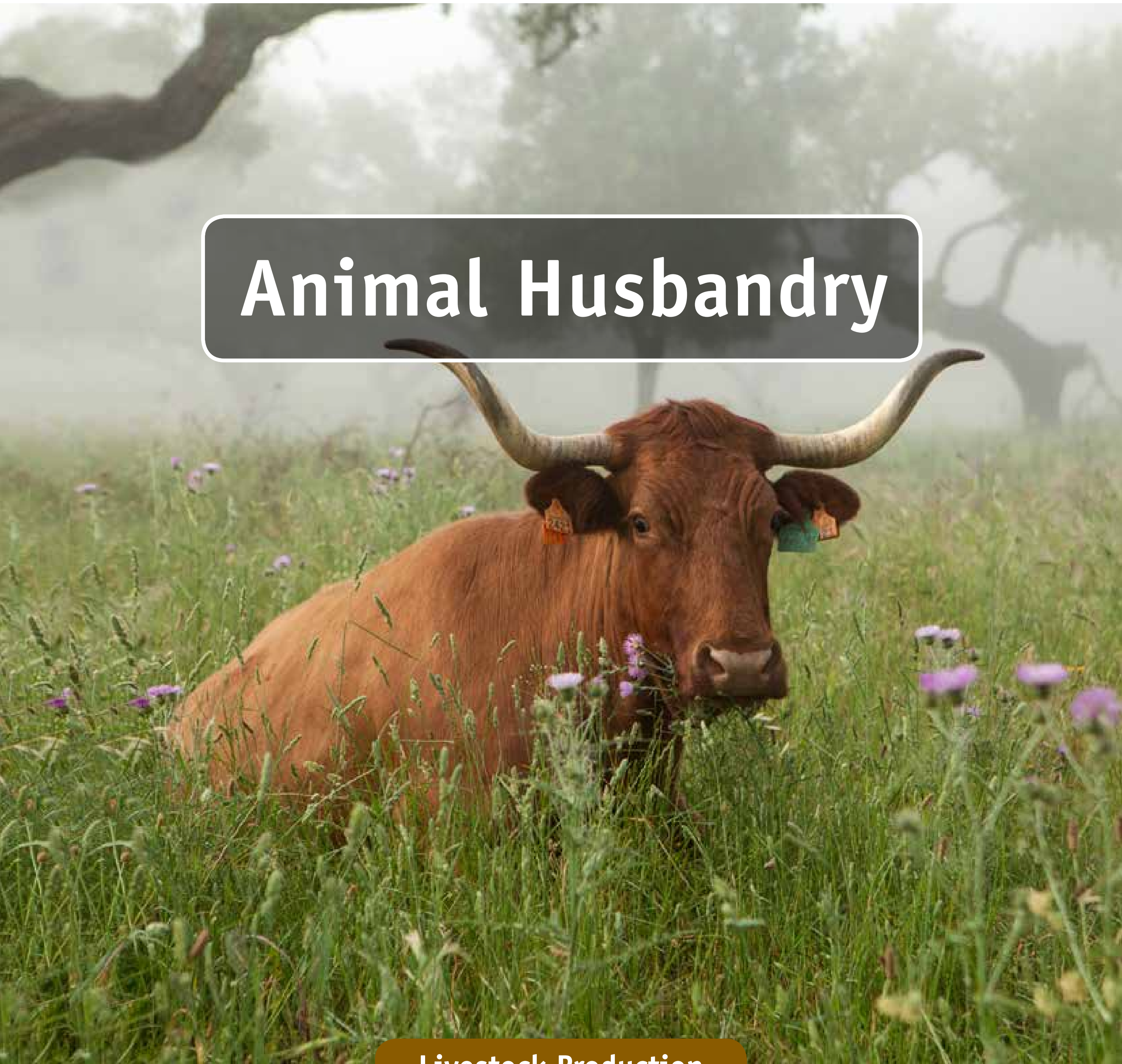
BIODIVERSITY FACT SHEET

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.

BIODIVERSITY FRIENDLY AGRICULTURE

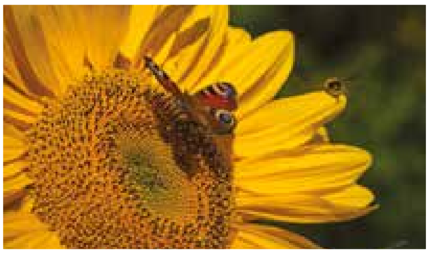
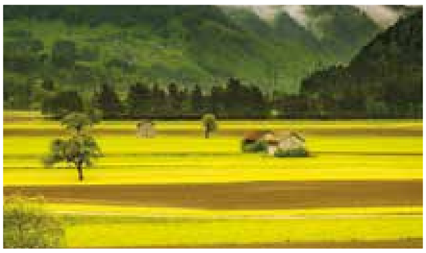
Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides) **VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY**	Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors) **BIODIVERSITY MANAGEMENT**

