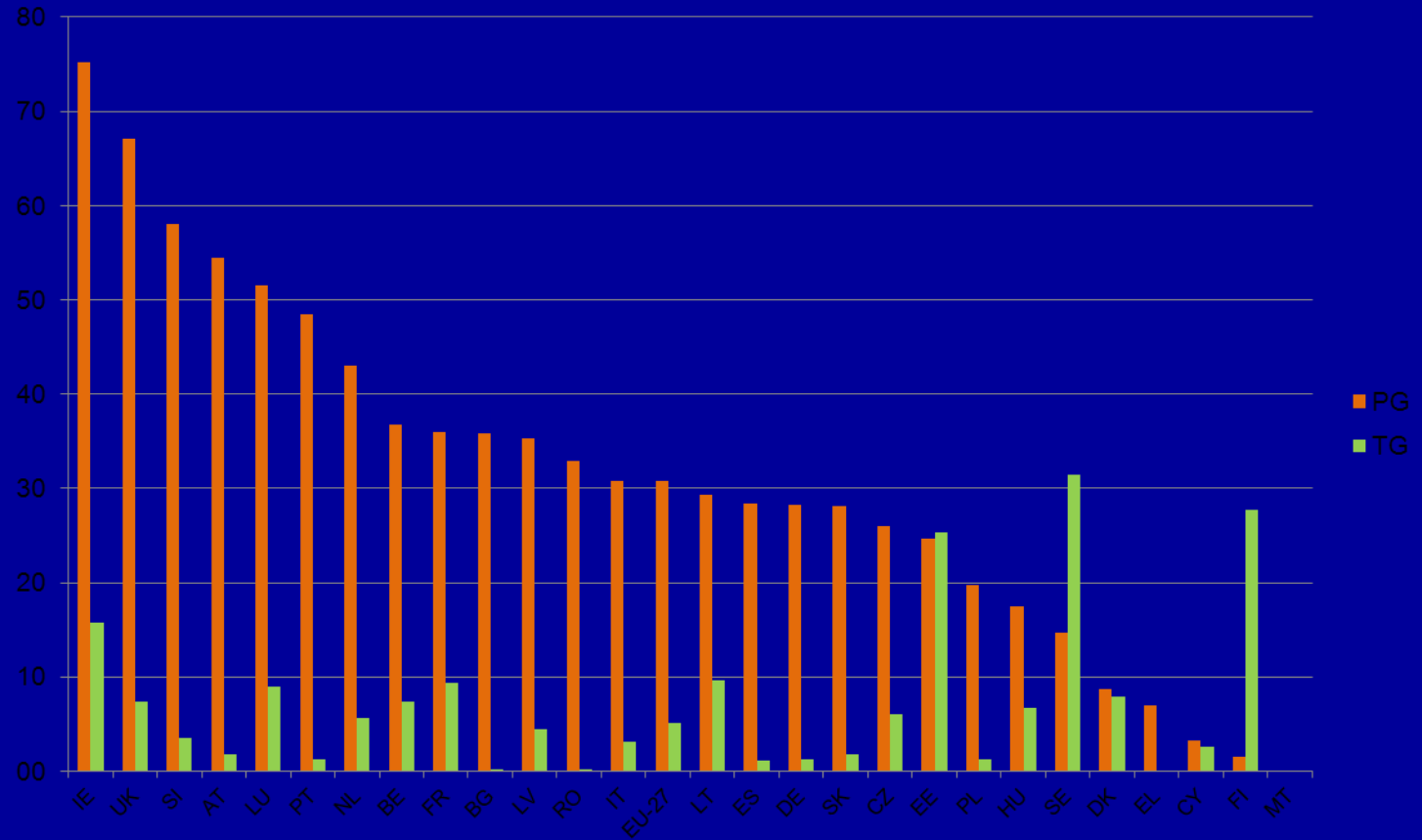
Forage categories

EUROSTAT definitions of forage categories (Eurostat, 2001)

Forage plants	Green fodder from arable land	Annual green fodder	Fodder maize	
			Other annual green fodder	Fodder beets
		Perennial green fodder	Temporary grasses and grazings	Other root crops
			Clover and mixtures	Temporary grasses
			Lucerne	Temporary grazings
			Other legumes	
	Green fodder from permanent grassland	Permanent pastures	Herbages	
		Permanent meadows	Rough grazings (natural grasslands)	

Distribution of grasslands in EU

Permanent and temporary grasslands in EU (% UAA)



Source: Agricultural Statistics. Main results 2007-2008 (Eurostat pocketbook)

Other forage crops

- Forage maize : 3%UAA in EU 27 / Germany (1.7 millions ha); France (1.5 millions ha); Italy (280000 ha)
- Clovers (mixtures): variable importance / lack of good data – confusion with temporary grass mixtures
- Lucerne: Italy (700000 ha/ 5%UAA); Romania (323000 ha/ 2,4%UAA); Spain and France (240000ha/1%UAA)
- Sainfoin, sweet clover: Romania (146000 ha); Greece (133000ha); Latvia (100000ha); Spain (73500ha)
- Fodder beet: marginal area in every country
- Whole crop cereal silage: Northern Europe

Comeback of the legumes: home grown legume based protein source!

