



ILHAM-EC

# Biodiversity and ecosystem services in grasslands

Sassari, 12-16 June 2017

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***SIMONETTA BAGELLA***





**Grasslands  
what –where**

**Ecosystems services**

**management**



**Biodiversity**

**Case study: Mediterranean grasslands**



## What?

Very different habitats/land uses under  
the term **GRASSLAND**

- Frequent disturbance regimes
- Physiognomic continuum between forest and desert

Wide spectrum of grassland definition



## What?

**ground covered by vegetation dominated by grasses, with little or no tree cover (FAO, 2010)**

**land covered with herbaceous plants with less than 10 percent tree and shrub cover (UNESCO)**

**large land areas covered with grass typically used for grazing (USDA)**

- large open land areas containing grass, plants and shrubs used for grazing (=rangelands USDA)



Recommended term	Environment and structure	African term(s)	Approx. equivalent South American term(s)
Wooded grassland	Single dry season > 4 months. Trees with crown cover < 40%, > 10%. One tree layer. Grasses narrow-leaved, tussock-forming and xeromorphic. Single dry season > 4 months. Fires regular, often annual. Tree-dominated vegetation; crown cover at least 40%. Usually only one main tree layer. Woody climbers and epiphytes absent or very scarce. Grasses narrow-leaved, tussock-forming, often xeromorphic.	Scattered tree grassland, wooded grassland	Campo cerrado, sabana arbolada*
Bushed grassland	Single dry season > 4 months. Bushes (multi-stemmed, short stature) < 40%, > 10%. One shrub layer. Grasses narrow-leaved, tussock-forming and xeromorphic.	Open bushland, bushed grassland, savanna bushland, bush savanna	Campo sujo, sabana arbustiva
Grassland	Single dry season > 4 months. Woody plants with canopy cover < 10%. Grasses usually tussock-forming and xeromorphic, at least in Africa. Fires regular. Natural grasslands often in sites with seasonal waterlogging, shallow soil or high metallic ion concentrations.	Grass savanna, savanna grassland	Campo limpo (no large woody plants), camp sujo, sabana abierta, sabana lisa

Dixon et al.,  
2014





**Tropical wet & dry**  
Only 2 seasons:  
A rainy and hot one  
A dry and warm one  
(the fire's season)

# Where?

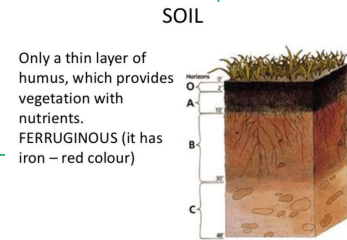
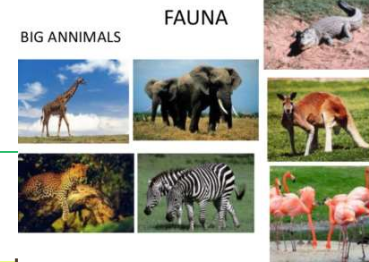
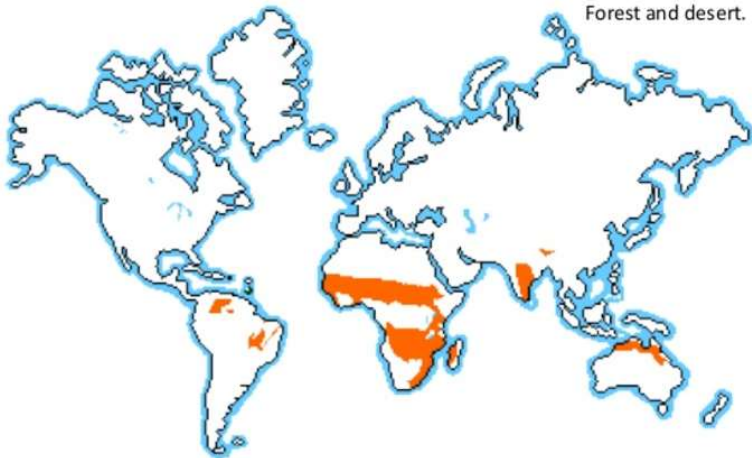
## natural grasslands

resulting from environmental constraints

### Tropical grasslands

between the Tropic of Cancer and the Tropic of Capricorn. cover much of Africa as well as large areas of Australia, South America, and India

North and south of the Equator, between trop. Forest and desert.