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

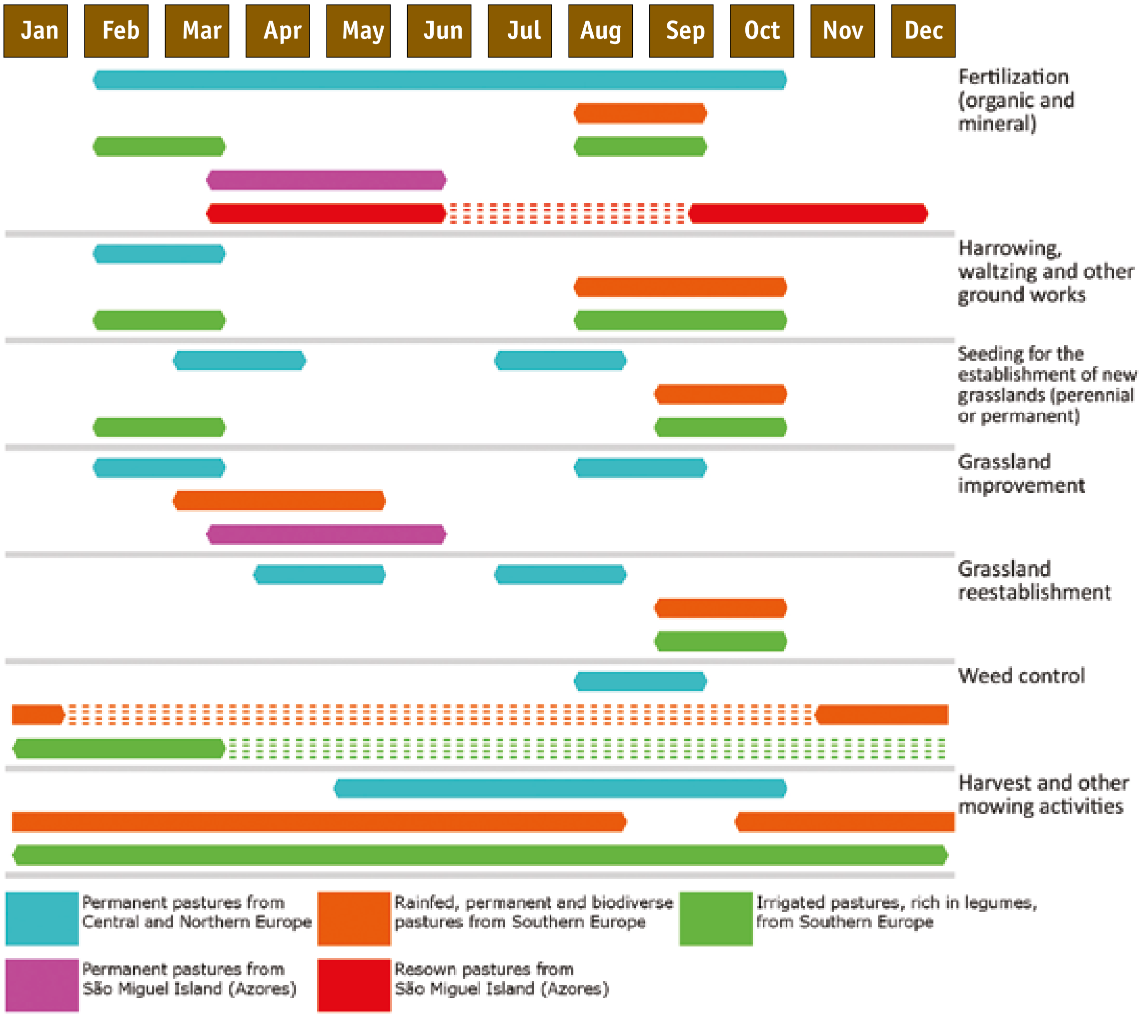
Livestock represents about 40 % of the global value of agricultural output and supports the livelihoods and food security of almost 1.3 billion people worldwide. The livestock sector is one of the fastest growing in the agricultural economy, due to the shift in diet and food consumption patterns towards 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).

© Countrypixel, www.fotolia.com

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

© Terraprima

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.

© Terraprima

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

© Terraprima

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.

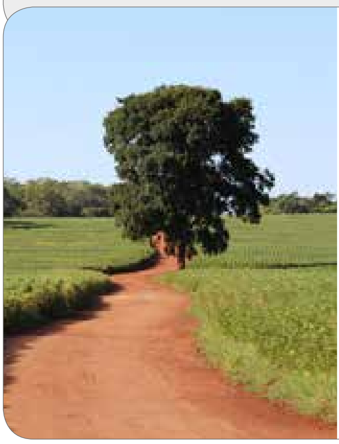
About 95 % of the soy produced in South America is genetically modified (GMO). Direct seeding has been extensively adopted (Shurtleff and Aoyagi 2009). Production follows a round-up-ready system. This means it involves a very basic soil treatment, no crop rotation, the extensive use of pesticides (mainly 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.

