BIODIVERSITY FACT SHEET

Animal Husbandry

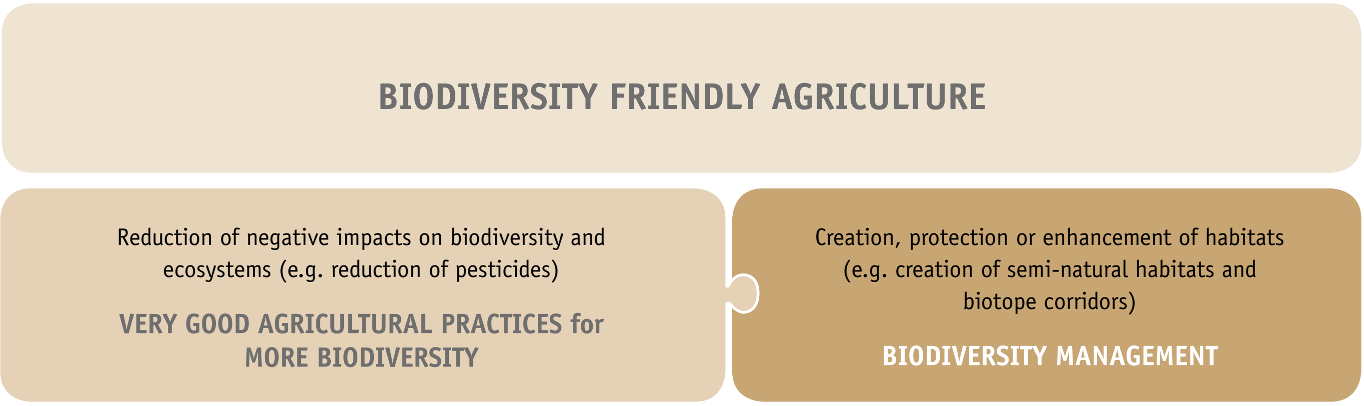
Livestock Production

CONTENT

1. INTRODUCTION

The LIFE Food & Biodiversity project supports food standards and food companies to develop efficient biodiversity measures and to include these measures in their pool of criteria or sourcing guidelines.

In this Biodiversity Fact Sheet, we provide information on the impacts of livestock production on biodiversity in temperate climate regions of the EU, as well as ways to very good practices and biodiversity management. Biodiversity-friendly agriculture is based on two main pillars, shown in the graph below. Within this paper, the aspects of "very good agricultural practices" are discussed in each chapter. The aspect of biodiversity management, including biodiversity action plans, is described in more detail in the fifth chapter.

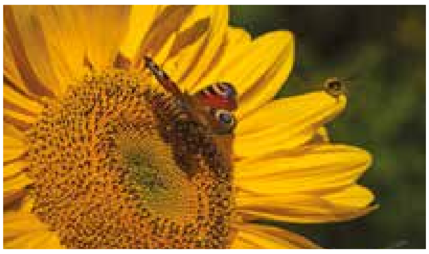
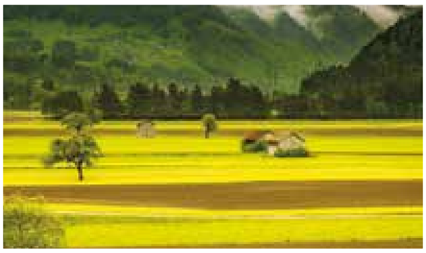


The Fact Sheet is aimed at everyone who takes decisions on product design and development, supply chain management, product quality, and sustainability aspects in food processing companies and food retailers in the EU. We wish to raise awareness on the importance of biodiversity in the field of providing key ecosystem services as the fundamental basis for agricultural production.

2. AGRICULTURE AND BIODIVERSITY

Biodiversity loss: time for action

The loss of biodiversity is one of the greatest challenges of our time. Species loss driven by human activities is taking place at rates up to about 114 times higher than under natural circumstances. Many ecosystems which provide us with essential resources and ecosystem services may also decline (Ceballos et al. 2015). The conservation and sustainable use of biodiversity is essential to maintain ecosystem services, agricultural production and ultimately human nutrition and quality of life (Mace et al. 2012).

Biodiversity is defined as the diversity within species (genetic diversity), between species and of ecosystems

The main drivers of biodiversity loss are:

- **Habitat loss due to land use changes and fragmentation.** The conversion of grassland into arable land, land abandonment, urban sprawl, and rapidly expanding transport infrastructure and energy networks are causing large habitat losses. Habitat loss is the main threat to 85 % of currently threatened or endangered species (WWF 2016). In particular, farmland fauna and flora have been declining considerably, with the European farmland bird index declining 52 % from 1980 to 2010, as an example (PECBMS 2012). About 20 % of the world's 7,600 animal breeds (from 36 domesticated mammal and bird species) are classified as being at risk (FAO 2007).
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilizers containing nitrates and phosphates (IUCN 2018).
- **Overexploitation of forests, oceans, rivers and soils.** 30 % of species are threatened by overexploitation of habitats and resources (IUCN 2018).
- **Invasive alien species.** 22 % of species are threatened by invasive alien species. The introduction of alien species has led to the extinction of several species (IUCN 2018).
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats (Harvell et al. 2002).

Livestock and biodiversity

The main task of livestock production is to provide a secure protein supply for a fast-growing world population in order to contribute to food security. Consumption patterns in industrialized and emerging economies have led to an intensification of animal husbandry and a more globalized food market, resulting in tremendous changes in the use of agricultural land, grassland and pastures, highly intensive production systems and worldwide trade of animal food and animal products.

Currently, the production of animal food and animal husbandry in general depend on biodiversity and at the same time play an important role in shaping biodiversity. On the one hand, agriculture and animal husbandry led to the decline of many wild species in Europe, since the Neolithic. However, on the other hand, in some instances these activities allowed for an increase in landscape and species diversity, at least at the local scale. The European continent used to have larger areas covered with forests. New landscape features emerged with the expansion of agriculture, including fields, pastures, orchards and cultivated landscapes (such as meadows). The conservation of biodiversity and habitats is closely linked to agro-ecosystems ever since, particularly after the decline of species such as the wild herbivores that used to roam in herds and in higher numbers. Currently about 40 % of the surface in Europe (EU-28), i.e., about 176 million hectares of arable and grassland areas, is used for agriculture (EC 2017). Consequently, it is estimated that about 50 % of European species are associated with agricultural habitats (EEA 2003).

The food sector can substantially contribute to biodiversity conservation. The appropriate integration of biodiversity as a factor into sourcing strategies allows the evaluation of risks for internal operations, brand management or legal and policy changes, improves product quality, and helps to ensure a secure supply to retailers and end customers. A good strategy for biodiversity conservation, i.e. a positive biodiversity performance, opens up opportunities in terms of differentiation in the market, value proposition, meeting consumers' demands and more efficient sourcing strategies.

