EIP-AGRI Focus Group
Profitability of permanent grassland

HOW TO MANAGE PERMANENT GRASSLAND IN A WAY THAT COMBINES PROFITABILITY, CARBON SEQUESTRATION AND BIODIVERSITY?

STARTING PAPER

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1. Scope of the paper

This paper aims at presenting the questions to be dealt with by the focus group on Profitability of Permanent Grassland. It also proposes a structure to collect information and introduces some preliminary ideas to feed the discussion.

The paper has three main sections. The first one explains the main objectives and tasks of the focus group. Secondly, the basic concepts and main figures of permanent grasslands in Europe are outlined. Finally, a framework for analysis to be used in the focus group is proposed and a preliminary reflection on farming systems and management practices is presented with regard to productivity, biodiversity and carbon sequestration as well as animal health & welfare and product quality.

2. Objectives of the focus group

Even if turnover to arable crops is restricted by CAP rules, in intensive production areas, arable production may be more profitable than grassland. In the other hand, many agricultural systems in marginal areas, grassland based, are threatened by abandonment processes. Both dynamics, besides its economic consequences, could reduce biodiversity and soil carbon storage. Thus, the focus group should address competitiveness of grassland based production systems in combination with biodiversity conservation and carbon storage.

The goal of the group is to explore practical innovative solutions to problems or opportunities in the field, and to draw on experience gained from related useful projects and to share experiences among actors involved in those projects (researchers, farmers, advisers etc.). The Focus Group is expected to:

- Identify and describe the main farming systems using permanent grassland.
- Identify practices to improve efficiency and productivity in milk/meat production systems both for extensive and intensive farming systems.
- Identify grassland management practices which enhance animal health, welfare and productivity. Identify improved grassland composition and management practices that allow for the development of premium and functional products.
- Identify key traits that relate grassland management with biodiversity and carbon footprint; as well as examples of strategies to combine maintenance of biodiversity and low carbon footprint with farming profitability.
- Identify fail factors that limit the use of the identified techniques/systems by farmers and summarize how to address these factors.

These tasks will be accomplished following this sequence:

a) Identifying good management strategies, practices and techniques to increase productivity for each vegetation and agro-climatic conditions and livestock culture in EU, for the most relevant management issues and farming systems.

b) Evaluate those strategies identified in view of animal health-product quality and biodiversity - carbon footprint.

c) Identify and propose strategies and methods to promote that the identified techniques/systems are used by farmers as well as list the gaps that may need further research, the development of innovation projects, etc.

In principle, the Focus Group will meet two times. The first meeting will be held on the 26th-27th of June in Frankfurt (Germany). The date and place for the second meeting will be decided later.

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During the first phase of the FG (including the first meeting) the work will be mostly focused on identifying good and innovative practices and techniques for addressing the main questions posed. Reference to concrete and relevant innovative and/or research projects will be very useful. Then, the gaps to be filled and methods to do so will be addressed, especially from the practice and field perspective (diagnosis of current implementation and recommendations for improvement). The Focus Group will generate as final output a report. The report will basically have a similar structure than explained in the lines above.

3. Definitions and main figures in Europe

The latest definition of permanent grassland/pastures was included in the Regulation Nº 1307/2013 published the 17th of December 2013, were permanent grasslands and permanent pastures are defined in Article 4 as the "*land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or more, it may include other species such as shrubs and/or trees which can be grazed provided that the grasses and other herbaceous forage remain predominant as well as, where Member States so decide, land which can be grazed and which forms part of established local practices where grasses and other herbaceous forage are traditionally not predominant in grazing areas;*

Within the frame of this Focus Group and regarding the type of vegetation and farm, "Permanent grasslands" will be referred to as "any land/vegetation that can be grazed" independently of the type of vegetation (more or less herbaceous), the type of animal (cow, sheep, goat, horse…) or the type of farming system (intensive/extensive; meat/milk…).

The definition of permanent grasslands includes herbaceous and also non-herbaceous permanent pastures which provide essential forage in many extensive livestock systems, especially in more marginal regions. Those systems provide multiple key ecosystems services in some of Europe's most bio-diverse habitats (e.g. heathlands, Montados or Dehesas, northern woodlands grazed reindeer, etc.), reducing fire risks, maintaining open landscapes and cultural heritage.

3.1. EU Agro-climatic zones

It is clear that the effect of climate on European grasslands will be region-specific. The EU JRC PESETA project defined eight agro-climatic zones (Table 1) based on the cluster analysis of temperature and precipitation data, district crop yield data and irrigation data.

Table 1. Countries/regions within agro-climatic areas.

Agro/climatic area	Countries/regions
Boreal	Sweden, Finland
Atlantic north	Ireland, United Kingdom
Atlantic central	Belgium, Denmark, Germany, Luxembourg, The Netherlands
Continental north	Check Republic, Estonia, Latvia, Lithuania, Poland, Slovakia
Continental south	Bulgaria, Croatia, Hungary, Romania, Slovenia
Alpine	Austria
Mediterranean north	France, Portugal
Mediterranean south	Cyprus, Greece, Italy, Malta, Spain

Source: JRC PESETA project (2009). Available at: http://ftp.jrc.es/EURdoc/JRC55391.pdf

A deeper analysis of the PESETA-Agriculture study (2009) added another region (Atlantic South) and redefined each one with more detail (Figure 1) and so, for example, the Atlantic areas of Spain and Portugal were also taken into consideration into the Atlantic South region.

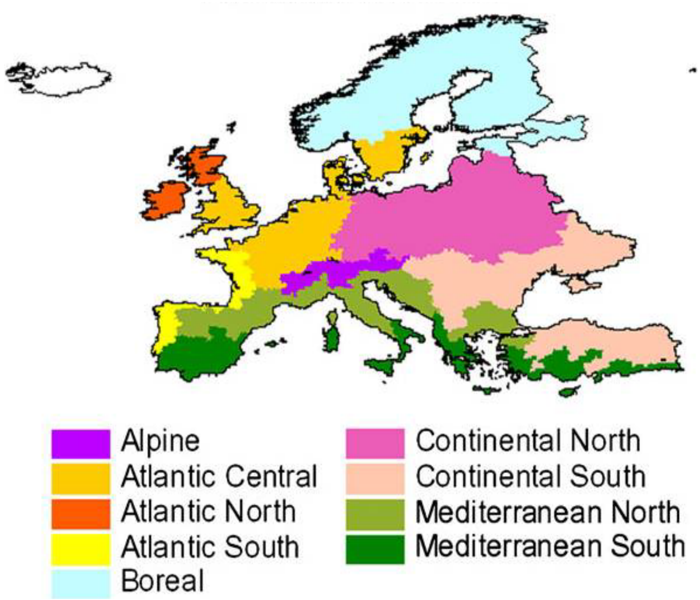

Figure 1. European agro-climatic zones according to the JRC PESETA-Agriculture study (2009). Available at: http://ftp.jrc.es/EURdoc/JRC55386.pdf

In the frame of this Focus Group, these agro-climatic zones might be simplified into three main areas for a more practical analysis as follows:

Mediterranean zone: It is the region of 'Mediterranean' plant species, favored by mild winter and warm summer temperatures with relatively wet winters and dry summers.

Atlantic zone: It is the region of 'Atlantic' plant species, which grow in moderately cool or cold winters and fairly mild summer temperatures, with relatively wet winters and wet to occasionally dry summers.

The continental zone: It is the region of 'Continental' plant species that grow in cold relatively wet winters and mild dry summers as well as in cold relatively dry winters and warm dry to occasionally wet summer.

Several graphs included in the present paper will classify the data from the different EU members into these three mayor zones and therefore the Boreal area will be analyzed together with the Atlantic one, and the Alpine area together with the Continental one.

3.2. Land use & livestock

Focusing of key global land uses, world's surface is covered by wide areas of forest (31%) and permanent meadows and pastures (25.8%) although regional differences are to be mentioned: forests dominate American and European territories (40.3% and 45.4% of all the land respectively) whereas permanent meadows and pastures cover wide areas in Oceania, Asia and Africa (44.0%, 34.9% and 30.7% of all land respectively).

Permanent grasslands cover 60.840.280 ha across the EU-28 (Annex 1), representing the 16% of total area. The land use by pastures is not equally distributed along the EU-28 (Figure 2). Relevant surfaces are found in United Kingdom (17.92% of all EU-28 surface), France and Spain (around 14% each one), Germany (7.65%), Romania (7.41%) and Ireland (6.54%).

Permanent grasslands also occupy a relevant percentage (34.6%) of the total Utilized Agricultural Area (UAA), with differences between countries (Annex 1): up to 79.7% of the UUA in Ireland, 64.6% in United Kingdom, 59.2% in Slovenia, and around 50% in Greece, Luxemburg, Austria and Portugal.

Table 2. World and regional land area (1000 Ha) as well as surface linked to land uses. Source: FAOSTAT 2011.

