Biodiversity Indicators on Silvopastoralism across Europe

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Acknowledgements

Biodiversity is being influenced by miscellaneous driving forces. A major goal at global and European level aims at halting the loss of biodiversity by 2010. Since some years several international initiatives have emerged basing their work on developing indicators in order to assess the current state of biodiversity and the impact of different factors. Among these initiatives the European Environment Agency (EEA) is setting up a set of indicators where forest aspects are included within the biodiversity section. Such indicators may find application in policy and decision making processes while contemporarily providing transparent information on the environment to the public in general as expressed within the Aarhus Convention.

This report was elaborated as one of the tasks of the European Forest Institute (EFI) that were implemented for the European Topic Centre on Nature Protection and Biodiversity (ETC/NPB) of the EEA in particular towards EEA's activities on the development of indicators. The EFI has been a consortium member of the ETC/NPB from 2001 to 2004 and has addressed out a wide range of topics which may have influence on forest biodiversity. The topics include climate change, urban forestry, tourism, forest conservation, forest certification, silvopastoral management, illegal logging for which potential indicators were proposed. The current EFI Technical Report focuses on the influence of silvopastoralism on biodiversity.

The authors would like to thank Andreas Schuck and Jo van Brusselen from the EFI for their valuable assistance and comments on the report. Further the authors would also like to express their gratitude to Vasilios Papanastasis, Ioannis Ispikoudis and Kostas Mantzanas from the Aristotle University of Thessaloniki for their assistance at the time of preparing the report. Our sincere thanks goes also to the EEA represented by Tor-Björn Larsson and to Dominique Richard from the ETC/NPB

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Executive Summary

Agroforestry comprises a set of practices that combine crops and/or animals (an agronomic component) and trees (a forestry component) within the same area. It is a dynamic system that diversifies and sustains production with social, economic and environmental benefits for land users at all levels. In particular, silvopastoralism is one of the oldest practices of agroforestry, a deliberate growing of woody perennials on the same unit of land as livestock in interacting combinations for multiple products or benefits from the same management unit.

Within forests non-wood forest products, besides timber, can be an important source of income in rural areas. Among the products it is possible to list, mushrooms and truffles, cork, berries, medicinal plants, honey, nuts, barks, resin, tar… These products can be obtained both from forests, other wooded land and trees outside forest as for instance in silvopastoral systems, where also livestock is produced for wool, leather, meat or milk.

Silvopastoralism enhances biodiversity due to the diverse environmental conditions that are created within (vegetation structure, shading, moisture), but also in terms of preservation and improvement of landscape diversity and maintaining traditional systems. It increases connectivity within landscape components which benefit the mobility of animals thus reducing habitat fragmentation. Silvopastoral systems may simulate also structures and processes that were important when wild mega-herbivores were dominating European forests.

The loss of autochthonous animal breeds is currently alarming at global level. The responsibility of preserving them is very important for Europe, as half of the autochthonous livestock breeds are recorded to belong to this continent. These autochthonous species can be used within silvopastoralism due to their adaptation to local conditions. This is one of the ways in which silvopastoralism may contribute to reach the 2010 target of halting the loss of biodiversity, as endorsed at pan-European level by the Ministers of Environment at the fifth ‘Environment for Europe’ Ministerial Conference in Kiev, 2003.

A recent proposal for amendment of the Rural Development Policy (14/07/2004 COM(2004)490) addresses the development of rural areas and animal welfare. It gives for the first time in European policy attention to the activities which combine both agricultural and forest. Among the priorities of rural development concerning land use planning is the support for farmers to establish agroforestry systems combining extensive forestry and agricultural systems. These are systems with many advantages. They are however also more difficult with respect to management due to the interactions between the components forest, pasture and husbandry production. This calls for appropriate knowledge transfer.

Due to the important economic, ecological and social role that silvopastoral systems can play in different environments, there is a need for the studying their state-of-the-art in order to set up a basis for further monitoring, management and planning of the production and conservation of natural resources in Europe. The role that the different types of silvopastoral systems can play for sustainable land management and the preservation of biodiversity rich landscapes across many regions in Europe, justifies the development of indicators to assess its state and trends regarding biodiversity features.

This report has been compiled under the umbrella of the ‘Forest Biodiversity Indicators and EUNIS’ project carried out during 2004 at the European Forest Institute (EFI) for the European Topic Centre on Nature Protection and Biodiversity (ETC/NPB) of the European Environment Agency (EEA). It presents a brief review of the silvopastoral systems in Europe. The report includes a historical review of silvopastoral systems and groups them under different types of existing systems. It describes the social, economic and environmental benefits, as well as the different policies at global, pan-European and European Community level that may have influence on the evolution of these systems.

After compiling the background information on silvopastoral systems, international initiatives on indicators were screened to search for already existing indicators assessing biodiversity in relation to these systems. Further proposal for additional indicators were elaborated following the EEA Indicator Fact Sheet model. These indicators may serve as an input to the environmental indicators process as promoted by the EEA. The following indicators have been selected for further development with the aim to (a) contribute to policy and decision making processes and (b) raise awareness among European citizens:

1. Types of silvopastoral systems: species composition
2. Afforested land: potential area for silvopastoralism
3. Silvopastoralism within European policy
4. Forest damage by wildlife and grazing.

These four indicators are considered relevant by the authors to assess biodiversity of silvopastoral systems across Europe, their potential contribution to a sustainable land management and the preservation of our biodiversity rich landscapes.

1. Introduction

Agroforestry comprises a set of practices that combine trees and crops and/or animals within the same area. It is a dynamic system that diversifies and sustains production with social, economic and environmental benefits for land users at all levels. In particular, silvopastoralism is one of the oldest practices of agroforestry, a deliberate growing of woody perennials on the same unit of land as livestock in interacting combinations for multiple products or benefits from the same management unit (Nair 1993).

Within forests, besides timber, non-wood forest products are an important source of income in rural areas. Among the products it is possible to list, mushrooms and truffles, cork, berries, medicinal plants, honey, nuts, barks, resin, tar… These products can be obtained both from forests, other wooded land and trees outside forest as for instance in silvopastoral systems, where also livestock is produced for wool, leather, meat or milk.

Due to the important economic, ecological and social role that these silvopastoral systems play its typification is justified and mapping its geographical distribution in the different European countries would be useful.

The current report will present a brief review of the situation of the silvopastoral systems in Europe along history, its assets concerning biodiversity and sustainability and the policies that affect its implementation. Finally, proposals are made for the development of the indicators for assessing the biodiversity within silvopastoral systems across Europe.

2. Historical perspective

There exist several theories on how forests looked like before humans started playing a role in the change of landscape. One of them supports the idea of the existence of mega-herbivorous influencing the structure and development of the forests, leading to a co-evolution of the tree species adapted to such animal pressure. It is supposed that there existed more gaps within the forest, bigger trees were more abundant, and seedlings might have been scarcer that in the current pristine forests (Bengtsson et al. 2000). Most of that wild herbivorous of European forests have disappeared and been replaced by domesticated animals already in Roman times, when already many of the silvopastoralism principles were recognized (MacDicken et al. 1990). High pruning allowed the sun-light to reach the understorey consisting of crops and allowing forage under trees, at the same time, while pruned branches were used as firewood and the leaves as food for cattle. Sheep and goats grazed under olive and orange trees keeping control of the vegetation and having shelter under the trees. Leaves and fruits were used as complementary feed in periods of drought.

In Europe it was common until the Middle Ages to fell degraded forests, burn the area, establish crops for several years and to plant or sew trees before, during or after sowing the crops. This practice was still common in different countries until the XIX century, e.g. in Finland, or in the XX century as in Germany (Nair 1993).

Though it was already in the XVII century that, in connection with a high demand on wood products (e.g. for naval construction), forests started to be closed to livestock (Rubino 1996). The XVIII century is the moment when it is considered definitively that agriculture and forest should occupy different land (Rackham 2001). Prior to that idea coming into the general thinking, main functions of the forests were the provision of acorns or other fruits for the livestock and game, production of firewood and timber and forage for grazing. Still in some places as Northern Scandinavia, mountain areas and the Mediterranean basin forests kept serving also for grazing.

Not only livestock was forbidden in forest but trees have been increasingly removed from European agricultural landscapes, mainly because of agricultural mechanization, land reallocations and the increasing specialization of farming enterprises (Herzog 2000).

Therefore both sectors agriculture and forestry followed independent paths and traditional mixed approaches were considered in more marginal areas. Nevertheless since some monocultures may lead to environmental degradation it is in the 70s when forest researchers realize the potential of the agroforestry systems as a possible land use common to both disciplines (Nair 1993; Rigueiro et al. 1999). Also agricultural scientists became aware of the functions and benefits of trees in agricultural landscapes and this has provoked efforts to conserve them (Herzog 2000).

A general, underlying problem rests in the fact that the presence of trees on farmland may change the legal status of the land, bringing it into the domain of forestry and nature protection laws. These laws often restrict the farmers' options. Only a "landscape approach" can lead to coherence between agricultural, forest and environmental policies (European Union DG VI: Agriculture, 1998 in Herzog 2000).

3. Types of silvopastoral systems across Europe

Agroforestry is the science that studies the agroforestry systems, within which are included the silvopastoral practices. Agroforestry is the practice of combining trees, crops and/or livestock in the same land in any spatial or temporal arrangement (Nair 1993, Silva-Pando & Rozados-Lorenzo 2002).

The 'silvopastoral systems' can be defined as managed units of three main components within a particular edapho-climatic context: (1) trees, (2) pasture and (3) animals (Mosquera-Losada et al. 2001). When crops as a fourth component are also present, the system would be typified as 'agrosilvopastoral'. The main limiting factors for pasture production are water availability, nutrients and sunlight. Man influences through the management the components of the system, its interactions and derived productivity.

Nowadays several criteria are used to classify the silvopastoral systems, among such criteria it is possible to identify the systems according to spatial and temporal arrangement and according to the biogeographical region where they are implemented.

According to the criteria on the spatial and temporal planning of the components the following types are specified (Mosquera-Losada et al. 2001): (a) silvopastoral systems within the same area and time-scale, and (b) silvopastoral systems in the same time-scale but not same area.

(a) Silvopastoral systems within the same area and time-scale

i Pure silvopastoral systems or grazing in the forest

In order to allow sun-light to reach the understorey it might be convenient to do some thinning and pruning depending on the state of the forest stand. Livestock will benefit then of the growing understorey species. Tree density may vary through a wide range. Example of this type is the Iberian dehesa or montado and the Nordic reindeer husbandry.

The Spanish **dehesa** and Portuguese **montado** are the same system, usually using *Quercus suber* or *Quercus ilex* with pigs, sheep, goats, cows or bulls. It is a system that goes back more than 1000 years ago (San Miguel 1994; Gómez-Gutiérrez 1992). Oaks provided with acorns for animal but also for human consumption, and other products as timber, coal, tannins and cork.

Reindeer husbandry in northern boreal forests is another example of silvopastoralism. Semi-domesticated reindeer feed on lichens, dwarf bushes and grasses in the forests. They can dig into the snow to find food until the snow layer is too thick, when they turn to eat the lichens from the tree crown (Kumpula 2001). Recently felled trees can therefore provide a high proportion of lichens for the reindeer. Since the number of old trees rich in lichens is low, planning should foresee felling such trees in winter and leave the branches for some time in the stand. Summer harvest affects the reindeer much less, since there are enough grasses and vegetation for the reindeer.

ii Ligniculture on sward

It consists of forest trees planted at very low density; therefore many of such plantations may not be covered by the definition of forest. Examples of this type are found in the United Kingdom or Ireland with species such as maple, aspen, ash or oak grazed by sheep or cattle. Spacing may range from 100 to 400 trees/ha. Other example is the poplars in Navarre (Spain)

where bovine breeds are used for clearing understorey. This low density will allow maintaining the pasture as main production of the region but generating further income with forest products.

iii Silvopastoral systems in lines

Trees are established as lineal formations to act as living fences, windbreaks offering also shelter for livestock.

In mid XIX century trees were planted as **windbreaks** around crops, swards and farms. The main function was to prevent from wind erosion, but at the same time trees provided shelter for animals and were a source of firewood and timber (Nair 1993). They were widely used in France, Denmark and the Russian steppe.

Living fences have played an important role in Great Britain. They have been established between 1700 and 1870 but many of them have been eliminated between 1946 and 1970 in order to dedicate more land to mechanised crop management. Still many of them have remained due to high costs of the removal but also due to the recognized environmental and landscape benefits and property delimitation (Caborn 1971). In most European countries, the establishment of hedgerows and forested riparian buffers is subsidized by agri-environmental programmes which are based on EU regulation EEC 2078/92, on agricultural production methods compatible with the requirements for protection of the environment and maintenance of the countryside. However the implementation and effect of those programmes varies strongly between member countries. In France, for instance, up to 1500 km of hedgerows are planted every year.

(b) Silvopastoral systems in the same time-scale but not in area

i Forestry in livestock farm

It forms a mosaic of swards, crops and forest trees not within the stand but at landscape level. This type requires a higher maintenance cost but it holds a high landscape and ecological value. The different patches form a discontinuity that offers greater resistance to the spread of forest fires, comparing to large continuous forest stands (Loehle 2004).

A broad characterization of the above described systems in Europe can be based on the criteria according to the biogeographical regions (Figure 1), to which the species and management are adapted to.

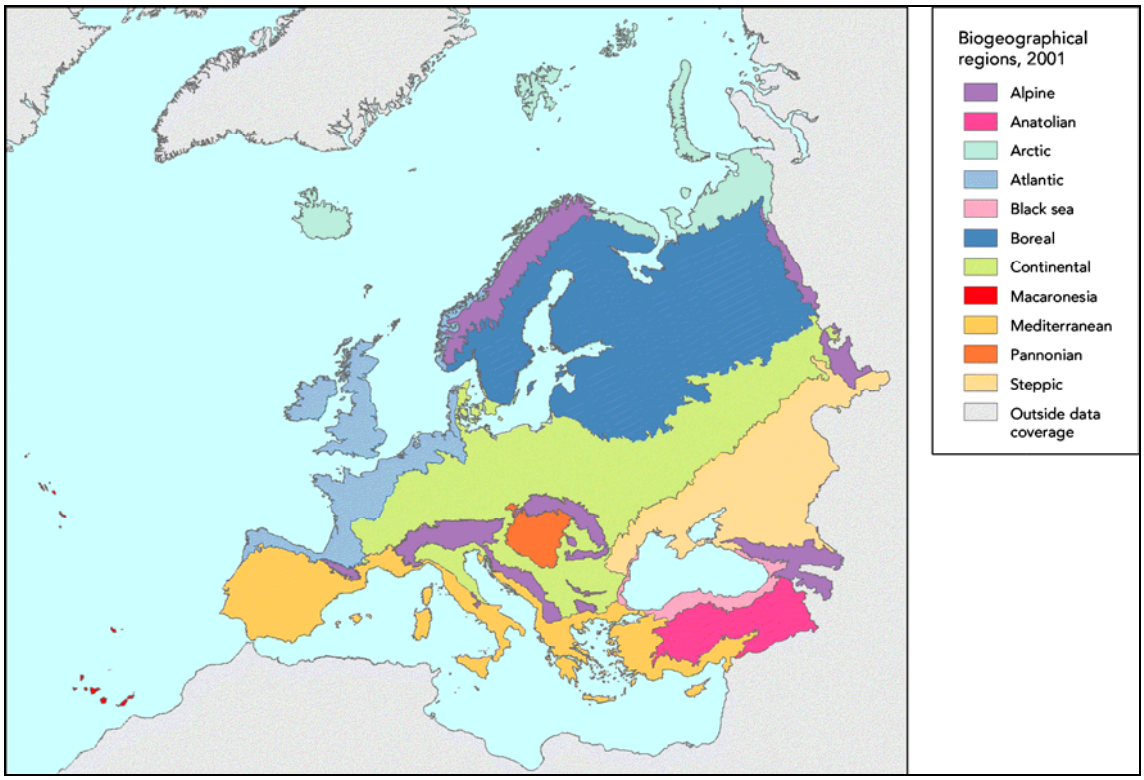

Figure 1. Biogeographical regions in Europe (EEA 2001).

Examples of silvopastoral systems adapted to these areas are:

- Atlantic area: *wood pastures* in northern Spain, living fences or hedgerows in Great Britain

Continental area: windbreaks in Russia

Alpine area: *larchenwisen* (larch meadows) of the eastern Alps and Jura mountains

Boreal area: *lovangar* (foliage meadows) of Sweden, *reindeer husbandry* in Finland

Mediterranean area: *dehesas* in Spain, *montados* in Portugal, *kouri* (wood pastures) in Greece, *pascoli arborati* in Italy

Silvopastoral systems are of special relevance in the Mediterranean region, nevertheless there is also scarce but traditional implementation of these systems in other parts of Europe and furthermore new experiments in other areas as the case of Great Britain. The origin of silvopastoral systems differs between the British Isles and the rest of Europe, in the sense that in the British Isles woodland was almost inexistent and silvopastures established from a base of open pasture, what required a longer process. On the European mainland, a tree base already existed, so types evolved from woodland and grazing land and mingled in farm-forestry interface (McAdam 2004). These systems account for a high biodiversity and form part of the tradition and culture of the people of each country (Ispikoudis & Sioliou 2004).