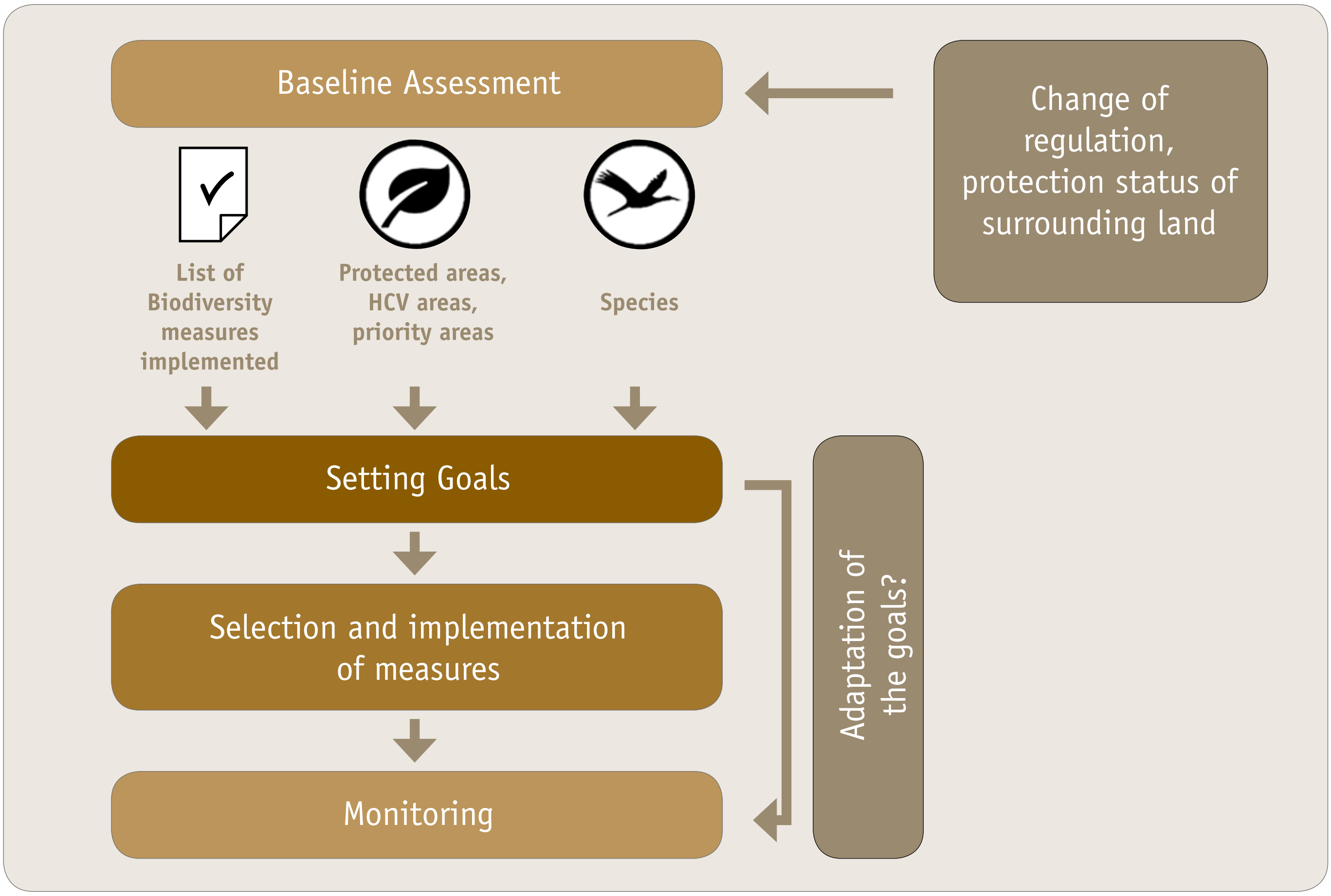
3. Selection, time line and implementation of measures for enhancing biodiversity

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



6. REFERENCES

Acácio, V., and M. Holmgren. 2014. Pathways for resilience in Mediterranean cork oak land-use systems. Annals of Forest Science 71:5–13.

Almeida, M., C. Azeda, N. Guiomar, and T. Pinto-Correia. 2016. The effects of grazing management in montado fragmentation and heterogeneity. Agroforestry Systems 90:69–85.

Asner, G. P., A. J. Elmore, L. P. Olander, R. E. Martin, and A. T. Harris. 2004. Grazing systems, ecosystem responses, and global change. Annual Review of Environment and Resources 29:299.

Basch, G., M. Carvalho, R.-A. Düring, and R. Martins. 1995. Displacement of herbicides under different tillage systems. Pages 25–38 in F. Tebrügge and A. Böhrnsen, editors. Experience with the applicability of no-tillage crop production in the West-European countries. Proceedings EC-Workshop II. Wissenschaftlicher Fachverlag, Giessen, Germany.

Basch, G., T. Friedrich, A. Kassam, and E. Gonzalez-Sanchez. 2015. Conservation Agriculture in Europe. Pages 357–390 in M. Farooq and H. S. Kadambot, editors. Conservation Agriculture. Springer International Publishing, Basel, Switzerland.

Battaglini, L., S. Bovolenta, F. Gusmeroli, S. Salvador, and E. Sturaro. 2014. Environmental sustainability of Alpine livestock farms. Italian Journal of Animal Science 13:431–443.

Boccaccio, L., A. Brunner, and A. Powell. 2009. Could do better - How is EU Rural Development policy delivering for biodiversity? BirdLife International, Brussels.

Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, and V. H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications 8:559–568.

Ceballos, G., P. R. Ehrlich, A. D. Barnosky, A. García, R. M. Pringle, and T. M. Palmer. 2015. Accelerated modern human–induced species losses: Entering the sixth mass extinction. Science Advances 1:e1400253–e1400253.

Cuevas, M., M. Calderón, J. Fernández, M. Hermosín, F. Moreno, and J. Cornejo. 2001. Assessing herbicide leaching from field measurements and laboratory experiments. Acta Agrophysica 57:15–25.

EC. 2013. REGULATION (EU) No 1307/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation. Official Journal of the European Union L 347:608–670.

EC. 2017. EU Agricultural outlook for the agricultural markets and income 2017-2030. European Union, Brussels, Belgium.