	Total Land Area	Agricultural area	Arable land	Forest area	Permanent crops	Permanent meadows and pastures
World	13,009,473	4,911,631	1,396,279	4,027,468	153,937	3,358,654
Africa	2,964,766	1,169,696	226,453	670,998	29,090	911,393
America	3,889,231	1,215,119	371,051	1,566,181	27,655	816,412
Asia	3,093,539	1,633,521	473,572	594,205	80,043	1,079,905
Europe	2,213,281	469,874	276,497	1,005,770	15,559	177,817
EU-28	418172	186555	107456	157370	11867	67231
Oceania	848,654	423,419	48,704	190,312	1,589	373,125

Shrublands are mainly concentrated in Mediterranean countries (Figures 2 and 3), but their presence is noticeable on the north-west border of Sweden and also in the highlands of Scotland.

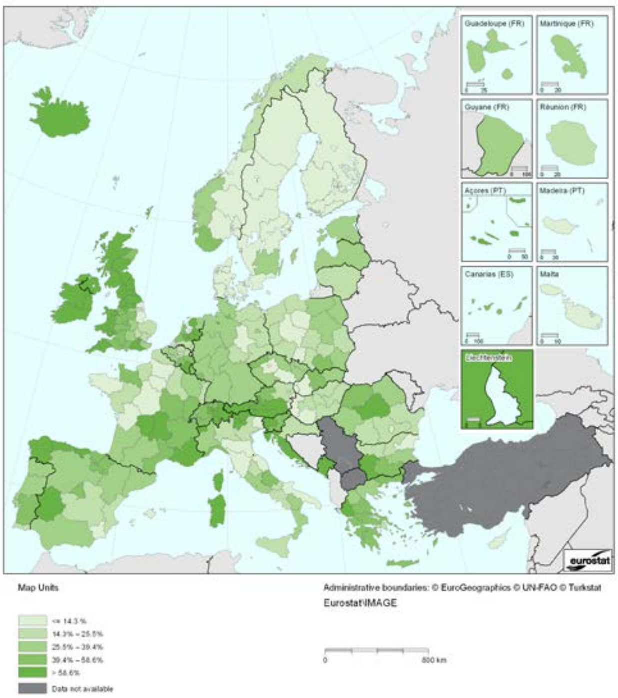

Figure 2. Share of permanent grassland in UAA, EU-27, IS, NO, CH, ME and HR, 2010, NUTS2

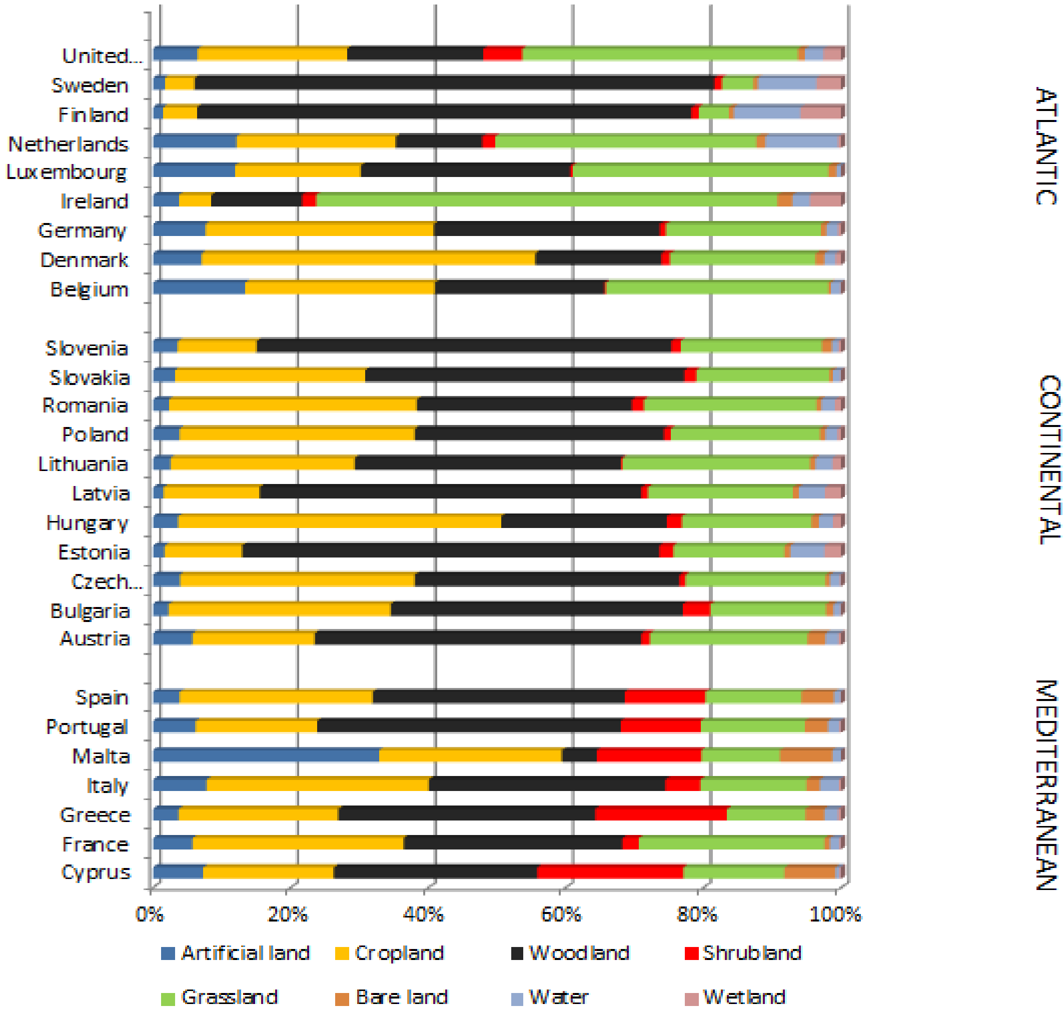

Figure 3. Land Cover in the EU. Source: Eurostat. Most recent data from 2012.

Regarding the EU-28's livestock herd it was composed of around 350 million heads (Annex 2): around 25% were cattle, 43% were pigs and 28% were sheep. The global herd is not evenly distributed as the greatest Livestock Units (LSU) locate in four member States (France, Germany, Spain and United Kingdom).

The distribution of the populations of large domestic herbivores is related to the agro-climatic conditions which shape the type of vegetation cover to be found in each area. So, while in Mediterranean zones cattle rearing is focused on beef animals, dairy cattle is common in the Continental and Atlantic zones (Figure 4a).

This link with environmental conditions (sward characteristics) can apply when comparing different livestock species. So, small ruminants, and especially goats, acquire especial relevance in the Mediterranean zone whereas cattle dominates in the other zones, especially in the Atlantic one (Figure 4b). The case of sheep and goats is particularly interesting as they account for limited LSU but they concentrate in few countries: sheep mostly in UK, Spain, Greece, Romania, France and Italy, and goats predominate in Greece, Spain, France and Romania.

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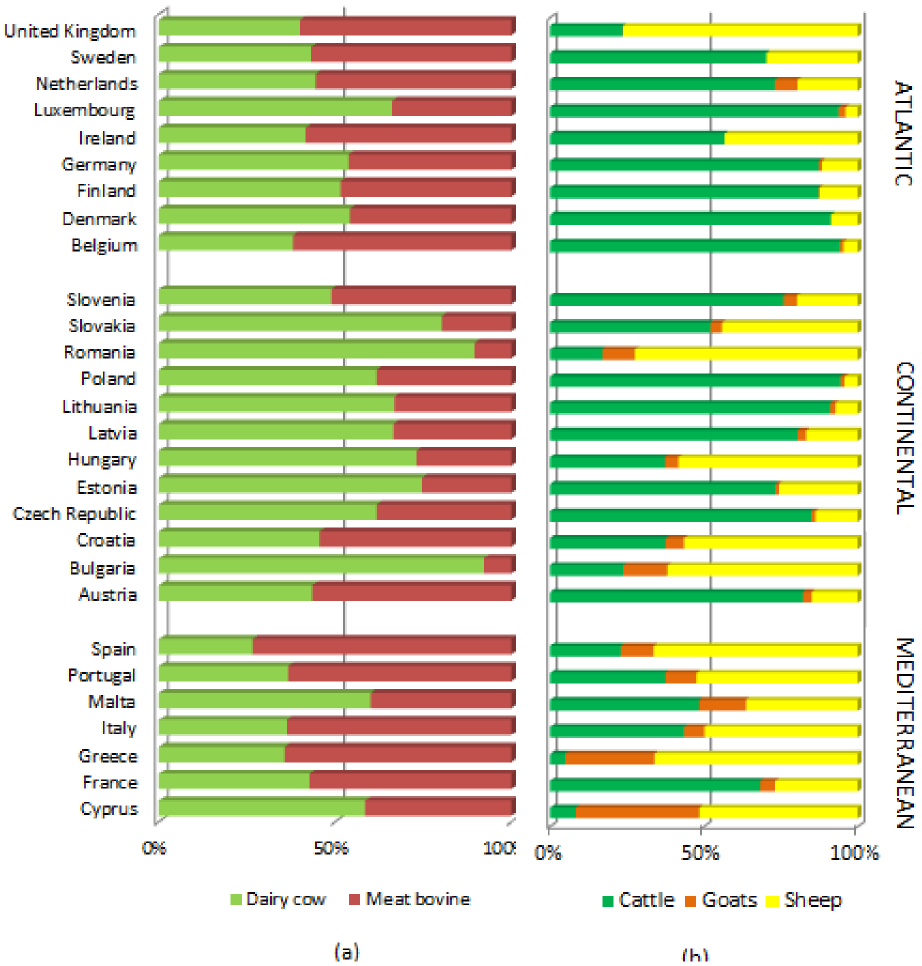

Figure 4. Percentage of (a) dairy cow and meat bovine, and (b) cattle goats and sheep across the EU Members grouped into three main zones. Meat bovine refers to the number of slaughtered heads.