Grassland DM productivity

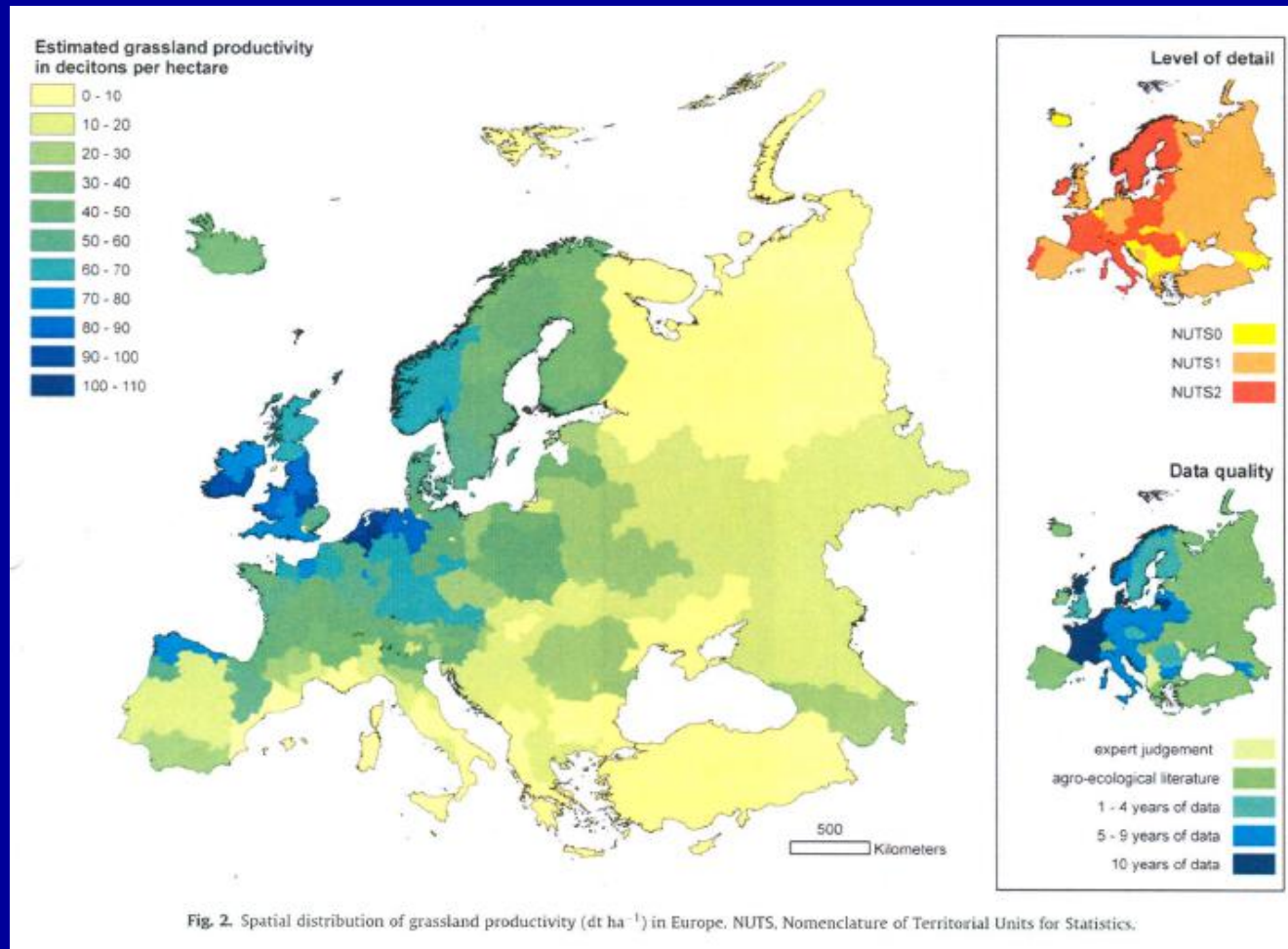
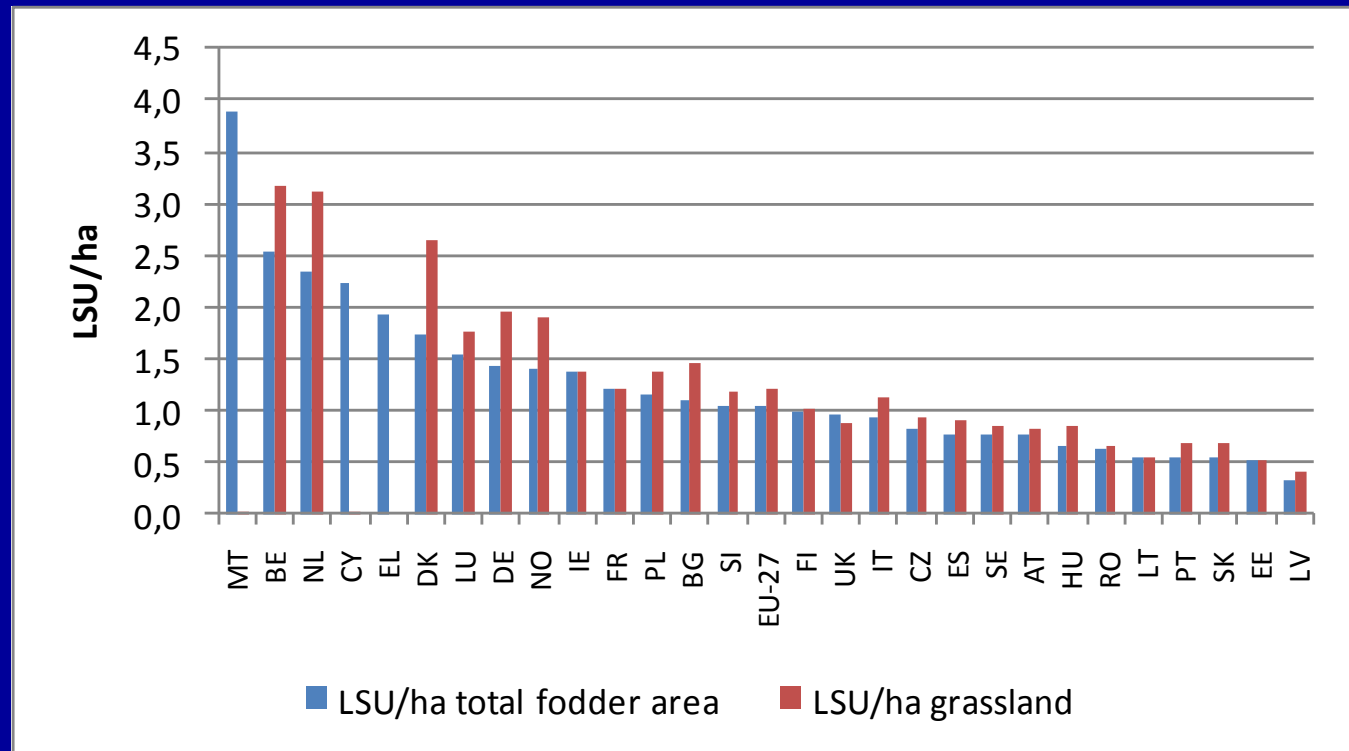