EEA. 2003. EEA core set of indicators - Revised version April 2003 - Adopted version for ECCAA countries May 2003. European Environment Agency (EEA), Copenhagen, Denmark.

Espelta, J. M., M. Riba, and J. Retana. 1995. Patterns of seedling recruitment in West-Mediterranean Quercus ilex forests influenced by canopy development. Journal of Vegetation Science 6:465–472.

Eurostat. 2018. Eurostat - Statistical office of the European Union. http://ec.europa.eu/eurostat.

FAO. 2007. The state of the world's animal genetic resources for food and agriculture. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAO. 2018. Food and Agriculture Organization of the United Nations. http://www.fao.org/animal-production/en/.

Farooq, M., and H. S. Kadambot, editors. 2015. Conservation Agriculture. Springer International Publishing, Basel, Switzerland.

Freixial, R. M., and J. F. Barros. 2012. Pastagens - Texto de apoio para as Unidades Curriculares de Sistemas e Tecnologias Agropecuários, Noções Básicas de Agricultura e Tecnologia do Solo e das Culturas. Universidade de Évora, Évora, Portugal.

Gerber, P. J., H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci, and G. Tempio. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO), Rome.

Godinho, S., N. Guiomar, R. Machado, P. Santos, P. Sá-Sousa, J. P. Fernandes, N. Neves, and T. Pinto-Correia. 2016. Assessment of environment, land management, and spatial variables on recent changes in montado land cover in southern Portugal. Agroforestry Systems 90:177–192.

Hart, K., D. Mottershead, G. Tucker, E. Underwood, A. Maréchal, L. Menet, I. Martin, C. Dayde, C. Bresson, E. Deniel, J. Sanders, N. Röder, B. Osterburg, and S. Klages. 2017. Evaluation study of the payment for agricultural practices beneficial for the climate and the environment. European Union, Luxembourg.

Harvell, C., C. Mitchell, J. Ward, S. Altizer, A. Dobson, R. Ostfeld, and M. Samuel. 2002. Ecology - climate warming and disease risks for terrestrial and marine biota. Science 296:2158–2162.

IUCN. 2018. The IUCN Red List of Threatened Species. http://www.iucnredlist.org.

JRC. 2010. Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS) - Executive summary. Joint Research Centre, Ispra, Italy.

Lambin, E. F., H. J. Geist, and E. Lepers. 2003. Dynamics of land-use and land-cover change in tropical regions. Annual Review of Environment and Resources 28:205–241.

Mace, G. M., K. Norris, and A. H. Fitter. 2012. Biodiversity and ecosystem services: a multiplayered relationship. Trends in Ecology & Evolution 27:19–26.

Monfreda, C., N. Ramankutty, and J. A. Foley. 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles 22:1–19.

Mountford, E. P., and G. F. Peterken. 2003. Long-term change and implications for the management of wood-pastures: experience over 40 years from Denny Wood, New Forest. Forestry: An International Journal of Forest Research 76:19–43.

Nepstad, D., B. S. Soares-Filho, F. Merry, A. Lima, P. Moutinho, J. Carter, M. Bowman, A. Cattaneo, H. Rodrigues, S. Schwartzman, D. G. McGrath, C. M. Stickler, R. Lubowski, P. Piris-Cabezas, S. Rivero, A. Alencar, O. Almeida, and O. Stella. 2009. The end of deforestation in the Brazilian Amazon. Science 326:1350–1351.

Pausas, J. G., T. Marañón, M. Caldeira, and J. Pons. 2009. Natural regeneration. Page 352 in J. Aronson, J. S. Pereira, and J. G. Pausas, editors. Cork oak woodlands on the edge: ecology, adaptive management and restoration. Island Press, Washington, D.C.

PECBMS. 2012. Population trends of common European breeding birds 2012. Czech Society for Ornithology, Prague, Czech Republic.

Piva, G., G. Bertoni, F. Masoero, P. Bani, and L. Calamari. 1999. Recent progress in animal production science. Proceedings of the Aspa 13th Congress (Piacenza, 21-24 June 1999). FrancoAngeli, Milan, Italy.

Plieninger, T., T. Hartel, B. Martín-López, G. Beaufoy, E. Bergmeier, K. Kirby, M. J. Montero, G. Moreno, E. Oteros-Rozas, and J. Van Uytvanck. 2015. Wood-pastures of Europe: Geographic coverage, social–ecological values, conservation management, and policy implications. Biological Conservation 190:70–79.

Pokorny, M. L., R. L. Sheley, T. J. Svejcar, and R. E. Engel. 2004. Plant species diversity in a grassland plant community: evidence for forbs as a critical management consideration. Western North American Naturalist 64:219–230.

Ramankutty, N., A. T. Evan, C. Monfreda, and J. A. Foley. 2008. Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochemical Cycles 22:1–19.

Robinson, T. P., G. R. W. Wint, G. Conchedda, T. P. Van Boeckel, V. Ercoli, E. Palamara, G. Cinardi, L. D'Aietti, S. I. Hay, and M. Gilbert. 2014. Mapping the global distribution of livestock. PLoS ONE 9:e96084.

Rook, A. J., B. Dumont, J. Isselstein, K. Osoro, M. F. WallisDe-Vries, G. Parente, and J. Mills. 2004. Matching type of livestock to desired biodiversity outcomes in pastures - a review. Biological Conservation 119:137–150.