4. Farming systems and management issues in permanent grassland

Permanent grasslands and farming systems linked to them have a great diversity in Europe and can differ between the main agro-climatic zones. Therefore, the practices to improve efficiency and productivity and/or their influence on biodiversity conservation or carbon footprint may vary according to that diversity. In order to structure the work of the Focus Group a classification is proposed in which the different vegetation composition of grasslands and the farming systems are categorized.

Tables 6 shows that structure. The two first columns list the grassland types according to the main vegetation composition (1st column) and the farming-livestock types linked to them (2nd column). This structure will allow to address the diversity of management issues, management objectives and management practices/techniques. The same structure is developed for the three agro-climatic zones across EU and includes (the rest of columns) the more relevant management issues which should be considered; i.e. which are the adequate livestock species (and breeds), whether grazing or cutting (or both) are commonly developed/should be developed, which plant varieties can be seeded, fertilization methods commonly used/should be used, the utilization of irrigation, etc.

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Table 6 develops the initial structure for the Atlantic region. Besides completing it, the same structure will be developed by the Focus Group for the other two regions.

Table 6. Grassland System categories table for the Atlantic Region.

ATLANTIC REGION

Vegetation composition	Farming type	Management issue						
	Livestock	Grazing/Cutting	Livestock Breeds	Improved plant Varieties	Fertilization	Irrigation	Animal health PFMN	Products/ Produce
Silvopastoral systems	Small Ruminants	Mixed grazing	Local	-	Animal faeces	-	+ + + -	Meat and landscape / Fiber / wool
	Reindeer	Grazing						
	Suckler cows	Grazing						
Scrubs	Small rumin	Mixed grazing	Local	-	Animal faeces	-	+ + + -	Landscape / Fiber / wool / Honey
	Horses	Sequential Grazing						
Scrubs+ herbaceous	Small rumin	Mixed grazing	Local	-	Animal faeces	-	+ + + -	Meat /cheese/ Honey / Fiber / wool
	Suckler cows	Single grazing						
	Suckler cows + goats	Mixed grazing						
Natural herbaceous + heathlands	Small rumin	Mixed grazing	Local	-	Animal faeces	-	+ + + -	Meat /cheese/ Honey / Fiber / wool
	Suckler cows	Single grazing						
	Suckler cows + goats	Mixed grazing						
Natural vegetation + improved pastures	Small rumin	Mixed grazing / cutting	Local and crossbreeds	Ryegrass + white clover	(1) First year Lime 2500 kg/ha (1) Every year NPK 40 90 60	-	I I I +	Meat /milk with high fat and protein content = dairy produces as cheese (DOP) / Fiber / wool
	Suckler cows	Single grazing / cutting						
	Suckler cows + goats	Mixed grazing / cutting						
Improved pastures	Yearling beef cattle	Grazing / cutting	Medium-high productive	Ryegrass + white clover	NPK 160 120 90	-	- - I +	Milk/beef calves and yearling
	Dairy cows							
	Dairy heifers							
Improved + crops	Yearling beef cattle	Grazing/cutting/ harvesting	High productive	Faba beans, maize, peas, sunflowers, Italian ryegrass	(2) NPK 160 120 90 + Crops' needs	-	- I I +	High milk production / yearling beef
	Dairy cows							

PFMN: Parasite infestation, contents in fibers, minerals and nutrients: (**+)** positive effect as vegetation contributes to control the levels of infestation and vegetation contains high concentrations of fibers, minerals and/or nutrients; (**-**): negative effect as vegetation cannot contribute to control infestation so it could affect animal health, and vegetation has got low concentrations of fibers, minerals and/or nutrients; (**I**): neutral effect, neither vegetation is related to the infestation levels nor the components have apparent effect on animal health.

The management strategies to be developed in each area will depend on the objectives and those might vary within each agro-climatic area. We assume that all strategies aim at being sustainable and attend both to the existing vegetation cover and the most suitable livestock production system for each type of vegetation and culture of knowledge of the area.

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4.1. Objectives and recommendations (for management issues listed)

Some management objectives and concrete recommendations are listed below for the identified management issues.

4.1.1. Grazing management

- Select livestock species with favourable diet selection and grazing behaviour to the existing vegetation characteristics.
- Select species and/or breeds adapted to environmental characteristics to maintain favourable animal performances on pasture during the longest possible periods and therefore, reducing dependence on external inputs which compromise the profitability of the system.
- Manage mixed or single flocks attending to sward characteristics to maximize resource utilization and livestock diet selection. Manage simultaneously species with lowest possible competition (e.g. cattle and goats show low competitive levels as they are grazers and browsers respectively). Sequential grazing can be an interesting alternative as well (e.g. use of horses after cattle).
- Rotation systems in more intensively managed systems might allow rangeland to recover in certain but can also provide ecosystem services (e.g. floral resources for honey bees or appropriate nesting sites for some birds) which might not be as abundant in grazed areas.
- Apply grazing patterns which provide a heterogeneous landscape. Maintain a sward with a range of heights during the growing season, except when the field is closed or shut up for a cut of hay or silage. E.g. according to ADAS, in permanent grasslands with low inputs, at least 20 per cent of the sward should be less than 7 cm and at least 20 per cent should be more than 7 cm, to allow plants to flower and to provide a more varied habitat for associated fauna (e.g. invertebrates and birds).
- Maximize forage production for animal supplementation within the farm system to reduce external inputs.
- Crop residues can provide valuable food residues in some cases according to livestock dietary preferences.
- Maximize livestock intake without surpassing the carrying capacity of the ecosystem and risking its biodiversity, set stocking rates according to forage quantity and availability. Moderate stocking rates would be the most appropriate (Figure 5).

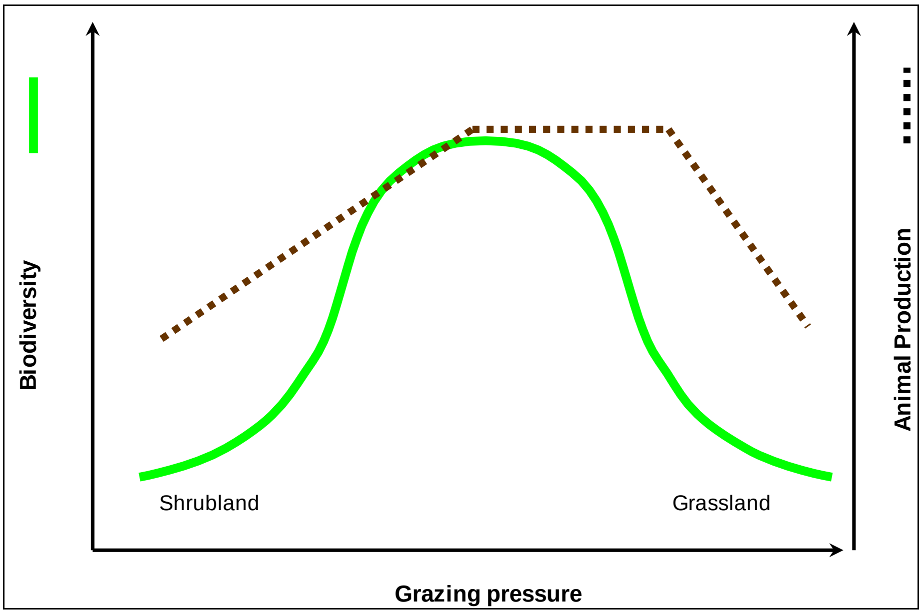

Figure 5. Evolution of biodiversity and animal production according to the grazing pressure.

- Control weed proliferation by taking advantage of the diet selection of different species to reduce the use of herbicides when possible.
- Efficient use of medicines taking advantage of medicinal properties of natural vegetation when possible to reduce unnecessary extra-costs and control de residues of medicines to avoid undesired environmental problems (e.g. ivermectines can affect adversely the local insect fauna).
- Include animal health as a key element of the grazing system to avoid unnecessary use of medicines, reduce reproductive problems and maximize production.
- Diminish leftovers.
- Reduce livestock carbon footprint: The major contributing factors are emissions related to feed use and manure handling as well as the nature of the land required to produce the feed in question so: improve feed conversion at the system level, use of feeds that increase soil carbon sequestration versus carbon emission, ensure that the manure produced substitutes for synthetic fertilizer, and use manure for bio-energy production when possible. Proper management of manure and urine waste nutrients contribute to avoid possible leaching to groundwater and other risks to livestock, human health and the environment.