In Europe there is not a monitoring scheme on silvopastoral practices, but on forestry in general, within which some silvopastoral practices are included. Forest and 'other wooded land' are important natural resources that provide a wide range of goods and services, covering 47% of Europe's land (MCPFE 2003). Total forest area (excluding other wooded land) amounts to 1000 million ha, of which 800 million ha growing in the Russian Federation. Other wooded land amounts in Europe to 112 thousand ha mainly in Southern and Northern countries, e.g. Mediterranean macchia and Nordic peat lands. While forest area is increasing in all European countries but in the Russian Federation, other wooded land was slightly decreasing during the last decade, mainly due to conversion of other wooded land to forest land, mainly in Mediterranean countries but also in Slovenia and Finland (MCPFE 2003). Existing forest monitoring schemes refer to several parameters on forest, other wooded land and trees outside forestry but there are not reliable and harmonized statistics on forests managed with livestock. Depending on its tree cover, area or width, silvopastoral systems are included under forest area, other wooded land, as trees outside forest or even under agricultural area. Silvopastoral systems may fall within the different terms (forest, other wooded land and trees outside forestry) due to the different shape they might adopt: crown cover, area, width… There exist though scattered figures for some countries or types. Dehesas in Spain and Portugal cover round 3 mill ha, ancient grazed wooded land are estimated to cover 8,500-17,000 ha in Scotland, grazing in mountains is spread over 15% of the forest land in Switzerland, approximately 1,200 and 1,500 km of hedgerows are planted every year in Denmark and France and all silvopastoral systems in Germany amount to nearly 60,000 ha. It is also known that in Spain 74% of the forest area (almost 20 million ha) hold some type of extensive livestock husbandry. Even if this type of management seems to be of importance in some regions there is a clear lack of harmonized statistics on the real area occupied by these systems that could justify a study on the classification and geographical distribution as a particular type of forest management.

It is not possible to give an accurate estimation neither based on the data collected at pan-European level that is the CORINE LandCover database (CLC). Silvopastoral systems in their different types may fall under several of the different classes and subclasses of the CLC: (1) olive groves, (2) pastures, (3) agro-forestry areas, (4) broad-leaved forests, (5) coniferous forest, (4) natural grasslands, (5) sclerophylous vegetation and (6) transitional woodland/shrub (Table 1). Nevertheless such classes and subclasses may include some areas that are not silvopastoral landscape and it is not possible to separate such landscapes within the database. Therefore it is not advisable to give any estimation based on the CORINE LandCover since it would show a larger area not representative of the current silvopastoral landscapes in Europe.

Table 1. CORINE LandCover classes that may include silvopastoral landscapes.

Class 2: Agricultural areas

Class 2.2 Permanent crops
All surfaces occupied by permanent crops, not under a rotation system. Includes ligneous crops of standards cultures for fruit production such as extensive fruit orchards, olive groves, chestnut groves, walnut groves shrub orchards such as vineyards and some specific low-system orchard plantation, espaliers and climbers.

223 Olive groves
Areas planted with olive trees *Olea europaea* ssp. *europaea*, including mixed occurrence of olive trees and vines on the same parcel.

This heading includes olive groves shading herbaceous layer. This heading excludes olive trees (Olea europaea ssp. sylvestris) as part of evergreen forest areas (class 311); wild olive trees (Oleaster spp.) as part of sclerophyllous vegetation areas (class 323); abandoned olive groves (class 323).

Class 2.3 Pastures
Lands, which are permanently used (at least 5 years) for fodder production. Includes natural or sown herbaceous species, unimproved or lightly improved meadows and grazed or mechanically harvested meadows.

231 Pastures: Dense grass cover dominated by graminacea, not under a rotation system. Mainly for grazing, but the fodder may be harvested mechanically. Includes areas with hedges (bocage). This class includes grazing used by cattle. Including among other types also scattered trees and shrubs (10-20% of surface)

Particularity of class 231: Wooded meadows: meadows where dispersed trees and shrubs occupy up to 50% of the area. These meadows are characterized by rich floristic composition.

Class 2.4 Heterogeneous agricultural areas
Areas of annual crops associated with permanent crops on the same parcel, annual crops cultivated under forest trees, areas of annual crops, meadows and/or permanent crops which are juxtaposed, landscapes in which crops and pastures are intimately mixed with natural vegetation or natural areas.

244 Agro-forestry areas: Annual crops or grazing land under the wooded cover of forestry species.
This class includes annual crops or grazing land and fallow land covering less than 50% of the surface. This heading includes areas of forest trees imbricated with fruit trees/olive trees while neither of the two kinds of trees dominates; carob trees shading agricultural lands; agricultural land shaded by palm trees in Mediterranean context.

Table 1. continued.

Class 3 Forests
Areas occupied by forests and woodlands with a vegetation pattern composed of native or exotic coniferous and/or deciduous trees and which can be used for the production of timber or other forest products. The forest trees are under normal climatic conditions higher than 5 m with a canopy closure of 30% at least. In case of young plantation, the
minimum cut-off-point is 500 subjects by ha.

311 Broad-leaved forest
Vegetation formation composed principally of trees, including shrub and bush understoreys, where broad-leaved species predominate.

This heading includes among others plantations of eucalyptus; walnut trees and chestnut trees used for wood production included into forest area context; evergreen broad-leaved woodlands composed of sclerophyllous trees (mainly *Quercus Ilex*, *Quercus Suber*, *Quercus Rotondifolia*); olive-carob forests dominated by *Olea europaea sp. sylvestris*, *Ceratonia siliqua*; etc.

312 Coniferous forest
Vegetation formation composed principaly of trees, including shrub and bush understoreys, where coniferous species predominate.

This heading includes among others non-evergreen coniferous trees woodland composed of larch trees (*Larix spp.*); coniferous wooded land;

Class 3.2 Shrubs and/or herbaceous vegetation associations
Temperate shrubby areas with Atlantic and alpine heaths, sub Alpine bush and tall herb communities, deciduous forest re-colonisation, hedgerows, dwarf conifers. Mediterranean and sub-Mediterranean evergreen sclerophyllous bush and scrub (maquis, garrigue, mattoral, phrygana sensu lato), re-colonisation and degradation stages of broad-leaved evergreen forests.

321 Natural grassland
Natural grasslands are areas with herbaceous vegetation which cover at least 75% of the surface covered by vegetation which developed under a minimum human interference (not mowed, fertilized or stimulated by chemicals which might influence production of biomass); here belong for instance areas of shrub formations of scattered trees.

323 Sclerophylous vegetation
This class includes evergreen sclerophyllous bushes and scrubs which compose maquis, garrigue, mattoral and phrygana. This heading includes among others abandoned olive groves.

324 Transitional woodland/shrub
Bushy or herbaceous vegetation with scattered trees. Areas of natural developmental forest formations for instance; in abandoned meadows and pastures etc.

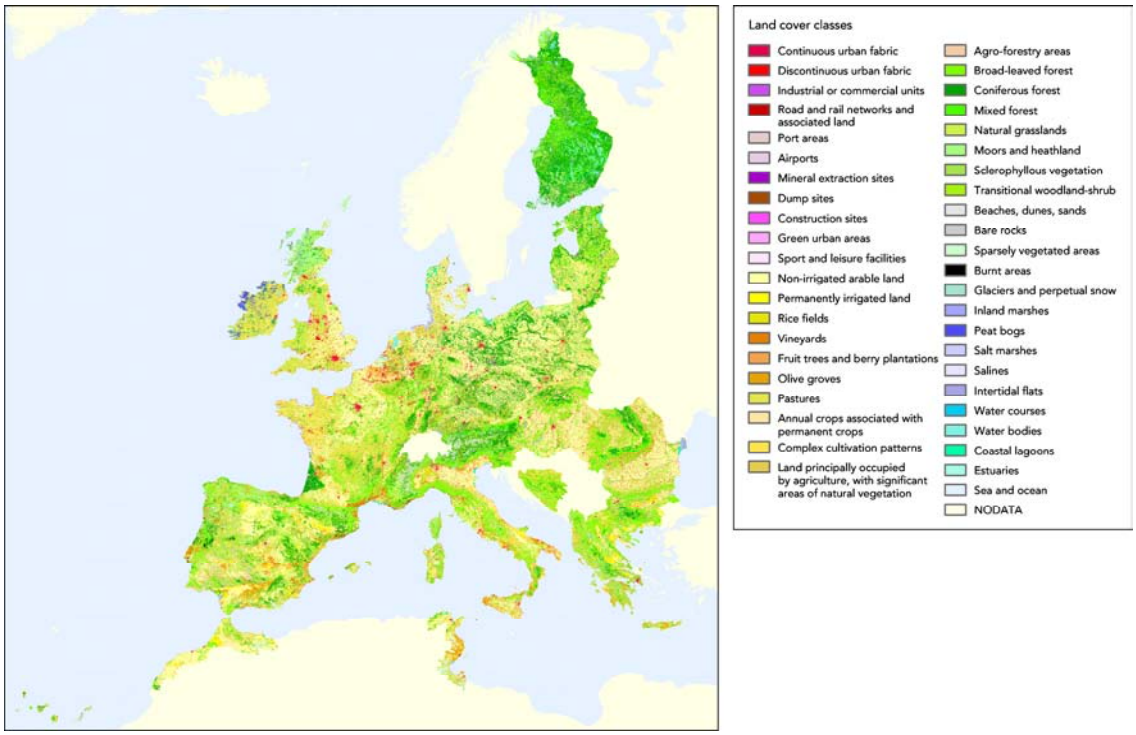

Figure 2. Corine LandCover map (European Environment Agency).

Even if silvopastoral landscape are of importance in some regions (e.g. Mediterranean area) there is a clear lack of harmonized statistics on the real area occupied by these systems in their different combinations that could justify a study on the classification and geographical distribution across Europe as a particular type of landscape and management.

4. Benefits of silvopastoral systems

In 1987, the World Commission on Environment and Development developed a political concept that has been widely accepted, which is *sustainable development* that has the goal to *meet the needs of current generations without compromising the capacity of future generations to meet their own needs*. Such concept constituted the basis for the organization of one of the main international summits, the United Nations Conference on Environment and Development, in Rio de Janeiro (1992).

Advantages of silvopastoral systems hold economic, social and environmental dimensions, which are the pillars of sustainable development. Such benefits are described below. Special attention is dedicated to biodiversity issues within silvopastoral systems.

4.1. Economic benefits

Silvopastoral systems are a system where the interaction of the different components promotes a complementary use of the available resources. This synergy leads to a higher **productivity** than of the components individually (Sharrow 1997). Several case studies in temperate areas show a possible increase of the productivity up to 25 or 50% of these systems in comparison to pure forestry in countries such as Spain, France, United States and United Kingdom (Sibbald 1996), Mosquera-Losada et al. 2001). Productivity is kept in long-term, while diminishing the economic risk due to the high diversification of products, including timber, meat, leader, firewood, fruits, mushrooms, medicinal and ornamental plants, etc (Balandier 2002; Klopfenstein et al. 1997). Production costs are rather low (Klopfenstein et al. 1997), and in the Mediterranean area the period of use of the pasture increases since trees will favour growth of pasture for longer period than when pure swards are fully exposed to dry conditions (Balandier 2002). Besides the quantity and quality, the period of availability is a very important factor to consider in order to expand grazing season, as was highlighted in the last meetings of the European Grassland Federation (Peyraud et al. 2004).

Some expensive management practices become not necessary as for instance the clearings since livestock will graze the understorey. The same as in forest stands, early pruning will favour knot-free high quality timber with consequent high economic benefits (Balandier 2002; Sharrow 1997). In silvopastoral systems such pruning practices will allow more light to reach the understorey what results in higher and longer pasture productivity (Sharrow 1997). Several forage species under tree shelter tend to have lower fibre and being more digestive due to slower ripening under shadow and softer wind (Klopfenstein et al. 1997; Sharrow 1997). Shelter for forage species and for livestock improves livestock productivity and also diminishes its mortality (Klopfenstein et al. 1997). Also tree leaves fodder (e.g. *Morus alba*) has high nutrient value and provides healthier food for animals since it has not received either chemical components or livestock manure. All in all these systems contribute to improve the animal welfare that is one of the measures adopted under the CAP.

4.2. Social benefits

Such economic productivity can enhance **rural development** and can help to keep population living on the countryside (Klopfenstein et al. 1997), being rural abandonment a problem that Europe has to face. Rural economies can be revitalized by implementation of diversified

sustainable practices. Tourism can be also promoted within these systems, since they form landscapes highly appreciated by society. Since silvopastoral practices also favour game production, they can play a role in hunting planning and derived income and tourism (Klopfenstein et al. 1997; Sharrow 1997).

4.3. Environmental benefits

Several environmental benefits are also derived. **Biodiversity** is favoured due to the several gradients of light, moisture, physical aspects, etc. generated by trees in combination with grasses and shrubs, more diverse than in arable land without trees. These gradients offer great variety of ecological niches for plants and animals with different requirements (Herzog 2000). Biodiversity aspects of silvopastoral systems are further explained in the following section *4.4 Biodiversity in silvopastoral systems*.

Environmental concerns are also tackled within silvopastoral systems. Especially in young forest stands with roots in the upper soil layers, forage species (herbs or shrubs) are a competing factor for water and nutrients. Livestock will, while grazing, decrease this competition. Also understorey species will be controlled by livestock so that no herbicides will be needed, diminishing therefore expenses and environmental pollution (Klopfenstein et al. 1997). Manure of livestock will contribute to nutrients recycling (N, P, K…) in the system, reducing then the need for fertilizers (Sharrow 1997, Nair & Kalmbacher 2004). In older stands tree-roots grow deeper than grasses (Sinclair 1999), therefore nitrate and phosphate pollution is absorbed and reduced. Otherwise the affluent could affect rivers and other water catchments (Balls et al. 1995). Soil erosion prevention is also a benefit of the forest and herbaceous cover in such systems. The problem of compaction due to livestock can reduce biodiversity and lead to soil erosion, but it can be controlled with a proper livestock stocking rate.

The silvopastoral systems are a more environmentally friendly approach than intensive farms concerning water quality, odours, noise levels, treatment and sickness of animals (Klopfenstein et al. 1997). Also due to a lower number of mechanized activities than in standard agriculture (soil preparation, irrigation, sowing, transport, fertilizers, pesticides…) that release carbon (C) to the atmosphere, these systems contribute to control the emission of greenhouse gases, functioning also as C sinks and could be e.g. valuable as buffer around sensitive nature areas. Some experiments show that young silvopastoral stands can fix 740 kg ha^{-1} $year^{-1}$ more C that young forest stands for the same density, and 520 kg ha^{-1} $año^{-1}$ more than in swards showing a more efficient C assimilation than both monocultures (Sharrow & Ismail 2004).

Another important environmental benefit is the reduction of forest fires risk. This is a consequence of the control of development of fuel vegetation by grazing. Therefore profitability and biodiversity will be maintained and C release due to fire will be avoided. Forest fires are a very important problem in Europe, especially in Southern Europe where these systems are considered of great importance both within forest stands and in fire-breaks to keep them clean of vegetation. Nevertheless livestock numbers have been decreasing in Mediterranean pastures and this has led to reduced flora biodiversity, increasing shrub encroachment and accumulation of fuel biomass with the consequence of increasing the risk for major forest fires (Dal Zennaro et al. 2004). Furthermore it is necessary to involve local communities in forest management and protection in order to avoid intentioned fires (FAO 2003).

Shrestha & Alavalapati (2004) have studied the environmental benefits (improvement of water quality, carbon sequestration, habitat protection for wildlife…) of silvopastoral practices in Florida region. Valuation method was based on the willingness of inhabitants to pay for such public goods. Environmental benefits are public benefits, being though the farmers who pay the costs of the establishment and maintenance, and therefore they do not consider these services

when taking any related decisions. If such externalities would be internalized by means of compensatory policies, farmers might adopt more environmentally-friendly practices such as silvopastoralism to generate environmental services at optimum levels. In that case study inhabitants would be willing to pay between 30 and 70 US$ per year during 5 years for such services, and this funding could be used to compensate to farmers. Such measures should be socially acceptable and efficient. Further more market incentives may reduce public costs.

In conclusion agroforestry in general and silvopastoralism in particular in Europe could help reducing surpluses of agricultural products, promote or enhance rural employment, create new environments and landscapes, and reduce European imports of good quality timber (Bergez & Msika 1996). Productivity in silvopastoral systems is kept in long-term due to the high diversification of products, animal welfare is improved, and rural development is enhanced maintaining the population living in the countryside while also tourism is promoted. Environmental benefits are also achieved within, biodiversity is favoured, nitrate and phosphate pollution is reduced, C sequestration is assured, and erosion and forest fires risk are reduced. Silvopastoralism is a potentially valuable land use option as also recognized by the Agenda 21.

4.4. Biodiversity in silvopastoral systems

The Convention on Biological Diversity defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

Biodiversity loss may have important consequences for the human wellbeing, both for developed and developing countries, since it would reduce the resilience and ecosystem capacity to provide goods and services, including water, food, medicines and cultural, historical, scientific and educational resources (Martens et al. 2003). A better landscape planning, management and response measures bearing in mind ecological and social consequences of biodiversity loss may offer a better landscape management for preservation and enhancement of biodiversity.