Sales-Baptista, E., M. C. D'Abreu, and M. I. Ferraz-de-Oliveira. 2016. Overgrazing in the Montado? The need for monitoring grazing pressure at paddock scale. Agroforestry Systems 90:57–68.

Shantz, H. L. 1954. The place of grasslands in the Earth's cover. Ecology 35:143–145.

Shurtleff, W., and A. Aoyagi. 2009. History of soybeans and soyfoods in South America (1882-2009): Extensively annotated bibliography and sourcebook. Soyinfo Center, Lafayette, CA, USA.

Simões, M. P., A. F. Belo, M. Fernandes, and M. Madeira. 2016. Regeneration patterns of Quercus suber according to montado management systems. Agroforestry Systems 90:107–115.

Sims, P. L., and P. G. Risser. 2000. Grasslands. Pages 323–356 in M. G. Barbour and W. D. Billings, editors. North American terrestrial vegetation. Volume 2. 2nd edition. Cambridge University Press, Cambridge, United Kingdom.

Sutherland, W. J., L. V Dicks, N. Ockendon, and R. K. Smith. 2017. What works in conservation. Open Book Publishers, Cambridge, United Kingdom.

Teillard, F., A. Anton, B. Dumont, J. A. Finn, B. Henry, D. M. Souza, P. Manzano, L. Milà i Canals, C. Phelps, M. Said, S. Vijn, and S. White. 2016. A review of indicators and methods to assess biodiversity – Application to livestock production at global scale. Livestock Environmental Assessment and Performance (LEAP) Partnership, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Thórhallsdóttir, A. G., Á. D. Júlíusson, and H. Ögmundardóttir. 2013. The sheep, the market, and the soil: Environmental destruction in the Icelandic Highlands, 1880-1910. Pages 155–173 in D. Jorgensen and S. Sörlin, editors. Northscapes: History, Technology, and the Making of Northern Environments. UBC Press, Vancouver, BC.

Van Uytvanck, J. 2009. The Role of Large Herbivores in Woodland Regeneration Patterns, Mechanisms and Processes. Research Institute for Nature and Forest, Brussels, Belgium.

Valada, T., R. da S. Vieira, C. M. G. L. Teixeira, T. Domingos, and A. G. Ferreira. 2014. Efeitos ambientais diretos e indiretos do regadio português. AGROTEC 13:72–76.

Wassenaar, T., P. Gerber, P. H. Verburg, M. Rosales, M. Ibrahim, and H. Steinfeld. 2007. Projecting land use changes in the Neotropics: the geography of pasture expansion into forest. Global Environmental Change 17:86–104.

WWF. 2016. Soy scorecard - assessing the use of responsible soy for animal feed. WWF – World Wide Fund for Nature, Gland, Switzerland.

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:

Global Nature Fund · Bodensee Stiftung – Internationale Stiftung für Natur und Kultur · Técnico Lisboa · Fundación Global Nature · auf! · A Good For good · Solagro

We appreciate the support of our partner standards and companies:

Nestlé – Good Food, Good Life · Kaufland · always inspiring more... symrise · UTZ – Better farming Better future · Fairtrade Deutschland · Union for Ethical BioTrade – Sourcing with Respect® · Gesicherte Qualität Baden-Württemberg · Baden-Württemberg Ministerium für Ländlichen Raum und Verbraucherschutz

IMPRINT

Authors: Carlos M. G. L. Teixeira (IST), Tobias Ludes (GNF), Nuno Sarmento (IST), Vânia Proença (IST) e Tiago Domingos (IST)

Editor: Global Nature Fund

Graphic Design: Didem Senturk, www.didemsenturk.de

Version: August 2018

Photo Credit: © Adobe Stock, www.stock-adobe.com
© Fotolia, www.fotolia.com
© Pixabay, www.pixabay.com
© Terraprima, www.terraprima.pt

The project is funded by:

EU LIFE Programme
LIFE15 GIE/DE/000737

Recognized as a Core Initiative:

www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback

BIODIVERSITY FACT SHEET

FOOD & BIODIVERSITY

Permanent Crops

Vineyards and Olive Groves

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 the production of permanent crops on biodiversity in Mediterranean 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.

BIODIVERSITY FRIENDLY AGRICULTURE

Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides)

VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY

Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors)

BIODIVERSITY MANAGEMENT

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 biggest challenges of our time. Species loss driven by human intervention occurs around 1,000 times faster than under natural circumstances. Many ecosystems that provide us with essential resources are at risk of collapsing.

Conservation and the sustainable use of biodiversity is an environmental issue and, at the same time, a key requirement for nutrition, production processes, ecosystem services and the overall good quality of life for mankind.



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. 70% of species are threatened by the loss of their habitats. In particular, farmland flora and fauna has declined by up to 90% due to more intensive land use, the high use of pesticides and over-fertilisation.
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilisers containing nitrates and phosphates.
- **Overexploitation of forests, oceans, rivers and soils.** 30% of species are threatened by overexploitation of habitats and resources.
- **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.
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats.

Agriculture and biodiversity – A symbiosis

The main task of agriculture is to provide a secure food supply for a fast-growing world population in order to ensure stable livelihoods. Consumption patterns in industrialised and emerging economies have led to an intensification of agriculture and a more globalised food market, resulting in enormous changes in the use of agricultural land, grassland and pastures, highly intensive production systems and a simplification of agricultural landscapes.