4.1.2. Reseeding

- Reseeding when necessary with mixtures of plant species of high nutritive value to maintain livestock performances but also to provide floral resources to pollinator insect communities and therefore simultaneously contribute to ecosystem services and contribute to the production of added valued products such as honey (e.g. *Trifolium* species are very attractive to bees and bumblebees).
- In order to take advantage of the potential of legume forages to replace N- fertilized grass swards, proper management is required as it would help reduce the need for protein-rich feed (Hopkings, 2008). A controlled expansion of legumes could be achieved while meeting consumer expectations remaining coherent with environmental policy goals (Peeters et al., 2006).
- Grassland renovation should aim at developing a permanent botanical composition of the sward which becomes fine-tuned to the site yield potential (Wachendorf and Goliński, 2006).

4.1.3. Cutting for hay/silage

- Hay requirements might be met by purchasing hay based on nutritive value and weight.
- The differences in hay digestibility from different grasslands must be taken into account. For example, the digestibility of some hays from neutral grasslands is often 10 to 40% lower than forages cut from intensively managed grasslands.
- If clovers are components of the pasture system, allowing them to set seed with hay harvest after seed maturation might provide some of the hay requirements. The seed-abundant hay bales can play a role in reseeding pastures.
- Where hay is cut annually, the subsequent aftermath can provide grazing for finishing lambs provided a sward height of about 6 cm is maintained.
- Mowing the fields in sections at different dates prolongs the overall flowering season and gives wildlife (e.g. pollinators and birds) a chance to move aside. This way the farmer can take advantage of the best hay feed quality with optimum sugar and mineral content with early hay cut while maintaining high flora and fauna diversity by cutting other sections later on.
- Rotational cutting (leaving a different area uncut each year) can be considered where there is a conflict of interests between later or early cuts.
- Where hay cuts are not routinely practised, cattle are useful grazers of certain grasslands, being able to compensate for lower digestibility vegetation by increasing retention time in the rumen.
- Aftermath grazing, ideally by cattle, is identified as being important for maintaining maximum diversity of several grassland types by provisioning regeneration niches in the sward and getting the meadows in a condition suitable for breeding waders in the following spring (Pinches et al., 2013). The selection of the livestock species could aim at providing a heterogeneous sward taking into account its diet selection and grazing behaviour.

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- Leave a 1-2 m uncut or ungrazed strip alongside the boundary. Those margins will provide seed sources and over-wintering cover for insects.

4.1.4. Fertilization

The number of species in herbaceous swards is related to soil pH, humidity and fertility. Raised fertility levels cause loss of species, except in cases of extreme acidity or infertility, where the reverse is true. Whilst fertiliser use is most effective in increasing production, it might also cause the greatest loss of diversity. According to Kirkham et al. (2014) decisions on the sustainable levels of fertilizer use to maintain or enhance the botanical diversity of grassland might be based on knowledge of soil physical and chemical status and past fertility management. The study of UK upland hay meadows (Pinches et al., 2013) revealed that botanical responses to nutrient applications are driven by which ever macro-nutrient is growth-limiting in the grassland and by historic nutrient inputs. Therefore the additional application of nutrients for any given meadow should be informed by its soil nutrient status, grass utilisation, past fertility management and conservation objectives.

- Proper pre-assessment of soil needs to make a controlled use to fertilizers according to each area, vegetation characteristics and livestock demands. For all the major nutrients, (nitrogen, phosphate and potash), there is an optimum level at which maximum species density is maintained.
- Control the use of fertilizers in areas where there is the potential risk for leaching into water bodies.
- Strategic, timely application of N imperative to match climatic conditions and best utilize the optimum effectiveness of N rate and forage production.
- On improved grasslands ensure crop requirements for pH and nutrients, particularly phosphate and potash, but also sulphur, sodium and magnesium, are maintained for optimum response to nitrogenous fertilisers.

4.1.5. Chemicals (pesticides/herbicides)

- Reduce the use to herbicides as much as possible. Apply them spot-treat or weed-wipe for the control of injurious weeds (ie creeping and spear thistles, curled and broad-leaved docks or common ragwort) or invasive alien species (eg Himalayan balsam, rhododendron or Japanese knotweed).
- Herbicides and insecticides, among others, affect directly the aquatic biota by their toxicity and some fertilisers act either as toxic compounds or by increasing the growth of algae, thus changing the trophic structure of the environment.

4.1.6. Irrigation

- Efficient irrigation planning combining more and less water-demanding plant species (especially for associated crops) reduces economical costs and contributed to ameliorate water problem in sensitive areas (e.g. within the Mediterranean areas). In other regions (controlled) drainage is an issue/management, also related to CO2/NO.

4.1.7. Interactions between vegetation and Livestock Production Systems

Silvopastoral

Animal species should be related with available vegetation components: grazers and browsers, and therefore, sheep-cattle as well as goats and horses. Productions should be low or medium depending on nutrients and it would be advisable to use rustic local breeds, depending on palatable vegetation species. Other main management factor to be considered involves the adjustment of the stocking rates to maintain the sustainability and good balance between animal-vegetation and forest components. Positive plant response to different fertilization treatments might depend on tree age, initial soil fertility, soil pH, the competitive interactions between tress and pasture production as well as previous liming application (López-Díaz et al., 2007). Organic fertilizer might enhance pasture and

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tree growth compared to no fertilizer or treatment with mineral fertilizer. Inorganic fertilization enhanced pasture production but might reduce tree growth over no fertilization application (Mosquera-Losada et al., 2005). Nevertheless, in very acid soils the combination of liming and fertilization might enhance pasture production but reduce tree growth. Organic fertilizers like dairy sewage sludge enhance both tree and pasture production in neutral soils (López-Díaz et al., 2007). The presence of readily degraded manure from the livestock on the pasture and of nitrogen-fixing plants in the silvopastoral system is associated with retention of calcium and phosphorus and might mean that artificial nitrogenous fertilizers are not required, just supplementary metals in some circumstances. This is a major factor in sustainability as the carbon cost of producing, transporting and applying artificial nitrogen fertilizers is very high (López-Díaz et al., 2007). By reducing the need for external inputs such as fertilizer and pesticides, the systems should be of particular relevance to low-input and organic farmers. Furthermore, properly managed systems in silvopastoral areas are aimed at restore degraded land, for example, in areas prone to soil erosion or salinization, as well as to increase the productivity of marginal land. Given the acute problem of greenhouse gas emissions and global climate change, it is clear that the incorporation of trees can also provide a major boost to carbon sequestration (Smith et al., 2012). Livestock grazing in these systems can provide key relevant ecosystem services linked to control fire risk in areas which can be of special environmental value. Added meat and milk (e.g. cheese) products can be manufactured in these systems as well as forest products (fruits and wood).

Scrubs

High quantity of biomass but very low palatability, intake and nutritive value. Therefore, this type of vegetation can only be used for very short periods and mainly by browsers (sheep and goats), and products that demand low nutrients (fiber and wool).Harsh environmental conditions mostly favorable for autochthonous breeds. Frequently associated to marginal areas where added valued products and income from livestock systems represent one of the few sustainable alternatives. Rich floristic composition with key plant species for animal health. High fire risk can be arrested through proper grazing strategies which will control scrub proliferation.

Scrubs + herbaceous

Medium-high biomass, low or medium palatability depending on herbaceous components (narrow or wide leaves), they can be grazed only for short periods (mainly in summer and autumn) by small ruminants in mixed flocks. Similar conditions as previous vegetation type but higher nutritive value might allow the maintenance of extensive mixed flocks which include larger herbivorous (e.g. cattle) from Autochthonous breeds.

Natural herbaceous with heathlands

Medium biomass, medium palatability, medium or low intake and low digestibility, and therefore low to medium potential for productivity. Mixed flocks of sheep and goats could be more appropriated for these conditions. Meat and fiber production could be developed as well as milk to make local cheese where the availability of wide leaves and grasses is high. Other added valued local products like honey can provide additional income. Local breeds well adapted would be the most appropriate. Mixed flocks might contain livestock species which ingest shrubby vegetation and might favor the presence of herbaceous vegetation (e.g. goats) and contribute to arrest fire risk. Rich floristic composition with key plant species for animal health (e.g. heather and gastrointestinal parasites control in goats).

Natural and improved vegetation

Medium biomass, medium-high palatability and intake, mixed flocks of suckler cows, sheep and goats (quantity depending on percentage of improved area) could be the most appropriate. Even some dairy cow with medium milk production potential but with very high quality. The addition of improved areas could be a sustainable option in areas with wide surfaces covered by natural vegetation of low nutritive value. Aftermath grazing in hay/silage fields could contribute to maintain floristic diversity.

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Improved vegetation

Systems with high quantity of biomass and quality (digestibility) and therefore high nutrient intake and productive potential. The most efficient production systems would be milk production and beef production (steers and yearly calves). Fertilization and periodical reseeding might be necessary. Higher risk of gastrointestinal parasite infestations than previous vegetation types. Seek for balanced diets in dairy cattle to avoid undesired health problems. Aftermath grazing in hay/silage fields contributes to maintain floristic diversity.

