European grasslands overview: temperate region

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Abstract
The temperate region, from Ireland to Poland through France, Benelux and Germany is characterised by and important contribution of permanent and temporary grasslands to the Utilised Agricultural Area, with a strong decreasing gradient from West to East of the region, where they provided a range of environmental services, especially in terms of preservation of plant biodiversity. There are contrasting acreages of grasslands under organic farming. The acreage of permanent grasslands decreased on average over the last decades. The acreage of pure forage legume swards decreased too in relationship to the changes in annual cropping systems. The potential of biomass production from grasslands shows a strong West to East pattern. The whole forage and grassland systems are relevant with the changes in potential of animal performance, especially visible in dairy cows, that is showing a steady increase in genetic potential, a concentration around a dominating breed, and strong difference among countries for the monthly milk deliveries. There is a range of animal PDO products that ensured an economic valorisation of grassland-based production systems. Countries of the temperate regions also developed a very important plant breeding activity dedicated to grass and legume forage species. The present paper documents all these aspects for the various countries.

Introduction
Grasslands are a major component of the landscapes in temperate regions of Europe, as they are related to a very important economic activity of animal production. In the present paper, the temperate regions include oceanic, sub-oceanic and sub-continental climatic zones. We will analyse Ireland, the UK, France, the Benelux, Germany, Czech Republic, Slovakia and Poland. Because of the large variation in climate and soil conditions, and in history, both permanent and temporary grasslands are used, the later ones including a varying proportion of forage legumes. In the temperate regions, there is a very limited share of common land, and they little contribute to feed production, even if they can play a key role for preservation of environment in some areas.
In the paper, we will focus on the present acreage of permanent and temporary grasslands, the variation over the last decades and their production. We will also describe the animals that are using this feed resource and document their number and their productivity and investigate how this influence the grassland acreage and management. Temporary grasslands depend upon the seed sector and the potential genetic improvement of the varieties available for farmers. Alongside with these supporting and provisioning services, we will assess how the grasslands contribute to environmental services in the temperate regions.
The data presented in this paper were collected during the Multisward project (www.multisward.eu) (Huyghe et al., 2014)
1. Grassland acreage and production in temperate European regions and changes over years

1.1. Grasslands acreage and changes over decades

Permanent and temporary grasslands contribute a contrasting share of the utilised agricultural area in the various countries of the temperate region, as defined in the present study (Figure 1). Overall, permanent grasslands account for 75% to 20% of the UAA, in Ireland and Poland respectively. The share of temporary grasslands is lower, as it ranged from 15% in Ireland down to 2% in Poland. On average, this means that permanent and temporary grasslands are a key component of the agricultural landscape in the temperate region. There is a very strong gradient from the most oceanic countries where grasslands, and especially permanent grasslands are very abundant, to the most continental countries. This is to be related to the potential of biomass production (see section below).

![Figure 1. Share of permanent and temporary grasslands in 2009, expressed as a percentage of Utilised Agricultural Area (UAA) in the countries of the considered temperate region. Source: Eurostat, 2009.](image)

Organic farming is rapidly expanding in Europe and herbivore production based upon grasslands, both permanent and temporary, is the main production in organic farming. Indeed, this production is easier without mineral fertiliser and pesticide and makes it possible to combine with and to provide fertility to annual crops. However, there are strong differences among countries, both expressed as a percentage of the grasslands and in absolute values (Figure 2). Acreage of permanent grasslands under organic management is very large in Germany, UK, Czech Republic and France, while most organic forage crops (temporary grasslands and annual forage crops) are the most abundant in France, Poland and Germany.
Since the 70’ies, the proportion of permanent grasslands in the utilised agricultural area has slightly declined in France, Germany and Netherlands. But it remained very stable in Poland and UK and even slightly increased in Ireland (Figure 3). This is due both to the role they play in the economic activity as a cheap feed source for the herbivore production and to their ability to valorise poor soils or fragile environments. However, in countries where it declined, the losses of permanent grasslands, expressed in hectares may reach large areas. For instance in France, the limited variation in %UAA, is in reality 3 Mha of grasslands lost between 1970 and 2007. This loss corresponds for half of its to an abandonment and for the other part to a conversion into ploughed land and also to urbanisation (Huyghe et al., 2005). The stability reported for the permanent grasslands is also true for temporary grasslands in all countries. The only exception is the acreage of lucerne, when grown as pure stands, which severely declined where it was a significant crops in early 1970’ies.
Figure 3. Changes in the proportion of the permanent grassland area in the UAA (%) in some countries of the considered temperate region between 1961 and 2007. Source: FAOSTAT and authors’ own calculations