Agroforestry systems in general and silvopastoral systems in particular promote the maintenance of biodiversity for several reasons. These systems create gradients of moisture, light and fertility in soil so that many different microbial and vegetal species adapted to the different microclimates can be developed (Mosquera-Losada et al. 2004). The size, structure and pattern of the trees' leaves will allow different intensity of sun-light in understorey, also different chemical composition and decomposition rate will determine the species to develop in the stand, including birds, butterflies… Furthermore livestock will favour some species or others and modify their interactions. Biodiversity is also enhanced due to the connection between forest and agricultural habitats, acting as corridors for the movement of the species.

It is not known how European forests looked exactly like before humans started playing a role in the change of landscapes. Several theories exist. One hypothesis sustains that mega-herbivorous lived in the forests and they had influence on the structure and development of the forests, with the consequent co-evolution of tree species as a response to such pressure. More gaps were created, more large trees and less seedlings were present than in the "pristine" forests. Some authors hold the idea that some grazed forests in England or the dehesa in Spain might be more similar to the original forests than the ones that are not grazed (Bengtsson et al. 2000). Such mega-herbivorous have been replaced by domestic animals in Roman times. In the Mediterranean region for instance, where grazing in forest has been kept in many areas, it is possible to find a high richness of vascular species (ca. 30,000). This theory needs a rigorous evaluation, given the current interest in Europe to mimic natural forest structure in silvicultural

practice and to set aside forest areas for natural succession (Bradshaw et al. 1994; Larsen 1995). Each interglacial period had its own characteristics both in climate and in species content, e.g. the penultimate interglacial had a markedly savanna-like aspect with abundant grazing elements like mammoth and horse, while the last interglacial had a fauna that reflected a higher proportion of forest habitat. However, the presence of mixed-feeding ungulates, as well as browsers, in each of the Middle and Late Pleistocene interglacials in Britain, indicates that even the more densely forested episodes were tempered by locally open spaces. It is suggested that a mixture of open and closed habitats was favourable to the high mammalian diversity. It is also plausible that such a mosaic might have been partly maintained by the activities of the herbivores themselves. Main causes of these extinctions are human hunting and major changes in vegetation structure driven by climate change (Bradshaw et al. 2003).

Much of the present-day, non-intervention, old growth, temperate, mixed deciduous forest found in northwest Europe is closed in structure with little light reaching the forest floor. Light-demanding species, including trees and shrubs such as *Quercus* and *Corylus* and other species linked to forest habitats, cannot easily regenerate under these conditions and are declining in abundance. At the same time much valuable biodiversity, particularly among insects and herbaceous plants, is linked to open habitats even though, at present, these conditions can only be created and maintained by cultural activities (Nilsson 1997). Vera (2000) has suggested that contemporary, non-intervention forests significantly differ in structure and dynamics to forests occurring earlier, prior to intensive anthropogenic influence. On the other hand, the contrasting 'high forest' hypothesis assemblages were so dominated by tree pollen that they interpreted the first European forests as dense, dark habitats with little evidence of an extensive herbaceous layer. Large herbivores were not thought to have played a major ecological role in these systems. A complete theory should probably incorporate elements of both hypotheses.

Browsing animals, storms and fires were factors contributing to open conditions, but it would be wrong to emphasize one factor to the exclusion of the others. The disturbance factors acted together to create a varied landscape that hosted a great diversity of species. The balance of the palaeoecological evidence however indicates that the landscape was primarily a closed forest matrix containing some open areas rather than vice versa.

Semi-natural grasslands, grazed mountain lands and alpine pastures and meadows are considered as *high nature value farmland areas* (*HNVF*) (EEA/UNEP 2004). Also part of silvopastoral systems (e.g. dehesas) are considered within this term. All these areas can host high biodiversity. These low-intensity practices allow wildlife to flourish, having therefore a crucial role to play for meeting the 2010 goal of halting the loss of biodiversity. Nevertheless such high nature value farmland areas are under severe pressure from two contrasting trends: increasing intensity of agriculture in some areas and abandonment of farming in others. Its conservation depends largely on the rural development measures that can be taken under the EU common agricultural policy (EEA 2004). Part of these high nature value areas are also included within Nature 2000 sites. These Natura 2000 sites in some countries match in fact with ancient transhumant routes that passed through pastures and also silvopastoral landscapes (Ispikoudis et al. 2004). In Europe many of the most valuable areas for wildlife are often semi-natural habitats where species have co-evolved with traditional agricultural practices for centuries. These landscapes associated to traditional practices are usually seen as of cultural importance.

The grazed temperate swards are more heterogeneous than mechanically harvested swards, with a natural dynamic that results in a higher diversity of fauna and flora. Such heterogeneity is influenced by the grazing, which is based on a combination of factors such as the diet of livestock, trampling, nutrients cycle (manure and urine), seeds dispersal, etc (Adler et al. 2001; Rook et al. 2004). Diet selection depends on the species size, its metabolism, physiological condition, breed, sex, age, etc… The same effects are observed in swards under tree cover. Grazing can cause sometimes a decrease in heterogeneity but causes are not so clear as for increasing it (Adler et al. 2001). A very important and crucial factor affecting the dynamic and

health of the systems is the stocking rate (Rook et al. 2004). In the United Kingdom horses have been considered as an animal not appropriate for conservation of heathlands, but this has been due to the use of a too high stocking rate (Bullock and Armstrong 2000). In fact horses have been successfully integrated for controlling the encroachment in the Netherlands and in France (Rook et al. 2004), with the benefit of prevention of forest fires especially in southern Europe. In the Alps, 15% of the mountain forests (*Picea abies, Larix decidua* and *Sorbus aucuparia*) are grazed during summer by domestic animals, mainly cattle (Mayer et al. 2004). They graze in mosaics of coniferous forests, open pastures and half open pastures. The results of some experiments suggest that grazing cattle do not severely damage young trees if stocking density is low and the ranges are sufficiently large. Grazed forests had a more heterogeneous structure than ungrazed forests. Alpine silvopastoral systems can combine agriculture and forestry in a sustainable way. The percentage of young trees damaged on the traditional ranges was generally quite low (9%) and variation could almost completely be explained by the stocking rate given in livestock units per hectare. Grazed forests were less dense than the ungrazed forests, however the density in the investigated forests was mostly high enough to impede the release of avalanches. The young trees grew faster in the grazed forests. There were less dominant trees in the grazed forests, and these trees were much older than in the ungrazed forests. The management of mountain forests as wood pastures seems to enhance the willingness of the forest owners to conduct selective logging operations. Tree regeneration is highly related to animal density, but not only related to domestic animals. Hunting statistics e.g. for moose and roe deer in Sweeden suggest large recent population increases that have probably contribute to the decline of deciduous tree species (Bradshaw & Mitchell 1999). Damage might be due to high stocking rate and inadequate management of livestock in forest since research has proved that silvopastoralism can be a sustainable practice with several advantages.

Grazing in forests can encourage botanical diversity by reducing more vigorous species such as bramble and bracken, creating areas where more dwarf or less vigorous species typical of woodland can survive. Woods could be fenced in order to control livestock numbers, not to completely exclude them. A cycle of grazing and exclusion from grazing may encourage optimum botanical diversity and regeneration (McEvoy 2004) as certain experiments in Galicia (Spain) have shown. Also the traditional way to use winter ranges in which reindeer were only allowed to graze boreal woodland lichen pastures in the best condition in mid and late winter, and after which a lichen pasture was left for three to five years to recover, seems a very rational adaptation of utilising lichen ranges that will be formed by small mosaic-like sites (areas cratered by reindeer in different winters) inside of which the succession level of lichens varies (Kumpula 2001).

McAdam et al. (1999) observed that wide spaced trees with cattle could enhance higher biodiversity than in pure pastures low in biodiversity. It was observed a higher diversity and number of individuals in pasture plots were ash or maple had been introduced than in agriculture or forests. Also number of beetle species was higher comparing to agricultural plots. Such invertebrates are an important part of the ecosystem, enhancing number and species of birds. These ecosystems attract birds both from pastures and forests.

The dehesa is highly rich in plant and animal species including a number of globally-threatened species including the imperial eagle (*Aquila heliaca*) and the Iberian lynx (*Lynx pardina*). It is a complex system, a diverse mosaic of three main habitat types: areas of extensively grazed grasslands, shrubland/tree and arable. In the woods, acorns principally from *Quercus rotundifolia* and *Q. suber* provide food for livestock and also for wintering birds and the shrubs are important refuges for small mammals. Different bird species are associated with different areas and while the grassland has the greatest bird-species richness, the greatest density is in the woods. Shifts in the management of the dehesa will alter the balance between the elements. For example, increased grazing pressure reduces acorn yield, which leads to decreases in wintering birds in some areas. On the contrary, abandonment increases shrub cover and results in loss of the more wide-ranging bird species. As a consequence, management of the landscape mosaic

within limits of acceptable change is vital to the conservation of biodiversity (Mitchley & Ispikoudis 1999).

In relation to the animal as component, although commercial animal breeds are usually very profitable, autochthonous breeds are recommended for a proper conservation of the ecosystems, enhancing also the preservation of local breeds of which many are threatened by extinction, thus enhancing biodiversity in the agribusiness and helping to preserve agricultural values and diversity. Preservation of autochthonous livestock is in fact one of the measures adopted and subsidized by the Common Agricultural Policy of the EU. Such native species are better adapted to marginal areas, they require less veterinary intervention, they do not require special feed and the products are usually more valorised by the consumers. Products are considered to be of a better taste or quality even if is not always possible to prove it scientifically, but also because they are associated to the image of a particular region. It is not only the breed what makes the difference on meat or milk quality and taste but also the vegetation consumed, the slow production system, etc (Rook et al. 2004).

Besides ecological value in silvopastoral systems, the high historical, aesthetic and recreational values combines to provide strong arguments for preserving and managing special areas. They are an important part of the cultural heritage and the aesthetics of the landscape (Ispikoudis & Sioliou 2004). Cultural landscapes are in fact recognized and protected in international level and they include silvopastoral landscapes as well. The 'organically evolved landscape' is one of the three main categories of *cultural landscapes* protected by UNESCO.

Previous arguments show the relevance that silvopastoral systems may have for conservation and enhancement of biodiversity. The traditional practice of forest grazing offers an alternative for systems rich in biodiversity being simultaneously profitable in socio-economic aspect.

5. Policies as driving forces of the silvopastoral systems in Europe

Silvopastoralism is a traditional system that allowed to combine forest products (fire wood, timber…) with husbandry products in a sustainable way. In XVIII century commences the abandonment of these practices and surges forest and agriculture specialization that lead to several environmental concerns (biodiversity loss, nitrate pollution, pesticides use, erosion, forest fires…). Such environmental concerns are discussed and considered in policies at different levels. Afforestation became a priority objective in Europe, nevertheless rural abandonment continues taking place and this should be counteracted. Silvopastoral systems are a sustainable land use that may contribute to solve some of the problems that Europe has to face. They are systems that need slightly more complicated management than individual forest or agricultural systems and farmers need proper training based on traditional knowledge that is threatened of extinction and the new technical knowledge. The obstacles for the implementation of these practices are either technical (e.g. tree protection in particular during regeneration) or adoption of policies that have not promoted these mixed practices but independent. Nevertheless there have been some policies at national level, e.g. in Spain to subsidize the dehesas. Nowadays it is possible to appreciate a change in the approaches and these systems may obtain financial support for its implementation (Balandier et al. 2002), e.g. under the new proposed rural development measures of the Common Agricultural Policy (CAP).

The main objectives of silvopastoralism in Europe among others are: (a) to improve the environment, (b) increase the forest cover, (c) reduce the levels of intensive livestock production, (d) decrease the imports of roundwood, and (e) provide animal welfare and quality animal products. All in all the goal is to promote rural development after a economic, social and environmental point of view adapting to society needs (McAdam 2004).

Most relevant policies affecting the establishment and conservation of these systems are discussed below according to geographical level of actuation. Main sectors relate to agriculture, environment, forestry and sustainable development.

World level

i. Rio Convention
ii. Lugo and Orlando Declarations
iii. United Nations Education, Scientific and Cultural Organization (UNESCO)

Pan-European level

iv. Ministerial Conference "Environment for Europe"
v. Ministerial Conference on the Protection of Forests in Europe (MCPFE)
vi. Pan-European Biodiversity and Landscape Strategy (PEBLS)
vii. European Convention on Landscapes

Community level (European Union EU)

Agriculture

viii. Common Agricultural Policy (CAP)
    a. Market policy
    b. Rural development policy
        i. Forestry measures

Environment: Sixth Environmental Action Programme

ix. Policy of Nature and Diversity
    a. Policy of Nature Conservation
        - Biodiversity Strategy
        - Habitats and Birds Directives

    - Forests
        - European Forest Strategy
        - Forest Focus: Regulation No. 2152/2003 on the monitoring of forests and the environmental interactions within the Community

x. Policy of Sustainable Development
    a. European Strategy for Sustainable Development

World level

Rio Conference
Orlando and Lugo Declarations
United Nations Education, Scientific and Cultural Organization (UNESCO)

Rio Conference

The Commission for Sustainable Development of the United Nations organized in 1992 the Conference of the United Nations on Environment and Development (UNCED) in Rio de Janeiro, known as Rio Conference. Several multilateral environmental agreements were signed: Convention on Biological Diversity, Convention on Climate Change, the Convention to Combat Desertification, Rio Declaration on Environment and Development. Also the Forest Principles (not binding) and the action plan **Agenda 21**.

Agenda 21 tackles current environmental problems and looks towards the achievement of a world-wide sustainable development. Agenda 21 promotes the maintenance of sustainable forestry through conservation and management and the expansion of areas under forest and tree cover and specifies the adequacy of silvopastoral systems as a way of sustainable land management. Silvopastoralism can be a way of conserving and enhancing forest protection from fires and increasing of incomes from rent and biodiversity. It increases rent income in the short, medium and long term for managers due to the different products obtained within, it promotes management of wildlife, as well as eco-tourism, which ensures the adequate participation of the private sector, rural communities, indigenous people, youth and other user groups in sustainable forest management.

Agenda 21 highlights the importance of agroforestry systems in particular concerning (1) combat deforestation and erosion prevention, (2) combat desertification and drought, (3) sustainable development in mountainous areas, (4) promotion of agriculture and sustainable rural development through means of multidisciplinary research and technology transfer, and (5) conservation of biodiversity within the chapters 11, 12, 13, 14 and 15, respectively. Silvopastoral systems is considered within chapter 11 as one of the activities to increase vegetal cover to combat desertification, avoid erosion problems and facilitate other protective functions and programmes for restoration of degraded areas. It is also stated in this chapter that "measures should be taken to promote and provide intermediate yields and to improve the rate of returns on investments in planted forests, through interplanting and underplanting valuable crops"

The Agenda 21 promotes the adoption of economic, social or other incentives to preserve the biodiversity and the sustainable use of natural resources, also including the promotion of sustainable systems like traditional practices of agriculture, forestry, wildlife management or agroforestry that conserve and enhance the biodiversity. It is a key agreement that identifies agroforestry as sustainable production systems and considers it has a higher potential than the current use.

After Rio, the forest dialogue continued within the United Nations with the Intergovernmental Panel on Forest (1995-1997), the International Forum on Forests (1997-2000) and the current Forum on Forests. In 2005 is foreseen that within this Forum recommendations on a legal framework of all forest-types will be established, and also to discuss on a possible forest convention, where silvopastoral systems could also be taken into account.

In the 4th Forum on Forests (2004) it was suggested to connect the "Millenium Development Goals" with the National Forest Programmes, due to the relation between sustainable forest

management and poverty reduction and at the same time maximize the potential benefits of agroforesty according to a better spatial planning. Such Millenium Goals are a key aspect in the agenda of global development (Garrity 2004). Research and development of agroforestry contribute to the achievement of practically all objectives, increasing income and improving human wealth, promoting gender equality and environmental sustainability. Only a few of the developing countries have developed national agroforestry strategies within their plans of poverty reduction or development.

Traditional agroforestry systems have been recognized in tropical areas, but their multifunctional role is being also appreciated more and more in developed countries as North America and Europe, which will contribute through market, debt relief, investments… to support the implementation of such systems in developing countries that need a political and economic reform to meet the Millennium Development Goals.

Orlando and Lugo Declarations 2004

The **"Orlando Declaration on agroforestry systems"** of the I World Agroforestry Congress and confirms the advancements of the last 25 years establishing a scientific basis for the agroforestry systems management that has allowed farmers to improve and adapt to society demands. These systems will contribute at the same time to meet the "Millenium Development Goals". It declares that these systems increase the income, promote gender equity, improve health and wellbeing and promote environmental sustainability. It calls for an increase of funding and the integration of these systems within natural resources management; it upholds the potential of these systems to contribute to achieve the international agreements such the Convention on Biodiversity, Desertification and Climate Change and the Forum on Forests of the United Nations.

The **"Lugo Declaration on silvopastoral systems"**, highlights the economic, ecological and social benefits of this integrated systems and calls for its promotion and related research, e.g. on traditional knowledge, surveys, management difficulties, technology transfer and capacity-building. It considers silvopastoralism as an option to contribute to rural development within Europe.