Improved + crops

Systems with high energy and protein production located in areas with arable lands, adequate for dairy cows with high production potential and for finishing yearling calves from suckler cows managed in highlands and lowlands. High fertilization demand and reseeding. Depending on the crop irrigation might be demanded as well (e.g. corn). Control of balanced diets to prevent health problems in dairy cattle. Options to increase C sequestration include the expansion of long-term grasslands by reducing short-term leys, maize and arable crops as well as preserving existing permanent grasslands and especially those ones considered carbon sinks like peat grasslands (Freibauer et al., 2014).

We provide an example (Table 7) of the objectives and practices to be developed in areas covered by natural vegetation and improved pastures in the Atlantic Region.

Table 7. Example of objectives and practices which can be developed in Atlantic areas with natural vegetation and improved pastures.

Vegetation Composition	Farming type - Livestock	MANAGEMENT ISSUES									
		Grazing/Cutting		Livestock Breeds		Fertilization		Animal health		Product quality	
		Objectives	Practices	Objectives	Practices	Objectives	Practices	Objectives	Practices	Objectives	Practices
Natural vegetation + improved pastures	Small rumin	Addition of vegetation with higher nutritive quality Control of shrub proliferation	Mechanical clearance. Ploughing, dressing and sowing perennial ryegrass and white clover	Optimize performances	Manage Autochtonous breeds or well adapted alien ones (e.g. for fiber or milk production)	Pre-assessment soil needs	Determine soil nutrient status, grass utilization, past fertility management and conservation objectives	Reduce gastrointestinal parasites	Provide fiber rich and tannin-rich vegetation	Produce cheese/yogurt/fiber/wool	Manage autochthonous breeds of alien ones which provide specific products (e.g. Chashmere for fibers)
	Suckler cows	Maintain plant diversity in hay/silage fields Maintain performances during period of confinement by silage production	Aftermath grazing key in maintaining plant species richness of agriculturally unimproved meadows Proper timing and techniques also growing nutritive species	Sustain dairy breeds with medium levels of milk production	Manage dual purpose cow breeds (e.g. Parda Alpina) or crossbreeds	Reducing N fertilizers Reducing nutrient leaching	Inclusion of legumes Use of organic fertilizers			Produce milk/yogurt/cheese	Manage milk producing cows
	Suckler cows + goats	Maximize use of forage resources	Manage ruminant species with lowest dietary overlap (lowest competition)		Autochthonous or alien goat breeds	Reduce carbon footprint	Use organic fertilizers			Produce milk/yogurt of cheese	Mix milk from various species to produce yogurt or cheese

4.2. Biodiversity conservation

The main threats to the permanent pastures of high environmental value are:

- intensification,
- increasingly abandonment and
- afforestation.

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The conservation of the different areas also requires an individualized analysis (Table 8).

Table 8. Summary of principal impacts of key agricultural practices on biodiversity in permanent grasslands. Source: Modified from Poláková et al. (2011).

		MANAGEMENT ISSUES							
		Grazing	Breeds	Cutting	Cultivation and planting	Fertiliser	Irrigation	Pesticides	Animal health
Silvopastoral		Extensive grazing key for its mainteinance and increase flora and fauna diversity and control fire risk	Traditional breeds can contribute to habitat restoration and biodiversity conservation. Alien breeds can develop similar general environmental benefits but can have higher carbon footprint	Not used	Tree Plantation of autochtobous species reduce nutrient and can contribute to habitat conservation/restoration	Use livestock manure and nitrogen-fixing shrub species such as L. leucocephala mean that artificial nitrogenous fertilizers might not be not required. Sludge might allow nutrient recycling and preserve fertility.	Hydrological management usually unecessary	Not commonly used	Residues of medicines could affect negatively insect fauna
Scrubs, scrubs + herbaceous, natural herbaceous +heathlands	Pastures	Extensive grazing key for its mainteinance and increase flora and fauna diversity and control fire risk		Not used	Can cause damages and hinder habitat restoration	High rates of artificial fertiliser, slurry and farmyard manure use reduces fauna and flora biodiversity • Animal faeces provide resources for associated faunas (e.g. dung beetles, flies)	Drainage highly damaging but some management can benefit (e.g. to allow winter flooding or high water tables). Irrigation is not frequent but traditional systems in meadows can increase diversity	Not used	
	Meadows	Autumn/spring aftermath grazing helps to maintain flora and fauna diversity		Haycut in proper period maintains habitat and increases biodiversity					
Natural vegetation + Improved grasslands, improved pastures		Outdoors provides benefits for invertebrates and birds and control fire risk		Early and too frequent silage can reduce biodiversity and bird nests. Looses can be reduced with proper strategies. Aftermath grazing helps to maintain floristic diversity	Cultivation and redeeding can cause loss of semi-natural elements and biodiversity • Recovery possible if seedbank is present • Inclusion of ryegrass clover could have postive effects for pollinators		Traditional systems can increase diversity. (e.g. to allow winter flooding or high water tables). Modern systems intensification with detrimental effects	Organic compounds used ocasionally few significant impact	
		Overgrazing negative impact flora and fauna. Can benefit birds although trampling can cause high nest looses • Overgrazing, trampling and poaching should be avoided. Controlled grazing can promote heterogenuous areas of higher environmental value						Herbicide direct impact (toxicity) and indirect (disruption of food webs)	
Improved pastures + crops		Continuos cropping reduces productive capacity of soils. Pasture phases in crop rotations improve soil fertility and nutrient cycling, arrest possible soil erosion	Selection of proper livestock reeds can also help to control accumulation of weed seeds generated under continuos cropping		Self-regenerating persistent legumes migh contribute to fix nitrogen in soils with low fertility	Crops have higher fertilization rates which could have potentially environmental risks			

At a farm and local landscape level, abandonment of the semi-natural pastures (especially the least accessible) in certain areas and concentration of the stock on more productive land are becoming increasingly common, as observed for example in Ireland, United Kingdom, Spain (Iragui Yoldi et al., 2010) or Sweden (Kramm et al., 2010; Jordbruksverket, 2010; McCracken et al., 2011).

Halting and reversing this decline of permanent pastures, including ligneous pastures, is one of the biggest challenges for the maintenance of European biodiversity and wider ecosystem services (Rosa García et al., 2013). It is also vital for the social fabric of some of Europe’s most marginal rural areas. The farmland habitats on Annex 1 of the Habitats Directive consist of various types of semi-natural permanent pasture that require continued farming use for their conservation (Annex 4). Commission data show that these farmland habitats are generally in worse condition and are declining faster than other habitats types, such as forests. They extend far beyond designated Natura 2000 sites and therefore, the latest EU biodiversity targets include maintaining all of these habitats, not only within Natura 2000, as well as maintaining, enhancing and restoring ecosystem services (EC, 2011c).

Biodiversity conservation in permanent pastures is clearly linked to the development of proper management strategies (Rosa García et al., 2013; Table 9). Whereas grazing might be of the few strategies developed in natural habitats, this activity as well as cutting can deliver positive environmental benefits in other habitats such as meadows and pastures (Table 8). However, the generalization is complex because optimal levels for practices such as grazing, cutting, hydrological management, burning and even use of manure, vary according to local circumstances (e.g. soil type, vegetation type and condition, stocking rate, climate, historical management and current management objectives).

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Farming activities like livestock grazing have also faced controversial issues such as the coexistence of livestock with wild predators (e.g. wolfs in mountainous areas of Northern Spain) or other wild herbivores with the consequent tensions and conflicts with farmers and local communities.

Finally, the occurrence of recurrent fires in some EU areas (especially within the Mediterranean zones) due to the accumulation of flammable shrubby vegetation is of special concern from the environmental point of view, as it dramatically alters soil characteristics and impacts on the local flora and fauna communities (Osoro et al., 2012a,b; Rosa García et al., 2010).

A summary of possible consequences of different livestock species on flora and fauna attending to their grazing behaviour and diet selection is presented in Table 9. For example, the ability of horses and goats to control gorse re-growth can be an interesting tool to control the accumulation of this flammable vegetation along the northern Iberian Peninsula where the abovementioned fires take place (Osoro et al., 2012b).

Table 9. Overview of the main livestock species commonly managed in permanent pastures in relation to their effects on the vegetation and fauna. Source: Modified from Rosa García et al. (2013).