## Where?

# natural grasslands

resulting from environmental constrains

**Temperate grasslands**



Precipitation in the late spring and early summer. The annual average is about 508 to 889 mm



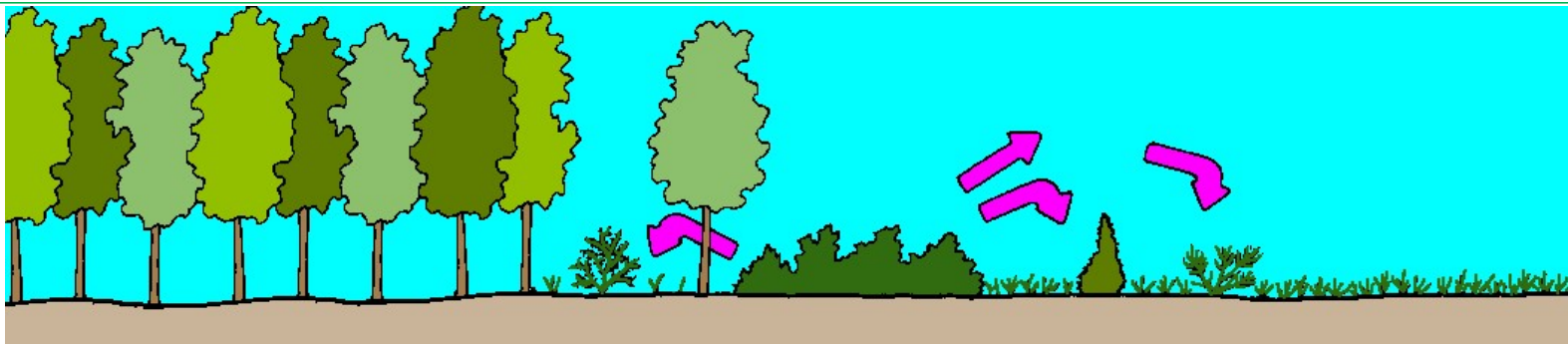


## Where?

# semi-natural grasslands

worldwide where woody vegetation was cleared

The evolution towards the original vegetation  
is prevented by repeated burning, cultivation  
or grazing



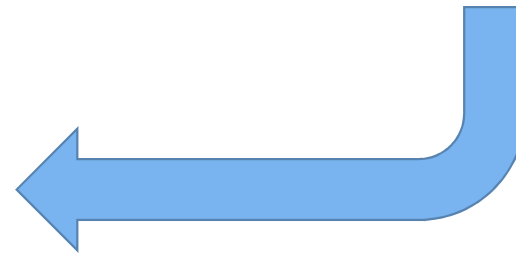




# Biodiversity



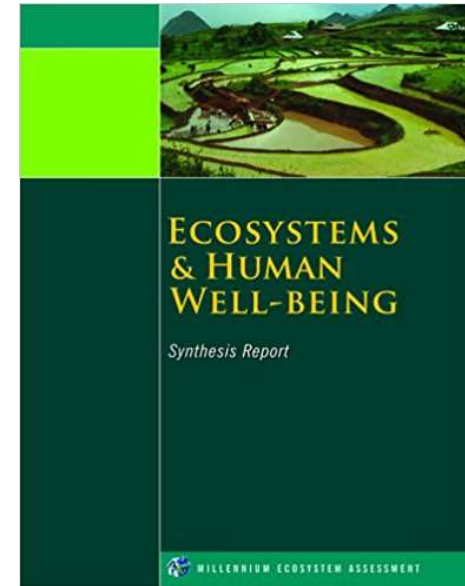
**"Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.**