Such Declarations were agreed by qualified scientists from all over the world, therefore showing the importance of these systems as sustainable land management, and the need to include them in the political agenda.

United Nations Education, Scientific and Cultural Organization (UNESCO)

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has established a category to preserve *organically evolved landscapes* linked with traditional uses in the category of cultural landscapes. Designed sites are for instance: the Mount Perdu in Pyrenees in France and Spain (formed by canyons and pastoral activities in upland regions), and Ouadi Qadisha (the Holy Valley) and the Forest of the Cedars of God (Horsh Arz el-Rab) in Lebanon where pastoral activity was integrated within. It is to be highlighted the inclusion in the last proposal (under evaluation) for the new Rural Development Policy of the Article 41 to subsidize the establishment of agroforestry systems in the EU. They are recognized due to its traditional importance for sustaining rural population with traditional knowledge adapted to nature, religious and cultural conditions that are linked to environmental-friendly management.

Pan-European level
Ministerial Conference "Environment for Europe" Ministerial Conference on the Protection of Forests in Europe Pan-European Biodiversity and Landscape Strategy PEBLS European Convention on Landscapes

Ministerial Conference "Environment for Europe"

The "Environment for Europe" process aims at assessing and developing environmental programmes for Europe. In the last conference environment ministers agreed within the Kiev Resolution on Biodiversity to identify the "*high nature value farms*" by 2006 and to adopt necessary conservation measures. Certain areas included under this term are silvopastoral systems such as dehesas or montados. By 2008 most of these areas should count with a management plan using e.g. less favoured areas measures, agro-environmental programmes, organic farming, etc. to support its ecological and economical viability (UNECE 2003).

Ministerial Conference on the Protection of Forests in Europe

The Ministerial Conference on the Protection of Forests in Europe (MCPFE) is the political plataform for discussion and cooperation concerning opportunities and threats to the forest sector and promotes a sustainable forest management, considering biodiversity as a key element of the sustainable management.

Below are listed the main aspects from the different Resolutions that can be enhanced by the silvopastoral systems. Overgrazing is considered as a biotic factor that may damage forests, being therefore needed a proper management with adapted stocking rate, use of tree protectors and use of animal species and breeds that may not cause such damage.

The Signatory Members and the European Community are committed to apply the following guidelines:

1. Promote the implementation of the Rio Declaration, Agenda 21, Convention on Biological Diversity and on Climate Change, and the Forest Principles in the European context.

The **forest fires and soil pollution** must be rigorously controlled. Global policies and goals may be limited in most vulnerable areas.

The **multifunctional silviculture** should be promoted to meet a right balance of the different society needs.

Management practices should tend to the maintenance and improvement of the **stability, vitality, regeneration capacity, resistance and adaptation capacity** of the forest ecosystems against pressures, including protection against forest fires, pests, wildlife and other damaging agents as overgrazing and uncontrolled grazing. Management practices should simulate nature processes.

Both **timber and non-timber forest products** should be promoted to increase the potential of traditional and new products that may provide income to further finance forest management.

2. The conservation and enhancement of biodiversity should be a key aspect of the forest management. Forest management should look towards the increase of the diversity of forest habitats.
3. The contribution of the forests to rural development should be utilized by means of policies, programmes and activities linked to other sectors such as agriculture, tourism, environment, etc taking advantages of complementarities and synergies. New employment and income opportunities should be stimulated through diversification of the activities related to forests.
4. Social and cultural dimensions should be included within the national forest programmes and other related policies.
5. Landscape attraction should be maintained and improved while preserving the traditional elements of the cultural landscape, raising public awareness about the knowledge and traditional practices of sustainable management, preserving biodiversity and protect against natural hazards.

Biodiversity loss due to fragmentation and land use change should be prevented and reduced and **ecological connectivity** should be maintained and established.

Emissions of **greenhouse gases** should be reduced.

Pan-European Biodiversity and Landscape Strategy (PEBLS)

It aims at providing an innovative and proactive approach to stop and reverse the degradation of biological and landscape diversity values in Europe. The Strategy reinforces the implementation of existing measures to ensure conservation and sustainable use of biological and landscape diversity and identifies additional actions that need to be taken. The Strategy also provides a 20-year vision for Europe and a framework to promote a consistent approach and common objectives for national and regional action to implement the Convention on Biological Diversity. The Action Themes included in the Action Plan are a.o.: integration of biological and landscape diversity considerations into sectors, conservation of landscapes, forest ecosystems and action for threatened species. All of these aspects are fulfilled by silvopastoral systems as was previously mentioned.

European Convention on Landscapes

The aims of this Convention are to promote landscape protection, management and planning, and to organise European co-operation on landscape issues. This Convention takes a new approach by promoting the cultural significance and social value of all landscapes and expands concerns from simply looking at parts of our heritage, for instance monuments, buildings or species of wildlife, to a concern for the whole landscape. The Convention conveys a strong concern for awareness raising, the exchange of information and expertise. It promotes multi disciplinary approaches and the need for a clear process of understanding and assessment of the values of landscapes.

The Council of Europe, firstly through PEBLS (Pan-European Biodiversity and Landscape Strategy) and later through the European Convention on Landscape gave a new dimension in the landscape concept not only as a goal but as a policy means as well. European policies recognize the patrimonial value of cultural landscapes and the necessity of their creative management, one of which can be silvopastoral systems (Sioliou & Ispikoudis 2004).

Community level

Agriculture
Common Agricultural Policy (CAP)
- Market policy or first pillar
- Rural development policy or second pillar
  - Forestry measures

Common Agricultural Policy (CAP)

The Common Agricultural Policy (CAP) is the policy that most influences the decisions on agricultural production in Europe. From its beginning, it promoted specialization and intensification but in the last years it has been amended several times to minimize the negative impacts of the intensification especially by means of e.g. agri-environmental measures, less favoured areas, good farming practices, etc.

(a) The "*first pillar*" of the CAP is related to the agricultural production. More and more subsidies to farmers are being decoupled from quantity production with a wider list of crops, introducing some environmental standards to be met (EEA/UNEP, 2004).

(b) The "*second pillar*" is based in the Rural Development Regulation. Support can be provided to farmers to adapt their businesses, management techniques or practices to a rural sustainable development. Several measures are established and are grouped under the following headings (1) investments in farms, (2) human resources, (3) less favoured areas, (4) agri-environmental measures, (5) agricultural products marketing, (6) forestry measures and (7) rural areas adaptation and development.

Examples of compromises adopted by the farmers under national or regional agri-environmental measures that may relate to silvopastoral practices are (EC 2003): extensification of agriculture, management of extensive pastures, maintenance of landscape and historical aspects as living fences or forested areas, conservation of high value habitats and their biodiversity.

The latest proposal of amendment of the Rural Development Policy (14/07/2004 COM(2004)490) pays special attention to the development of rural areas and animal welfare. It gives special relevance to agriculture and forest sector at the same time as the combination of both for the first time in European policy. It highlights the high ecological and social value of the agroforestry systems that aim to high quality timber production and other forest products, specifying that its establishment should be promoted. Among the priorities of rural development concerning land use planning it is to support farmers to establish agroforestry systems combining extensive forest and agricultural systems (Article 41). It is foreseen to cover the establishment costs. Christmas trees and short-term growth species are excluded of the subsidies.

Experts on agroforestry systems (SAFE 2004) consider the CAP should review certain ambiguities as for instance to define in a more precise form the term of forest it uses that follows a different concept than the term adopted internationally. Such definition may lead to the removal of trees from agricultural landscapes with the respective environmental and landscape damage. The CAP consider that the tree density to be entitled to the subsidy should be under 50 trees/ha, but there are exceptions to this threshold as in "mixed crops" where

agroforestry systems should be explicitly mentioned. The CAP should also clarify that there exist the possibility of combined activities within the same parcel

The European Forestry Strategy highlights the contribution of forest to employment, wellbeing and environment, and the role within rural development, in particular the added-value that the Community actions based on multifunctionality and sustainability may provided by means of forestry measures within the rural development measures.

The forestry measures of the rural development programmes aim at contributing to the global concerns as biodiversity conservation. The Regulation of Rural Development is one of the means to implement the Forestry Strategy. The integration of the forestry aspects in the rural development policy include:

- Investments to improve the multifunctionality of the forests.
- Afforestation in agricultural land

Both measures can be linked to silvopastoralism due to the different products obtained and the contribution to keep the rural population, due to the income from livestock while forest cannot provide it.

Environment: Sixth Environmental Action Programme

Policies on Nature and Diversity

- Policy on Nature Conservation
    - Biodiversity Strategy
    - Habitats and Birds Directives
- Forests
    - European Forest Strategy
    - Forest Focus

Policies on Sustainable Development

- European Strategy for Sustainable Development

Sixth Environmental Action Programme (2010 Target) (Decision 1600/2002/EC) (6EAP)

This Programme establishes the EU environmental political agenda until 2012 and highlights nature and biodiversity as a key priority. It is after the Cardiff Process in June 1998 when environmental aspects are integrated into other sectors as agriculture. It is within the 6EAP that environment is integrated into all policies to achieve a sustainable development. The EU Strategy on Sustainable Development combines in the long-term a dynamic economy with social cohesion and high environmental measures.

EU commits itself to halt the loss of biodiversity by 2010 (2010 target). One of the keys for achievement is to preserve the "*high nature value farmlands*" (EEA/UNEP 2004). It is foreseen that the "2010 target" will not be met unless correct measures will be applied to such areas. Even if silvopastoral systems are not mentioned in the 6EAP, part of them are included under the concept of *high nature value farmlands*. In order to achieve the objectives of the

biodiversity strategy and halt the loss of biodiversity, the recommendations of the meeting of the European Platform for the Strategy of Research on Biodiversity (EPBRS 2004a) highlight as key priority, among others:

- To develop a georeferenced inventory within Europe on the distribution of species and habitats, their status and evolution that quantifies the genetic diversity of the relevant species for economical and conservation reasons,
- To define classification systems for agricultural and landscape types to identify the priority objectives for biodiversity, establish reference conditions and develop policy instruments adapted to specific agricultural and habitats types, and
- To develop ecological food and agriculture systems to promote biodiversity.

These objectives do not refer specifically to silvopastoral systems but show the need to carry out an inventory of agriculture and landscape richness at the same time to promote production systems that do not damage biodiversity which can be achieved by silvopastoral systems. There exists the awareness of the need to integrate biodiversity issues within the CAP and the sustainable forest management at regional, national and global level, so that both sectors may contribute to the "2010 target".

Policies on Nature and Diversity

For the last 30 years, the EU has made efforts to protect the natural heritage and has signed a number of conventions for protecting the nature. The current objective is to reach the "2010 target" and include nature protection within the other policies, e.g. agriculture.

Policy on Nature Conservation

Biodiversity Strategy

This strategy aims at anticipating, prevent and fight the causes of biodiversity loss, to change the current trends and maintain an adequate level of species and ecosystem conservation. It aims at finding solutions for the biodiversity within the framework of the Convention on Biological Diversity. Main threats to biodiversity are the high degree of habitat fragmentation, intensive agriculture, land abandonment, climate change, desertification and fires. Close to half of the European livestock breeds are threatened of risk of extinction due to reason as intensification, large-scale industrialization of farming and globalization of world trade in agricultural products and breeding stocks, including the consequences of the destruction of the traditional farming systems associated with particular livestock breeds and the development of genetically uniform breeds.

Habitats Directive 92/43/CEE on the conservation of natural habitats and the wild flora and fauna; and Birds Directive 79/409/CEE on the conservation of wild bird species.

Such Directives aim at protecting the threatened species and habitats were they feed and nest. Each Member State has to identify the important areas and establish the management plan combining long-term conservation and social and economical activities, as part of the sustainable development strategy. The habitats of both Directives constitute the Natura 2000 Network, key of the policy of nature protection of the UE.

These Directives are also an instrument related to agri-environmental aspects, very important to protect agricultural areas of high biodiversity, which are under a constant pressure and that also include dehesas, montados and other extensive systems.

Habitats Directive does not only preserve the ecosystems but also traditional systems, as some of the silvopastoral systems. It also includes non-agricultural habitats close to agricultural areas such as living fences, shrubs and forests.

Forests

European Forest Strategy

It relates to silvopastoral systems when considering necessary to take the relation of the forest sector with other sectors as agricultural, tourism among others into consideration within sustainable forest management.

Forest Focus: Regulation No. 2152/2003 on the monitoring of forests and environmental interactions in the Community

This Regulation substitutes the previous Regulation 2158/92 on the protection of forests against fires and the Regulation 3528/86 on the protection of forests against atmospheric pollution (EC 2004). This programme establishes measures to monitor European forests in a harmonized way and in the long-term. The aim is to monitor the following main aspects: (1) protection against atmospheric pollution, (2) biodiversity, climate change, C sinks and soil, and (3) protection against forest fires.

European countries will have to establish 3-year national programmes where funding will be available among others for forest fire prevention measures. It is here where silvopastoral systems could have a potential availability of funding due to their advantages as preventive measure against fires, especially in Mediterranean areas or Atlantic areas with dry summer. Its foreseen monitoring may give further information on their positive influence on biodiversity and fight against forest fires.

Policy on Sustainable Development

Sustainable development is a broad objective that needs a cross between sectors and therefore practically all policies of the different sectors are involved in one way or another.

European Strategy on Sustainable Development

This strategy has promoted the inclusion of the sustainable development in the different policies, among others it has favoured that the CAP was amended for e.g. subsiding quality instead of quantity.

One of the objectives to reach a sustainable development is to manage natural resources in a responsible way and protect habitats and ecosystems, halting the loss of biodiversity by 2010. Therefore several measures are established as the development of biodiversity indicators and the promotion of agri-environmental measures within the CAP to establish a system of direct payments for environmental services, e.g. for promotion of grazing with autochthonous breeds.

It is possible to conclude that various disciplines as forestry, agriculture, cattle farming, environment and rural development have an implication on silvopastoral systems, having competences on them.

Agroforestry, including silvopastoralism, offers a strategic policy option to meet some of the goals within the amended CAP, not especially within the 'competitive pillar' (intensive farming), but as delivery of other goods and services within the 'rural development pillar' (McAdam 2004). Extensification will depend on farmers' attitudes to medium-/long-term goals rather than short-term goals, nevertheless in times of crisis or uncertainty farmers will opt for short-term goals and subsidies may facilitate farmers' decision-making.

It is foreseen that in 2005 the results of the "Silvoarable agroforesty in Europe" (SAFE) project will be published as the results "Agroforestry Policy Options" that will allow to the European Union (EU) frame the new Regulations so that agroforestry will receive the same attention as forestry and agriculture, due to its potential as sustainable land use.

6. Indicators on silvopastoralism

The important role that silvopastoral systems may play for a sustainable management and its relation to biodiversity justifies the development of indicators to assess its state and trends in relation to biodiversity. In order to propose such indicators at international level the main initiatives on indicators have been screened, such as the European Environment Agency (EEA), the Organization for Economic Cooperation and Development (OECD), the Commission on Sustainable Development (CSD) and the Ministerial Conference on Protection of Forests in Europe (MCPFE).

6.1. Existing indicators

Currently there are no indicators at European or national level specific for silvopastoral systems. There exist several agricultural and forest-related indicators on environment and biodiversity in which silvopastoral practices may have an influence on. Such parameters are nitrogen, fertilizers, pesticides, erosion, greenhouse emissions, forest fires, landscape, etc. In the Table 2 and Table 3 such selected indicators are listed and also the effect of silvopastoral systems on them is indicated in comparison to intensive agriculture practices or forest without grazing that are already developed or under development are listed below grouped by environmental and diversity aspects. All selected indicators refer to some extent to aspects that silvopastoral systems have also an effect on, such efficiency, nitrogen surplus, fertilizers, pesticides, soil erosion, greenhouse emissions, forest fires, etc.

Environmental aspects	
EEA	
- Nitrogen surplus from agricultural land	↓
- Intensification of agriculture	↓
- Livestock units per hectare of utilized agricultural area in the EU	↓
- Number of fires/areas burnt per year	↓
- Use of fertilisers	↓
- Use of pesticides	↓
OECD	
- Use of integrated pest management	↑
- Nitrogen balance and efficiency	↑
- Pesticide use and risk	↓
- Risk of soil erosion	↓
- Water quality	↑
- Gross agricultural greenhouse gas	↓
- Off-farm sediment flow	↓
CSD	
- Use of fertilizers	↓
- Use of agricultural pesticides	↓
- Forest area as a percent of land area	↑
- Land affected by desertification	↓
MCPFE	
- Forest area	↑
- Growing stock	↑
- Carbon stock	↑
- Roundwood production	↑
- Non-wood forest products	↑
- Protective forest area	↑

Table 2. List of existing environmental and biodiversity indicators developed or under development at EEA, OECD, CSD and MCPFE, for the agriculture and forestry sectors with relevance for monitoring of silvopastoral practices Sources: **EEA:** Environmental indicators (URL: http://themes.eea.eu.int/indicators/), **OECD**: Agro-environmental indicators (OECD, 2001), **CSD**: Indicators on sustainable development (URL: http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm), **MCPFE**: Indicators of sustainable forest management (URL: http://www.mcpfe.org/). The arrow ↑ shows an increment in the parameter, the arrow ↓ shows a decrease, the arrow ↔ shows that it is not possible to give a general assessment. Comparison is made to intensive agricultural systems except in MCPFE indicators that it is compared to forest systems without grazing.