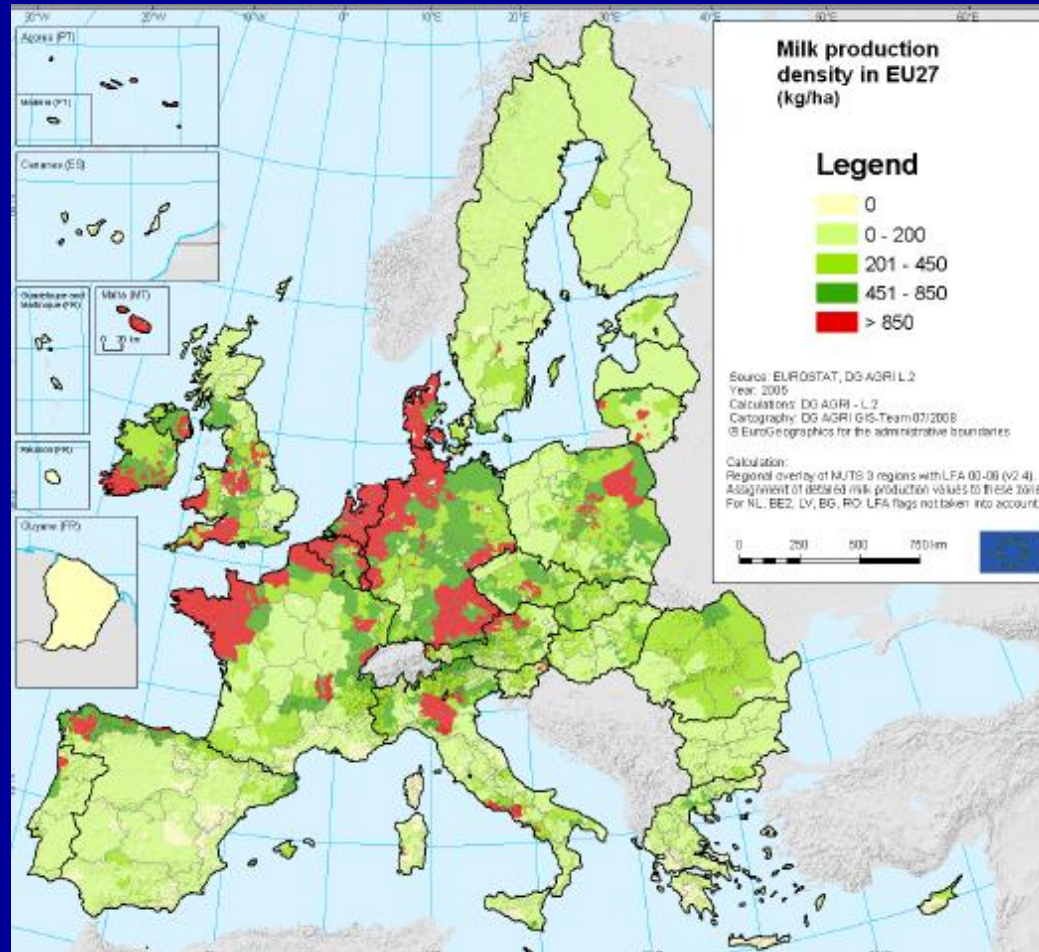
Fig. 2. Spatial distribution of grassland productivity (dt ha⁻¹) in Europe. NUTS, Nomenclature of Territorial Units for Statistics.

Smith *et al.*, 2008)

Animal production: cattle density



Milk production density in EU-27



EC 2008

Favourable area for dairy production

Very favourable:

5% EU-territory - 20% EU dairy production

Neutral:

71% EU-territory - 70% EU dairy production

Area with potential in specific conditions – need of encouragement by rural development policy

If not: socio-economic problems for the region when milk price is low

Less favourable:

24% EU-territory - 10% EU dairy production

Production at risk but no other agricultural activity possible!

→ prevention of abandonment / conservation natural areas

Source: Rural development in the EU Report 2008

Beef farming systems in EU-27

Sarzaud *et al.* (2008): 3 large areas:

Mediterranean, mountainous and Scandinavian areas:
pastoral systems are dominant / local breeds

Grassland areas:

- enterprises (France) and cow-calf and steer fattening on grazing permanent pastures (Ireland and UK)
- not very intensive/ often combined with sheep flocks
- Irish and British beef farming systems: real grassland based beef production with rearing and finishing of steers and heifers 'on the farm'

The Forage Crop and Grasslands and Crops and Livestock areas:

- Galicia and western part of France and Belgium, Po valley
- combination of mainly beef fattening with dairy and arable cropping

Agro fuel production

Grassland biomass transformation to energy

1. Methane production by anaerobic fermentation (+ slurry)
 - Methane production/kg OM, OM yield/ha
 - Growing stage more important than species
 - Maize > grass → grass only in marginal conditions
2. Combustion
 - C4 (e.g. Miscanthus) better than C3
 - Acidification: SO₂, NO_x, HCl emissions !
3. Gasification
 - >700°C, pyrolysis
 - Syngas production
 - Transformation or combustion
 - Research effort needed

Green biorefinery

Fractionation of grass:

- Liquid:
 - lactic acids (bio degradable plastic, solvents)
 - amino acids (cosmetics, food fermentation)
 - protein pellets ...
- Solid (press cake):
 - grass fibres → a wide range of applications: construction, insulation plates, energy, paper, ...

Promising, but still a long way to go!

Overview research activities: O'Keefe et al. (2009)

Grassland related to ecology and landscape

Type of grass	Practices	Biodiversity	Landscape effect	Water quality	Erosion prevention	Carbon storage	Product quality
Annual fodder	1	*	*	*	*	*	*
	2	*	*	**	*/**	*	*
Temporary meadows	3	*	**	*/**	**	**	**
	4	*/**	**	***	***	**	***
Permanent meadows	3	**	***	**	**	***	**
	4	***	***	***	***	***	***
Grasslands with ecologic sensibility	5	*/***	****	***	***	****	****

1 maize with no crops alternating ; 2 maize with crops alternating ; 3 intensive management ; 4 reasoned fertilisation ; 5 wet or dry meadows ; * little impact ; **** high impact

Institut de l'élevage, 2007"

Grassland related to ecology and landscape

Permanent grassland and extensively managed, low input grasslands perform better in fulfilling the ecological requirements!

Threats:

- Intensification of grassland use
- Conversion to arable land
- Abandonment

EU policy: efforts to maintain the permanent grassland area and to stimulate the ecological management of the semi-natural grasslands

Grassland related to greenhouse gas (GHG) balance

Share of agriculture in total EU GHG-production:

- 2% of CO₂
- 50% of N₂O
- 45% of CH₄

Main N₂O and CH₄ production pathways in agriculture:

- Fermentation in ruminant animals: 72% of CH₄- production
- Manure decomposition: 27% of CH₄ and 12% of N₂O- production
- Soil denitrification: 88% of N₂O- production

➔ GHG production closely related to cattle husbandry and grassland use

Grassland related to greenhouse gas (GHG) balance

Balance: GHG production and carbon sequestration

Grassland can act as an important carbon sink and counterbalance GHG production:

CH₄ and N₂O emissions are compensated by 70-80% of the EU grassland carbon sink (Ciais et al., 2010)

Janssens *et al.*, 2005 published country specific carbon balances (grassland – forest – arable land – peatland)