Agriculture depends on biodiversity while also playing an important role in shaping biodiversity. Since the Neolithic age, agriculture has significantly increased the diversity of landscapes and species within Europe. The European continent used to be 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 has been closely linked to agro-systems ever since. Currently, European farmers use more than 47 % or 210 million hectares of arable and grassland areas, which equates to almost half of the surface in Europe (EU-27) for agriculture. Consequently, 50 % of European species depend on agricultural habitats. This symbiotic and beneficial relationship between agriculture and biodiversity has altered fundamentally since the 1950s.

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. It was based on the experience of hunger and starvation in Europe and targets on securing the supply of food for the population and the independence of European food supply from international markets. 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 as well as 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 the 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, which has been ratified by all member states and directly transferred into national conservation laws.
- **Directive 2000/60/EC –** "Water Framework Directive" aims to improve the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, cross-compliance (CC) regulations address any shortcomings in relation to environmental issues of the CAP philosophy described above. CC represents a first step towards environmentally-friendly farming, forming a principle for linking the receipt of CAP support by farmers with basic rules related to the protection of the environment (besides others). These regulations target general measures to reduce the severe impacts of agriculture on the environment such as erosion, nitrification, pollution of water bodies, landscape change and others. Conservationists only see a small improvement, if any, to biodiversity protection by the cross compliance regulations.

Since 2012, the CAP has promoted the implementation of voluntary agro-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 measure, encompassing actions, which directly focus on the protection and conservation of agro-biodiversity. Farmers can sow flowering strips, set aside fields temporarily or permanently, organise buffer strips along open waters, plant hedgerows and others. Studies show positive effects of such measures on biodiversity (What Works in Conservation 2017).

The most recent CAP "REGULATIONS OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" (No. 1305/2013 - on support for rural development; No. 1306/2013 - on the financing, management and monitoring of the common agricultural policy; No. 1307/2013 - establishing rules for direct payments to farmers; No. 1308/2013 - establishing a common organisation of the markets for agricultural products), introduced in 2014, oblige farmers to implement "greening measures" when applying for direct payments. Hereby, biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. 30 % of direct payments are tied to strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, especially to improve the use of natural resources. First assessments after two years indicate the necessity to adjust the current set of greening measures, as the effect on biodiversity is not apparent.

3. PERMANENT CROPS IN MEDITERRANEAN EUROPE

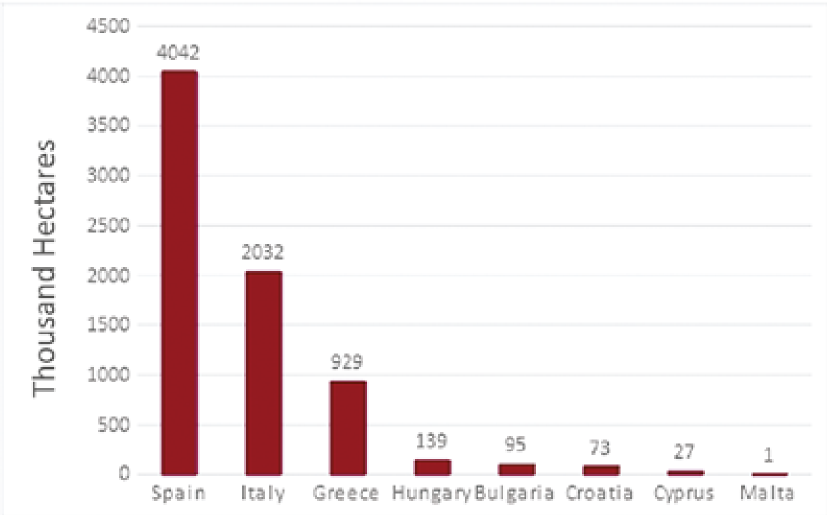
Permanent crops include a variety of different cultures. They are characterised by the fact that they are not included in crop rotation. Once planted, they remain on the land for at least five years and provide recurring yields.

Permanent crops in European Mediterranean countries include, in particular, the following cultures:

- Grapes
- Olives
- Plums and sloes
- Oranges
- Peaches and nectarines
- Tangerines, mandarins, clementines, satsumas
- Grapefruit (including pomelos)
- Lemons and limes
- Carobs

Due to the wide range of crops, agricultural production methods are also very different. In this document, we have included recommendations focused on the most important cultures in the countries of the European Mediterranean Region: grapes for wine and olives.

According to Eurostat, about 6 % of the agricultural area utilised in Europe is planted with permanent crops. This corresponds to a planted area of around 11,386,000 hectares (as of 2016). Spain (4,042,360 hectares), and Italy (2,032,310 hectares) are the most important Mediterranean Region member states of the EU-28 in terms of permanent crops.



Most important permanent crop cultivation areas in 2016 for the EU-28 Mediterranean countries, Source: Eurostat 2018

The majority of the grape production in Mediterranean European countries, according to FAOSTAT, occurs in Spain (920,108 hectares), followed by Italy (668,087 hectares) and Greece (112,294 hectares). Overall, the EU-28 production amounted to 23,722 thousand tonnes in 2016, a slight decline compared to 2015, with 25,576 thousand tonnes.

Grape cultivation is one of the ancient activities of civilization in the Mediterranean Basin. This crop requires a soil rich in potash, permeable and not very humid. When grape crops are grown on fertile and fresh land, the quantity of fruit increases, but the quality is lost, the wine obtained has poorer quality than when the vines planted in dry and rough lands.