Biodiversity aspects	
EEA	
- High nature value farming areas: area ……	↑
- Breed genetic diversity ……	↑
- Percentage of varieties or breeds of a particular crop or livestock species threatened ……	↓
- Fluctuation in forest bird populations ……	↑
- Mean number of plant species per plot in hedgerows ……	↑
- Classification and distribution of valuable pasture lands ……	↑
- Pressure on grasslands ……	↓
- Landscape heterogeneity ……	↑
- Linkages between valuable natural/semi-natural habitat types. ……	↑
- Gene pool diversity within populations of farm-related plant and animal species in semi-natural agricultural land ……	↑
- Hedgerow length in farms < 2ha/total Utilized Agricultural Area ……	↑
- Hedgerow length in farms >50 ha/total Utilized Agricultural Area ……	↑
- Preservation of semi-natural habitats (e.g. dehesa)……	↑
OCDE	
- Species diversity: wild species and non-native species ……	↑
- Ecosystem diversity ……	↑
- Structure of landscape ……	↑
- Landscape costs/benefits ratio……	↓
MCPFE	
- Tree species composition ……	↓
- Regeneration ……	↔
- Genetic resources ……	↑
- Landscape pattern ……	↑
- Threatened forest species ……	↓
- Causes of forest damage (including wildlife and grazing) ……	↔
UE	
- Evolution of genetic diversity of domesticated animals and crops of socio-economic importance ….....	↑

Table 3. List of existing environmental and biodiversity indicators developed or under development at EEA, OECD, CSD and MCPFE, for the agriculture and forestry sectors with relevance for monitoring of silvopastoral practices Sources: **EEA:** Biodiversity indicators (EEA, 2004), **OECD**: Agro-environmental indicators (OECD, 2001), **MCPFE**: Indicators of sustainable forest management (URL: http://www.mcpfe.org/). **EU**: Headline indicators (EPBRS 2004b). The arrow ↑ shows an increment in the parameter, the arrow ↓ shows a decrease, the arrow ↔ shows that it is not possible to give a general assessment. Comparison is made to intensive agricultural systems except in MCPFE indicators that it is compared to forest systems without grazing.

Several of the indicators are considered under the different initiatives, showing the relevance for environment and biodiversity. They relate to aspects on which silvopastoral systems may have a positive influence when comparing to agriculture or forestry systems but currently there are no data to test the indicators and show the comparison at European level. The estimation of the influence shown in the table relates to the above mentioned environmental benefits, as for instance the improvement of landscape structure through the connectivity between land uses, it allows a high use of domestic animal breed and autochthonous tree species despite its long-term yield, etc. Some of the parameters should be treated with caution since the influence on them depends highly on the management, for instance in the forest regeneration or the forest damages, since if exist a high stocking rate and an inadequate grazing management, this may impede the regeneration or may cause damages, but a proper stocking rate with adequate management does not necessarily lead to damage in regeneration or any other damages related to grazing. Grazing may even favour tree regeneration and developing of the saplings (McEvoy et al. 2004). Concerning the indicator of the ratio cost/benefits of landscape it could be taken as example the case of forest fires, the cost of obtaining the positive benefit of a landscape with low risk of fire decreases if livestock is used.

Overall consumption of fertilisers has stabilised in recent years, following a significant decline during the first half of the 1990s in CEE (Central and Eastern European countries) and EECCA (Eastern Europe, Caucasus and Central Asia countries). Without appropriate management, current fertiliser input in Western and Eastern Europe may still be too high to be environmentally sustainable in the longer term (EEA 2003). Silvopastoral systems are characterised by a low input of fertilizers and an increase in the use efficiency as rooting areas are increased (trees+pasture), therefore they can contribute to lower the level of such inputs in Europe.

Livestock numbers fell markedly between 1989 and 2001 in Central and Eastern Europe, the Caucasus and central Asia. However pressures on the environment form intensification and the concentration of livestock production in large units with poor animal waste management persist, especially in Eastern Europe, the Caucasus and central Asia and the accession countries. The total numbers of cattle, pigs, sheep and goats in CEE and EECCA have decreased; numbers in the EU-15 have been nearly stable since 1990. Livestock production in the EU has become more specialised and intensive. The loss or intensification of traditional extensive livestock grazing systems has had particularly negative effects on biodiversity (EEA 2003).

The contribution of livestock (housed animals) to gaseous emissions is also significant: 94% of total EU ammonia emissions and 49% of total methane emissions arise from animal husbandry (EEA 2003). High livestock population densities are associated with excessive concentrations of manure, leading to an increased risk of water pollution, that in the EU has been partly minimised, but it still remains in other CEE countries (Poland and Romania) and EECCA (Belarus, Ukraine and Russian Federation).

At stand level though, indicators for assessing the rangeland health are proposed for Mediterranean systems, e.g. based on oaks (*Quercus pubescens, Q. petraea*) and goats and sheep. They are related to soil stability, hydrological function and biotic integrity. Sixteen indicators have been identified with strong correlation. Such indicators are: cover of litter, cover of bare ground, cover of annuals, cover of perennials, cover of shrubs, cover of trees, erosion, animal trail, height of trees, height of herbs, plant vigor, number of seedheads, age-class distribution, presence of legumes and relative palatability factor for each animal species. Indicators related to the cover of the vegetation and erosion seemed to be the most relevant for assessing rangeland health (Pantazopoulos et al. 2004).

With the benefits observed for a sustainable development within silvopastoral systems, and the clear lack of indicators specific for this ecosystem, there is justification for a proposal of indicators on how silvopastoral systems affect biodiversity. Such indicators are proposed in the next section.

6.2. Indicators proposed

It is necessary to find a compromise between the existing data and the ecological and political relevance of the indicators. Statistics on silvopastoral systems are not collected in a systematic, harmonized and accessible way across Europe. There are existing statistics in some countries but rather dispersed. A monitoring activity would be needed if a reliable indicator has to be developed. Silvopastoral practices could be recognised as a separate land- use class or as a sub-category of an existing class as applied in already existing monitoring schemes (at pan-European most optimal), such as e.g. CORINE[1], LUCAS (Land Use/Cover Area Frame Statistical Survey) or of national woodland and forest surveys. Preliminary indicators are proposed and developed within this report[2] although there is a need for monitoring to obtain harmonized figures between countries.

- Types of silvopastoral systems: species composition
- Afforested land: potential area for silvopastoralism
- Silvopastoralism within European policy
- Forest damage by wildlife and grazing

Indicators proposed to be developed in the long term are:

- Area of each silvopastoral system type in Europe according to harmonized data collection scheme
- Endangered bird species associated to agricultural land occurring in silvopastoral systems

The proposed indicators are considered relevant to assess the silvopastoral systems as a sustainable land management and the preservation of biodiversity rich landscapes in Europe.

[1] See chapter 3. Types of silvopastoral systems accross Europe.
[2] See Annex 1.

7. Conclusions

Silvopastoralism was an extensive system widely used in the past, and after a separation of its components -agriculture and forestry- its benefits start to be recognized again. It is a potential land-use in Europe as it promotes biodiversity of species and maintenance of traditional landscapes, nutrients leakage is diminished, welfare animal is favoured and it is a multifunctional land use with many different outputs with the consequent economic, environmental and social benefit in the short and long term. Even though silvopastoralism is not the unique solution for many of the problems the EU has to face (e.g. forest fires, rural land abandonment, degraded sites, etc.), it represents a possible win-win-win solution for economic, social and environmental aspects of sustainable development. Nevertheless it implies a more complex management due to the interaction between all the components of the system: trees, forage and livestock.

It is to be highlighted that even if the CAP had a clear impact on silvopastoralism and silvopastoralism matches very well in the policy defined by the PAC there is not a specific policy addressing silvopastoralism, but it falls within competences of agricultural, forest, environment or rural development policies. Silvopastoralism is progressively being taken into the policy agenda at all levels.

It is not well defined which Administration has the competences on these systems, since they are affected by agriculture and forestry. For instance, in Spanish dehesas the livestock management depends on the Ministry of Agriculture while the forest management depends on Ministry for Environment, even if pastures are considered as non-wood products.

Grazed forest may enhance biodiversity for the gradients of environments that are created, also for the preservation and improvement of landscape diversity, maintaining traditional systems, increasing connection within landscape components in benefit of the mobility of animals. These systems may simulate structures and processes that were important when wild mega-herbivorous dominated in European forests. Moreover timber production, meat and other livestock products within forest may constitute a sustainable land use where management is close-to-nature oriented. Furthermore the loss of autochthonous animal breeds is currently alarming at global level, being the responsibility of preserving it very important for the European Union, as half of the livestock authocthonous breeds belongs to this continent. These autochthonous species are to be used within the silvopastoralism due to their adaptation to each location for a successful implementation and its sustainability over time. This may contribute to reach the 2010 target of halting the loss of biodiversity.

These are systems with many advantages but also of a more difficult management due to the interactions between the components forest, pasture and husbandry production, that needs appropriate knowledge transference.

These systems have not received so far the proper recognition at European level, and there is a lack of the state-of-the-art, the know-how and the potential of these systems both in areas deriving either from agricultural or forest land. It is therefore considered necessary an inventory of these practices in Europe and this is planned as activity of a developing network of researchers across Europe.

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Definitions

Dehesa / Montado	Rangelands occupied by scattered oak trees and characterized by silvopastoral uses. Dehesa is the term used in Spain and montado is used in Portugal.
Forest	Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ. May consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5m are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest. Includes: Forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas within the forest; forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and a width of more than 20 m. Rubberwood plantations and cork oak stands are included. Excludes: Land predominantly used for agricultural practices.
Kouri	Dehesa-like landscapes in Greece, linked with traditional tree management. Koura involves cutting of the branches of a tree at a height of 1,5-2 m in order that the new sprouts are out of the reach of the animals.
Larchenwisen	Larch meadows in Austria/Switzerland and France, grazed by livestock. Now in decline.
Lovangar	Foliage meadows in Sweden were pollarded trees are used for fodder for livestock.
Meadow	An area of natural or planted vegetation dominated by grasses and grass-like plants used primarily for hay production.
Other wooded land	Land either with a tree crown cover (or equivalent stocking level) of 5-10 percent of trees able to reach a height of 5 m at maturity in situ; or a crown cover (or equivalent stocking level) of more than 10 percent of trees not able to reach a height of 5 m at maturity in situ (e.g. dwarf or stunted trees) and shrub or bush cover. Excludes: Areas having the tree, shrub or bush cover specified above but of less than 0.5 ha and width of 20 m, which are classed under "other land"; Land predominantly used for agricultural practices.
Pascoli arborati	Pastures in Italy for livestock where tree crown cover is under 10%.
Reindeer husbandry	Reindeer herding (semi-domestic and wild) in circumpolar countries such as Norway, Finland, Sweden and Russia.
Silvopastoralism	One of the oldest agroforestry practices, that combines three main components within a particular edapho-climatic context: (1) trees, (2) pasture and (3) animals.
Sward	A population of herbaceous plants, characterized by a relatively short habit of growth and relatively continuous ground cover, including both above and below-ground parts.

Trees outside the forest	Trees on land other than forest or other wooded land. Includes: Trees on land that meets the definitions of forest and of other wooded land except that the area is less than 0.5 ha and the width is less than 20 m; scattered trees in permanent meadows and pastures; permanent tree crops such as fruit tree orchards and coconut palm plantations; trees in parks and gardens, around buildings, in hedgerows and in lines along streets, roads, railways, rivers, streams and canals; trees in shelterbelts and windbreaks of less than 20 m in width and 0.5 ha in area.
Wooded pastures	Wooded pastures are traditional silvopastoral ecosystems, with high biodiversity, where the regeneration of both grassland and woodland is natural. The vegetation of a wooded pasture is composed of a complex and various assemblage of trees, shrubs, grasses, forbs and mosses, forming shifting mosaics driven by the alternation of plant facilitation and competition.

List of acronyms and abbreviations

CAP	Common Agricultural Policy of the EU
CEE	Central and Eastern Countries
CSD	Commission on Sustainable Development
EEA	European Environment Agency
EECCA	Eastern Europe, Caucasus and Central Asia countries
EU	European Union
HNVF	High Nature Value Farmland Areas
LUCAS	Land Use/Cover Area Frame Statistical Survey
MCPFE	Ministerial Conference on Protection of Forests in Europe
OECD	Organization for Economic Cooperation and Development

Annex 1 Types of silvopastoral systems: species composition

☺ Key message[3]

Silvopastoral systems are traditionally used with autochthonous tree species. Only few exotic species are used. Afforestation policy may promote therefore plantations with autochthonous species, allowing a long-term timber production while in the same time obtaining short-term income due to livestock, achieving a more feasible and profitable economic return. They are traditionally extensive systems with low concentrate, fertilizers or pesticides input.

Main occurring species in silvopastoral systems across Europe

Tree species
Autochthonous or subspontaneous
Abies alba, Acer monpessulanum, Acer opalus, Acer platanoides, Acer pseudoplatanus, Alnus glutinosa, Alnus incana, Betula alba, Betula pendula, Castanea sativa, Celtis australis, Ceratonia siliqua, Corylus avellana, Cupressus orientalis, Fagus sylvatica, Fraxinus angustifolia, Fraxinus excelsior, Fraxinus ornus, Juniperus thurifera, Ilex aquifolium, Larix decidua, Picea abies, Pinus brutia, P. halepensis, P. nigra, P. pinaster, P. pinea, P. sylvestris, P. uncinata, Populus sp.*, Prunus avium, Quercus aegilops, Q. canariensis, Q. cerris, Q. faginea, Q. ilex, Q. petraea, Q. pubescens, Q. pyrenaica, Q. robur, Q. suber, Salix* sp.*, Sorbus aucuparia, Sorbus hybrida, Taxus baccata, Ulmus minor*
Exotic
Eucalyptus globulus, Pinus radiata, Pseudotsuga menziesii, Quercus rubra, Robinia pseudoacacia, Eucalyptus camaldulensis
Understorey
Herbaceous
Agropyron, Agrostis, Anthoxanthun, Anthyllis, Arrhenatherum, Astragalus, Avena, Avenula, Brachypodium, Bromus, Cynodon, Cynosurus, Dactylis, Deschampsia, Festuca, Hippocrepis, Holcus, Lolium, Lotus, Lupinus, Medicago, Melilothus, Molinia, Nardus, Ornithopus, Phleum, Poa, Pseudoarrhenatherum, Pteridium aquilinum, Scorpiurus, Stipa, Trifolium
Shrubs
Adenocarpus, Arbutus, Arctostahylos, Bupleurum,Buxus, Calicotome, Calluna, Chamaerops, Cistus, Colutea, Coronilla, Cornus, Cytisus, Echisnopartium, Erica, Erinacea, Evonymus, Halimium, Hedera, Helianthemum, Helichrysum, Fumaria, Genista, Juniperus, Laurus, Ligustrum, Medicago, Myrtus, Olea, Ononis, Origanum, Pistacia, Ptilotrichum, Pterospartium, Prunus, Quercus coccifera, Quercus lusitanica, Rhammus, Rhododendron, Rosa, Rosmarinus, Rubus, Santolina, Satureja, Sideritis, Spartium, Stanrachanthus, Thymus, Ulex, Vaccinium
Livestock
Sheep, horses, goats, pigs, cows and wild ungulates

[3] Note that the symbols used hereon indicate ✪ positive trend(s), ✯ negative trend(s), ✰ neutral, no negative or positive trend(s).

Table 1. Main occurring species or genera in silvopastoral systems across Europe. Source: own.

Results and assessment

There exist scattered figures on the extent that these systems occupy in some countries. Dehesas in Spain and Portugal cover over 3 mill ha, ancient grazed wooded land are estimated to cover 8,500-17,000 ha in Scotland, grazing in mountains is spread over 15% of the forest land in Switzerland, approximately 1,200 and 1,500 km of hedgerows are planted every year in Denmark and France and all silvopastoral systems in Germany amount to nearly 60,000 ha. It is also known that in Spain 74% of the forest area (almost 20 million ha) hold some type of extensive livestock husbandry. Even if this type of management seems to be of importance in some regions there is a clear lack of harmonized statistics on the real area occupied by these systems that may justify a study on the classification and geographical distribution as a particular type of forest management. Silvopastoral systems have special relevance to contribute to halt the loss of biodiversity. Preserving traditional practices such as silvopastoralism will contribute to preserve valuable landscapes and species, therefore contributing to achieve the "Objective 2010".

Silvopastoral systems that can be found across Europe are mainly based on autochthonous species of each region. Only few alien species e.g. *Eucalyptus globulus, Pinus radiata, Pseudotsuga menziesii, Quercus rubra* and *Robinia pseudoacacia* host this type of forests. This is very relevant concerning the added value using autochthonous species traditionally and the implications for enhancement of biodiversity and the nature to be found.