Grassland related to green house gas (GHG) balance

SOC content (0-30 cm):

arable land < temp. grassland < perm. grassland < forest

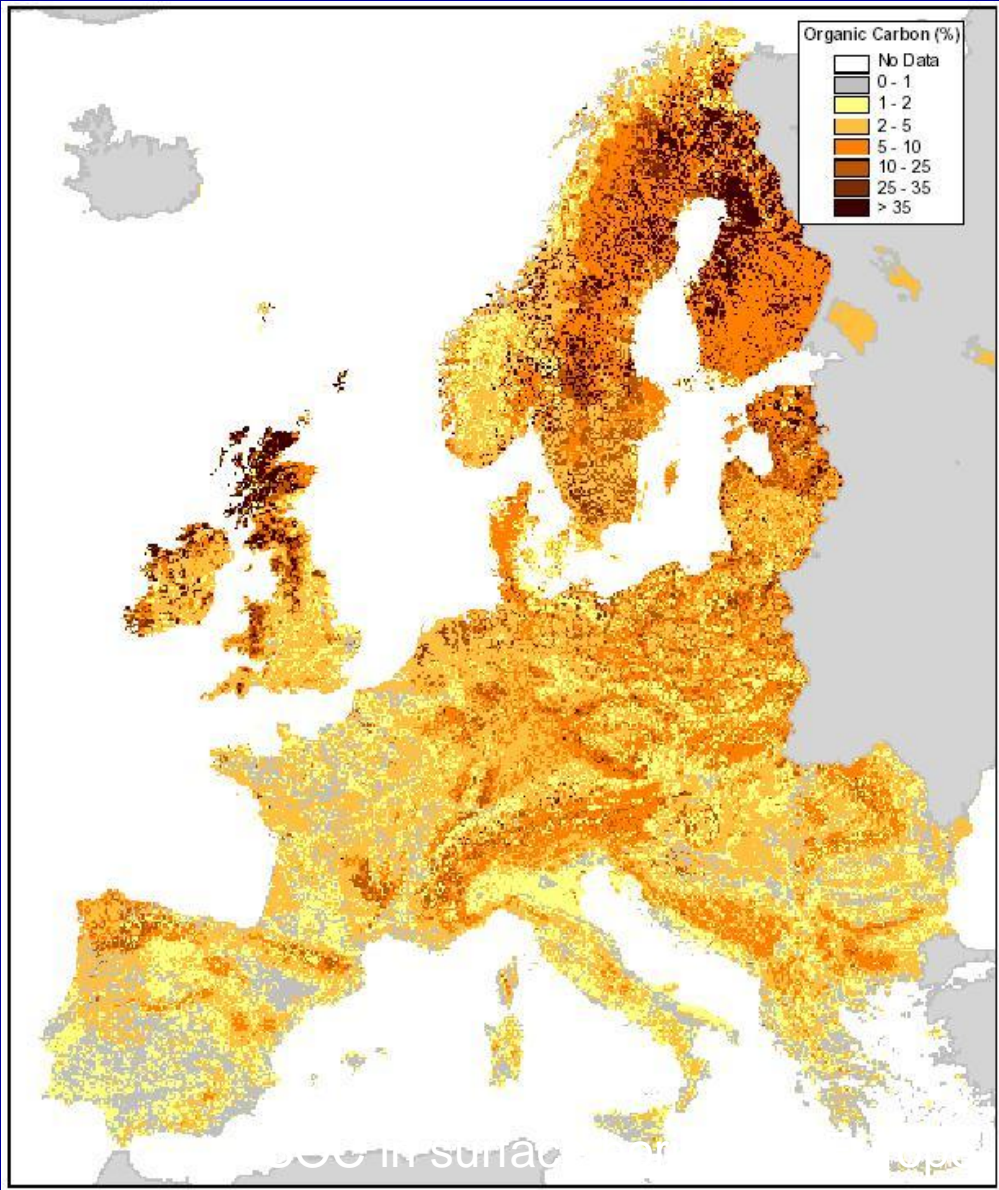
Permanent grassland: + 0.52 ton/ha/y

Arable land: - 0.84 ton/ha/y

Conversion to arable land: SOC losses happen faster than built up when establishing grassland!

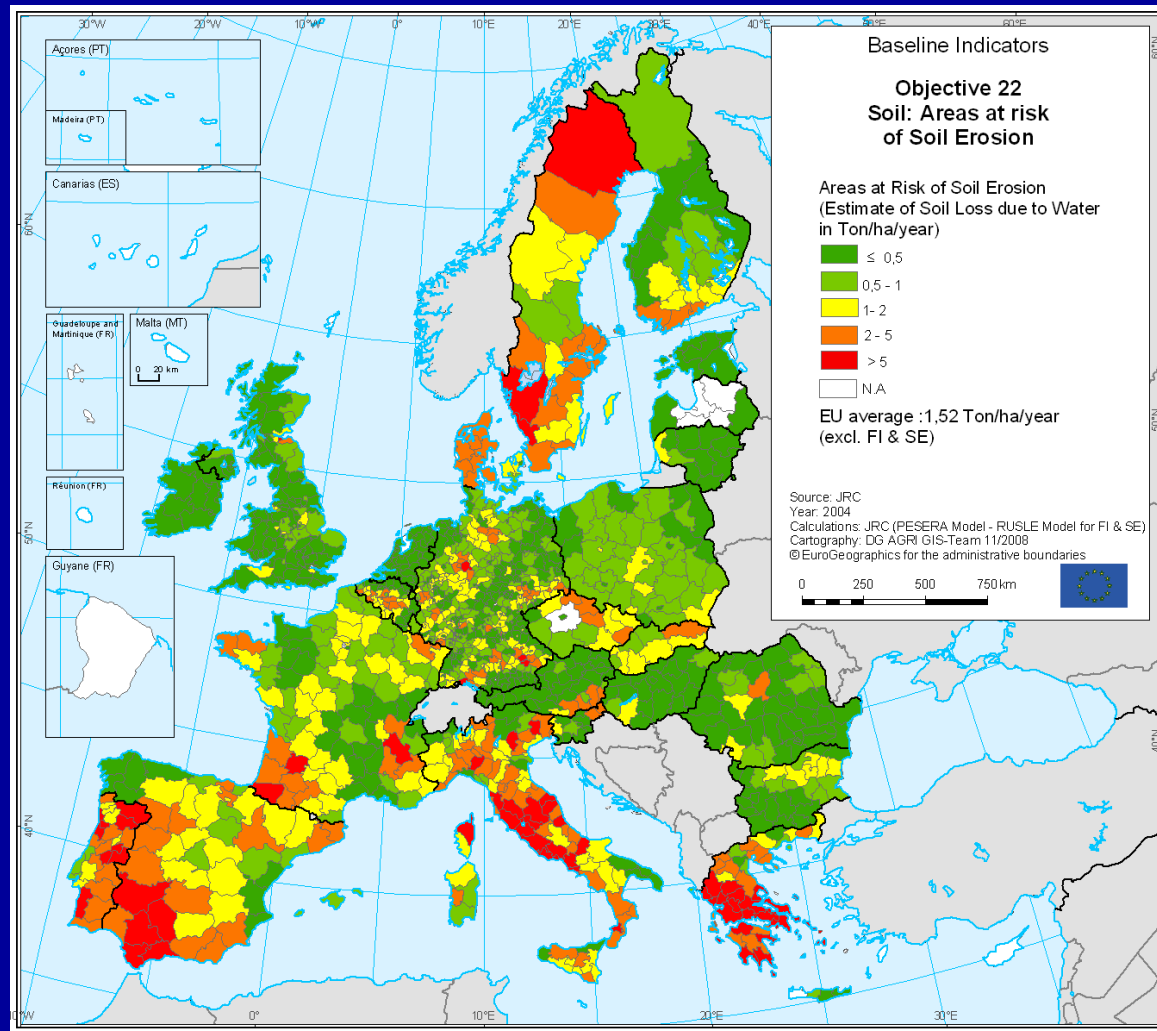
- No conversion of permanent grassland
- Frequency or resowing as low as possible

Source: http://eusoils.jrc.ec.europa.eu/esdb_archive/octop/octop_download.html



- High SOC:
- Forest
 - Perm. Gr
 - Semi-nat. Gr.
 - Peatlands

Soil erosion



Source: Rural development in the EU (Report 2008)

Soil erosion: water and wind

A problem in many countries and regions in EU!