VEGETATION	FAUNA
CATTLE	
-Grazers which prefer grassy habitats within heathlands -Can generate heterogeneous swards -Can reduce invasive grasses as *Nardus stricta* or *Molinia caerulea* -Promote recover of *Erica tetralix* arresting invasion of *Deschampsia flexuosa* -Consume undesired species like *Betula* spp., *Salix* spp., *Pinus* spp. or *Populus* sp. -Less selective than sheep, equines or goats -*Calluna* and *Erica* spp. avoided -*Gentiana pneumonanthe*, *Rynchospora alba*, *R. fusca* or *Carex panicea* increased in number or re-established as cattle substituted sheep -Less impact on regenerating heather, but more likely to cause uprooting and trampling, than sheep -Induce creation of tree-grass-heather mosaics -A tool to break up scrub stands and to stop succession to woodland -Seeds contained in dung could alter local flora composition	- Can generate patchy and structurally diverse/tussocky sward which benefits invertebrates - Associated with lower numbers of wolf spiders and higher numbers of Hemiptera - Dung beetle diversity peaks in areas traditionally grazed - Dung favours birds and bats that live on excrement-related insects - Soil compaction, direct treading disturbance or the reduction of soil crevices can affect certain *Carabus* spp. - Grazing favoured sand lizards, wheatears, dung fungi, dung beetles, badgers, rabbits or foxes and might help to re-establish rare species like the grayling butterfly, the spider *Dictynia latens* or the common lizard - Sheep + cattle leave uniform swards suitable for the spider *Erigone atra* while single grazing leads to heterogeneous ones preferred by *E. dentipalpis* - At high stocking rates leave taller patches suitable for spiders unlike sheep - Certain *Pardosa* or linyphiid spiders migrate from shrubland to short and cattle grazed vegetation during summer to reproduce - Together with defoliation from heather beetle can deplete *Calluna* - May either improve habitat quality for deer or affect it negatively
SHEEP	
-Selective grazers which prefer grasses but also consume heather and green shoots of gorse -Can graze closer to ground and generate a shorter [3 cm] sward than cattle -Consume invasive plants like bracken but avoid *Nardus* or *Molinia* more than cattle -With rabbit grazing and cutting will control *Molinia* and restore *Calluna* -Can induce a shift from heather cover to graminoids [*M. caerulea*, *N. stricta*, *Eriophorum vaginatum* and *Scirpus cespitosus*] or leave heathers at a competitive and young state -Less damage to lichen rich swards or mature and degenerate *Calluna* through trampling than cattle or horses -Target flowering plants or heather and gorse growing tips and can have adverse effects on species diversity -Allow greater shrub re-growth (especially gorse) and less grass development than goats -Use of >80% of season's growth leads to loss and deterioration of heather	- Provide suitable habitat for endangered dragonfly *Coenagrion mercuriale* - Wrong management can affect entomofauna, herpetofauna and avifauna - Overgrazing can reduce habitat quality for ground-nesting birds and carabids - May favour some halophilic ground beetles and spiders with high dispersal capacities but have negative effects on spider species richness when microclimatic conditions homogenize - Web-spinning spiders select *Senecio jacobaeae* avoided by sheep - Open heather swards that favour breeding of waders and foraging birds - Can keep mosaic-like vegetation that benefits Hemiptera and birds - Linked to different arthropod fauna than goats when grazing in grass-rich heathlands but not in heather- or gorse-dominated ones - Linked to higher abundances of wolf spiders and lower abundances of Hemiptera than cattle in pastures of partially improved heathlands - Some *Carabus* spp. prefer sheep grazed swards to cattle grazed or mixed - Together with deer have caused habitat degradation but both have differential pattern of grass path use within the heather

VEGETATION	FAUNA
HORSES	
- Selective grazers which prefer grassland communities on heathlands - Graze very close to the ground and can generate very short swards [2 cm] - Can overlap diet with cattle but differ in patterns of habitat use, are more likely to eat poor quality vegetation and have greater forage intakes - Maintain LW using woodland, gorse or bracken as forage is reduced - Avoid consuming heather, pine or Rhododendron while European holly, birch, oak or willow may be eaten - Overgrazing of palatable grasses can led to bare patches and areas of rank vegetation - Useful tool to control gorse proliferation on heathlands or areas with high fire risk and open up dense bracken strands - Can maintain flower-rich swards as they do not select flower heads - Useful to reduce dominance of *Molinia* and favour *Calluna* regeneration	- Can lead to a structurally diverse sward that benefits invertebrates - Overstocking has adverse effects on entomofauna and herpetofauna - Horse riding might churn up the ground too much to be used by burrowing invertebrates - Associated 'latrine areas' can benefit insects and small mammals, but also undesired grasses - The populations of sika deer increased while roe and fallow deer decreased when co-grazing with ponies
GOATS	
- Predominantly browsers which select heathland over grass rich areas - Likely to produce as short sward as sheep - Consume larger proportions of dwarf shrubs and woody plants than sheep, cattle or horses - Heather and gorse are preferred even when pasture is also available - Eat more *Molinia* than sheep, have a distinct preference for pine, and could reduce blackthorn and birch invasion on heathlands - Useful tool to control shrub encroachment and arrest fire risk - Unique role in steep areas like maritime heaths to reduce forage in areas less attractive to other larger grazers - More susceptible than sheep or cattle to gastrointestinal parasites	- Greater diversity of arthropod fauna when co-grazing with cattle or sheep than monospecific grazing of cattle or sheep - Promote the development of herbaceous vegetation which favours certain arthropod species - Can contribute to preservation of the shrubland habitat needed for butterflies like *Plebejus argus* - Can generate vegetation and environmental heterogeneity which might favour the presence of a wide variety of arthropods - High stocking rates favoured xerofilous arthropods and certain grasshoppers but other species which demand higher shrub cover and humidity like many harvestmen might prefer areas less intensively grazed

Greening measures and agri-environment schemes

The new CAP introduces a mandatory "greening" component of direct payments for the enhancement of environmental performance (Regulation (EU) No 1307/2013). Member States should use part of their national ceilings for direct payments in order to grant an annual payment for compulsory practices linked to agriculture, such as crop diversification, the maintenance of permanent grassland and the establishment of ecological focus areas. Regarding permanent grassland, among other aspects, Member States shall ensure that the ratio of areas of permanent grassland to the total agricultural area declared by the farmers does not decrease by more than 5 % compared to a reference ratio to be established by Member States in 2015.
Agri-environment schemes are one of the main policy initiatives for delivering biodiversity objectives and offer compensatory payments to farmers for environmentally beneficial management practices to protect, maintain or enhance environmentally valuable features, including permanent grasslands.

Aspects of husbandry, such as stocking rate, grazing period, season, animal species, and indeed animal breed, need careful consideration depending upon the specific environmental outcome required, and will influence the management of the whole farm. On the other hand, management of a sward for an environmental outcome may also influence the palatability, age and structure of the vegetation, as well as its composition, with possible implications for nutritive quality and therefore on nutrient digestibility, intake and animal performance, health, etc.

Examples of commitments covered by national/regional agri-environmental schemes are:

- environmentally favourable extensification of farming;
- management of low-intensity pasture systems;
- integrated farm management and organic agriculture;
- preservation of landscape and historical features such as hedgerows, ditches and woods;
- conservation of high-value habitats and their associated biodiversity.

The Institute of European Environmental Policy (2013) mentioned several other key measures for biodiversity which include:

- reducing the use of fertilisers (which also help to reduce off-farm impacts);
- reducing the impacts of pesticides (by reducing use and/or toxicity levels and/or spectrum breadth to non-target species)
- adoption of beneficial farming practices, such as retention of stubble, incorporation of rotational fallow and 'bird-friendly' cutting practices;

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- the restoration of damaged or degraded habitat features such as hedgerows and woodland for farmland species and to support broader landscape-scale conservation needs, such as reducing habitat fragmentation and facilitating climate change adaptation (Kettunen et al., 2007);
- specific measures for target species (such as the planting of field margins with seed-rich, or nectar-rich plants that provide food resources for birds and pollinators respectively).

Agri-environment measures may be designed at the national, regional, or local level so that they can be adapted to particular farming systems and specific environmental conditions.

4.3. Carbon footprint

C sequestration potential of permanent pastures worldwide is between 0.01 and 0.3 Gt C yr-1 (Lal, 2004).

The assessment published by the European Environmental Agency (EEA) indicated that soil carbon stocks in the EU were around 75 billion tonnes of carbon; around 50 % of which is located in Ireland, Finland, Sweden and the United Kingdom (with large areas of peatlands).

Grasslands contain a substantial amount of the world's soil organic carbon, about 343 billion tonnes of C (Sombroek et al., 1993; FAOSTAT, 2009), nearly 50 percent more than is stored in forests worldwide (FAO, 2007). Within permanent grasslands, C sequestration potential worldwide ranges between 0.01 and 0.3 Gt C yr-1 (Lal, 2004). Regarding future expectative, an estimated 0.2—0.8 Gt2 CO2 yr-1 could be sequestered in grassland soils by 2030, given prices for CO2 v of USD20–50/tonne (IPCC, 2007).