Legal Framework for Agriculture in Europe – Common Agricultural Policy (CAP)

Since 1962, the EU-Common Agricultural Policy (CAP, Directive 1782/2003/EG and the 2013 amendments) has presented the legal framework for agriculture in the European Union. Initially, it was based on the experience of hunger and starvation in Europe and aimed at securing food supply for the population and the independence from international markets. Nowadays, the CAP aims at securing food production, maintaining about 44 million jobs in the EU and introducing technological advance whilst simultaneously protecting nature and safeguarding biodiversity. The CAP regulates subsidies to farmers, the market protection of agricultural goods and the development of rural regions in Europe. Farmers receive payments per hectare of cultivated land and get additional subsidies related to production and farm management.

The EU CAP refers to a set of EU directives, which must be respected by farmers:

- **Directive 91/676/EEC –** ”Nitrates Directive” – regulates best practices for fertilisation of crops.
- **Directive 2009/128/EC –** ”Pesticides Directive” – regulates best practices for the use of insecticides, herbicides and fungicides.
- **Directives 92/43/EEC –** ”Flora-Fauna-Habitats Directive” and 79/409/EEC – “Birds Directive” – provide the legal framework for biodiversity conservation in Europe.
- **Directive 2000/60/EC –** ”Water Framework Directive” – aims at improving the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, Cross Compliance (CC) regulations address shortcomings of the original CAP philosophy concerning environmental issues. This principle, connecting CAP support received by farmers to basic rules on environmental protection, represented an important step towards environmentally friendly farming. The rules of CC include measures designed to reduce severe impacts of agriculture on the environment such as soil erosion, nitrification, pollution of water bodies, land-use change, etc. Regarding biodiversity, environmental organizations have highlighted the need to go beyond the requirements associated with CC (Boccaccio et al. 2009).

Since 1992, the CAP promotes the implementation of voluntary agri-environment measures supported by payments per hectare that depend on the efforts and losses in yield due to the implementation of these measures. Member States, federal states and provinces define regionally adopted agro-environmental measures. These encompass actions, which focus directly on the protection and conservation of agro-biodiversity. Farmers can sow blooming stripes, set aside fields temporarily or permanently, organise buffer strips along open waters, plant hedgerows and others. Studies have shown positive effects of such measures on biodiversity (Sutherland et al. 2017).

The most recent CAP regulations, introduced in 2014, require farmers to implement “greening measures” when applying for direct payments (EC 2013). Biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. About 30 % of direct payments are focused on strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, particularly in order to improve the use of natural resources. A recent assessment observed scarce effects on biodiversity after two years of application of greening measures, and highlighted the need to adjust the current setoff measures in order to increase its effectiveness (Hart et al. 2017).

3. LIVESTOCK PRODUCTION IN EUROPE

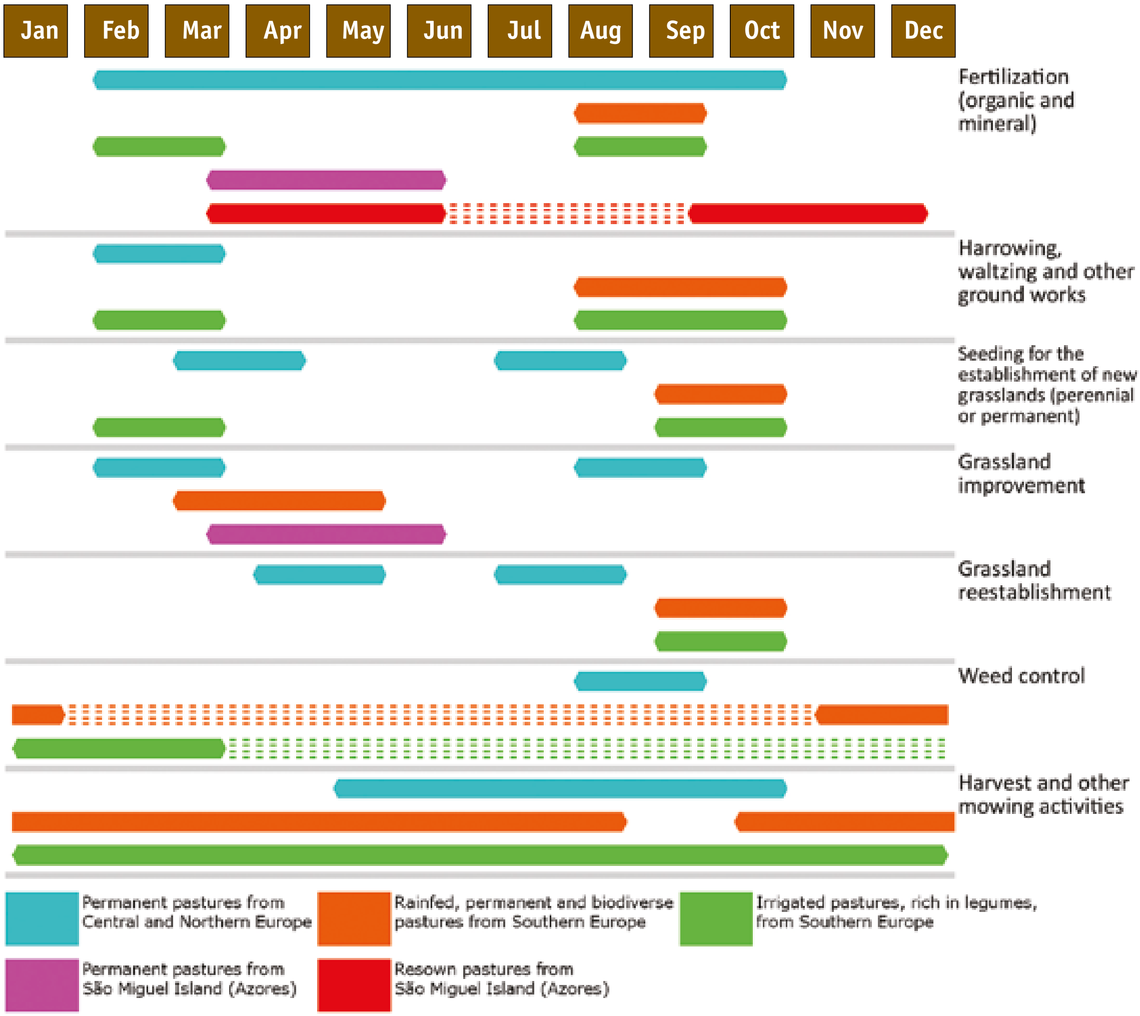
Livestock represents about 40 % of the global value of agricultural output and supports the livelihoods and food security of almost 1.3 billion people worldwide. The livestock sector is one of the fastest growing in the agricultural economy, due to the shift in diet and food consumption patterns towards livestock products. It is the world's largest user of land resources, taking up about 30 % of the Earth's ice-free terrestrial surface (about 25 % corresponding to grazing land and 5 % to cropland dedicated to the production of feed – which is actually 1/3 of global cropland). This whole surface corresponds to almost 80 % of total agricultural land and requires about 8 % of global water use, primarily for irrigation of feed crops (Monfreda et al. 2008, Ramankutty et al. 2008, Teillard et al. 2016, FAO 2018). The global livestock standing populations are estimated to include about 1.43 billion cattle, 1.87 billion sheep and goats, 0.98 billion pigs and 19.6 billion chickens (Robinson et al. 2014).