- Grassland
 - Permanent cover
 - Dense rooting system
- Conversion to grassland is a solution
 - total/buffer strips depends on the slope

Mitigation of pollution

- Low use of pesticides on grassland
- Less transfer to surface waters
- Quick decomposition by the intensive biological activity of the soil micro-organisms
- P and nitrate N: be careful with fertilisation
- Grassland is a biological filter and a barrier for migration of various chemicals towards surface and ground water!

Grassland & biodiversity

Semi-natural grasslands with an unique and high species diversity are crucial for maintaining biodiversity!

These grasslands are the most vulnerable ecosystems (abandonment, intensification) and are protected in many ways by EU-directives and national agro-environmental schemes

Intensified grasslands are considered positive for biodiversity compared to (annual) forage and arable crops

Biodiversity: plant and animal species! Above and in the soil

Grassland & biodiversity

Vegetation:

Species rich grassland:

- >150 species/100 m² Alps
- >80 species/ 100 m² Estonia
- >60 species/ 100 m² CZ/Slowakia

Management is extremely important:

(N) fertilisation; resowing, use of species poor mixtures, cutting frequency and timing, ...

Restoration: extensification of management

Grassland & biodiversity

Vegetation:

Abandonment :

- rural/parcels of little agricultural value
- encroachment of shrubs and woody species
- competition and disappearance of typical grassland species
- landscape change

About 50% of the total EU grassland area is 'natural grassland' (Soussana *et al.*, 2004)

Grassland & biodiversity

Fauna:

Farmland birds: (526 species in EU)

- different habitat requirements
- 30% of the birds species associated with grassland
- negative relationship between agric. intensity and bird occurrence
- Birds Directive (1979) was the start of nature legislation

Grassland & biodiversity

Fauna:

Butterflies

- specialist species rely on one or a few host plant species and are related to certain plant communities
- relationship between extensive managed grassland and butterfly diversity is not so clear: not always a higher diversity in extensive managed grassland
- Small mammals, snails, insects,...

Grassland & biodiversity

Soil ecosystem (soil food web):

(Permanent) grassland compared to arable land

- more organic matter
- much more diverse earthworms
- much more diverse nematodes
- more fungi, less bacterial communities
- 50% more microbial biomass

-Management: fertilisation, soil cultivation!

Grassland & landscape

Grassland provide an attractive landscape: open or surrounded by hedgerows or wooded edges

Grasslands are perceived as a rather 'natural' element of the landscape

Semi-natural grasslands show more colour and structure, score higher for 'naturalness'

Landscape management and planning becomes more and more important in rural development (e.g. recreation, tourism)

THE CASE OF THE
ALPS AND OTHER
EUROPEAN
MOUNTAINS

AGRICULTURE OF ITALIAN ALPS

UAA	1.369.865 ha (30% totale alpino)
- UAA > 10 ha	15 % (Switzerland 70%)
Number of farms	247.1110 (ca. 500.000 in alps)
Employees	5,4 %
- full time	27%
- age	78,8% > 45y
Grasslands	85,6 %
Arable crops	6,3 %
Permanent crops	6,4 %

data 1998



Alpine grasslands

Natural grasslands

Secondary grasslands

Artificial grasslands

1 mil ha



Uplands

- Herbaceous species mixed with shrubs till to only herbaceous species
- More complex vegetation because of: snow cover, short summer, rigorous temp, wind
- Gramineae, cyperaceae, juncaceae
- Shallow soils
- Siliceous rocks- calcareous rocks



Natural calciferous grasslands

- Firmetum
- Elinetum
- Seslerietum - semperviretum

Natural acidophilus grasslands

- Curvuletum
- Festucetum
- Seslerietum
- Nardetum

Firmetum

Caricetum firma

Poor grasslands on calcareous substr.

Diffused on cold and windy sub-nival slopes

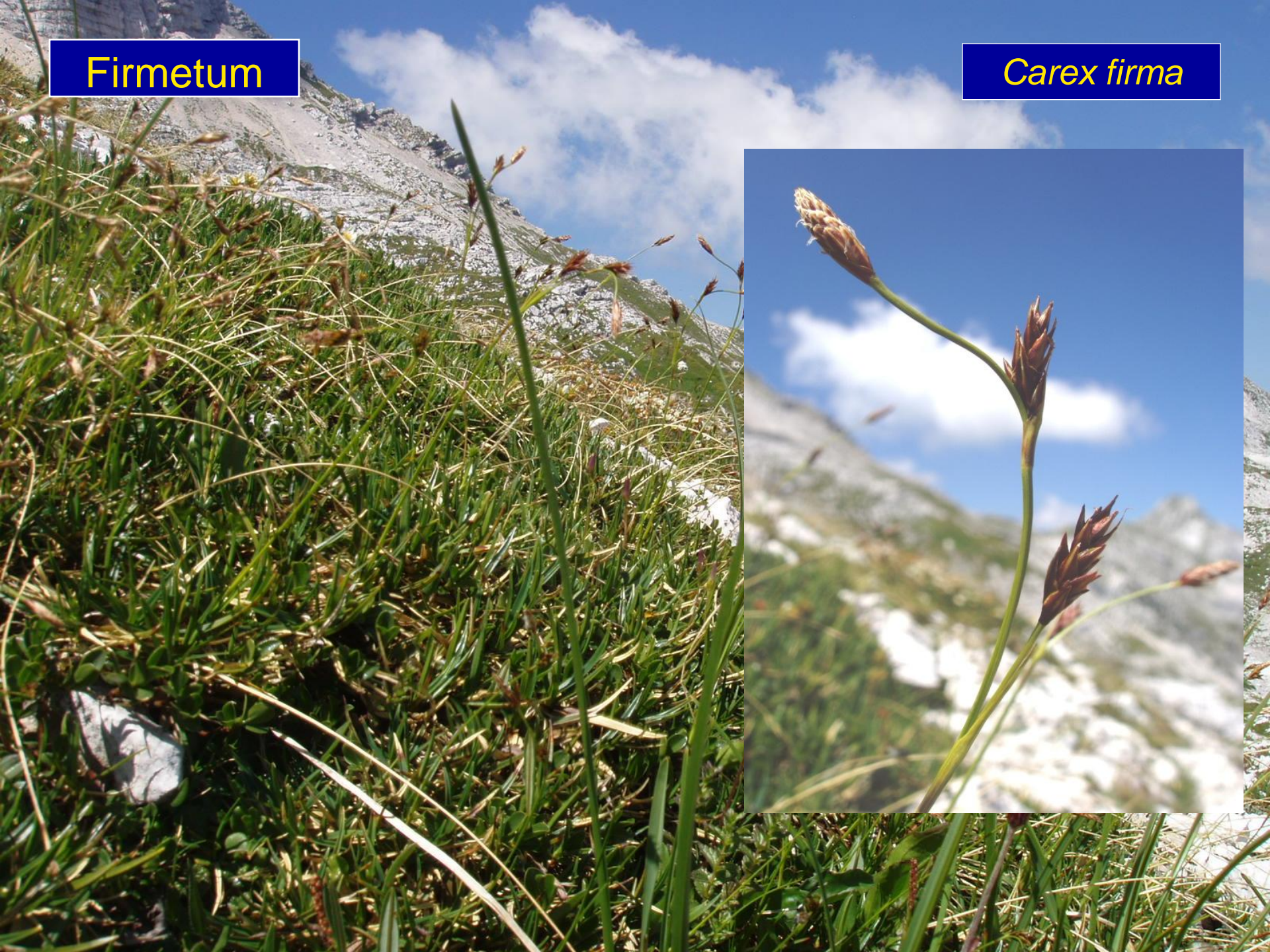
On calcareous and gravel; shallow soils with high level of calcium carbonate and low humus content