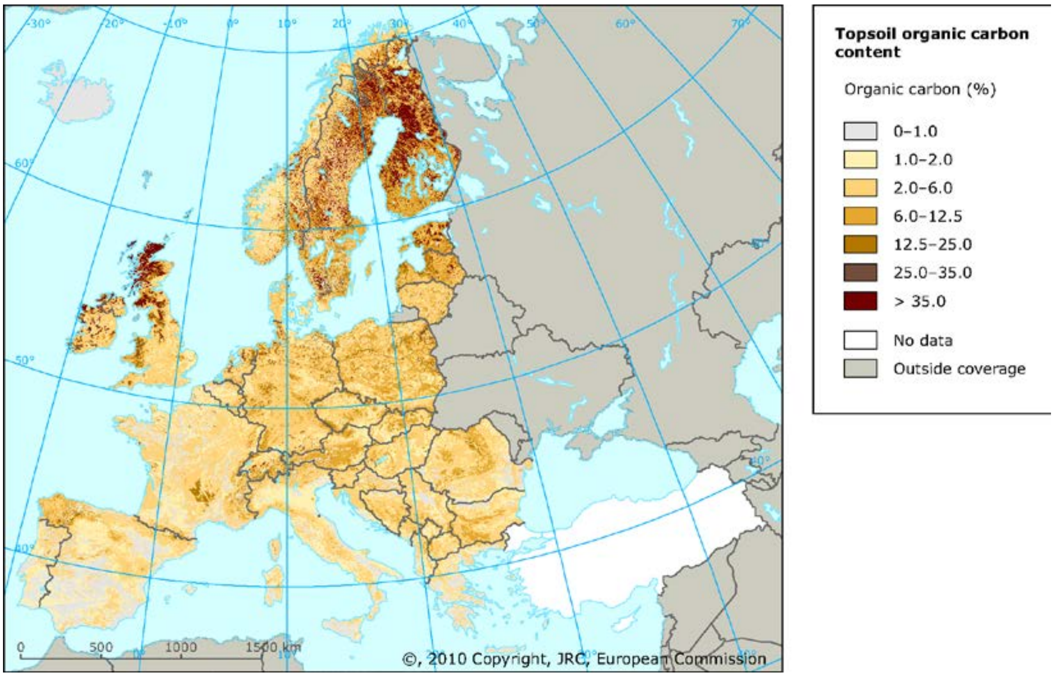

Figure 6. Topsoil organic content in EU countries. Source: European Environmental Agency.

The EEA has pointed out that soils under grassland and forests are a carbon sink (estimated up to 80 million tonnes of carbon per year) whereas soils under arable land are a smaller carbon source (estimated from 10–40 million tonnes of carbon per year). In fact, carbon stocks are susceptible to be lost upon conversion to other land uses or when performing unsustainable management strategies that lead to grassland degradation. So, when grasslands are converted to agricultural land, soil carbon stocks tend to decline by an average of about 60 percent (Paustian et al., 1997; Guo and Gifford, 2002). Relevant accumulation rates occur in other humid and cold European areas with Atlantic influence (Figure 6) like northern Spain, and especially Asturias and Galicia, although they are also threatened by recurrent fires which liberate carbon as forest vegetation is burned and soil surface is altered (a great source of carbon is present in the soil surface through organic matter accumulation).

Implementing grassland management practices that increase carbon uptake by increasing productivity or reducing carbon losses (e.g. through high rates of offtake) can lead to net accumulation of carbon in grassland soils – sequestering atmospheric carbon dioxide (CO2). Globally, the potential to sequester carbon by improving grassland practices or rehabilitating degraded grasslands is substantial – of the same order as that of agricultural and forestry sequestration.

According to FAO (2010) several practices can increase carbon stocks in grasslands, and a summary of the importance of the different strategies for carbon sequestration is presented in Table 10.

Table 10. Summary of the implications of different management strategies in carbon sequestration.

<table>
<tr><th></th><th colspan="5">MANAGEMENT ISSUES</th></tr>
<tr><th></th><th>Grazing</th><th>Cutting</th><th>Livestock Breeds</th><th>Improved plant Varieties</th><th>Fertilization</th></tr>
<tr><td>Silvopastoral systems</td><td>Deforestation, degradation of native grasslands, overgrazing and conversion to cropland have prompted losses of biomass and soil carbon • Proper grazing can reverse grazing practices that continually remove a very large proportion of aboveground biomass conditions, but overgrazing might deplete vegetation • Improved grazing management (management that increases production) leads to an increase of soil carbon stocks</td><td rowspan="4"></td><td rowspan="7">Alien breeds can develop similar general environmental benefits but can have higher carbon footprint</td><td rowspan="4"></td><td rowspan="4">Can enhance N balances, increasing plant productivity and carbon inputs. •Inputs tend to require energy and can each enhance fluxes of N2o, which are likely to offset carbon sequestration gains • When low-fertility soils receive fertilizer or lime, forage productivity and soil carbon levels generally increase</td></tr>
<tr><td>Scrubs</td><td rowspan="3">In some regions biomass has increased due to suppression of disturbance and subsequent woody encroachment • Proper fire management in areas with accumulation of woody flammable vegetation can greatly contribute to mitigate carbon looses • Sustainable grazing management can thus increase carbon inputs and carbon stocks without necessarily reducing forage production • Grazing management can also be used to restore productive forage species, further augmenting carbon inputs and soil carbon stocks</td></tr>
<tr><td>Scrubs+ herbaceous</td></tr>
<tr><td>Natural herbaceous + heathlands</td></tr>
<tr><td>Natural vegetation + improved pastures</td><td rowspan="2">Grazing accelerates annual shoot turnover, adds organic C in the form of animal excreta, and redistributes C within the plant-soil system • Systems that maximize production, rather than offtake, can increase carbon inputs and sequester carbon • Grazing can also increase the microbial population due to increasing fine root biomass, surface area of roots and deposition of cattle manure</td><td rowspan="2">Considerable quantity of carbion is stored in the aboveground biomass (grain, hay, silage, biofuels) that may be harvested and removed form the site • Higher mowing frequency has a greater impact on CO2 emissions • Small differences between different silage making systems (round bales, bunker silos, tower silos), while hay has somewhat</td><td rowspan="3">Can contribute to increase production through species better adapted to local climate, more resilient to grazing, more resistant to drought and able to enhance soil fertility (i.e. N-fixing crops) • Certain invasive plant species can affect C stocks • The use of fertilizer or the addition of alfalfa can increase pasture productivity, and may also increase carbon storage and sequestration • Addition of deeper rooted plant species also has the potential to increase sequestration by putting plant carbon inputs deeper in the soil profile • Highly productive grass-clover mixtures in grasslands can store relevant amounts of C • Changes from annual to permanent crops can contribute to mitigate negative effects</td><td rowspan="3">Application of organic manure increases SCO stocks compared to mineral fertilizers application</td></tr>
<tr><td>Improved pastures</td></tr>
<tr><td>Improved + crops</td><td>Emissions from conversion from forests to cropland or other land use have dominated carbon losses from terrestrial ecosystems • Including grass in the rotation cycle on arable lands increases production return organic matter (when grazed as a forage crop)</td><td>Annual cropping and tillage operations result in a loss of soil organic matter and carbon the soil • Including grass in the rotation cycle on arable lands reduces disturbance to the soil through tillage</td></tr>
</table>

Because adequate practices that sequester carbon in grasslands often enhance productivity, policies designed to encourage carbon sequestering grassland management practices could lead to near-term dividends in greater forage production and enhanced producer income. Adequate practices that sequester carbon in grasslands might also enhance resilience in the face of climate variability, and are thus likely to enhance longer-term adaptation to changing climates.

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Livestock grazing in particular can play a relevant role for carbon sequestration as sustainable grazing management can increase carbon inputs and carbon stocks without necessarily reducing forage production and can also be used to restore productive forage species, further augmenting carbon inputs and soil carbon stocks.

Other practices that enhance production, such as sowing more productive and deeper rooted species or supplying adequate moisture (irrigation) and nutrients (fertilization), also result in greater carbon uptake, ecosystem carbon stocks and forage production (Conant et al., 2001).

4.4. Animal health and welfare

Animal health in permanent grasslands is linked to vegetation characteristics and management strategies.

Feeding livestock with large amounts of high-fiber forage generally has a positive impact on livestock health and welfare (Nielsen and Thamsborg, 2005). In general, cattle from suckler herds live on marginal lands, unploughable pastures, or from crop residues, utilizing resources that may otherwise be unused or wasted. Normally, marginal land has a higher plant biodiversity, in contrast to pastures within crop rotation, offering the likelihood of animals ingesting different herbs and forages with possible beneficial effects on health and product quality (Hadjigeorgiou et al., 2005), as observed for goats in northern Spanish heathlands (Osoro et al., 2007).

Excessive supplementation in dairy cattle intensive systems might cause health problems related to unbalanced diets (e.g. Left or Right Displaced Abomasum). In the case of beef cattle, their excessive supplementation during the finishing period might increase the risk of metabolic or feed-related disorders, such as acidosis.

Regarding animal welfare, extensive management systems in permanent pastures like shrublands and silvopastoral areas, where local or well adapted breeds are managed, can meet animal welfare demands clearly more easily than intensify systems or monoespecific grasslands or pasture.

The EU’s “Strategy for the Protection and Welfare of Animals” considers five types of freedom for animals:

- from Hunger and Thirst. Ready access to fresh water and a diet to maintain full health and vigor.
- from Discomfort. Provide an appropriate environment including shelter and a comfortable resting area.
- from Pain, Injury or Disease. Prevention or rapid diagnosis and treatment.
- to Express Normal Behavior. Provide sufficient space, proper facilities and company of the animal's own kind.
- from Fear and Distress. Ensue conditions and treatment which avoid mental suffering.

Reduction of ticks, and hence of disease, improves livestock welfare as does reduction of starvation, over-heating and injury. In addition to disease reduction, other aspects of poor welfare are also reduced by the presence of shrubs and trees. Starvation is less likely in the silvopastoral systems, which provide a diet with good nutritional composition in dry seasons, than in pasture-only systems, animals can select components to intake a diet well balanced in nutrients, even practice self-medication.