This Fact Sheet focuses on livestock farming for the production of meat in Europe. Many of the facts are applied to dairy production, which is the focus of another Fact Sheet. The EU livestock sector is the largest in the world and meat, milk, and eggs make up about 39 % of the EU's agricultural industry output. In 2015, about 10 million people were employed in agriculture in the EU-28, with the majority dedicated to crop and animal production, hunting and related service activities (Eurostat 2018). Pastures and meadows occupy nearly 22 % of Europe's agricultural area (Eurostat 2018). In 2016, in the EU-28 the largest total populations of livestock were held by Spain, Germany, France, the UK and Italy. Different Member States hold the largest populations of different animal groups, namely: cattle (France: 19 million), sheep (UK: 23.8 million), goats (Greece: 3.9 million) and pigs (Spain: 29.2 million). Generally, livestock production has been described as having both positive and negative impacts on biodiversity, through five main drivers of change: habitat change, pollution, climate change, over-exploitation and invasive species (Teillard et al. 2016).

Despite the role that livestock has played and still plays, in particular through grazing, in shaping part of Europe's biodiversity in relation to agroecosystems, the main impacts highlighted in literature and scientific reports, and frequently by non-governmental organisations (ENGOs), are negative. These include: a) the destruction of habitats through the conversion of native primary forest into pastures or feed crop production areas, mostly in South America and particularly in the Amazon rainforest and the Brazilian Pantanal regions (Lambin et al. 2003, Wassenaar et al. 2007, Nepstad et al. 2009, Teillard et al. 2016); b) the degradation of soils due to excessive livestock densities and/or intensification practices; and c) the acidification and eutrophication of soils and water bodies, due to diffuse pollution driven by nutrient run-offs and caused by inadequate animal waste disposal and/or excessive fertilizer use.

Livestock production also contributes to global climate change through the significant emission of greenhouse gases (GHG), i.e., methane (CH_4) (≈44 %), nitrous oxide (N2O) (≈29 %) and carbon dioxide (CO_2) (≈27 %) (Gerber et al. 2013). Worldwide, the livestock production sector has been estimated to generate about 7.1 Gt of CO_2-equivalent per year, representing about 14.5 % of all anthropogenic GHG emissions (Gerber et al. 2013). In the EU, it is estimated that about 9.1 % of total GHG emissions result from this sector (if the impact of sourcing animal feed, for which the EU is a significant importer, is included), 12.8 % if land use and land use change emissions are included (JRC 2010).

4. LIVESTOCK PRODUCTION AND IMPACTS ON BIODIVERSITY



Detailed chronogram regarding the common application of the main agricultural practices in pastures: a) from Central and Northern Europe (permanent or perennial); b) from Southern Europe (rainfed, permanent and biodiverse, or irrigated and rich in legumes); and c) from the Island of São Miguel (Azores) (permanent or resown).

The cultivation and treatment of permanent or perennial pastures requires a set of specific operations. However, some of the details regarding these operations, as well as the appropriate time period for implementing them, may vary as we are considering Central and Northern Europe or Southern Europe (check chronogram).

In the Autonomous Region of the Azores, and in particular in the Island of São Miguel, besides permanent pastures (not resown for at least 10 years) and of resown pastures, there are still some rare areas with semi-natural pastures, which include native and endemic species (mainly bryophytes and pteridophytes), located in high altitude sites. These pastures are mainly used for grazing during spring and summer, when climatic conditions are adequate, and not usually fertilized with chemical fertilizers. However, these pastures do absorb the organic matter resulting from grazing cows which are taken there from one to three times a year (usually cows which are not lactating).

In the Island of São Miguel, there are also pastures dominated by annual ryegrass (*Lolium multiflorum*), in rotation with the production of maize for foraging purposes, very common up to about 300/500 meters of altitude. The pastures predominate between October and May and the maize crop between May and October. These pastures are usually harvested or grazed up to 5 times a year and the use of chemical fertilizers is common. After the maize is harvested (in September or October), it is common to allow for the herbs, that spontaneously emerged among the maize crop residues, to be grazed. Only after this a new pasture is sown.

4.1 Management of permanent and perennial grasslands

In Central and Northern Europe, fertilization usually takes place from February to October. In Southern Europe, closer to the Mediterranean, the application of mineral fertilizers on rainfed, permanent and biodiverse pastures must take place before the productive cycle initiates, i.e., in August and September (installation and maintenance). The application of solid and liquid organic fertilizers should take place in the same period, but the former should only be applied during the installation (first seeding) stage while the latter may be applied during the installation and maintenance stages. In the same region, the application of mineral fertilizers on irrigated pastures rich in legumes also takes place in August and September, but maintenance may be performed in February and March. Both solid and liquid organic fertilizers must be applied exclusively during the installation stage.

In the Island of São Miguel, the application of chemical fertilizers in permanent pastures – dominated by meadow soft grass (*Holcus lanatus*) or, more rarely, by cat grass (*Dactylis glomerata*) – usually takes place in spring and, eventually, in the autumn. Concerning the most common pastures – which are frequently resown, i.e, reinforced or resown after 2, 3 or 5 years) and dominated by ryegrass (*Lolium perenne*) or annual ryegrass (*Lolium multiflorum*) – fertilization takes place after each harvest or grazing period, with a higher incidence in the spring and in the autumn, considering that, depending on the altitude, periods of lower growth may occur during the winter or summer. In addition to chemical fertilizers, it is common to apply slurry in these pastures, which was previously deposited in other sewage areas. This occurs from spring to autumn after the harvests or grazing periods.

In Central and Northern Europe, mechanical ground work such as harrowing and waltzing, aimed at improving the grasslands, is usually carried out in February and March. In Southern Europe, these operations are usually carried out from August to October, but in the case of irrigated pastures some operations may also take place in February and March.

Seeding operations may be implemented for three main purposes: the establishment of new grasslands, the maintenance or improvement of existing grasslands and the re-establishment of jagged grasslands.

As far as the establishment of new grasslands is concerned, in Central and Northern Europe this usually takes place in March and April or July and August. These grasslands are frequently the perennial component of crop rotations and rarely truly permanent grasslands. In Southern Europe, seeding may take place in September and October but, in the case of irrigated pastures, it may also take place during February and March. Ploughing and additional steps to arrange the seedbed are commonly applied.

In Central and Northern Europe, if an application of new seeds is needed in order to maintain a plot with high value grassland or to improve it, grass seeds are applied from February to March or from August to September. In Southern Europe, a reinforcement of seeds may be applied between March and May in rainfed pastures, and selective grazing may be used in irrigated pastures in order to favour the relevant species and varieties present. In the Island of São Miguel, resown pastures are directly grazed mainly during spring and summer. Therefore, the reinforcement with ryegrass seeds takes places particularly during the spring.

In Central and Northern Europe, jagged grasslands are re-established either in April and May or July and August, depending on the weather and water availability. Seeds may be applied with a fertilizer sprayer or through direct seeding techniques. In Southern Europe, it is in September and October that both rainfed and irrigated pastures may be re-established. Direct seeding may be used for the former and a suspension of irrigation procedures followed by direct seeding may be applied in the case of the latter, so that perennial species may finish their cycle or enter summer rest.