# Ecosystems services

the benefits  
 people obtain  
 from ecosystems





**SUSTAINABLE DEVELOPMENT GOALS**  
17 GOALS TO TRANSFORM OUR WORLD







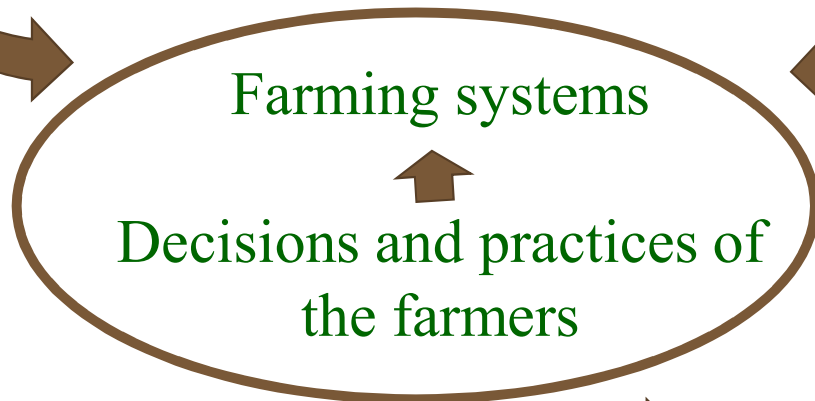
# Mediterranean grasslands





Environmental  
constraints

European agricultural and  
environmental policies



intensification

abandonment

shape the landscape and define the  
patterns of biodiversity and ESS

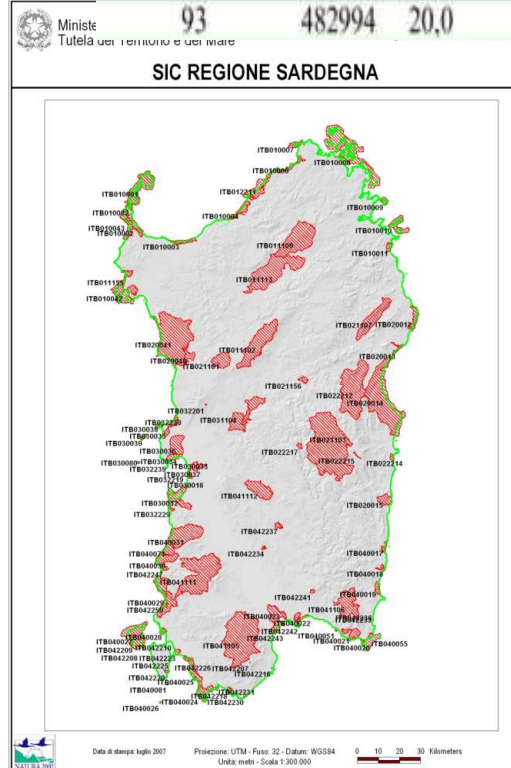




	Sardegna		
	2013	2014	2015
Bovini	316.311	259.299	259.942
Bufalini	2.507	358	976
Ovini	3.266.824	3.248.619	3.248.119
Caprini	200.711	208.975	208.200
Equini	18.342	15.856	19.735
Suini	146.484	150.654	150.272
<b>Totale</b>	<b>3.951.179</b>	<b>3.883.761</b>	<b>3.887.244</b>

Sheep farms 12669  
Cattle farms 7852  
ISTAT, 2015

SIC			ZSC		
N. siti	Sup. (ha)	%	N. siti	Sup. (ha)	%
93	482994	20,0	0	0	0



Drop of milk price (0.55€ L<sup>-1</sup>)  
Drop of meat consumption

## Mediterranean agro-silvo-pastoral system

- NE Sardinia, 200-300 m a.s.l.
- Granitic substratum
- Soil pH 5.1-6.4
- NPV *Quercus suber* forest