Even if the proportion of permanent and temporary grasslands appears stable at a country level, this may mask significant changes at the local level. This is especially important for the temporary grasslands, as they are both linked to the changes in animal production and the changes in the other crops of the rotations. One of the most striking examples is the spatial distribution of lucerne in the Seine Basin in France (Mignolet et al., 2012) (Figure 4). In this region, in 1970, lucerne was used both in mixed farms for feeding the herbivores and in specialised cereals farms where lucerne was used for dehydration. In 2010, the mixed farming mainly disappeared in the Seine Basin and lucerne is now only located where the dehydration factories are located. This clearly means that the contribution of lucerne, a perennial legume, is restricted to the sustainability of the cropping systems dominated by cereals. Moreover, this was accompanied by a strong reduction of animal production and a quick simplification of the rotations, down to 2 or 3 crops. Another example is the transfer from grassland to green maize in Brittany, Belgium, The Netherlands and Germany. In Belgium the grassland area decreased with 215 000 ha in the period 1970-2010 while the green maize area increased from 18 000 ha to 176 000 ha in the same period (Anonymous, 2014).
1.2. Biomass production and utilisation of feed

The potential of aerial biomass from grasslands predominated by grasses was calculated for Europe, under the hypothesis of a good sward structure, a good nitrogen fertilisation and a good water supply. These calculations were performed by Alain Peeters (Figure 5). The results slightly differ from the map drawn by Smit et al. (2008) by taking into account the soil quality. The striking feature is that the temperate region is the region with the highest potential of biomass production from grasslands, with on average good soil quality and adequate climate conditions. There is a slight West to East gradient, with higher potentials in the West due to the possibility to have longer growing seasons because of the oceanic climate. This is also to be related to the range of species that may be used for sowing temporary grasslands or being the most productive in the permanent grasslands. Indeed, in the Western part of the temperate region, perennial ryegrass is the predominant grass species, while on the eastern part of the considered zone, meadow fescue, smooth-stalked meadow grass and timothy will be used, and cocksfoot and tall fescue are used in France in the areas with a water stress in summer. Similarly, different legumes species are used in mixtures with grasses. White clover, suitable for grazing, is the most abundant in the Western countries while red clover, not suitable for grazing, is often used in mixtures in the Eastern countries of the temperate region.

A first consequence of this pattern is the mean livestock density (Figure 6). It is the highest in the Benelux countries and the lowest in Poland, Czech Republic and Slovakia. The lowest value in these countries may also be due to the lowest levels of fertilisation in some farms, in relevance with the lowest soil fertility.

The direct consequence of this pattern may be found in the management of grasslands and
especially their use by the animals. Where the potential of production is high, with a long growing season, grazing is the favourite practice, as it reduces the needs to make stocks and as a consequence the production costs. On the opposite, where growth is limited by cold winter, or summer drought, the duration of the growing season is getting shorter and stored feed (silage, hay, haylage) is produced and distributed either in barns or as a supplementary feed directly in the paddocks, especially for the suckling cows.

Figure 5. Production potential (annual yields in t DM/ha) of mown and heavily fertilised grasslands. Source: A. Peeters, own calculations.

Figure 6. Grazing livestock density in the countries of the temperate region in 2007. Source:
Eurostat and authors’ own calculations.

2. Animal production

The first ecosystem service provided by grasslands is the provisioning service, as they ensured the production of feed to ruminants. This diet, rich in cellulose and protein, may cover a large part, or all of the nutrient requirements of cattle and sheep. In the temperate regions, cattle represent the major part of the livestock units, even if there are large numbers of sheep in Ireland and especially in the UK, where they contribute 10 and 30% of the total grazing livestock respectively.

The number of dairy cows and suckling cows is presented in Figure 7. With more than 3.5 million dairy cows, Germany and France have the largest numbers of dairy cows in Europe. The numbers of dairy cows in most countries have steadily declined since the establishment of the milk quotas in 1984, as a consequence of the high increase in the milk yield per cow (Figure 9). The peculiarity of the temperate region is the high number of suckling cows (named as ‘other cows’ according to Eurostat). The number of suckling cows equals the number of dairy cows in Belgium, Ireland and UK and even exceeds it in France. All these countries have specialised meat breeds: Belgian Blue, Aberdeen Angus, Hereford, Limousin, Charolais, Blonde d’Aquitaine, ..... The predominant dairy breed is the Holstein Friesian, while other dairy breeds as Normande, Montbeliard and Braunvieh are also quite popular and experienced increasing genetic merits that are close to those met in Holstein Friesian.