Low growth, on eroded turfs



Firmetum

Carex firma

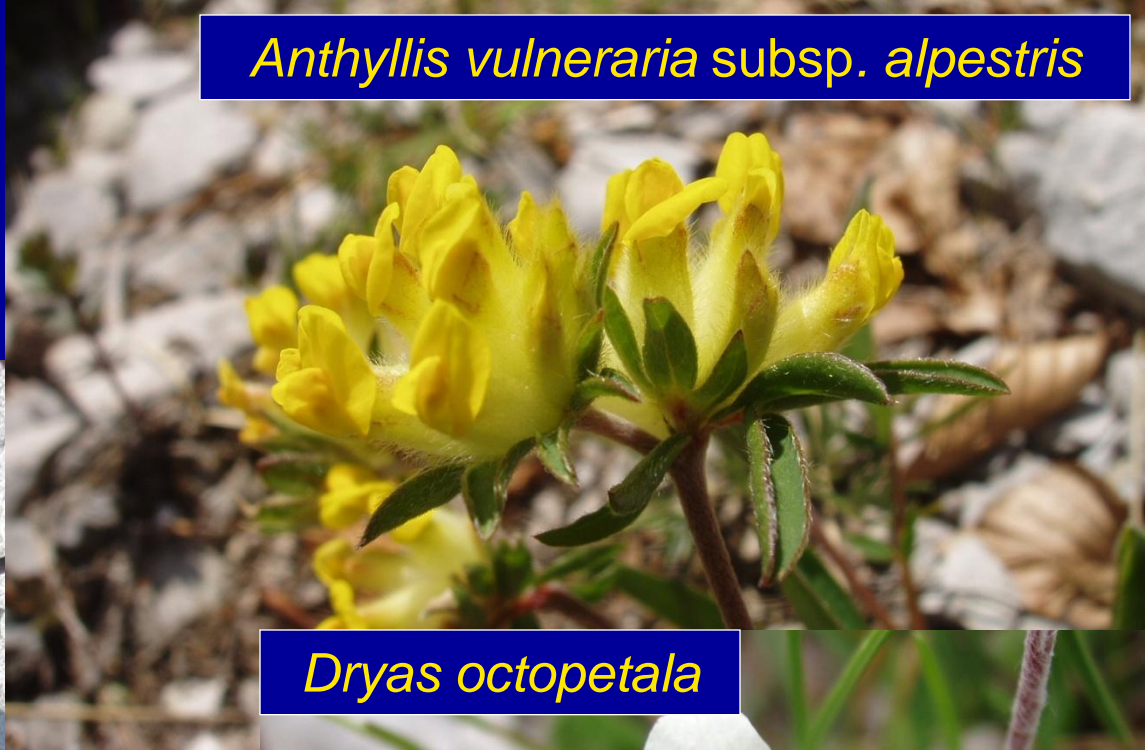


Firmetum



Gentiana clusii

Anthyllis vulneraria subsp. *alpestris*



Dryas octopetala



Elinietum

Poor grassland
Calcareous substr.

Diffused on cold and
windy sub-nival
slopes

Adaptable to pH from
weakly basic to quite
acid

Low growth, on humus but
with carbonats.
Evolution from pioneer
communities



Elyna myosuroides



Elinietum

Leontopodium alpinum



Senecio abrotaniifolius



Seslerio-Semperviretum

Poor grasslands on calcareous soils

The most diffused on Alps, calcareous substr. or dolomia. Its the classic grazed grassland.

On warm slopes with a southern exposure, it expands at low altitudes fading into pine-forest.

Species consolidating slopes subject to landslides, tick roots and large tufts of average quality.