## Progetto PASCUUM

Co-funded by the  
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## Main production activities

grazing systems (Caballero et al 2008)

permanent grasslands

hay-crops

fallow grasslands

grape-growing

cork extraction





# Relationships biodiversity patterns - ESS - management practices

Supporting the design of sustainable management of  
Mediterranean grasslands

Indicators:

**Biodiversity:** plants

**Provisioning ES:** grassland quality (grazing value) and  
production

**Regulation ES:** soil C stock



## Key issues

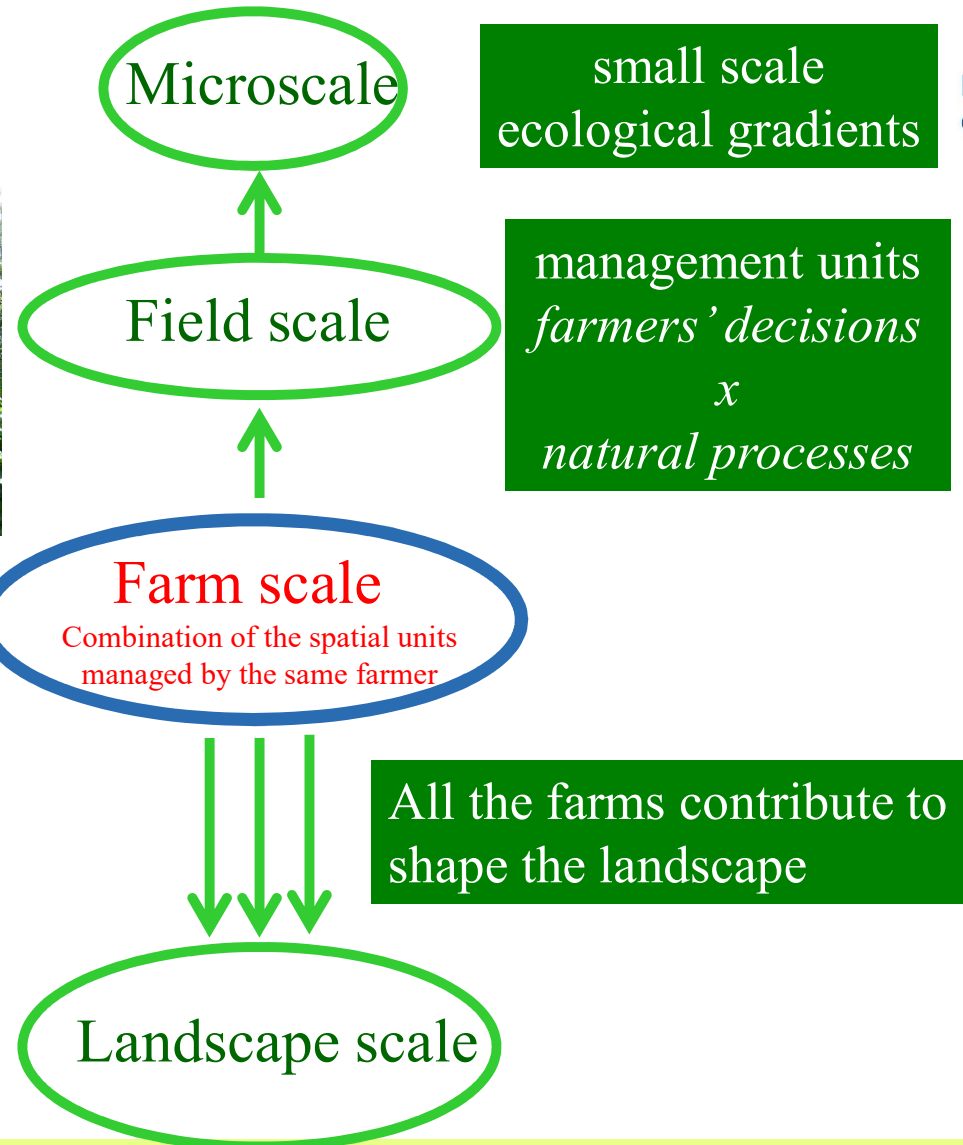
Understanding the processes in order to answer the question “what if.....”