Livestock species to be used depends mainly on the fodder to be found in the understorey, but it is also important the food they can obtain from acorns or beech fruits or the tree fodder (leaves). Main herbaceous genuses are *Trifolium, Medicago, Lolium* and *Dactylis.* Sheep and cow feed on herbaceous species, while horse and goat feed on woody shrubs too. The species the livestock feed on will influence on the products obtained, e.g. feeding on *Lotus corniculatus* may produce milk with slight yellow color with special taste very appreciated in certain Greek regions.

Holm oak (*Quercus ilex*) dehesas are one of the last breeding refuges for endangered species of birds like imperial eagle *Aquila adalberti* and black vulture *Aegypius monachus* (Dıaz et al. 1997), and constitute suitable wintering sites for birds like common cranes *Grus grus*. However, 67.0% of these birds still winter in holm oak dehesas of central and south Iberia. Most cranes arrive in Extremadura in November and remain until the end of February. Cranes gather in flocks that feed mainly on holm oak acorns, and the winter pattern of utilization of holm oak dehesas by cranes is correlated with the abundance of acorns (Avilés 2004.) Dehesas are considered to be one of the most important habitats for biodiversity in Europe containing many species from the Habitats Directive, especially birds and mammals (Bunce et al. 2004).

Bird species are a good indicator of the biodiversity in an ecosystem. While forest-related bird species have not decreased along the time, agriculture-related bird species have been continuously decreasing. Nowadays only 70% of the species existent in 1980 remains, due to agriculture intensification. This is an alarming fact that the EU has to tackle in order to achieve the 2010 target of halting the loss of biodiversity. Since silvopastoral systems can host species from agriculture and forest and they act as biological corridors between the different ecosystems, such systems contribute therefore to the maintenance of the species. Estimates show that 40% of the endangered bird species in Europe are threatened by agricultural intensification and 20% by abandonment (EEA/UNEP 2004). Such agricultural species are spread all over Europe, but many of them are associated to extensive systems in Southern Europe that should be preserved. Vulture population, e.g., has decreased in Greece due to the cease of traditional silvopastoral management in order to preserve the forest without human intervention. Vultures feed on sick or dead animals and their lack prone vulture to disappear. To combat the circumstances, forest service opted to bring periodically animal food for the vulture, which would not be needed case silvopastoralism would have been maintained (Kosmidou, M. & Ispikoudis, I., pers. com.). Also high diversity of passerines and raptors are to be found in these systems.

In some areas, e.g. Britain, *Salix* sp. has been removed from agricultural landscapes considering it as a weed, even if *Salix* has traditionally been present in areas grazed by cattle in many parts of Europe. Researchers have recently realized that cattle may use *Salix* leaves as medicament.

One practice linked to silvopastoralism is the transhumance that connects lowland agricultural areas to upland agricultural or also grazed forest areas. Although it is necessary to maintain transhumance systems for ecological and cultural reasons, such an endeavor is not easy because these systems are vulnerable to socio-economic factors. For example the rural population is constantly declining and the retiring farmers are not replaced. The younger farmers look for more intensive systems. It is extremely difficult to persuade young people to practice transhumance by moving to the upland areas where there is no social life (Ispikoudis et al. 2004). Transhumance has been taking place all over Europe: Norway, UK, Austria, France, Germany, Romania, Poland, Slovakia, Switzerland, Italy, Spain, Portugal… One unique case is *Cupressus orientalis*, found only in Crete (Greece) that forms silvopastoral systems. It is found in areas were transhumance was common in the past. It is the only pollarded conifer, since it has the capacity to produce offshoots (Ispikoudis et al. 2004).

It is to be highlighted the high variety of combinations of flora and animal species that constitute silvopastoral systems across Europe, using autochthonous species when maintaining the traditional systems. Livestock has also been successfully integrated under planted introduced species.

Cutting trees for collecting animal fodder was widely practiced in many countries from Nordic to Mediterranean countries, the choice of species, techniques and utilization varied from country to country and even from region to region. Collecting twigs and leaves for domestic animals is probably the oldest form of fodder harvesting. Therefore ceasing pollarding or shredding nowadays, results in a considerable loss to the heritage because pollarded or shredded trees disappear from the landscape, being prone to die once management is stopped. Their high historical, aesthetic, recreational and ecological value combines to provide strong arguments for preserving and managing special areas. Although in most cases they are now extinct or highly modified, there are few areas where such techniques are still practiced (Ispikoudis & Sioliou, 2004).

Definitions

Pollarding: cutting the branches of a tree at a height of at least 1,5-2 m of the trunk in order that the new sprouts are out of the reach of the animals. The technique was a way of protecting the trees from browsing and used the fodder for feed the domestic livestock.

Subindicator Autochthonous domestic livestock breeds

☹ **Key message**

Of the European breeds, almost half are categorised as being at risk of extinction or already extinct. Silvopastoral systems may offer an appropriate habitat for the reintroduction of some of the livestock breeds but also of hunting or other endangered wild species. Only in Spain there are 79 breeds threatened of extinction. These breeds had been traditionally used within extensive husbandry. They should be considered within husbandry policies and be used for the management and conservation of natural resources.

European autochthonous domestic livestock breeds by countries

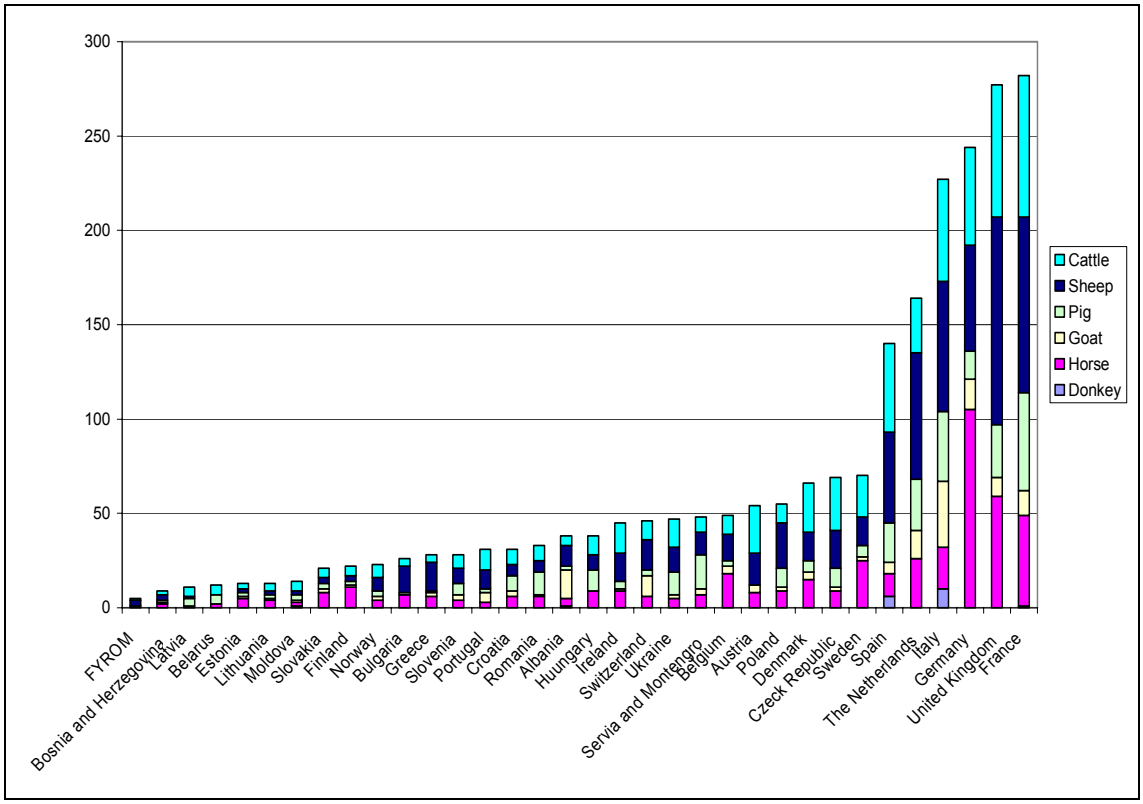

Figure 1. Domestic livestock breeds in Europe by species and by countries.

Total European autochthonous domestic livestock breeds: total, endangered and extinct

Donkeys			Cattle			Goats			Horses			Pigs			Sheep		
Total	End	Ext	**Total**	End	Ext	**Total**	End	Ext	**Total**	End	Ext	**Total**	End	Ext	**Total**	End	Ext
21	12	3	**524**	163	123	**169**	59	10	**359**	164	64	**298**	110	89	**646**	152	94

Table 1. Number of European autochthonous livestock breeds: Total, End (endangered), Ext (extinct). Source: FAO Database (URL: http://dad.fao.org/es/home.htm)

Assessment for the sub-indicator

Europe is home to almost half of the world's recorded animal domestic breed diversity. Of the European breeds, practically half are categorised as being at risk of extinction. Two successive updatings of the FAO database on domestic breeds (1995 and 1999) show critical trends. However, Europe is the region where the highest proportion of breeds is under active conservation programmes (EEA 2003). Table 2 shows the total number of breeds by species in the different European countries. Some breeds are present in several countries. Table 3 shows the total number of European breeds without double counting. Europe accounts for 974 breeds out of risk, 660 threatened of extinction and 383 already extinct.

Extensive systems may benefit of locally adapted breeds that helps to preserve the habitats and at the same time fixing the population obtaining products of quality. A response to the loss of traditional breeds has been e.g. the adoption of the Royal Decree 145/1999 in Spain to promote the bovine autochthonous breeds in extensive systems and the Royal Decree 51/1995 to promote agriculture production methods compatible with protection and conservation of natural resources that protects several of the endangered breeds. Furthermore support is foreseen under the new proposal of Council Regulation for Rural Development by the European Agricultural Fund for Rural Development (EAFRD) offering at least 200 Euros per livestock unit for using local endangered breeds.

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Data

Country	*Region*	*System*	*Type*	*Biogeographical region*
Belgium	Flanders	Planted dykes / sheep	PSS	Atlantic region
Spain	Asturias	*Fagus sylvatica* / cattle	PSS	Atlantic region
	Navarre	*Quercus faginea*	PSS	Atlantic region
	Basque country	Pastures, heathers, gorse, fern, wooded pastures / cattle	FLF	Atlantic region
	Basque country	Pig under tree canopy	PSS	Atlantic region
	Madrid	*Quercus pyrenaica*	PSS	Mediterranean region
	Galicia	*Betula alba* or *Pinus radiata* / *Dactylis* + *Lolium*	PSS	Atlantic region
	Galicia	Pasture under *Pseudotsuga menziesii, Pinus pinaster, P. radiata, Betula alba*, *Quercus rubra,, Castanea sativa or Ilex aquifolium*	PSS	Atlantic region
	Galicia	*Quercus robur* / *Lolium* + *Dactylis* + *Trifolium repens* / cattle (Rubia gallega)	PSS	Atlantic region
	Galicia	*Eucalyptus globulus, Pinus pinaster, Pinus sylvestris*, *Pinus radiata* / Goat, sheep or horse	PSS	Atlantic region
	Valencia	Pastures in forest fire-breaks	FLF	Mediterranean region
	Castilla y León	*Quercus ilex* / cattle, sheep or pig	PSS	Mediterranean region
	Extremadura	*Quercus suber or Q. ilex / Trifolium subterraneum* / cattle, sheep or pig	PSS	Mediterranean region
	Andalusia	*Quercus ilex* / cattle, sheep or pig	PSS	Mediterranean region
Finland/ Sweden / Norway		*Pinus sylvestris, Betula pendula or Picea abies* / reindeer	PSS	Boreal region
France	Alps	*Larix decidua* / cattle, sheep or horse	PSS	Alpine region
	Southern France	*Quercus pubescens* / sheep or horse	PSS	Mediterranean region
	Coast & Eastern Pyrenees	*Quercus suber* / goats, sheep or cattle	PSS	Atlantic region
	Southern France	*Pinus sylvestris, Quercus pubescens*	PSS	Mediterranean region
	Southern France	*Pinus pinea* + *P. halepensis* + *Quercus suber* / *Trifolium subterraneum*	PSS	Mediterranean region
Greece		Oak, walnut, aspen, chestnuts, fruit trees / cereals, alfalfa, clover, grasses, tobacco, etc…/ livestock	FLF	Mediterranean region
	Northern Greece	*Pinus pinaster* / *Dactylis glomerata*	PSS	Mediterranean region
	Northern Greece	*Pinus brutia* / *Dactylis glomerata, Agropyron cristatum, Bromus inermis, Trifolium subterraneum* + *T. pratense*	PSS	Mediterranean region
	Northern Greece	*Prunus avium* / goats	PSS	Mediterranean region
		Robinia pseudoacacia / goats	PSS	Mediterranean region
Holland	PN Veluwezoon	Heathers, meadows, abandoned fields, bushes, tree / cattle, horses + wild ungulates	FLF	Atlantic region
Hungary		Windbreaks	SSL	Continental region
Ireland		*Quercus robur* / cattle	LS	Atlantic region
		Fraxinus excelsior / sheep	LS	Atlantic region
Italy		Pasture for sheep in ski tracks	FLF	Mediterranean region
		Trifolium brachycalycinum + *Cynodon dactylon* / horses in fire-breaks	FLF	Mediterranean region
	Sicily	*Quercus ilex, Q. pubescens, Q. cerris, Fraxinus ornus*	PSS	Mediterranean region
	Sardinia	*Quercus ilex, Q. pubescens, Q. suber / Medicago, Trifolium, Lolium / sheep*	PSS	Mediterranean region
	Tuscany	*Quercus cerris* + *Q. pubescens* / sheep	PSS	Mediterranean region
Norway	Vigra (coast)	*Prunus avium, P. padus, Alnus incana, Sorbus hybrida, Fraxinus excelsior, Quercus robur, Acer pseudoplatanus*	SSL	Boreal region
Portugal		Montado	PSS	Mediterranean region
The Netherlands		Planted dykes / sheep	PSS	Atlantic region
United Kingdom	Scotland	*Betula alba* + *B. pendula* + *Pinus sylvestris* + *Salix caprea* + *Corylus avellana* / sheep	FLF	Atlantic region
Switzerland	Jura	*Picea abies* /sheep + goat	PSS	Alpine region
	Alps	*Picea abies, Larix decidua* + *Sorbus aucuparia*	PSS	Alpine region
	Jura	*Picea abies* / cows + horses	PSS	Alpine region
Ukraine		Tree belts to protect pastures	SSL	Continental region
Yugoslavia		Broadleaved /sheep, cattle or geese	PSS	Mediterranean region

Table 2. Some examples of the common types of silvopastoral systems in Europe. FLF = Forestry in livestock farm (It forms a mosaic of swards, crops and forest trees not within the stand but at landscape level); PSS = Pure silvopastoral systems (Combination in the same area of trees and livestock. Tree density may vary through a wide range); SSL = Silvopastoral systems in lines (Trees are established as lineal formations to act as living fences, windbreaks offering also shelter for livestock); LS = Ligniculture on swards (It consists of forest trees planted at very low density; therefore many of such plantations may not be covered by the definition of forest).

Meta data

Technical information

1. Data source:

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Mosquera-Losada, M.R., McAdam, J. & Rigueiro-Rodríguez, A., (ed.) 2004. Silvopastoralismo y Manejo Sostenible – Congreso Internacional – Libro de Actas, pp. 1-203. Unicopia, Lugo, España.

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2. Description of data: Qualitative
3. Geographical coverage: Selected European countries with literature available
4. Temporal coverage: None
5. Methodology and frequency of data collection: No official data collection
6. Methodology of data manipulation, including making 'early estimates': None

Quality information

7. Strength and weakness (at data level):

Weakness: no harmonized quantitative data across Europe

8. Reliability, accuracy, robustness, uncertainty (at data level):

The identified systems are the most common in Europe that are referred to in literature. Certain gaps referring to other types may exist.

9. Overall scoring (give 1 to 3 points: 1=no major problems, 3=major reservations):

Relevancy: 1

Accuracy: 3

Comparability over time: 3

Comparability over space: 3

Further work required

Harmonized data should be enhanced

Annex 2 Afforested land: potential area for silvopastoralism

😐 Key message

Between 1994 and 1999 close to 1 million hectares have been afforested in European agricultural land. It is not known though what percentage of afforested area is managed integrating livestock within. Agenda 21 recommends to take measures to promote and provide intermediate yields and to improve the rate of returns on investments in planted forests, through interplanting and underplanting valuable crops, e.g. as silvopastoral activity. When adopting certain protective measures against livestock damages, silvopastoralism is a feasible sustainable option to contribute to rural development.