In Central and Northern Europe, the application of measures in order to deal with undesired weed species usually takes place during August and September. Most weeds are suppressed due to the frequent cutting. In Southern Europe, such measures may be applied throughout the whole year, but particularly from November to January (rainfed) and from January to March (irrigated).

When undesired weeds have covered significant portions of the plot and mechanical or chemical approaches are not viable, the full re-establishment of permanent grasslands may be necessary. This may require soil preparation measures. The seedbed may be prepared mechanically through tilling, harrowing and seeding, depending on regulations stating when and where this is allowed. Alternatively, direct seeding may be applied (but frequently requires the undesired use of total herbicides).

In Central and Northern Europe, the grass is mainly harvested from May to October. In Southern Europe, in rainfed pastures this usually takes place between October and August of the following year, but operations may be reduced or suspended during spring in order to favour flowering and seed production. In the case of irrigated pastures, harvesting may take place throughout the whole year, 3 to 5 months after the installation stage. In the Island of São Miguel, in resown pastures where the slope is adequate, harvesting and storaging takes place when growth is faster.

EFFECTS ON BIODIVERSITY

In general, soil treatments effect biodiversity negatively. Oxygen, UV radiation and heat will come in contact with the soil, particularly when the soil has been turned through ploughing, and the resulting furrows lead to severe edge effects for life in the soils. Humification processes, which take place under exclusion of oxygen, will be hindered and the natural soil pore systems will be disrupted. Each treatment impacts biological diversity within the soil and the fauna and flora above ground to a different extent.

The use of glyphosate for the devitalisation of permanent grasslands prior to its reestablishment via direct seeding has catastrophic effects on biodiversity. Any total herbicide targets all plants on the field unselectively, washing away the established flora and with that destroying the overall food supply for a great number of insects, birds, mammals and other animal species, which may ultimately result in the breakdown of trophic webs. However, some studies indicate that if no tillage (i.e., reduced or no soil mobilization) is applied, both the persistence of herbicides in the soil and the amounts found in the runoff are reduced, due to a higher microbiological activity in the surface layer and a stronger adsorption to higher amounts of soil organic matter, respectively (Basch et al. 1995, Cuevas et al. 2001).

4.1

Very good agricultural practices to ensure more biodiversity

Increased biological activity improves the self-regulation of soil ecosystems and decomposition of organic material. Superficial treatments, such as mulch-seeding and direct-seeding, are usually less harmful to soil biodiversity than ploughing and therefore have lower impacts on soil biodiversity such as earthworms, spiders and ground beetles. The latter are also benefited by conservational soil preparation (Farooq and Kadambot 2015). In order to safeguard small invertebrates, which are basal in soil trophic webs, it is recommended not to mobilize the upper soil layer (0 to 30 cm). In Central and Northern Europe, adopting mechanical soil preparation techniques to control weeds is recommended as a replacement for the use of agrochemicals. In Southern Europe, reduced soil mobilization is preferable, but the application of herbicides should be avoided just before heavy rains (Basch et al. 2015).

4.2 Nutrient management and fertilization in grasslands

The targeted yield and the quality (protein content) of the grass determine the Nitrogen (N)-demand of grasslands. When the grassland is used exclusively as a pasture, the maximum amount of N should be around 130 kg/ha. In this system, the nutrient input from the manure produced by grazing animals contributes greatly to the total N supply. However, meadows may need up to 300 kg N/ha, depending on the production intensity.

No additional N is necessary in the case of grasslands rich in legumes, which can fix significant amounts of N, ranging from 75 to 200 kg N/ha in non-irrigated areas and from 150 to 500 kg N/ha in irrigated areas (Freixial and Barros 2012). Both pastures and meadows also need a reasonable supply of phosphorus, sulphur, magnesium and potassium. The complementary use of mineral fertilizers is recommendable.

In intensive systems, organic fertilizer in the form of manure may be the most important source for nutrients in grassland. The optimal time of application is defined by the growth habits of the grass as well as the pasture management. In Central and Northern Europe, manure can be applied from February onwards, on unfrozen and snow-free soils which are therefore, available for the uptake. In Southern Europe, the period for manure application is longer. Similar to mineral fertilizers, the maximal amount of manure to be used on grasslands depends on the nutrient that first reaches the maximum demand of the grass. Usually, this is phosphate.

EFFECTS ON BIODIVERSITY

Fertilization practices usually have two main types of effects on biodiversity. The first refers to changes in the trophic state of plant and animal communities and the second refers to changes in the global nutrient cycles, mostly through nutrient run-offs into the surrounding environment and the diffuse pollution, caused by nitrogen and phosphorous, that follows (Basch et al. 2015).

Grasslands are particularly diverse in plant and animal species. As one of the largest biomes on Earth, it is estimated that about 24 % of the world's plant species occur in grasslands (Shantz 1954, Sims and Risser 2000, Pokorny et al. 2004). However, changes to the communities of plant species in and around grasslands, including native and sometimes endemic species, as well as to the animal species that are associated with them, may result from careless fertilization.

Concerning animal communities, higher nutrient availability usually leads to higher biomass production and therefore to a higher food supply for herbivorous arthropods and other organisms. Some generalist species can benefit from this increase in biomass and show increasing populations. However, biodiversity is not driven by generalists, but mostly by specialized species occupying a significant number of ecological niches. Probably for this reason, several long-term studies show a significant and strong decrease in many species typical of agricultural landscapes and of the ecological niches found in these landscapes.

Nutrient run-offs due to excessive fertilization cause relevant diffuse pollution and impact aquatic ecosystems particularly through acidification and eutrophication, i.e., the oxygen depletion that takes place in a water body after an excessive growth of plants and algae as a consequence of higher nutrient and mineral availability (Carpenter et al. 1998).

The inadequate disposal of manure and slurry, particularly resulting from intensive livestock farming, may severely impact the soil and water bodies. The accidental disposal of manure may easily cause the collapse of a whole aquatic trophic web but the restoration of such an ecosystem is inherently complex and may take a long time. Even moderate manure disposals may lead to significant changes in inland water ecosystems, reducing the existing community of aquatic species to the few, which are tolerant to water pollution. The production and application of manure also contribute to climate change through the emission of such substances as ammonia (NH_3) and nitrogen oxides (NO_x).

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4.2

Very good agricultural practices to ensure more biodiversity

It is recommended to analyse the possibility and advantages of using organic fertilizers. This may mean that different kinds of organic matter have to be used. It is important that these fertilizers are applied according to some basic rules, which aim at prohibiting the nutrient run-off into existing water bodies. Manure must not be applied on:

- water-saturated or flooded soils;
- deeply frozen soils;
- and soils covered with snow.

However, manure should generally be applied under cold, moist and cloudy weather. This reduces the evaporation of ammonia and is beneficial for a high utilization of the N from the manure by the grass. A minimum distance of 1 metre (using precision application machinery) or 4 metres (using common application machinery) to water bodies must be ensured in order to further decrease the possibility of run-off. Furthermore, farmers should be able to store the manure produced in their farms for at least 9 months in order to avoid the application of available manure when facing sudden events and due to a lack of storage facilities.