Sesleria caerulea



Seslerio-
Semperviretum

Nigritella rubra

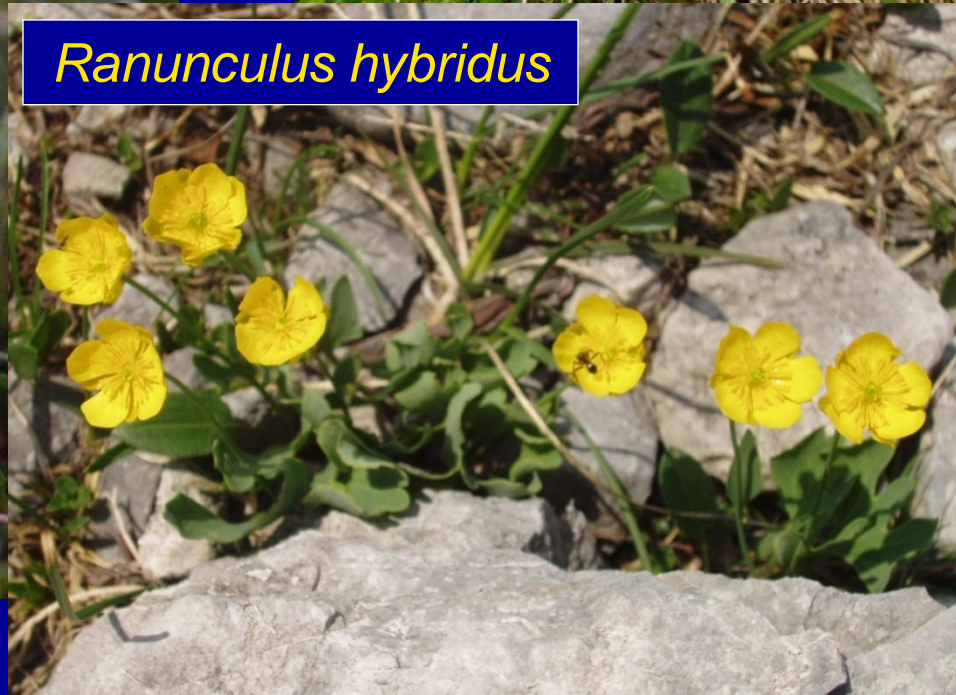


Carex sempervirens



Fonte: www.commons.wikimedia.org

Ranunculus hybridus



Seslerio-
Semperviretum

Achillea clavенаe



Gentiana verna



Caricetum

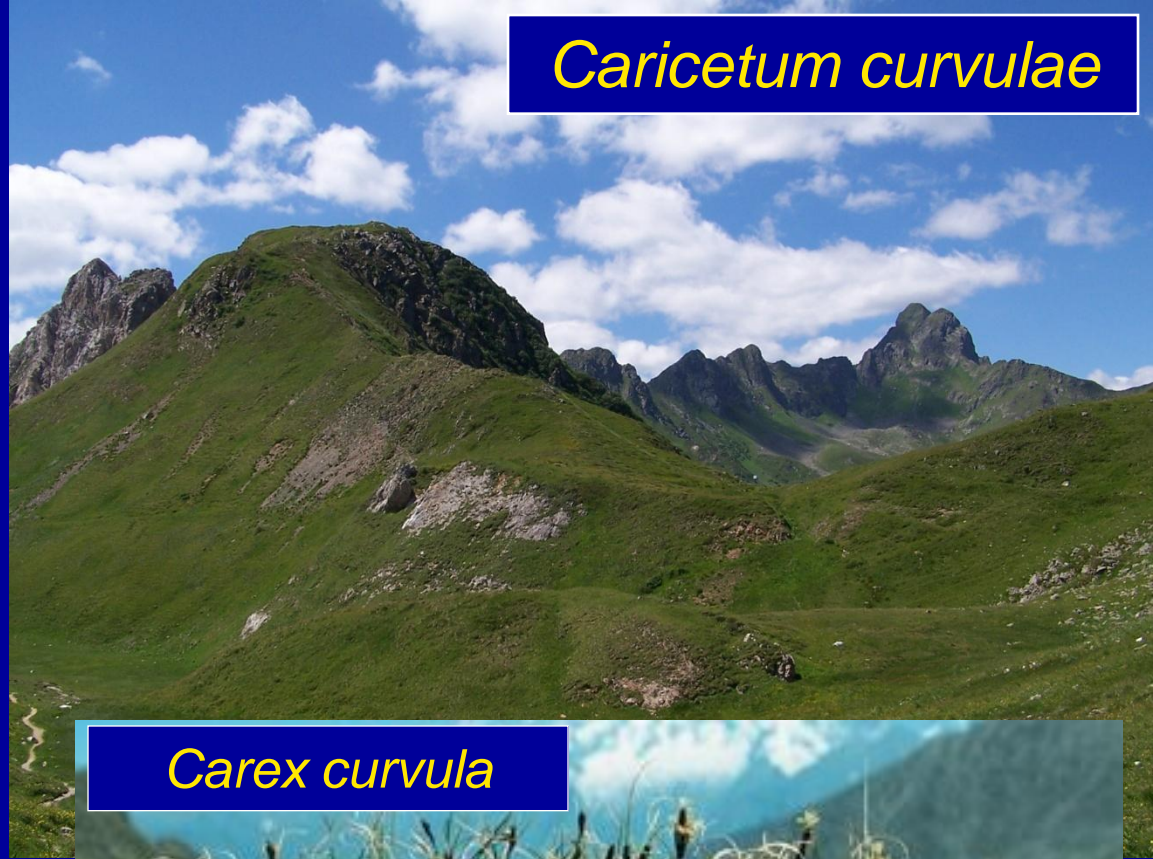
Primary grassland
on acid substr.

Siliceous and acidified soils
of the alpine and subnival
horizon

On gentle slopes and on
soils rich in humus

The most diffused primary
grassland on Italian Alps

Caricetum curvulae



Carex curvula



Caricetum

Primula glutinosa



Soldanella alpina



Fonte: farm4.static.flickr.com

Festuceto

Grasslands on acid
substratum

Diffused on sunny slopes
of internal Alps with
continental climate

Grasslands rich with
species, of high pasture
value



Festucetum varie

Festuca varia



Festucetum

Gentiana kochiana

Potentilla aurea



Nardetum

Grassland on acid
substratum

Diffused from mountain to
subalpine horizon

Siliceous substratum or
poor for calcium washing

Poor quality, low palatibility
and poor in species but
possible to be improved
with appropriate
management

Nardetum strictae



Nardus stricta



Nardetum

Campanula barbata

Arnica montana



Poetum

Fat pastures on acid substratum

Diffused from montaneous to sub-mont. level

Luxuriant and abounding with species grasslands; pastures of high value



Poa alpina



Crepis aurea



—————→ Grasslands on dry soils (Festuco-Brométea)
Rich in rare species derive from beech forests growing in mild areas of Central and Southern Europe.

—————→ Grasslands on humid soils (Nardo-Callunétea)
Derive from more or less humid and acid soils, originally covered by oaks, birches and firs

—————→ Cultivated grasslands (Molinio-Arrhenathéretalia)

- *Arrhenatherum elatius*
from oaks and beech trees

- *Arrhenatherum elatius*
and *Phleum pratense*
from *Molinia coerulea*

- *Trisetum flavescens*
from mixed forests
with beech trees



Arrhenatheretum

Fat grasslands
indifferent to substr.

Diffused from plain to
mountains

Typical nitrophilus mown
grasslands



Carum carvi



Arrhenatherum elatius



Brometum

Poor grasslands

Diffused from plain to mountains

Typical poor grasslands on neutro-basifilous substr.

High species biodiversity



Dactylorhiza sambucina



Bromus erectus



Artificial grasslands

Phleum alpinum



Anthoxanthum odoratum



Trifolium pratense



Trifolium repens



SITUATION AND TREND

Progressive depopulation

Reduction in farms number

Progressive reduction in bred animals

Pasture decline

Reduction in small permanent stock-farms

Strong increase in average herd size

Pastures abandonment

Strong landscape decay

E.g. in FVG inizi '900 → 426 malghe → 87 units

THE MALGA



ANIMAL SYSTEMS

Dairy cows	46,7 %
- cow milk	17,5 % (tot. of Italy)
Cows/farm	15 vs 58 (plain)
Production	4,5 t/cow vs 7,0 (plain)
Average cost	14, 2 € vs 13,0 (plain)
Total explicit costs	+ 27,0 %

Higher value for typical cheeses, PDO, PGI, etc.