4.5. Product Quality

There is increasing emphasis on the marketing of niche food products by geographical origin, method of production, gastronomic value as well as nutritional and health properties. These products can provide financial returns for farmers and wider rural economy, especially in Less Favored Areas where few viable alternatives can be developed. In addition, grassland biodiversity can be an input to the

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livestock production food chain in some systems such as European mountainous areas (Peeters and Frame, 2002) where permanent pastures are widely distributed.

Nowadays in many marginal or less favored areas in Europe, particularly in mountainous areas, there are livestock production systems based on permanent grasslands which are managed without fertilizers, pesticides or even treatments against parasites, using local rustic and well adapted breeds, producing singular produce with special sensorial and nutritive qualities which respond to organic production systems in spite of lacking official recognition. So, organization of these proctions on permanent grasslands is necessary to relocate their products into the "organic produce market". This produce can also play an important role contection rural culture with urban one, and consequently rural people will be valued properly according to their importance for the actual society.

Future investigations on particular swards types and plant species components related to livestock species from local breeds, which evaluate the quality and value of meat and milk products, might provide increasing opportunities for producers (Hopkins and Holz, 2006) as already observed for Autochthonous beef cattle breeders in northern Spain. Floristic diverse grasslands also have potential to provide nectar resources for honey bees and thus additional high-value consumer product, especially in less favored areas dominated by shrublands. Floristic diverse grasslands also have potential to provide nectar resources for honey bees and thus additional high-value consumer product, especially in less favored areas dominated by shrublands. Finally, a great part of the EU organic products come from permanent pastures. Livestock diet selection is a key issue to be considered as it can affect the taste and the chemical composition of meat and dairy products (Hadjigeorgiou et al., 2005) with consequences for human health.

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6. Anexes

Annex 1.Key records from permanent grasslands and meadows: Utilized agricultural area (UAA), total surface of permanent grasslands (hectares), percentage (%) of permanent grasslands within UAA, surface (hectares) under rough grazing and surface (hectares) not used for production. Source: Eurostat. Most recent data available from 2010. nd: no data available.

Country	UAA	Permanent grasslands (ha)	%	Rough grazing (ha)	
Belgium	1.358.020	499.690	37	2.940	ATLANTIC ZONE
Denmark	2.646.860	199.860	8	36.080	
Finland	2.290.980	32.950	1	23.000	
Germany	16.704.040	4.654.690	28	187.960	
Ireland	4.991.350	3.978.530	80	859.690	
Luxembourg	131.110	67.590	52	70	
Netherlands	1.872.350	813.310	43	44.570	
Sweden	3.066.320	451.910	15	45.620	
United Kingdom	16.881.690	10.899.970	65	4.998.140	
Austria	2.878.170	1.439.470	50	549.520	CONTINENTAL ZONE
Bulgaria	4.475.530	1.240.590	28	556.460	
Croatia	1.316.010	339.270	26	172.520	
Czech Republic	3.483.500	928.820	27	10.100	
Estonia	940.930	296.060	31	nd	
Hungary	4.686.340	720.900	15	698.550	
Latvia	1.796.290	651.050	36	349.950	
Lithuania	2.742.560	605.870	22	nd	
Poland	14.447.290	3.229.200	22	68.960	
Romania	13.306.130	4.506.250	34	305.690	
Slovakia	1.895.500	531.270	28	79.180	
Slovenia	482.650	285.710	59	49.900	
Cyprus	118.400	2.140	2	780	MEDITERRANEAN
France	27.837.290	8.418.880	30	2.067.150	
Greece	5.177.510	2.450.240	47	2.160.580	
Italy	12.856.050	3.434.070	27	1.182.510	
Portugal	3.668.150	1.784.600	49	1.316.080	
Spain	23.752.690	8.377.390	35	4.973.410	
			> 45%		

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Annex 2. Livestock numbers (thousands of heads) for livestock species during 2012. Sources: Eurostat (Dairy cows) and Faostat (rest).

Country	Cattle	Goats	Pigs	Sheep	Dairy cow	
Belgium	2438	36	6448	119	504	ATLANTIC ZONE
Denmark	1607	0	12331	154	579	
Finland	913	5	1290	130	280	
Germany	12477	162	28132	1658	4190	
Ireland	6754	10	1571	5170	1060	
Luxembourg	188	5	90	8	45	
Netherlands	3879	397	12234	1043	1541	
Sweden	1444	0	1474	611	346	
United Kingdom	9900	86	4481	32215	1786	
Austria	1977	72	3005	361	523	CONTINENTAL ZONE
Bulgaria	558	341	608	1455	294	
Croatia	452	72	1182	679	181	
Czech Republic	1354	24	1579	221	367	
Estonia	238	4	366	84	97	
Hungary	694	80	3025	1081	255	
Latvia	381	13	375	80	165	
Lithuania	752	15	790	60	331	
Poland	5777	90	11581	267	2346	
Romania	1989	1236	5364	8533	1163	
Slovakia	463	34	580	394	150	
Slovenia	460	27	347	120	111	
Cyprus	57	271	395	347	24	MEDITERRANEAN ZONE
France	19009	1310	13765	7464	3644	
Greece	680	4219	1128	9585	132	
Italy	6092	960	9351	7016	2009	
Malta	16	5	45	12	6	
Portugal	1498	404	2024	2092	237	

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Spain	5813	2693	25250	16814	827
Total general	87858	12571	148811	97773	23193
Selected >	5000	900	9000	5000	800

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Annex 3. Common grazing land: Surface (hectares), total number of holdings, number of holdings with livestock, Livestock Units (LSU) of holding with livestock and LSU of grazing livestock. Source: Eurostat. Data available from 2010. nd: no data available.

	Surface (ha)	Total Nº holdings	Nº holdings with livestock	LSU of holdings with livestock)	Grazing livestock (LSU)
Austria	252872	nd	nd	nd	1.546.550
Belgium	858563	42.850	31.820	3.798.680	1.876.050
Bulgaria	nd	370.490	279.710	1.149.470	744.430
Croatia	nd	233.280	194.090	1.020.180	487.160
Cyprus	805	38.860	9.950	200.750	91.160
Czech Republic	nd	22.860	15.920	1.722.460	1.001.070
Denmark	nd	42.100	26.030	4.919.400	1.199.090
Estonia	nd	19.610	9.680	306.280	196.580
Finland	nd	63.870	23.130	1.121.050	694.420
France	749492	516.100	309.370	22.674.170	15.099.090
Germany	nd	299.130	216.100	17.792.560	9.653.340
Greece	1689949	723.010	273.160	2.406.520	1.826.710
Hungary	73975	576.810	381.650	2.483.790	711.900
Ireland	422415	139.890	127.140	5.787.400	5.303.690
Italy	610165	1.620.880	217.330	9.911.520	5.302.870
Latvia	nd	83.390	48.700	474.630	316.100
Lithuania	nd	199.910	129.630	900.080	607.630
Luxembourg	nd	2.200	1.720	167.660	148.330
Malta	nd	12.530	2.740	41.650	14.810
Norway	nd	46.620	32.640	1.229.310	869.980
Netherlands	nd	72.320	50.440	6.711.500	3.038.860
Poland	nd	1.506.620	918.870	10.377.220	4.648.350
Portugal	127660	305.270	203.780	2.205.950	1.338.750
Romania	1497764	3.859.040	2.836.640	5.444.180	3.106.480
Slovakia	nd	24.460	18.390	668.340	389.480
Slovenia	8221	74.650	59.220	518.480	367.100

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Spain	1727617 (*)	989.800	245.160	14.830.940	6.312.600
Sweden	nd	71.090	40.360	1.751.890	1.224.860
United Kingdom	1195246	186.660	139.000	13.308.420	10.465.960
Iceland	nd	nd	nd	nd	145.830
Montenegro	nd	nd	nd	nd	97.760
Switzerland	nd	59.070	50.990	1.793.750	1.282.090

(*) Data cover only the part of common land which data were available

Annex 4. Importance of permanent grasslands and related habitats for biodiversity conservation. HD: Habitats Directive; BD: Birds Directive. Sources: Poláková et al (2011); Rosa García et al. (2013).

	Natural habitats	Semi-natural habitats		Improved grasslands		Cultivated Crops		
		Pastures	Meadows	Organic	Conventional	Extensive	Organic	Intensive
HD Annex 1 habitats [1]	63							
BD Annex 1 species [2]	54			32				
European HD Annex II Butterflies [3]	9	25						
European threatened amphibians [4]	3	5				1		
European threatened reptiles [5]	1	4						
Overall biodiversity importance	High biodiversity. Species rich and declining. Some species restricted to these habitats	High biodiversity and declining. Species-rich and some of themdependent on specific agricultural practices		Moderate biodiversity. Some species species of conservation importance use this habitats, sometimes in important numbers		High biodiversity. Rare habitat nowadays. Hold threatened species (e.g. birds)	Lower biodiversity levels in more intensive can be enhanced with proper management	

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