Area of agricultural land afforested under Regulation EEC 2080/92 (1993-1997)

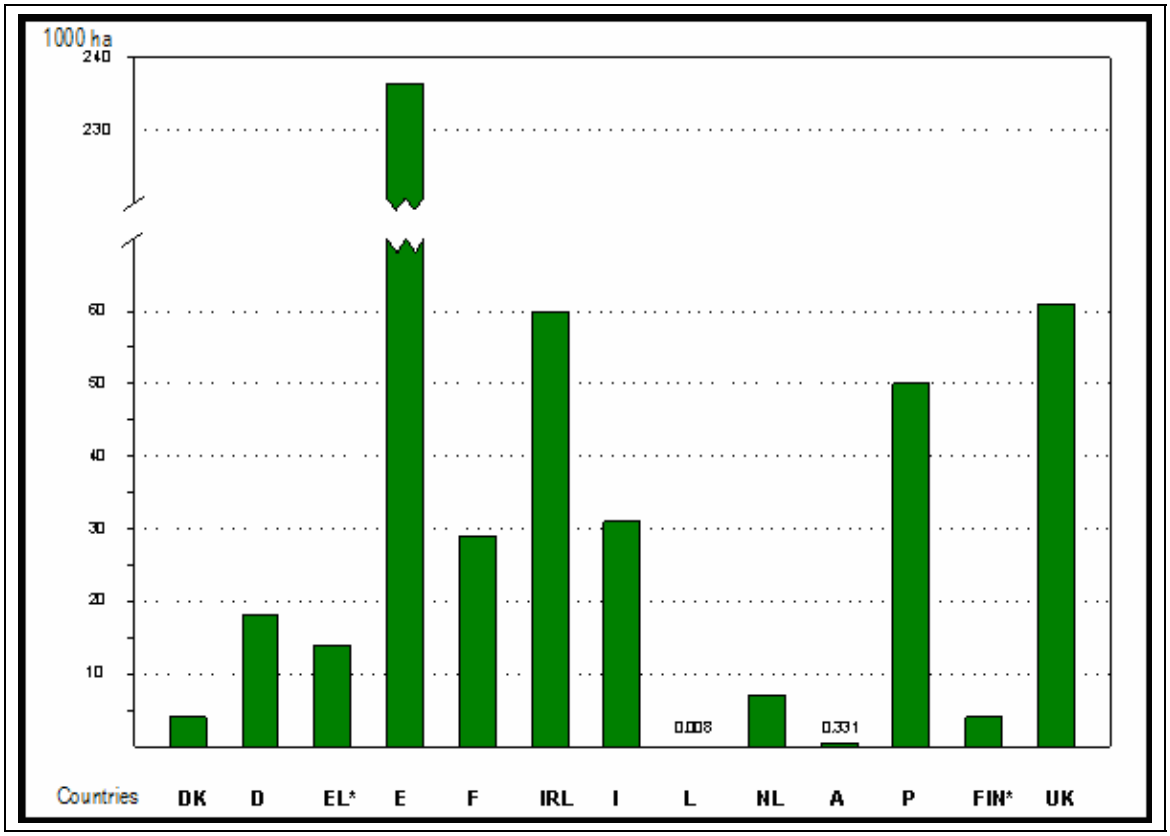

Figure 2. Area of agricultural land afforested under Regulation EEC 2080/92 (1993-1997) Source: DG VI Agriculture (EC 2002).

Results and assessment

Measures within the Common Agricultural Policy (CAP) reform to promote the afforestation of agricultural land started with the Regulation EEC no 2080/92. This resulted in the afforestation of about one million hectares during the period 1994-1999 (EC 2004). The above figure refers to previous records, for the period 1993-1997 when over half a million hectares have been afforested. Spain accounted during this reference period for 46% of this new wooded area, followed by the United Kingdom, Ireland and Portugal. These countries represented about 80% of the land afforested under this Regulation (EC 2002). The species breakdown by area for the EU has been about 40% conifers and 60% for broadleaf species, mixed plantations and fast-growing plantations (the latter occupies a very low share around 4%). The breakdown, however, varies widely between the countries even if countries are placing greater emphasis on the use of native broadleaf tree species (EC 2004). For instance, Denmark indicates that afforestation with indigenous broadleaf tree species represents 94% of the total area planted. In Germany, 96% of planted forests are mixed broadleaf stands; France indicates a rate of 70% of broadleaf tree species and UK of about 77% in the new plantations. The frequent planting of mixed stands in certain countries and autochthonous tree species contributed, for example in Germany, Finland and Austria in particular, to a greater diversity, and in Spain and Portugal they enabled the specific interventions connected with fire protection to be developed as well as the improvement of cork oak stands.

The aim of the afforestation of agricultural land is to improve forest resources, reduce the shortage of wood in the EU, encourage forms of countryside management more compatible with the environment and combat the greenhouse effect. Current afforestation programmes should not be seen as a threat to the farmers, but as a land use which is possible to combine with livestock. It is feasible to combine agriculture and forestry, producing high quality timber in the long-term still obtaining income in the short term. This would allow a wider use of noble hardwood species of slower growth e.g. oak, beech or chestnut and diversify the incomes (Ibarra et al. 2000, Mosquera-Losada et al. 2004). Nevertheless certain preventive measures have to be adopted in order to allow the livestock in the afforested land, e.g. a minimum number of years of establishment or tree protectors, etc.

For the EU15 as a whole, 60% of the newly planted forest was on permanent pasture and meadow, 37% arable land and 3% land under permanent crops. Afforestation rate is low in arable crop areas and in intensive livestock farming areas (where added value and rents are high). During the first years of establishment the pasture will show certain competition to trees that it is usually controlled by clearings (chemical, manual or mechanically) that must be repeated in order to reduce forest fires risk in Mediterranean countries when bushes otherwise may dominate in the understorey. Furthermore over two thirds of these afforested land are located in areas classed as presenting a fire risk under Regulation EEC 2158/92 on the protection of forest against fire (EC 2002). Using livestock in these areas may diminish the fire risk at the same time diminishing the costs since clearings will not be necessary due to the grazing of the understorey, increasing the income with livestock products. Management can also enhance livestock and tree compatibility through the adequate election of animal type and breed or fertilisation. Livestock grazing is usually used in plantations in order to clean the understorey in different regions of Spain like in Navarra where foresters pay to farmers to allow a particular cattle breed graze under poplar (*Populus* sp.) plantations as it does not cause any damage. Some treatments can enhance tree and pasture growth such the use of organic fertilisers in the first plantation stages (Rigueiro et al. 2000). This would contribute to fix the population in rural areas where afforestation is taking place and only generates income in the long term. Moreover the new proposal for amendment of the Rural Development Policy considers of relevance the establishment of agroforestry systems under the Article 41.

Even planted forests with the principal objective of industrial wood production can play an important role in biodiversity conservation and restoration, through providing habitat for particular species, buffering native forest remnants, enhancing connectivity between remnants, and under particular circumstances relieving pressure on natural forests. Agroforestry and silvopastoralism within, is an important use of planted forests that may provide farmers, communities and society with a wide array of forest related foods and services. Agenda21 recommends to take measures to promote and provide intermediate yields and to improve the rate of returns on investments in planted forests, through interplanting and underplanting valuable crops, e.g. as silvopastoral activity. Agroforestry can contribute to the accomplishment of sustainable forest management by providing a set of tree-based conservation and production practices for agricultural lands (UNFF 2003).

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Meta data

Technical information

9. Data source: European Commission EC
10. Description of data: 1000 ha of afforestation in agricultural land
11. Geographical coverage: European Union EU
12. Temporal coverage: 1993-1997
13. Methodology and frequency of data collection: Members States reporting to EU
14. Methodology of data manipulation, including making 'early estimates': none

Quality information

15. Strength and weakness (at data level):

Strength: Data are reported in a harmonized way that allows reliable comparison between countries.

Weakness: There are not data available on the share of afforested land that is managed also with livestock grazing.

16. Reliability, accuracy, robustness, uncertainty (at data level):

The data set is based on official periodical data collection therefore it is considered as reliable.

9. Overall scoring:

Relevancy: 1

Accuracy: 1

Comparability over time: 1

Comparability over space: 1

Further work required

More research is needed on how to improve and properly manage silvopastoral systems within plantations: livestock to be used, compatibility tree-livestock, fertilization, stocking rate, etc.

Annex 3 Silvopastoralism within European policy

😐 **Key message**

European policy has favoured over the years agriculture and forestry independently. There is nevertheless a slight change towards recognizing the cultural, social, economic and environmental value of traditional systems as silvopastoralism, as it fulfils most of the policy goals of sustainable land management.

Policies with impact on silvopastoral systems within Europe.

- ***World level***

i. Rio Convention
ii. Lugo and Orlando Declarations
iii. United Nations Education, Scientific and Cultural Organization UNESCO

- ***Pan-European level***

iv. Ministerial Conference "Environment for Europe"
v. Ministerial Conference on the Protection of Forests in Europe MCPFE
vi. Pan-European Biodiversity and Landscape Strategy PEBLS
vii. European Convention on Landscapes

- ***Community level (European Union EU)***

Agriculture

viii. Common Agricultural Policy (CAP)
  a. Market policy
  b. Rural development policy
    i. Forestry measures

Environment: Sixth Environmental Action Programme

ix. Policy of Nature and Diversity
  a. Policy of Nature Conservation
    - Biodiversity Strategy
    - Habitats and Birds Directives
  - Forests
    - European Forest Strategy
    - Forest Focus

x. Policy of Sustainable Development
  a. European Strategy for Sustainable Development

Sources: Own.

Results and assessment

Policy relevance and context

The importance at a global scale of silvopastoral systems is highlighted in the Agenda 21 (working plan on sustainability adopted during the Rio Convention) where agroforestry practices, and therefore silvopastoral systems, are considered as a sustainable and management in order to fulfil the objectives of its Chapters 11 (Combating deforestation), 12 (Managing fragile ecosystems: combating desertification and drought), 13 (Managing fragile ecosystems: sustainable mountain development), 14 (Promoting sustainable agriculture and rural development) and 15 (Conservation of biological diversity). This and other world and pan-European agreements or conferences (UNESCO sites, MCPFE, PEBLDS, etc) are also adopted within the European policy. At European level there are several policies under agriculture and environmental sectors that may impact on the implementation of silvopastoral systems. However, there is not policy that addresses specifically this type of land management, but the recent (14/07/2004) "Proposal for a Council Regulation on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)" estates that "measures targeting the sustainable use of forestry land through the first establishment of agroforestry systems on agricultural land" should be taken. The way of how it will be implemented is not known. Moreover, there is not any particular target concerning silvopastoral systems, and competences on the regulation of the different products (e.g. pasture and timber) may fall under different ministries, e.g. in the dehesas in Spain. There is not a common agreement on which sector to frame such integrated systems. It is also to be recognized that young population from rural areas has migrated to urban areas and traditional knowledge of the management of this traditional integrated systems is being lost due to rural population ageing.

Even if policy has favoured over the years agriculture and forestry independently, there is a current slight change at all levels towards recognizing the cultural, social, economic and environmental value of traditional systems as silvopastoralism.

Silvopastoral systems may contribute to solve main threats to biodiversity in Europe that are the high degree of habitat fragmentation, intensive agriculture, land abandonment, climate change, desertification and fires (EEA 1998), as well as to preserve domestic livestock breeds. Europe is home to a large proportion of the world's domestic animal diversity. Grazing livestock (ruminants and equidae) represents 63% of all recorded European breeds. Of the European breeds, almost half are categorised as being at risk extinction and, unfortunately, the percentage of mammalian breeds in Europe at a risk of extinction increased from 3% to 49% and of bird breeds from 65 to 79%. This declining genetic diversity is due to intensification, large-scale industrialisation of farming and globalisation of world trade in agricultural products and breeding stocks, including the consequences the destruction of the traditional farming systems associated with livestock breeds and the development of genetically uniform breeds (FAO 2004).

Besides the policies that affect the EU as a whole, each country may approach these systems in different ways both at national and regional level depending on the different forest, climatic and relief characteristics: in areas where forest area is low or in areas where forage productivity may increase due to tree cover (e.g. Mediterranean area) these systems are promoted, where avalanches are a threat, grazing is limited in order to avoid overgrazing and forest loss, etc…

United Kingdom establishes within its Action Plan on Forest Biodiversity by 2010 certain goals directly related to silvopastoral systems, as for instance: (1) Restore 100 ha of woodland pastures, (2) Restore 50 km per year and plant 3 km per year of living fences, (3) Increase the areas of 5 semi-natural ancient forest with possible forest grazing.

Legislation in **Switzerland** subjects wooded pasture to forestry laws. A plot of wooded pasture can only be released from forestry regulation through formal procedures to reclaim the land, which require the creation of an equivalent wooded area (Gillet & Gallandat 1996). Therefore from the forestry authorities' point of view, wooded pasture remains as forestry land, even when the proportion of tree cover becomes nil. By contrast, an agricultural domain becomes subject to forestry regulations if its tree cover reaches a threshold value, generally 10%. The Swiss forest law states that activities that can hinder a sustainable forest management must be forbidden. Some of the Cantons have considered grazing as damaging factor and therefore forbidden it. Still grazing covers 20% of the forest area in some of the Cantons (Mayer et al. 2002).

Other countries were grazing has traditionally been forbidden in forest are e.g. **Hungary** or **Poland**. Some of the new EU countries host high environmental quality in their ecosystems mainly due to low inputs of fertilizers or pesticides. Silvopastoral systems could be an option to consider for implementation in order not to lead to the same intensive agriculture developed in the former EU-15.

The **Spanish** Forest Strategy that highlights the cultural, environmental and economic value of the dehesas and other silvopastoral systems, including agricultural areas in mountains. It recognizes the need to preserve or restore such systems and lists the Spanish livestock species and breeds, including the endangered ones (e.g. Galician forest horse, Asturian mountain cattle, etc). If silvopastoral systems are promoted such breeds can be used, contributing to the 2010 target of the EU. A Royal Decree (145/1999) exists to promote the autochthonous cattle breeds in extensive systems and also the Royal Decree (51/1995) to promote the agricultural management compatible with protection and conservation of the natural environment that also protects some of the endangered species. Both Ministry of Environment and Ministry of Agriculture have a role to play in the production of the silvopastoral systems. Both ministries are developing a Spanish Programme on Dehesas that clarifies the roles of each administration.

Environmental context

In countries/regions where grazing is authorized, law may establish some restrictions so that a sustainable management is applied, e.g. regulation of grazing during few years after forest fire, during regeneration, promoting some animal instead of others. On the other hand silvopastoralism is used in some regions, especially in Mediterranean areas to prevent the built-up fuel in the understorey with the spinning benefit of forest fires prevention.

Assessment

Various disciplines as forestry, agriculture, environment and rural development have an implication on silvopastoral systems, having competences on them.

Agroforestry, including silvopastoralism, offers a strategic policy option to meet some of the goals within the amended CAP, not especially within the 'market pillar' but as delivery of other goods and services within the 'rural development pillar' (McAdam 2004). Extensification will depend on farmers' attitudes to medium-/long-term goals rather than short-term goals, nevertheless in times of crisis or uncertainty farmers will opt for short-term goals and subsidies may facilitate farmers' decision-making.

It is foreseen that in 2005 the results of the "Silvoarable agroforesty in Europe" (SAFE) project will be published as the results "Agroforestry Policy Options" that may allow to the European Union (EU) frame the new Regulations so that agroforestry will receive the same attention as forestry and agriculture, due to its potential as sustainable land use.

Definitions:

*** *Organically evolved landscape***: It results from an initial social, economic, administrative, and/or religious imperative and has developed its present form by association with and in response to its natural environment. Such landscapes reflect that process of evolution in their form and component features. They fall into two sub-categories: (a) a relict (or fossil) landscape is one in which an evolutionary process came to an end at some time in the past, either abruptly or over a period. Its significant distinguishing features are, however, still visible in material form; (b) continuing landscape is one which retains an active social role in contemporary society closely associated with the traditional way of life, and in which the evolutionary process is still in progress. At the same time it exhibits significant material evidence of its evolution over time.

Subindicator

Financing in selected countries

😐 **Key message**

Silvopastoral systems are traditional systems that have been partially lost due to agricultural intensification, abandonment of rural areas by young people, etc. To maintain the rich biodiversity of landscapes and species related to these practices there is a current need for funding. At European level there has been no funding specifically dedicated to these systems but within certain rural development policies (agri-environmental, less favoured areas…). Subsidies to promote extensive and environmental-friendly systems have been established several years ago. Nowadays it is proposed in the new Rural Development Regulation to dedicate specific funding for establishment of silvopastoral systems. It is at country level where so far the silvopastoral systems have been specifically addressed to receive funding.

Assessment for the sub-indicator

It is to be highlighted the inclusion in the last proposal (under evaluation) for the new Rural Development Policy of the Article 41 to subsidize the establishment of agroforestry systems in the EU. They are recognized due to its traditional importance for sustaining rural population with traditional knowledge adapted to nature, religious and cultural conditions that are linked to environmental-friendly management.

Subsidies have been established to promote extensive and environmental-friendly systems. The requirement to obtain subsidies for cattle is to manage a stocking rate under 2 livestock units (LSU) per ha. Farmers are eligible for an additional extensification subsidy when stocking rate is lower than 1.4 UML for beef cow or 1 UML for calf (MMA 2000). Nevertheless these figures are too general and treshold of stocking rates must be adapted to each region's productivity. The **Spanish farmers** received in 1997 over 215 million Euros for the subsidies of beef cow, over 77 million for calf and over 92 million for extensification. These figures reveal the importance of this sector that also includes forest land for the accounting of area available for the livestock. Subsidies for sheep and goat do not establish stocking rate requirements since they are usually extensive or semi-extensive systems. More specifically some Spanish regions, as the Region of Valencia, establish subsidies for using grazing as control tool of pasture and bushes in fire-breaks. The Environment Department established since 1994 an adequate fire-breaks network for a better fire fighting in major fire events. To keep such areas free of encroachment, the government offers subsidies to farmers to keep control of the vegetation by grazing instead of mechanised control (Dopazo & Suarez 2004).