Higher contributes and prizes

ISMEA data 2004

VARIATION IN NUMBER OF DAIRY FARMS (1990-2000)

Number	Total	1-5	6-20	21-50	51-100	101-500
Farms Number (rounded off)	27.000	9.500	10.500	5.000	1500	500
trend	- 38 %	- 55 %	- 35 %	- 10 %	+ 8 %	+ 22%

DISTINCTIVE ELEMENTS OF STOCK-FARMS

Indoor farming (90 %)

Utilization of grasslands in the bottom of valleys during winter

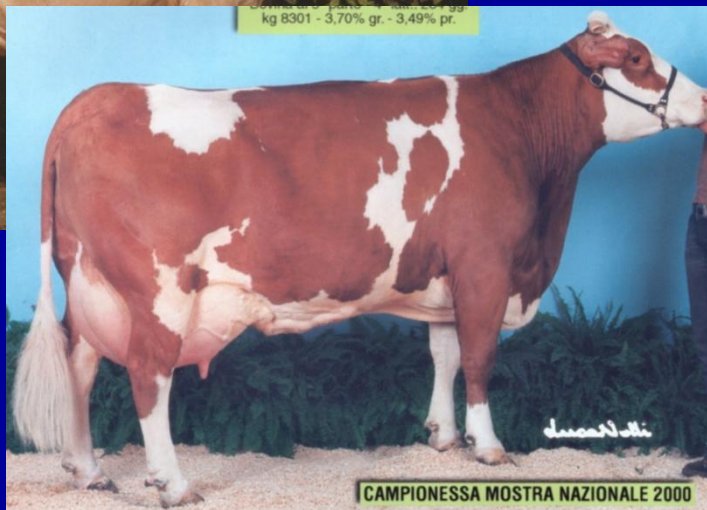
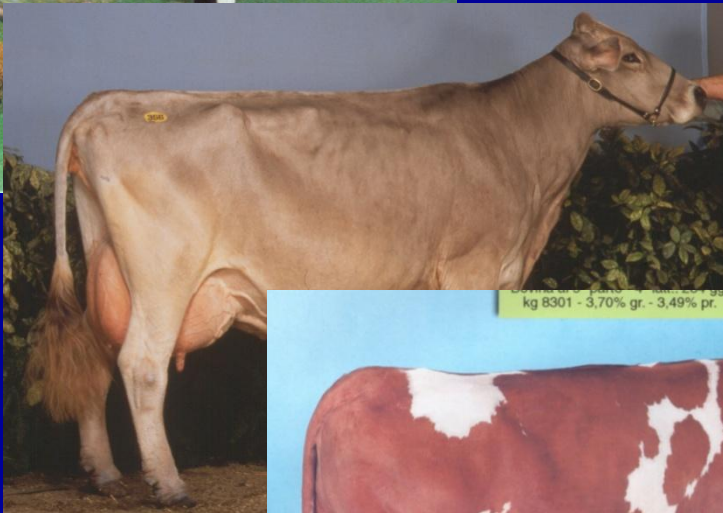
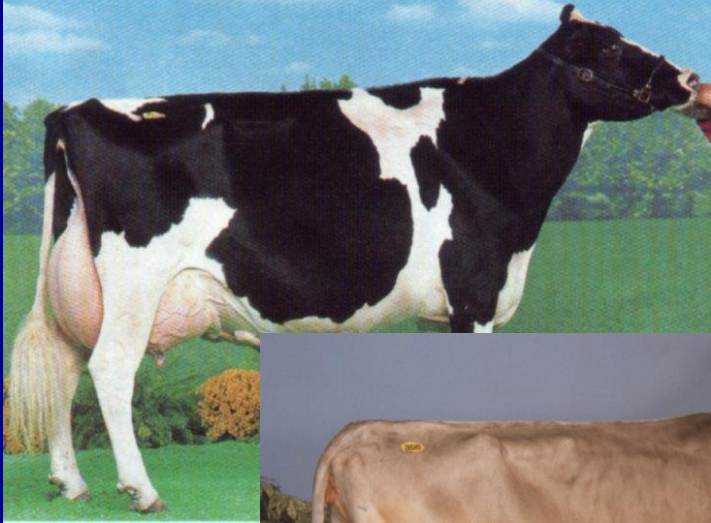
Summer alpine pasture

Seasonal labours

Presence of autochthonous breeds

Production of excellent dairy products

The case of milk



90% of
european
production



ANIMAL BIODIVERSITY IN ITALY

160 autochthonous breeds (cattle, sheep, horses, goats and pigs) several are under risk of extinction

29 cattle – 11 under risk (25 extinted)

20 horses – 14 under risk (6 extinted)

59 sheep – 31 under risk (31 extinted)

36 goats – 15 under risk (4 extinted)

6 pigs (33 extinted)

FAO data 2008



Grigia alpina



istriana



Norico



Bionda dell'Adamello



- **What should be done?**

- **Conservation *in situ***



- **Conservation *ex situ***

- **conservation *in vivo***



- **conservation *in vitro***



EUROPEAN FEDERATION OF ALPINE BOVINE RACES (FERBA)

Established in 1992 with the aim of exploiting the bovine autochthonous races and, in general, the safeguard of the alpine territory.

11 races from France, Switzerland, Austria, Germany, Italy:

Valdostana, Grigio alpina, Rendena,

Abbondance, Herens, Tarentaise, Vosgienne,

Pinzgauer, Tiroler Grauvieh, Vorderwälder,

Hinterwälder

ENVIRONMENTAL AND TURISTIC VALUE

- Reduce fire events in forests
- Indirect defence against erosion risks
- Indirect defence against overshadow risks
- Farmers clean ditches and canals, regulate surface waters, are guards of the territory
- Animals as elements characterizing the territory
- Sale of quality products from autochthonous breeds i.e. milk, cheeses and meat
- Breeds under risk of extinction
- Socio-cultural events (e.g.:shepherd fair)
- Museums of farmers history
- Overnight stay in refuges and agro-turistic facilities

ADDED VALUE



Product	Milk (industrial factory)	Milk (local factory)	Cheese	Typical cheese Environmental services Animal welfare
Production	500 t/y milk			
Dairy cows	60-80			

ENVIRONMENTAL SUSTAINABILITY



SOCIAL SUSTAINABILITY



HEALTH OPPORTUNITIES OF PRODUCTS

omega 3 e omega 6 fatty acids

CLA (Conjugated Linolenic Acid)

in cow milk 22,1 g/100 g fatty acids

(grazing animals) vs 3,9 g/100 g (indoor animals feed with concentrates)



Battaglini et al., 2003

PRODUCE, TRANSFORM AND CONSUME AT REGIONAL LEVEL



So.Zoo.Alps figures

Mountain agriculture may survive only if
human being will be able to valorize its
multifunctionality

where besides foodstuff production, will
garantue landscape and cultural heritage
conservation

On-going EU Projects

- **Multisward** <http://multisward.eu>

11 Partners from NL,B,F,Sw,N,IT,PL,UK

The objective is to support developments and innovations in grassland use and management in different farming systems

- **Salvere** <http://salvereproject.eu>

8 Partners from IT,AT,PL,CZ,SK,D

Want to promote HNVF with its biodiversity as valuable resource to support sustainable rural development



Thanks for
your
attention

We are
multifunctional