As a consequence of the growing season of grasslands and the management of the herds, the monthly deliveries of milk greatly varied among countries. Figure 8 illustrates the most contrasting patterns among the temperate region. For Ireland, there is a strong peak production in spring and summer months, where the animals grazed the abundant feed and this is achieved thanks to spring calving. During the winter, because of the low feed resource available for grazing, the cows are dried. The milk industry has been adapted to this large peak to trough ratio. On the opposite, France has a fairly flat distribution of monthly milk delivery. This was achieved along years thanks to a differential milk price between spring and winter, encouraging the farmers to produce milk in autumn and winter. The feed resource is then ensured by stocks, mainly silage, from either grass or maize. Maize silage has to be supplemented with soy meals. Indeed, when grazing grass swards, or mixtures of grass and legumes, the animals cover their needs in energy and protein. However, this may not be the case for the very high yielding dairy cows for whom the energy-protein balance in grazed grass may not be optimal. When fed with maize silage whose protein content is very low, supplementation with soy meals is compulsory. As a consequence, the agronomic and economic performance based upon grasslands should be compared to the performance achieved on the virtual area of animal production system using maize silage and the area used abroad for producing the soy grains. In practice, grass, prewilted and sometimes fresh forage are combined with maize silage and balanced with protein-rich concentrates to supply enough energy and protein in a correct ratio.

This underlines the coherence between the grassland acreage and management, the extra feed and concentrate resources, the dairy cows management and the whole dairy industry sector. It also questions the genetic value of cows and their ability to valorise grasslands. In the course of Multisward project, the potential of hybrid breed for milk solid production, performance for grazing and reproductive performance (intervals between calvings) was underlined. And it is an extra component of this coherent system for the optimised use of feed biomass produced by grasslands.
However, the present trend in animal performance, especially milk production per cow, shows a constant increase in mean milk yield per cow and per year (Figure 9). The trend is very similar among countries of the temperate region, except Ireland where it is less steady. As a consequence, this increasing animal performance, which is for a large part of it due to an increasing genetic merit, will not be fully relevant with a large share of the grasslands in the animal feed. A combination of grass and maize silage in a ratio on DM basis varying between 60-40 to 40-60 and complemented with concentrates can fulfil the requirements of energy and protein for cows with a very high milk production.

The trend of increasing performance is less pronounced in beef cattle, even though a regular increase in animal weight at slaughter is recorded. Beef cattle, in general heifers and suckling cows in particular, in all the countries of the temperate region, are mainly fed through grazing, with hay or grass silage during the winter in all the countries of the temperate region. They well valorise the permanent grasslands in many regions. In most intensive production systems, the fattening bulls are in stable, fed with maize silage and concentrates during the finishing period.

Grassland-based dairy products have a very high value in most countries of the temperate regions. Many PDO cheeses are produced and give an additional market value. We could for instance name Comté or Beaufort in France produced in the Jura and Alps and fully based upon grazing or hay. It is also the case for Oscypek (PDO). This hard sheep’s milk cheese is produced mainly in the Podhale and Tatra regions, and was once served as payment between farmers and senior shepherds.

Figure 7. Number of dairy and other cows in the countries of the temperate region in 2011. Source: Eurostat, 2012.
Figure 8. Changes in the monthly milk delivery of cow milk to the dairy industry in France and Ireland in 2011 (in 1000 tonnes).

Figure 9. Mean milk yield per dairy cow in France, UK, Netherlands, Ireland and Poland over the last decades. Source: National statistics, ICAR database.

3. Breeding and seed production

The temperate region has a climate that is very favourable for an important breeding activity...
of forage species and also for seed production. Most large forage breeding companies are based in this region, except DLF which is located in Denmark but has many trial sites in the temperate region. This situation occurs because the temperate region is a major European market and varieties must be well adapted, in terms of phenology, potential of forage production, resistance to foliar diseases. One of the most important tasks facing breeding of fodder grasses in this region, was to develop genotypes from the *Lolium* genus of increased tolerance to drought and frost by way of introducing resistance genes using species from *Festuca* genus by interspecific crossing (Goliński et al., 2005; Zwierzykowski et al., 2004). In conjunction with this situation, many public research institutes are also based in the temperate region (Teagasc, Ibers Aberystwyth, Inra Lusignan, Univ. Hohenheim, Wageningen Univ., Univ. Poznan for instance).

The seed production is also very important both for forage grasses and legumes (Figure 10). Denmark is the only country that produces more grass seeds than any country of the temperate region, with 101 300 t on average between 2007 and 2009. Production is mainly devoted to grasses, with the exception of France and Czech Republic where significant production of forage legumes, mainly lucerne and red clover, are performed.