Finally, criteria for optimal soil fertility and fertilization should be based on standards that require nutrient balances and provide proven methods to apply. Such standards should define grassland-specific nutrient limits, combined with tolerance thresholds and time references. The used fertilizers should be documented in detail and following legal regulations. Currently, the EU Nitrates Directive (91/676/EEC) sets a limit of 170 kg of organic N/ha and all Member States have adopted action programmes that include this limit. Standards and companies may define retention periods for the application of organic fertilizers, in order to reduce the likelihood of run-off into water bodies.

Generally, extensively managed grasslands are highly diverse in flora and fauna. Whenever possible, intensive grasslands should be managed extensively. A reduction in fertilization and plant protection substances results in a greater abundance of species such as birds that also use grasslands as foraging habitats.

4.3 Pest control and plant protection in grasslands

From an ecological perspective, grasslands, especially those that are extensively managed, are diversified polycultures that include many different grasses, legumes and other flowering species. Even intensively managed meadows are usually composed of up to 2/3 of grass species and 1/3 of forbs (but legumes may also be a variable part of the mix), although diversity may be strongly reduced depending on the kind of management. In these intensive meadows, grass species are usually clustered according to their dietary value for the cattle. Usually, the first step to reduce the presence of plant species regarded as unproductive is done by mechanical methods. These may include levelling, harrowing, rolling, mowing and mulching. Since the use of herbicides may have a negative side-effect on the productive grass species, such use of chemicals is avoided except when the undesired weeds cannot be controlled by mechanical measures or when highly problematic weeds have become established. Often a jagged sod is the reason for the spreading of unwanted plants, therefore a sustainable grassland management and weed control includes the reseeding, too.

Two types of herbicides can be considered: residual and contact. Residual herbicides seal the ground and inhibit the development of wild plant species. Contact herbicides disrupt the metabolism of emerging plants. Herbicides may also be regarded as total or specific. Total herbicides target any plant species. Specific herbicides target only particular plant species. Herbicides are very effective and glyphosate is an example of a total herbicide working as a contact toxin. The application of just 0.1 ml/m² of active matter is usually enough to obtain the desired effect. In grasslands, total herbicides are applied to devitalize a bigger grass community prior to reseeding. Specific herbicides are used as a mean to counteract weeds.

EFFECTS ON BIODIVERSITY

Due to their high impact on biodiversity, the use of pesticides is generally criticized by NGOs and regulating authorities. The scientific community has provided studies highlighting how precise agriculture may allow the use of some agrochemicals which, under reduced soil mobilization, will not persist in the soil (Basch et al. 2015). Water legislation restricts the application of some extensively used herbicides, and of those with high risks of leaching due to their application times. A careful application of pesticides is essential to minimize collateral damages.

Concerning the use of herbicides, it is important to note that floral diversity forms the basis for food webs associated to grasslands. Consequently, if such diversity is reduced, then less food diversity will be available to meet the requirements of the various animal species, such as arthropods and birds. In grasslands, plants with a low nutrition value are generally decreasing in their population size. Many typical farmland species are almost extinct in numerous agricultural landscapes.

The use of mechanical treatments to fight weeds also generates strong negative impacts. These treatments are usually applied in the whole field, leaving only a few places untreated and therefore virtually all animal species inhabiting the grassland are affected. The nests of early breeding birds, such as the wood lark (*Lullula arborea*) are often destroyed by these measures. The negative impact on amphibians, insects and arthropods, and the population declines that result from that, ultimately reduces the food availability for other vertebrate species.

Very good agricultural practices to ensure more biodiversity

As stated above, all agricultural activities, being of a chemical or mechanical nature, have effects on biodiversity. In Central and Northern Europe, reducing the presence of weeds using mechanical measures has less negative effects on the environment compared to the use of herbicides. In Southern Europe, avoiding tillage and preserving the existing soil organic matter is necessary and frequently complemented with localized and precise use of agrochemicals (with lower persistence due to less tillage).

Integrated pest management is a reference found in European legislation, which aims at preventing the use of pesticides by applying cultivation aspects to reduce pests and diseases in crops. These measures should always guide the farm management.

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4.3

Among the agricultural practices that reduce the risk of pests and diseases, the optimal use of organic matter and the promotion of beneficial organisms are important for grasslands. The spreading of harmful organisms can also be prevented through field sanitation and hygiene measures such as:

a) the removal of affected plants or plant parts;

b) the regular cleansing of machinery and equipment; and

c) balanced soil fertility or water management.

In order to protect open water bodies, buffer zones must be installed and maintained along the edges of waterways and water bodies (minimum width: 10 metres). The use of mechanical weeding is recommended in order to substitute pre-emergence herbicides. The use of pesticides which are dangerous to bees, pollinating insects, beneficial organisms, amphibians or fish should be prohibited. Furthermore, very harmful substances and their salt equivalent versions should not be allowed (e.g., glyphosate, diquat, paraquat, glufosinate-ammonium, indaziflam).

4.4 Harvesting and mowing for livestock feed production

Farmers mow intensively used permanent grasslands and alternating grasslands up to seven times a year, depending on the growth and length of the growing season. Starting from the first cut (which in temperate climate regions of Central Europe usually takes place in May) these grasslands are cut every four to six weeks. Vegetation period and mowing time vary considerably with the geographical latitude.

The mowing of catch crops used as fodder (e.g., clover grass) is done after flowering and some of these crops can flower several times a year. These crops may be fed fresh, dried as hay or preserved as silage for the winter. The preservation of fresh grass as silage has seen an increase since the 1950s. Extensive grasslands are usually mowed twice. In Central and Northern Europe, mowing may just take place once in short summers.

EFFECTS ON BIODIVERSITY

Grasslands provide habitat, breeding ground and protection to many animal species. Therefore, the intensive use of grasslands strongly impacts biodiversity. Some plant species are unable to flower in such grasslands due to the frequent mowing. This reduces the value for plant communities and for insects drastically. Furthermore, ground insects are regularly eliminated and cannot reproduce sufficiently. Finally, mowing frequencies of four to six weeks are critical for soil breeding birds, as there is not enough time for the breeding and upbringing of new generations to occur.

Mowing is usually carried out with large rotary mowers, or alternatively with bar mowers. Rotary mowers are very efficient and create suction to the rotating blades, which is deadly for insects and small animals up to deer fawns. The number of deaths caused by the mowing can hardly be found but in Germany it is estimated that at least 500,000 animals die every year. About 90,000 of these are deer fawns.

As it was previously mentioned, intensively managed grasslands are usually fertilized with up to 300 kg N/ha. Applying about 50 kg N/ha after each cut, in order to stimulate regrowth, heavily impacts the soil and its organisms which, on the long run, inevitably decline.

Some extensively used grassland types are protected under European nature conservation law because of their important function for biological diversity (e.g., Macaronesian mesophile grasslands, lowland hay meadows, or mountain hay meadows, among others). The extensive cultivation with little or no fertilisation leads to a high species richness in herbaceous plants. The double mowing simultaneously pushes back grasses and favours the growth of such plants.