When it comes to olive production, Spain is responsible in the EU-28 for the majority of its production (6,571 thousand tonnes) according to the latest Eurostat data in 2016. Together with Italy (1,945 thousand tonnes) and Greece (956 thousand tonnes), they represent 95 % of olive production in the EU-28.

The olive tree is a typical Mediterranean species, present in the landscapes of the Iberian Peninsula as an element of Mediterranean ecosystems and culture. Although it is a rustic species, it also has climate requirements that limit its distribution to areas of Mediterranean climate.

4. CULTIVATION OF PERMANENT CROPS AND IMPACTS ON BIODIVERSITY

The following pages describe the most important impacts on biodiversity of two representative Mediterranean permanent crops (vineyards and olive groves) as well as measures to prevent these impacts. For better understanding, the impacts have been divided into different categories (soil, water, fertiliser management, etc.) and for each section, recommendations for very good agricultural practices are given.

4.1 Soil works


Soil erosion in olive crops. © FGN

Grape vines and olive trees have been planted for centuries all over the Mediterranean areas. They grow in very different soil conditions and microclimates. Traditional vineyards and olive groves are rainfed and plants are sparsely distributed in the plots, which are in some cases very small and can occupy steep slopes. Soil work is reduced to a minimum in these traditional fields due to machinery and manpower limitations, although in the case of mountain plots, highly intense work was required to make terraces and reduce the erosion risk. Traditional vineyards and olive groves can be considered rather extensive due to low farming input and their integration in the landscape. However, over the last few decades, the least competitive fields have been changed for models which are more profitable in terms of yields. In that sense, larger and homogeneous plots have been created, new varieties have been introduced, irrigation has been used more or less intensively, and in recent years, plantations in trellis have become more common.

Keeping an appropriate organic matter level in Mediterranean soils is sometimes complex, but at the same time, the main challenge for soil protection and crops' competitiveness. Low moisture during a long period of the year, high summer temperatures, low organic biomass inputs due to poor grass covers and the low availability of manures, low biological activity; all these aspects are interdependent and work against organic matter formation. The fact is that organic matter is the major contributor to a better soil structure, fertility and water holding capacity. That is why, despite the natural limitations (lack of rain and high temperatures), farmers have to put all their efforts into bringing organic substances to the soils that could be potentially broken down into organic matter. An added problem in modern Mediterranean agriculture is that livestock farming has been decoupled from agriculture, so farmers struggle to find enough manure and similar substances to apply. Cover crops are an alternative option, as plants can produce a significant amount of biomass and provide nutrients. However, in Mediterranean areas, water scarcity and competition can be a problem, especially in rainfed crops. Rainfall is mostly concentrated during the autumn and winter months when evapotranspiration is also smaller. During that period, wild plants manage to cover the soils, producing a significant amount of biomass and protecting the soil from erosion. However, in early spring (basically around bud breaking or olive flowering) cover crops are removed to avoid water competition with the crop, limiting the amount of biomass that can be produced every year and, as a result, reducing the potential of organic matter formation.

EFFECTS ON BIODIVERSITY

Thinking that fertilisers can provide all the soil and plant needs is a very simplistic approach but unfortunately quite common. According to the German Federal Environment Agency, a gram of soil contains billions of microorganisms: bacteria, fungi, algae and protozoans. A mere one cubic meter of soil is home to anywhere from hundreds of thousands to millions of soil fauna, such as nematodes, earthworms, mites, woodlice, springtail, and insect larvae. A hectare of soil rooting layers contains around 15 tons of live weight – the equivalent of around 20 cows. In other words, immeasurably more organisms live in the soil than on it. Soil ecology plays a key role for natural soil functions. For example, the biological processes in soil ecosystems fulfil functions such as the integration of plant residues into the soil, by shredding, breaking them down and releasing the previously fixed nutrients as minerals for plant growth. Soil organisms create favourable physical conditions in the soil: by storing and mixing soil materials (bioturbation) as well as sticking the soil particles together through mucus secretion (revegetation), and play an instrumental role in the formation of soil pore systems. Soil organisms form stable clay-humus complexes with high water and nutrient storage capacity, and create a fine-grained, quasi erosion-resistant crumb structure. To some extent, these organisms can mitigate the harmful effects of organic substances on soil, groundwater, and the food chain.

Historically, high soil erosion rates have occurred in olive groves due to soil management. Soil erosion is considered as the main environmental problem of olive crops in the Mediterranean, as farm management in the past has prioritised economic benefit over sustainability. In Central and Northwest Spain, soil susceptibility is related mainly to climatic factors, while in Central and South Greece the main causes are soil properties and slope gradient. Soil management has a drastic impact on plant-soil interaction, since factors such as the depth and sequence of mechanical tillage, as well as the presence of plant cover, affect rainfall water run-off and consequently soil erosion and soil quality. Due to Mediterranean climate conditions and low water inputs, traditional management is based on reduced tree density, canopy size control by pruning, and intensive weed control. Weed control by conventional tillage is a traditional practice and alternative methods have only very recently been considered, such as reduced tillage, no tillage, or cover crop strips.

In general, soil work and treatments negatively affect biodiversity, as the natural processes described above are interrupted. Oxygen, ultraviolet radiation and heat will come in contact with the soil, particularly after ploughing the resulting furrows and this will lead to severe edge effects for life in the soil. Humification processes, which occur under the exclusion of oxygen, will be hindered; the natural soil pore system is disrupted. Each treatment affects biological diversity within the soil and the fauna and flora above the ground to a different extent and is fatal for many species. Other aspects that limit organic matter formation (low inputs of organic substances, direct or indirect destruction of biomass, direct or indirect destruction of soil organisms, compaction created by excessive machinery used, etc.) are also net contributors to soil degradation.