Strong collaboration among researches with different expertises

Farmer involvement

Different scales of analysis





# Field scale

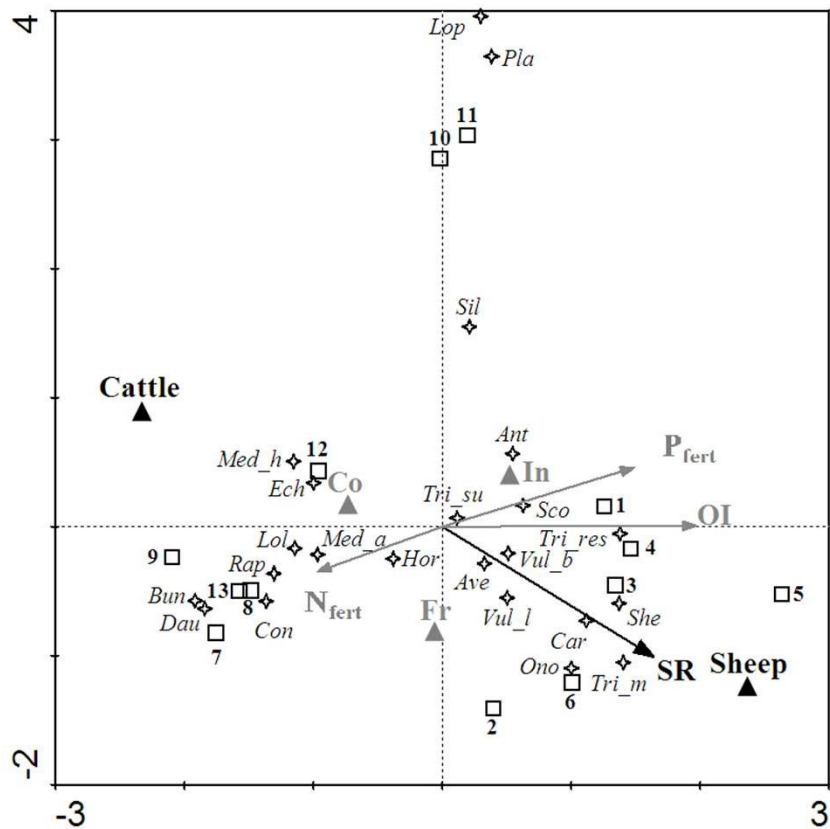


Plant Ecol (2013) 214:621–631  
DOI 10.1007/s11258-013-0194-x

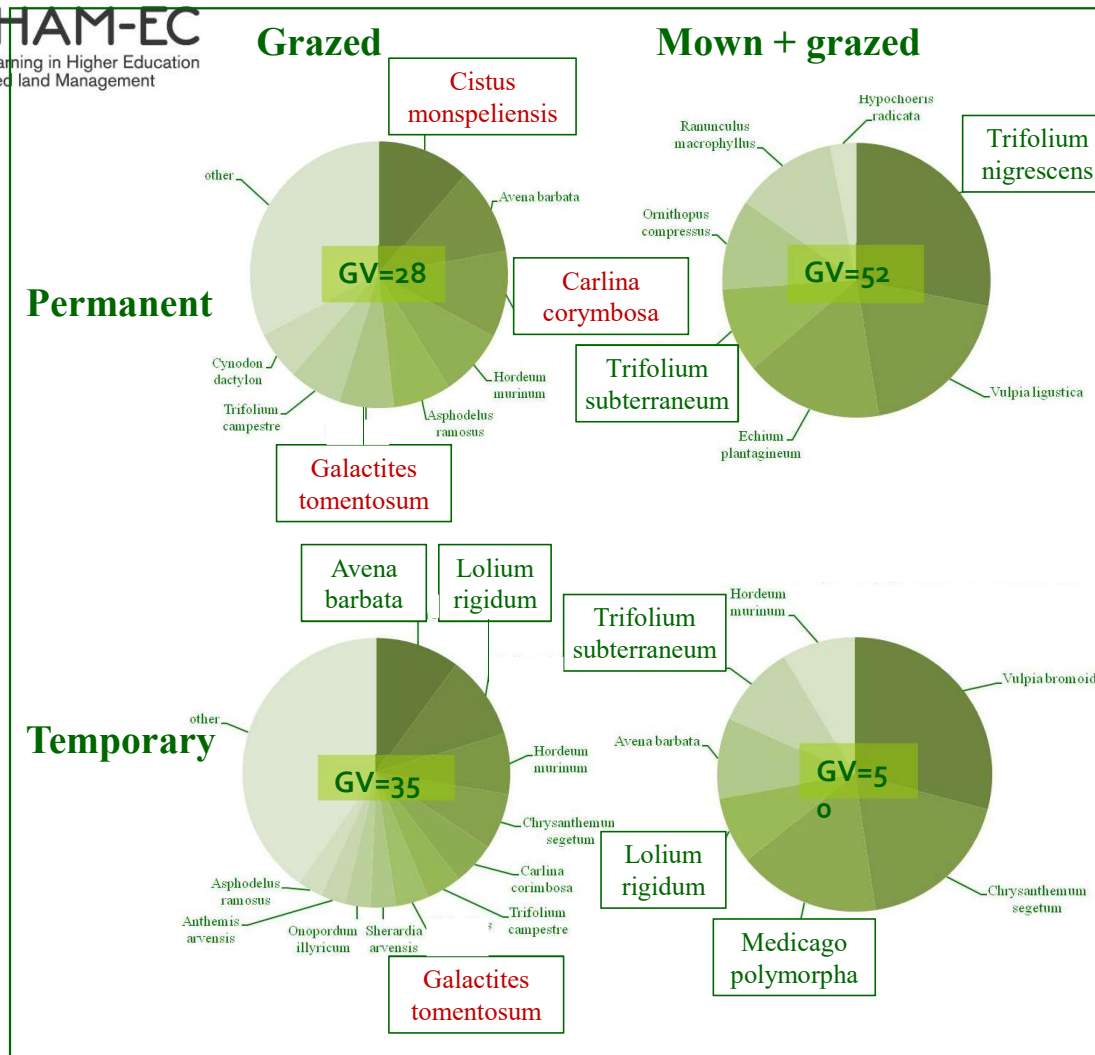
## Effects of long-term management practices on grassland plant assemblages in Mediterranean cork oak silvo-pastoral systems

Ilia · Lorenzo Salis · Gian Marco Marrosu ·  
Lefania Fanni · Maria Carmela Caria ·  
Gero

**stocking rate**  
**livestock species (51% of**  
**the total variance)**











- Focus on wooded grasslands
- Effects of isolated trees



Isolated cork oak trees affect soil properties and biodiversity in a Mediterranean wooded grassland

I. Rossetti<sup>a,\*</sup>, S. Bagella<sup>a,b</sup>, C. Cappai<sup>a</sup>, M.C. Caria<sup>b</sup>, R. Lai<sup>a,c</sup>, P.P. Roggero<sup>a,c</sup>, P. Martins da Silva<sup>d</sup>, J.P. Sousa<sup>d</sup>, P. Querner<sup>e</sup>, G. Seddaiu<sup>a,c</sup>



**Turkish Journal of Agriculture and Forestry**

<http://journals.tubitak.gov.tr/agriculture/>

Research Article

Turk J Agric For  
(2014) 38: 62-69  
© TÜBİTAK  
doi:10.3906/tar-1303-82

**Variation in soil C and microbial functions across tree canopy projection and open grassland microenvironments**

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**Plant biodiversity**  
**Grassland production**  
**Grassland quality**  
**Soil C stock**