4.4

Very good agricultural practices to ensure more biodiversity

A series of measures can help to reduce the impact of mowing on biodiversity:

1. **Strategically delaying the mowing season.** If the first mowing is delayed by some weeks, then the breeding season of many wild animal species, such as birds that breed in meadows or insects, is avoided.
2. **Establishing a minimum mowing height of at least 7 cm.** Generally, the higher the cut, the lower the loss of animals seeking protection by lying flat on the ground, and the lower the loss of nesting sites.
3. **Reducing the mowing frequency.** Increasing the interval, mainly between the first and the second cuts, gives soil breeding birds the possibility to lay a second clutch of eggs and to breed successfully.

Furthermore, the mowing regime can be changed into a more biodiversity friendly practice, by:

1. **Mowing when insects and other arthropods are less active.** Mowing should preferably take place under damp, cold weather conditions. Furthermore, insects visiting flowers such as bees and butterflies hardly fly under cloudy weather. The same applies to the early morning and evening. For silage, dry weather is not an issue, but for haying it may be.
2. **Mowing different areas in different moments.** If all meadows get mowed at the same time, huge areas are no longer available as habitats. For surviving insects, this means that they no longer find food and their life cycle is disturbed. Birds and other small animals no longer find cover and are exposed to predators. Therefore, mowing larger areas, section by section, has proved successful. Alternatively, leaving strips (e.g., 20 metres wide) may allow animals to retreat to those areas, which can be set up temporarily or permanently.
3. **Adopting an adequate mowing pattern.** In the past, pastures were often mowed in concentric circles inwards, which drove fleeing animals into the inner circle, where they eventually became victims. There are alternative mowing regimes which can minimize this risk (more details are available in the Biodiversity Fact Sheet dedicated to Dairy Production).

After the mowing, many animals of the grassland seek protection and hide in the cut grass. It is recommended to leave the grass for some days on the field in order to provide temporary shelter to these animals. The stripes of uncut grass at the margins of the field also serve as a withdrawal area for animals, during and after the mowing, and are an important over-wintering habitat. Such stripes should at least be 6 metres wide and should be implemented on fields larger than 0.5 hectares.

Animals may also be chased away from the field prior to the mowing and dummies may be strategically placed on the field for the same purpose (although it may be less effective).

4.5 Livestock management and grazing

The production of livestock is dependent on how much agricultural land is available to supply animal feed. The livestock population is usually accounted for in "livestock units" (LU or LSU) – a unit that aggregates livestock from various species and ages using coefficients estimated on the basic nutritional or feed requirements of each species. As a reference, 1 LU corresponds to the grazing equivalent of one adult dairy cow producing 3,000 kg of milk annually, without additional concentrated foodstuffs (Eurostat 2018).

The ratio of total livestock (including animals kept indoors) to the total utilised agricultural area (UAA) represents the total livestock density (TLD) (LU/ha of UAA). However, while omnivores (like pigs) and granivores (like poultry) are usually fed specific feedstuffs and do not necessarily require significant agricultural land, herbivores (e.g., cattle, sheep, goats and horses) may be raised indoors, and be fed with harvested fodder, or outdoors – grazing directly on pastures and grasslands.

For the latter, the ratio of total herbivores to the total fodder area, i.e., the grazing livestock density (GLD), can be considered (LU/ha of fodder area).

In the EU-28, the TLD values, registered in 2013, averaged about 0.7 LU/ha of UAA and the GLD values averaged about 1.0 LU/ha of fodder area. The highest (> 3.5 LU/ha) TLD values were observed in the Netherlands, Malta and Belgium (3.6, 3.2 and 2.7 LU/ha, respectively) and the highest GLD values were observed in Cyprus, Malta, the Netherlands and Belgium (2.6, 2.6, 2.5 and 2.3 LU/ha, respectively). Both the lowest TLD values (≤ 0.3 LU/ha) and lowest GLD values (≤ 0.5 LU/ha) were observed in Slovakia, Bulgaria and the Baltic countries (Eurostat 2018).

In the majority of Member States (and also in Norway), grazing livestock densities are higher than total livestock densities. However, the inverse has been observed in countries such as Malta, the Netherlands and Belgium. Particularly high livestock densities have been registered in regions such as North Brabant, in the Netherlands (7.6 LU/ha) or West Flanders, in Belgium (6.0 LU/ha). Very low values have been registered in regions such as the Scottish Highlands, where very extensive grasslands occur.

EFFECTS ON BIODIVERSITY

The existence of grazing, performed by either wild herbivores or domestic species, can generate a large spectrum of impacts on biodiversity, from the positive to the negative. While grazing was initially conducted by wild herbivores, these have been displaced and replaced by human activities, and now grazing is mostly driven by domestic species. Therefore, on a positive perspective, maintaining the high levels of biodiversity observable in European natural and semi-natural grasslands requires well-managed grazing to continue (Rook et al. 2004, Teillard et al. 2016).

On the negative side, high grazing livestock densities increase the risk of overgrazing and have highly negative impacts, leading to soil compaction, erosion and degradation (causing desertification in arid regions) (Asner et al. 2004, Eurostat 2018).

On High Nature Value (HNV) farmlands, i.e., agro-ecosystems holding relevant ecological, social and cultural values, such as the Alpine meadows and pastures (Battaglini et al. 2014) or the wood-pasture systems of which the montado (in Portuguese) or dehesa (in Spanish) is a good example, the effects of overgrazing may depend on the kind of livestock. In montados, higher grazing cattle densities have been found to correlate with increased fragmentation while higher grazing sheep densities have been found to correlate with the decrease of montado heterogeneity (Almeida et al. 2016). Livestock overgrazing may also severely affect seedling recruitment into the following life stages of the trees (Acácio and Holmgren 2014), particularly through repeated browsing and trampling as under canopy areas are preferred sites for livestock resting during hot hours (Espelta et al. 1995, Pausas et al. 2009, Simões et al. 2016). The grazing livestock density thresholds above which the regeneration of woody species becomes difficult may depend on the wood-pasture type it regards as well as on the tree species, the type of livestock, the region and the kind of management applied (Plieninger et al. 2015). Concerning montados, for instance, in the case of cattle even a low value of 0.3 LU/ha may already have a negative effect, but in the case of sheep the threshold may be around 1.2 LU/ha (Almeida et al. 2016).

High grazing livestock densities may also increase the likelihood of excessive nutrient run-offs, and the diffuse pollution that follows, affecting the soil and water bodies, due to high levels of manure production (Asner et al. 2004, Eurostat 2018). Overgrazing may also lead to a direct loss of biodiversity through the intensification of grasslands, driving the decline of native plant species, which are poorly adapted to herbivory (or to higher levels of herbivory) (Thórhallsdóttir et al. 2013), and of wild animal species that made use of that vegetation.

Contrastingly, in some regions, low grazing livestock densities, due to land abandonment, and the lack or low density of wild herbivores, may increase the risk for scrub and woodland invasion of meadows, the risk of fire and the homogenization of the landscape. This situation may also lead to the decline of soil fertility due to an insufficient input of organic nutrients previously supplied by the presence of manure.