France promotes agroforestry by compensating over-costs compared to a standard agriculture plot. The measure is contracted on a 5 year term, and two options are available: one for creating a new agroforestry plot (240 to 360 Euros/hectare/year during five years), and one for tending an existing silvoarable plot (100 to 140 Euros/hectare/year during five years). The value depends on the agricultural activity on the plot, because tree protection costs are different for annual crops, grazing by small animals or grazing by cattle.

Belgium has offered payments under Rural Development Regulation (No. 1257/99) to farmers to preserve and maintain landscape features and biodiversity, such as hedges, strips of woodland, old standard fruit trees in pastures.

Also **Denmark** and **France** offer payments to maintain and restore specific landscape features, such as hedges, shelterbelts and trees as part of their national plans of rural development.

British government pays subsidies under the Woodland Grant Scheme to farmers to develop agroforestry practices, including silvopastoralism. Such new plantations have to be maintained at least for ten years.

Generally, many of the agri-environment subsidies are more directly related to production factors, as e.g. the adoption of agricultural practices less input intensive. Less common are direct subsidies for environmental outputs as landscape or biodiversity, although some exist to preserve areas of high landscape value, wildlife, historical value and certain rare breeds, etc (OECD 2003).

Many habitats, species and special breeds associated with transhumance are unique and irreplaceable and have both economic and intrinsic values. Transhumance also contributes to the protection of mountain ecosystems and landscapes from natural hazards (e.g. fire, erosion, avalanches, landslides) by maintaining a stable mosaic of parches that have developed over centuries. More than four million hectares of agricultural land depend on transhumance throughout Europe. The movement of the flocks goes not only trough agricultural land but also silvopastoral systems in some areas (Alterra 2004).

Definition:

Transhumance: It is the seasonal oscillatory movement of livestock, vertical in altitude; it links mountain habitats with agricultural land in the valleys and adjacent lowlands, to exploit the different seasonal growth.

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Meta data

Technical information

17. Data source: -
18. Description of data: -
19. Geographical coverage: selected European countries
20. Temporal coverage: -
21. Methodology and frequency of data collection: -
22. Methodology of data manipulation, including making 'early estimates': -

Quality information

23. Strength and weakness (at data level): -
24. Reliability, accuracy, robustness, uncertainty (at data level):

Quantitative data on financing and supporting silvopastoral systems depends on country policy and no statistics at European level are harmonized.

9. Overall scoring (give 1 to 3 points: 1=no major problems, 3=major reservations):

Relevancy: 3

Accuracy: 3

Comparability over time: 3

Comparability over space: 3

Further work required

To follow up the implementation of the new policies related straight forward to agroforestry/silvopastoral systems implementation in a harmonized way.

Annex 4 Forest damage by wildlife and grazing

😐 **Key message**

Damage to European forests by wildlife and grazing amounts to 1.8 million ha, i.e. 0.2% of total forest and other wooded land area (FOWL) representing 14% of the total damaged forest and other wooded land area. Available data are nevertheless vague in the sense that it is not known the damage degree and which share of damage is due to wildlife or to domestic livestock and to which species of livestock. Data are not completely harmonized between countries for a fully comparison; therefore an effort in further harmonization of methodology for data collection is needed. Damage by wildlife and grazing can be controlled and minimized with the adequate forest management through means of individual tree protectors, adequate stocking rate or temporal exclosure where needed.

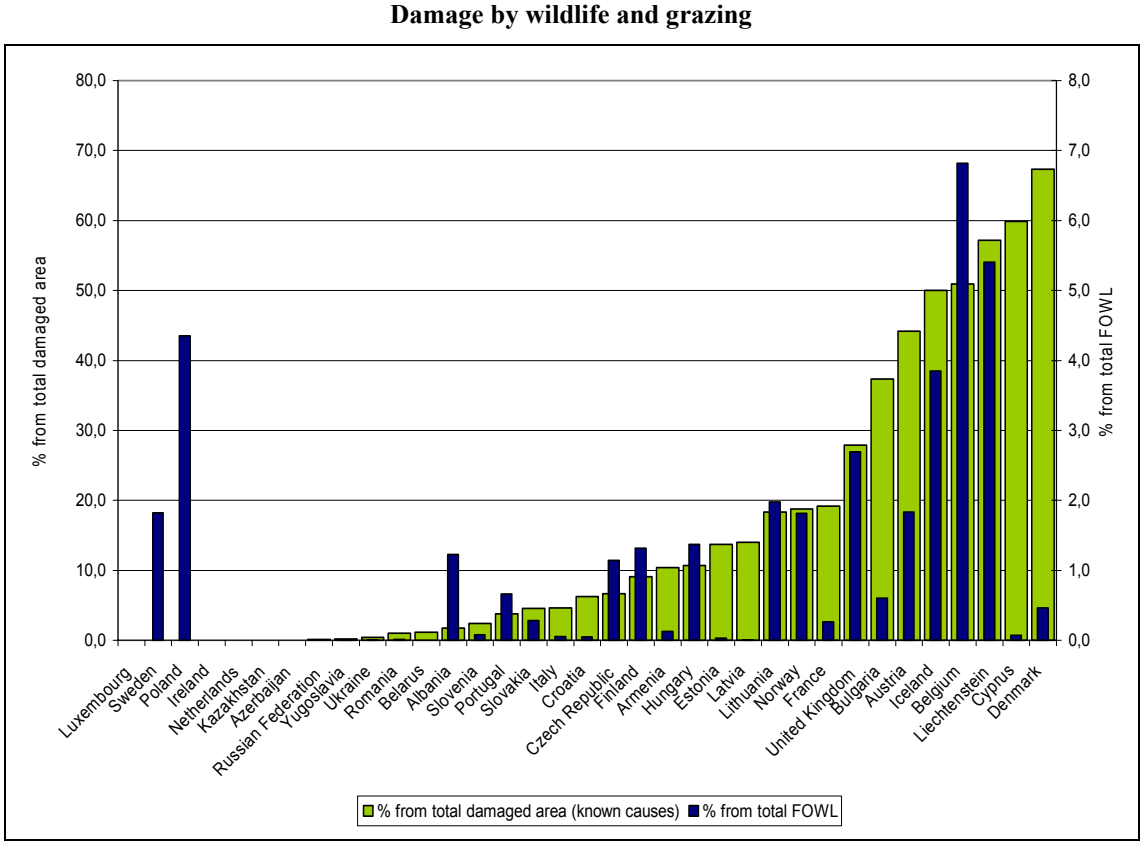

Figure 1. Damage by wildlife and grazing

Note 1. Data of damaged area by wildlife and grazing is not available for Bosnia and Herzegovina, Georgia, Germany, Greece, Israel, Kyrgyzstan, Malta, Republic of Moldova, Spain, Switzerland, Tajikistan, The FYR of Macedonia, Turkey, Turkmenistan and Uzbekistan. **Note 2**. Luxembourg, Sweden and Poland have reported area damaged by wildlife and grazing but not total damaged area by different agents. **Note 3**. Data should be compared with caution. **Note 4**. FOWL = Forest and Other Wooded Land. **Source**: UNECE/FAO. 2000. Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand (TBFRA 2000). Main report. UNECE/FAO Contribution to the Global Forest Resources Assessment 2000. United Nations, New York and Geneva.

Results and assessment

Policy relevance

This indicator is relevant for policies dealing with the reduction of damages in forests and their conservation. Agenda 21 states that overgrazing risks should be avoided through appropriate means, still grazing in the forest may provide with several benefits such as obtaining different products, promoting animal welfare, extensification of systems improvement of water quality, authocthonous breed preservation, rural population stabilisation, conservation of genetic diversity of domestic animals, etc.

Policy context

The guidelines agreed within the MCPFE refer to the need of forest management oriented to maintain and enhance the stability, vitality, regeneration capacity and resilience of the forest against pressures such as fires, pests, wildlife, overgrazing and uncontrolled grazing. Such guidelines also consider that "close to nature" forest management should be enhanced.

This indicator is related to the Criterion 2 Maintenance of Forest Ecosystem Health and Vitality, Indicator 2.4. Forest Damage of the MCPFE agreed Criteria and Indicators.

Environmental context

Some theories support the idea that before humans started playing important role in the change of the landscape, mega-herbivorous existed in forests and influenced its structure and development, leading to a co-evolution of the tree species associated to that pressure, with more gaps within the forest, more mature trees and fewer seedlings than the current pristine forests. Such mega-herbivorous have been replaced in some areas by domestic animals, maintaining in a way the same forest structure (Bengtsson et al. 2000). In fact within the Mediterranean biogeographical region where grazing continue to be a common activity within the forests, there is a high diversity of vascular species (ca. 30,000).

In a few nature reserves introduced domesticated cattle and horses play the part of "wild" descendants of the extinct species, aurochs and tarpan. Their role is comparable to that of wild herbivores such as roe deer and red deer. The introduced grazing animals are in effect subjected to a process of de-domestication (Siebel & Piek 2002). Oak and hazel do rejuvenate successfully in more open terrain grazed by large herbivores such as cattle and horses, especially when surrounded by thorny shrubs (juniper, rose, blackberry, hawthorn and sloe) or shrubs which do not have thorns but which are unappetising to herbivores like heather and broom (Vera 2002). Since ungulates have always played an important role in natural ecosystems, the importance of the natural grazing should not be ignored (Bunzel-Drüke et al. 2002, Redecker et al. 2002).

Grazing within the forest can be controlled with technical arrangements and managed in a way that forest natural regeneration can succeed and damage to young trees is minimised. Mature trees are not prone to suffer the damage as young ones. Therefore it is in the first stages of the regeneration period or plantation when attention to livestock has to be paid. There are different alternatives as for example individual tree protectors for low density stands, or temporal exclosure of forest to livestock or wildlife in denser stands. Regeneration may in fact be facilitated by previous grazing (McEvoy et al. 2004). It has to be recognized that an important factor with influence on vegetation dynamics and maintenance of a healthy ecosystem it is the adequate stocking rate (Rook et al. 2004, Adler et al. 2001, Rigueiro et al. 1999).

Also soil compaction could be a damage caused by grazing. This can be avoided with the convenient management.

Research has shown that the general assumption that a stable livestock density gives the best results is no longer valid, partly due to the fact that feed availability is not stable through the year(s) and stocking rate should be adapted to for a better balance between forage production and animal needs in order to reduce the pressure on trees. There is growing evidence that in fact a certain healthy dose of fluctuation in large herbivore populations is crucial in the long run for the conservation of species diversity and a more developed landscape pattern (LNV 2002). Site managers decide where animals may graze, when and for how long, the number and the species of animal to be put out to graze (Siebel & Piek 2002). It is becoming more and more evident that nature may benefit particularly from fluctuations in grazing intensity, with a positive effect on biodiversity. As in pristine wilderness periods of high grazing intensity vegetation becomes more open and this benefits species which have a low competitive ability under shading conditions. Species which are sensitive to grazing also benefit from the subsequent period of low grazing intensity.

It is also to be highlighted that forage obtained from tree leaves (birch, oak, fir, etc.) is healthier than the grazed pasture since there is not direct contact with manure and other chemical compound. Also some tree species act as natural medicines for animal diseases, as for instance species from *Salix* genus that had been traditionally kept in the farming landscape, and unfortunately such knowledge has been partially lost and removed these species in some areas, as e.g. in Great Britain (Ispikoudis, I., pers. comm.).

Integrating local breeds of livestock for grazing will benefit of reducing the need of buying extra feed for the animals since they are breeds adapted to grow up in harder conditions than high productive selected breeds, and forage growing season is also increased under tree canopy especially in dry areas when tree canopy cover is lower than 30% as it reduces evapotranspiration and increases water availability for pasture production. Furthermore environmental impact of the use of fertilizers, pesticides, etc. is reduced in these systems.

Assessment

European forests are damaged by various agents: storm, wind and snow (the most important cause of damage in many countries), insects and other diseases, fire (especially in the Mediterranean area), wildlife and grazing and local pollution sources. In some areas various number of factors acted simultaneously. Damage by wildlife and grazing amounts to 1.8 million ha, i.e. 0.2% of total forest and other wooded land area (considering only forest area of the countries reporting such damage) representing 14% of the total damaged forest and other wooded land area.

Many countries reported difficulties in the assessment of damage caused by wildlife and grazing. Some of the countries (e.g. Denmark) have reported figures based on estimates, while other countries (e.g. Poland) base the figures in periodical wildlife damage inventories. France for instance reported figures of damage on forest area under regeneration but it does not quantify damage in older stands, probably because the impact uses to be very low. Other countries have not reported any data. Therefore the assessment of the extent of the damage must be treated with caution.

In most cases, the damage is primarily to regeneration, with selective browsing by ungulates being particularly important. Damage to mature trees caused by arboreal mammals very seldom occurs in Europe. Damaging agents referred to within the TBFRA assessment are e.g. roe deer, hare, red deer, wild boar, grey squirrel, etc. However, there is not clear specification to domestic livestock.

In a number of European countries (e.g. Belgium, Liechtenstein, Poland, Iceland, United Kingdom, Lithuania, Austria, Sweden and Norway), the area of forest and other wooded land with such damage amounted from 2% to 7% of total forest and other wooded land area of the country. According to MCPFE (2003) this is due to many factors, including hunting practices and the absence of predators. Game populations are at the highest levels in several countries. As a consequence, extensive preventive measures have often to be taken for the regeneration areas. Countries were damage by wildlife and grazing amount to more than 40% of the damaged area are Austria, Iceland, Belgium, Liechtenstein, Cyprus and Denmark.

Despite possible damage caused by livestock within the forest, which is possible to prevent with proper management, silvopastoralism[4] may though provide a preventive solution to forest fires, which are another cause of forest damage (with similar percentage as grazing, but with higher degree of damaging) especially in southern Europe in Mediterranean areas or Atlantic areas with dry summer. Research has shown that livestock grazing in the forest has proved to reduce the high quantity of accumulated biomass that would have increased otherwise the forest fire risk (Rigueiro et al. 1999).

[4] Silvopastoralism: traditional agroforestry practice that combines forest and woodlands and any type of livestock.

Furthermore at low to moderate grazing levels woodland structural diversity may be enhanced, providing a range of feeding niches and shelter for birds. Certain bird species (woodwarblers, pied flycatchers, redstarts, thrushes, tree pipits, etc) prefer sites with less than 30-40% of shrub cover, for feeding and nesting, and low ground vegetation (15-20 cm). When grazing is reduced and shrub cover increases, commoner species such as blue tits will compete with pied flycatchers for nesting sites (Mayle 1999). Game birds and other small game species also rely on ground cover to avoid predation. Livestock also creates pathways that are used by other mammals and birds, e.g. woodland grouse (Dennis 1998). Cattle dung in particular attracts birds (jackdaws, waders, chough, starlings, woodland grouse, etc, which feed on the associated invertebrates and their larvae, and other species which feed on adult flies attracted to the dung. Dung is also an important habitat for beetles and many species of fly associated with it, as well as earthworms, nematodes, mites and springtails.

Many woodland butterfly species depend on open areas such as glades, rides or recently coppiced areas, and require a temporarily continuous mosaic of these open habitats (Robertson et al. 1995). Grazing may help to maintain these habitats by limiting the spread of grasses which compete with important herbaceous nectar plant species such as viola. Wood ants may also benefit of grazing and browsing since they build their nests in locations to obtain direct sunlight and a reduction in ground vegetation will enhance their habitat (Tubbs 1986). Also in some areas it was found a greater abundance of spiders in grazed than in ungrazed woodlands (Putman et al. 1989).

It is recommended that grazing regimes should start with low stocking rate, should be limited in sensitive areas and should be monitored, in order to maintain the ecosystem health and diversity (Mayle 1999).

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Meta data

Technical information

25. Data source: UNECE/FAO 2000
26. Description of data: Base data in ha, manipulated data as percentage
27. Geographical coverage: Europe
28. Temporal coverage: Varies between countries, from late 80s up to 1997.
29. Methodology and frequency of data collection: TBFRA is updated every ten years but only some countries collect periodically such information. Some countries do not report collected data but estimates. Methodology is not harmonized across all countries.
30. Methodology of data manipulation, including making 'early estimates': Calculation of percentage with data obtained from TBFRA.

Quality information

31. Strength and weakness (at data level):

Strength: The current data set is the most harmonised data possible to find within statistics. Since TBFRA is updated periodically, country reporting on such parameter is expected to improve for better reliability.

Weakness: Many countries had reported difficulties in the assessment of damage caused by wildlife and grazing. Some countries report for a single year, other as average and other as total of a period, therefore assessment must be treated with caution. Some countries report based on inventory and other based on estimates, and therefore the results are not completely comparable.

32. Reliability, accuracy, robustness, uncertainty (at data level):

Available data are vague in the sense that it is not known which share of damage is due to wildlife or to domestic livestock and to which species of livestock. Data are not completely harmonized between countries for a fully comparison.

9. Overall scoring:

Relevancy: 1

Accuracy: 2

Comparability over time: 2

Comparability over space: 3

Further work required

Data collection within the countries needs further improvement, taking into account the degree and type of damaging (wildlife or grazing by domestic animals), type of animals causing damage, relationship between age of the stand and period when damage is recorded per tree species.