**Under**

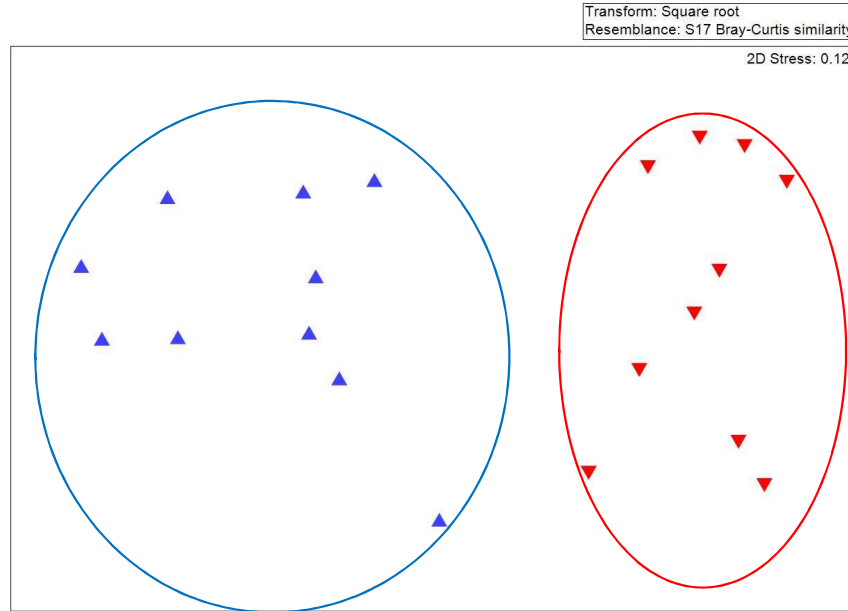


**Beyond**





Non-metric MDS



ANOSIM

Sample statistic (R): 0.902

Significance: 0.1%




**SIMPER**

*Lolium rigidum*  
*Geranium molle*  
*Stellaria media*  
*Lagurus ovatus*


*Trifolium subterraneum*\*  
*Anthemis arvensis*\*  
*Avena barbata*  
*Vulpia ligustica*



Biodiversity indices			Total
Avg $\alpha$	61.7 a	63.6 a	62.7
$\gamma$	135	146	177
$\beta$	2.2	2.3	2.8
similarity	45.6	46.1	38.9
<b>species replacement</b>	<b>42.1</b>	<b>42.2</b>	<b>50.0</b>
richness difference	12.2	11.6	10.9
<b>Unique/shared</b>	<b>31</b>	<b>42</b>	<b>104</b>



			P
<b>Production (kg ha<sup>-1</sup>)</b>	3461a	2665b	<0.001
<b>VP</b>	42.5a	32.4b	<0.001

			P
<b>SOC stock (Mg ha<sup>-1</sup>)</b>	83±9.5b	126±8.4a	0.001





## Landscape scale

# Patterns of biodiversity and ESS along a gradient of land use intensity connected to different production activities



Plants richness

40

58

56

48

23

SOC t ha<sup>-1</sup>  
 0-20 cm

35

51

47

25

28



## At the field scale

Animal grazing species are relevant in shaping plant biodiversity

More legumes in mown grasslands will result in increased N fixation





## At microscale

### **Isolated trees in wooded grasslands**

improve the fertility of the whole agro-ecosystem

contribute to enhance the total biodiversity and ecological complexity of the entire system



## At landscape scale

Traditional agro-silvo pastoral management practices are effective in maintaining good soil quality traits in comparison with other land uses



## Final remarks

The patterns of biodiversity are critically influenced by farmers' decisions at all the spatial scales

Targeted strategies must rely on the combination of scientific and farmers' knowledge, which can converge towards management practices compatible with biodiversity and ESS'