4.5

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Very good agricultural practices to ensure more biodiversity

As it was explained, well-managed grazing on European natural and semi-natural grasslands may allow high levels of biodiversity to be maintained and different ecosystem functions and services to be assured. The regeneration of HNV wood-pasture systems also depends on the kind of management applied. Therefore, it is essential to establish and keep rigorous livestock management plans, regularly updated with the best practices (Plieninger et al. 2015) available regarding biodiversity.

A grazing livestock density of 1.4 LU/ha was established in 1989 in order to limit the compensation benefits paid to farms located in less favoured areas (LFA), according to the CAP. Additionally, obtaining support for beef farming has required compliance with stocking density limits since 1992 (and at that time immediately helped to reduce average values from about 3.5 LU/ha, in 1993, to 2 LU/ha, in 1996). The 1.4 LU/ha limit has since been used to define extensive livestock farming and limit the eligibility to receive support for the application of extensification measures (Piva et al. 1999). In some cases, more ambitious livestock density limits have been set in the National Rural Development Programmes of Member States, and compliance with such limits is required in order to obtain support for HNV farming both within and outside Natura 2000 areas. In France, for instance, concerning supports for LFA, a range of minimum and maximum livestock densities have been fixed for livestock farms at regional levels, with the minimum ranging from 0.1 to 0.35 LU/ha and the maximum ranging from 1.6 to 2 LU/ha, depending on the type of disadvantage (Boccaccio et al. 2009).

In the wood-pasture systems of the New Forest (UK), during the main regeneration stages, maximum grazing livestock densities for cattle, ponies and deer have been set at 0.3, 0.15 and 0.45 LU/ha/year, respectively (Mountford and Peterken 2003, Plieninger et al. 2015). In Belgium, grazing livestock densities in former pastures and arable fields have limits of 0.35 to 0.5 LU/ha/year in order to allow tree regeneration in the developing mosaic vegetation during the first 5–10 years after the previous agricultural use has ended (Van Uytvanck 2009, Plieninger et al. 2015). For wood-pasture systems such as the montado, in Southern Portugal, it has been advised that the optimum carrying capacity should decrease to 0.18–0.60 LU/ha for livestock grazing, under current ecological conditions (Godinho et al. 2016).

Taking this into consideration, a maximum of 1.4 LU/ha of fodder surface should generally be respected, but more ambitious limits should be adopted in the case of HNV farmland, such as wood-pasture systems, depending on several factors. Farms with higher stocking densities must work towards a reduction of density values in order to match this limit within a given period. Farms with lower stocking densities should hold these lower densities. Overall, livestock density values should be subject to a continuous reduction over time until the optimum level is reached.

Management plans should include adequate grazing strategies and patterns, reducing the impact on the grassland and on biodiversity. Basic grazing systems may be:

a) continuous (the pasture is not divided in sub-pastures or paddocks and the livestock is allowed to graze all the pasture area at any given time);

b) rotational (the pasture is divided into sub-pastures or paddocks, using appropriate mobile and wildlife-friendly fences, and the cattle is allowed to graze each paddock for an adequate time period before being moved); and

c) ultra-high density, mob grazing and flash-grazing (usually in the morning, high livestock densities are allowed in a pasture for invasive species control but may also later be moved according to a rotation system).

When invasive and undesired grassland species are to be controlled, applying flash-grazing is preferred to mechanical or chemical control methods. If an overall livestock density reduction is not viable, the application of rotational grazing is recommended. In order to ensure tree regeneration while halting the encroachment of dense shrub cover in wood-pasture systems, it is advisable to allow for time and space gaps between grazing activities (Plieninger et al. 2015). In wood-pasture systems, such as montados, the recruitment of cork oak (*Quercus suber*) trees occurs at intermediate shrub cover levels (40–60 %). Therefore, maintaining shrub patches and their protective effect against direct radiation and grazing impact (while preventing shrub encroachment) is advisable (Simões et al. 2016).

The assessment and monitoring of pasture dynamics, livestock spatial location and grazing pressure are also recommended. For this purpose, the registry of location and movement of animals using modern imaging and communication technologies is an option. Wildlife-friendly fencing may also contribute significantly to reduce the mortality of wild animals (especially birds) from collisions with fences, and remove barriers to the movement of animals between different plots or farms.

Finally, management plans, their respective grazing livestock density limits, the grazing strategies and patterns applied and other practices performed should be continuously revisited and adjusted according to the changes observed in the system (Sales-Baptista et al. 2016).

4.6 Livestock fodder production overseas: soy

The EU imports about 35 million tonnes of soy (*Glycine max*) every year, mainly from South America, which corresponds to about 35 % of the global soy trade. Brazil, Argentina, Paraguay, Uruguay and Bolivia produce over 50 % of the world soy in an area of about 55 to 60 million hectares – similar to the area occupied by a country like Spain or France. Overall, about 80 % of the soy produced in these countries is exported. Soy production grew tremendously over the last four decades and is still increasing. For instance, about 6 million hectares are already cultivated with soy in the Brazilian region of Mato Grosso but the country is still offering another 50 million hectare for the same purpose, mainly in the same region.

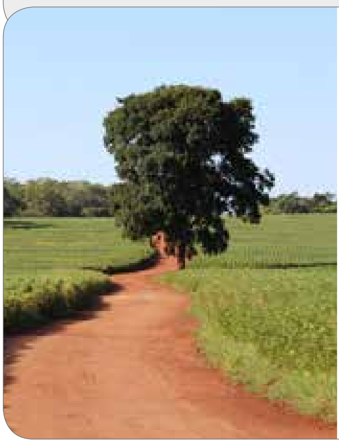
About 95 % of the soy produced in South America is genetically modified (GMO). Direct seeding has been extensively adopted (Shurtleff and Aoyagi 2009). Production follows a round-up-ready system. This means it involves a very basic soil treatment, no crop rotation, the extensive use of pesticides (mainly glyphosate) and a highly effective, industrialised agriculture. In 2006, the European Commission has approved the use of two GM soybean varieties for food or animal feed production. However, such products require compliance with EU's labelling and traceability rules.

EFFECTS ON BIODIVERSITY

Soy production has been one of the main drivers causing the loss of primary forests, areas of cerrado and unique wetlands in the Amazon, Pantanal and Mato Grosso regions. According to several NGOs, soybean cultivation has already led to the destruction of vast areas of the Amazonian and Pantanal rainforests and it is still driving further deforestation, even though since 2006 a memorandum on saving the tropical rainforests has helped to decrease some of the pressure.

The European CAP regulations obviously do not apply to South American agriculture. The use of GMOs in general is intensively discussed among environmentalists and agronomists. Problems with EU-compliance rules and cross-contamination of non-GM stocks have caused shipments to be rejected and put a premium on non-GM soy today. The use of direct seeding has reduced soil erosion and soil fertility loss, but new diseases and pests have emerged and the intensive use of herbicides led to the development of new herbicide-resistant weeds (Shurtleff and Aoyagi 2009).

4.6



Very good agricultural practices to ensure more biodiversity

Considering that the European legislation does not apply abroad, the production of fodder in Europe is generally advantageous when compared to imports from South America, with respect to biodiversity and additional environmental concerns. The use of irrigation in Portugal, for instance, as an alternative to importation, allows for higher productivity and the possible allocation of other areas for nature conservation (Valada et al. 2014). In order to guarantee GMO-free production, it may be necessary not to use soy products imported from overseas.