![Figure 10. Mean annual seed production in the various countries of the temperate region between 2007 and 2009 (in t). Source: National Certification Agencies.](image)

4. Environmental services of grasslands in the temperate regions

In comparison to other European regions, the temperate zone has a fairly low number of Natura 2000 sites, but hosts many High Nature Value farmland, especially in Scotland and Wales, Massif Central and the Alps, South of Germany, and the eastern and southern parts of Poland.

These regions are those where the grassland management is the less intensive and the biomass production is low. In the other grasslands, the high management intensity, both in terms of soil fertility or animal management tends to lead to a fairly low species diversity. Indeed, the botanical composition of pasture vegetation is strongly influenced by management (Štýbnarová et al., 2009). In case of remaining semi-natural pastures, botanical composition is the result of traditional agricultural activities such as haymaking or herding (Peratoner et al., 2009; Maurer et al. 2006; Isselstein et al., 2005). Plant species richness declines as fertiliser applications rise, especially nitrogen (e.g., Zechmeister et al., 2003) and phosphorus (Poozesh...
et al., 2008), even if, in some situations such as ultramafic soils of Tuscany, nutrient addition tended to increase the diversity (Ricotta et al., 2005). Nitrogen fertiliser levels — even when far below those applied on intensively managed grasslands — cause significant losses in sward plant diversity, with half of the number of plant species eliminated for fertilisations between 20 and 50 kg N/ha/yr (Plantureux et al., 2005). P enrichment presented a greater threat to biodiversity than N enrichment in a research on 132 semi-natural grasslands located along a gradient of nutrient availability and atmospheric N deposition. However, as N- and P-driven species loss appeared independent, results of this research suggest that simultaneously reducing N and P inputs is a prerequisite for maintaining maximum plant diversity (Ceulemans et al., 2013).

The abundance of forage legumes in the swards will have a similar effect. The impact of grazing management on grassland biodiversity has been documented in many studies (e.g., Rook and Tallowin, 2005). Nutrient depletion can be accelerated by haymaking. However, atmospheric nutrient deposits are increasing and are believed to slow down extensification effects on biodiversity (Plantureux et al., 2005).

Today, in regions with intensified agriculture such as the countries of the temperate region, semi-natural grasslands only persist on a low percentage of the total grassland area. Their preservation is a primary goal for nature conservation (Isselstein et al., 2005), such as through the Habitats Directive (1992) or the international treaty drawn up at the Ramsar Convention on Wetlands (1971). Semi-natural grasslands have persisted mainly on locations that are less suitable to agriculture because of biotic and abiotic constraints (Pärtel et al., 2005). Yet, areas of semi-natural grasslands still exist in Poland (Goliński and Golińska, 2011; Veen et al., 2001), where they must be preserved and possibly valorised economically, for instance through recreation of special and well-identified animal products (see above).

Erosion is becoming a major issue for the European soil (Souchère et al, 2003), as an effect of the change in land use. Because of their ability to reduce run-off thanks to the permanent soil cover, grasslands are a key asset for limiting soil erosion. In frame of good agricultural and environmental practices, permanent grassland is strongly recommended and in some regions obligatory and financially supported on slopes with a minimal gradient. However, because of the reduction of permanent grasslands area in the temperate region countries, this issue will become increasing important and should be considered as a benefit of grasslands.

Conclusions: the main drivers of the changes

Grasslands are experiencing dramatic changes in the countries of European temperate region. All the changes are occurring in a very relevant way related to an increasing animal performance and to an increasing productivity of human work in larger farms. Beyond the search for a higher biomass productivity, that is possible in this region because of the soil and climate conditions, there is also a risk of grassland abandonment or ploughing as herbivores, especially dairy cattle with high genetic merit are increasingly fed with maize silage complemented with soy cakes.

The common agricultural policy has been fully in line with this trend. The quotas, established in 1984, have secured the dairy farmers, and, in some countries, have slowed down the concentration of the milk production and the dairy industry in the most favourable zones for biomass production, milk processing and export. Their future disappearance will offer the possibility for a quick increase in mean production per dairy farm and, simultaneously a reduction in the number of dairy farms, that will be concentrated in these favourable zones.
However, these trends will endanger the large regulating, provisioning and cultural ecosystemic services provided by grassland and grassland-based production systems in the rest of the temperate region.

As a consequence, it is very important that the future European and national policies of the countries in the temperate region take into account both economic and environmental services provided by grasslands and grassland-based systems, but also consider the social aspects for farmers involved in the herbivore production and the whole society that makes a huge benefit from grasslands.

References


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