For additional best agricultural practices in agriculture, please consult the other Biodiversity Fact Sheets produced in this project, regarding animal husbandry (dairy production), arable crops (wheat), permanent crops (vineyards and olive groves as well as apples), vegetables and root crops (sugar beet).

5. BIODIVERSITY MANAGEMENT

A tool which is being proposed to tackle the issue of biodiversity at farm level is the Biodiversity Action Plan (BAP). The BAP facilitates the management of biodiversity at farm level. Some food standards prescribe the implementation of a BAP without defining the content and the approach to develop it. Such a plan should include:

1. Baseline assessment

The baseline assessment gathers information on sensitive and protected biodiversity areas, endangered and protected species and semi-natural habitats on or around the farm/collection area, including fallow/set aside land, cultivated and uncultivated areas as well as already existing biodiversity measures. These provide the information necessary to identify priorities, define measurable goals, assess the impact of implemented measures and if necessary, select approaches that are more appropriate.

2. Setting goals

Based on the baseline assessment the farmer sets goals for improvement. The aim is to identify the main impacts of the farming activities on biodiversity, which should be avoided, and the main opportunities existing to protect/enhance biodiversity.

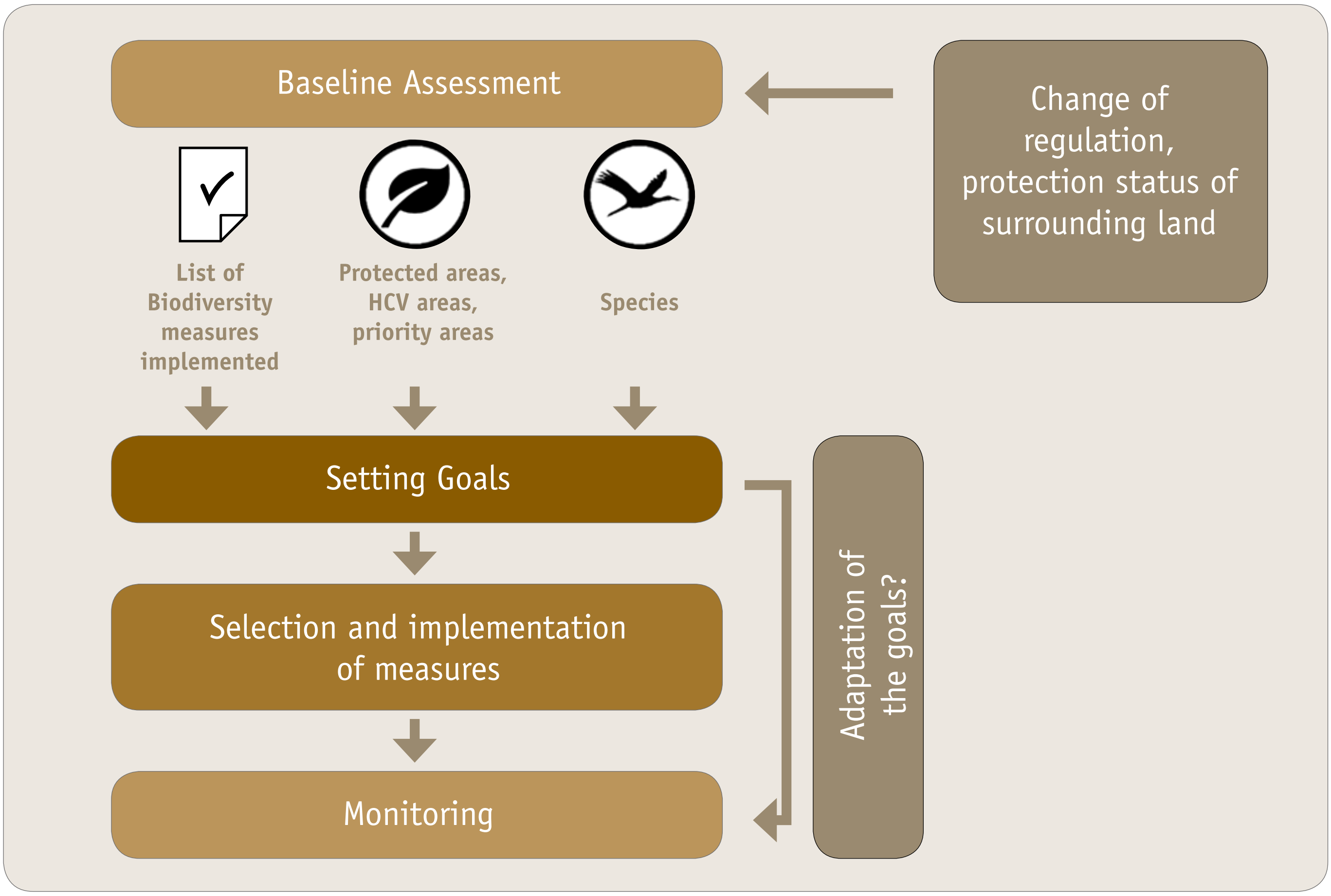
3. Selection, time line and implementation of measures for enhancing biodiversity

Some examples of measures are:

- **Semi-natural habitats (trees, hedges, dry stones)/set aside areas:** Criteria will be set for type, size, and minimal quality of semi-natural habitats and ecological infrastructures, for areas set aside or fallow land, and for newly acquired areas for agricultural production. A minimum of 10 % of the UAA (utilised agricultural area) is used to provide semi-natural habitats.
- **Establishing biotope corridors:** Specified areas for biodiversity on the farm will be connected with habitat corridors such as hedges and buffer strips.
- **Grassland conservation:** Grassland is not transferred into other kinds of agriculturally used land; grazing densities are kept in a sustainable range and the regeneration rate of grassland is respected in grassland management.

The whole catalogue of measures was published within the recommendations of the EU LIFE project: www.business-biodiversity.eu/en/recommendations-biodiversity-in-standards

4. Monitoring and evaluation



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7. OVERVIEW OF THE EU LIFE PROJECT

Food producers and retailers are highly dependent on biodiversity and ecosystem services but they also have a huge environmental impact. This is a well-known fact in the food sector. Standards and sourcing requirements can help to reduce this negative impact with effective, transparent and verifiable criteria for the production process and the supply chain. They provide consumers with information about the quality of products, environmental and social footprints, and the impact on nature caused by the product.

The LIFE Food & Biodiversity Project "Biodiversity in Standards and Labels for the Food Industry" aims at improving the biodiversity performance of standards and sourcing requirements within the food industry by

A. Supporting standard-setting organisations to include efficient biodiversity criteria into existing schemes; and encouraging food processing companies and retailers to include biodiversity criteria into respective sourcing guidelines

B. Training advisors and certifiers of standards as well as product and quality managers of companies

C. Implementation of a cross-standard monitoring system on biodiversity

The project has been endorsed as a "Core Initiative" of the Programme on Sustainable Food Systems of the 10-Year Framework of Programmes on Sustainable Consumption and Production (UNEP/FAO).

European Project Team:

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