Green cover in olive crops. © FGN

4.1

Very good agricultural practices to ensure more biodiversity

Less compaction can be created by generally reducing and optimising treatments. In each particular situation, the work needed should be assessed and optimised to the maximum (i.e. by combining work/treatments), so machinery passing is also reduced. Lighter machinery is also an option.

As mentioned before, the addition of organic substances is a must. This can be achieved through cover crops or organic substances. Establishing cover crops is complex but not impossible. Winter crops will always exist and options should be tested to extend the cover crops to the maximum during the crop cycle, so they can deliver the maximum amount of biomass. This entails understanding soils, rainfall patterns, if competition with the crop exists, the best species to be planted (superficial roots, fast growth, adaptable to cool temperatures, ...), etc. Using organic substances from livestock farming or other agricultural sources can be combined with cover crops. Despite livestock farming, activity has dramatically decreased in some areas over the last decades. The use of other substances is growing significantly, focused in most cases in reusing materials and closing nutrient loops. For example, several substances from vineyards (pruning, winemaking leftovers, etc.) and olive mills can be composted or transformed into fertilisers.

Both wine and olive oil, are processed products with high added value. Wine and olive oil producers that base their business on quality production report that raw material quality and peculiarities are easily transferred to the final products. There is a growing perception of the direct link between healthy soil and product excellence that will hopefully contribute to a better soil conservation.

4.2 Nutrient management and fertilisation

The aim of fertilisation is balanced plant nutrition. Good qualities and competitive yields can only be regularly achieved with well-nourished trees, which does not necessarily mean using very high amounts of nutrients. It also makes the plants more resistant and more tolerant against stress. Thereby, fertilisation and soil management are closely linked. Fertilisation should cover the nutritional needs. Plants need different nutrients for the growth and development of the fruit. The main nutrients are nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca) and sulphur (S).

The basis for proper fertilisation is soil analysis, which should be repeated at intervals of no more than 3–4 years. The soil samples should be taken randomly from the soil layer, at least 0–30 cm from the surface, before fertilisation. The analysis will determine the pH value as well as other parameters, and the levels of most relevant plant-available phosphate (P2O5), potassium (K2O), magnesium (Mg) and boron (B). The additional determination of organic matter content is an important decision aid to assess nitrogen fertilisation. The nutrients supplied with organic fertilisers (manure, compost) must also be considered. Location factors such as climate, water supply, soil type, root penetration and soil structure influence the actual nutrient utilisation and the actual supply level. For reasons of plant health and water protection, oversupply should be avoided. On the other hand, long-term nitrogen deficiency can seriously affect the performance of tree plants.

The nitrogen demand of olive and vines is relatively low, although there is significant variability related to different levels of intensification. The expected yield is therefore another variable that should be considered for understanding the nutrients needs, and this is closely related to other variables mentioned such as plant density, irrigation, etc.

EFFECTS ON BIODIVERSITY

Two aspects need to be considered with regard to the effect of fertilisation on biodiversity. The first concern is a change in the trophic state of plant communities, whereas the second affects run-offs into the environment, including pollution with nitrogen and phosphorous. Plant communities are composed of biotic and abiotic factors such as soil quality, precipitation, competition with other vegetation, etc. Permanent crops are not naturally composed plant communities, so this concept cannot be applied here. Nutrient run-offs to water bodies result in a dramatic change in the conditions, which is known as eutrophication. This entails changes to the water chemistry and limnic organisms. Algae and aquatic plants can then grow excessively and overwhelm other plant species and take away the nutrients required by other plant species, many microorganisms and animals.

Often, even with good nutrient management on the field, plant communities of buffer strips along pathways, hedges, and creeks are regularly influenced by nutrients from adjacent crops. High levels of nutrients, and particularly nitrogen, can be easily checked when the presence of certain plants is significant, such as *Chenopodium* spp., *Amaranthus* spp., *Urtica* spp., *Convolvulus* spp., different species in the *Brassicaceae* (*Diplotaxis*, *Sisymbrium*, *Moricandria*), *Euphorbiaceae* (*Euphorbia*, *Chamaesyce*) and *Malvaceae* family (*Malva*, *Lavatera*, etc.).

More nutrients lead to higher biomass production and therefore to a higher food supply for herbivorous arthropods at first glance. Some more generalist species can benefit from this increase in biomass and show increasing populations. Biodiversity on the other hand is not driven by generalists, but by specialised species occupying a huge number of ecological niches. Long-term studies show a significant and strong decrease in many species typical for agricultural landscapes and ecological niches within these landscapes.

4.2

Buffer strip. © FGN

Very good agricultural practices to ensure more biodiversity

Nutrient management should be viewed holistically, therefore paying attention to soil management while having a good understanding of nutrient inputs, outputs and crops needs. One way to improve the quality of the soil and to increase the humus content in the long term is the regular use of organic matter in the form of compost, ground cover within the interrows, or leaving behind trimmed timber. Much of the nutrients removed from the soil by the vegetative development of the plants are thereby preserved and turned back to the soil. The nutrients bound in the organic substance represent a slowly flowing nutrient source. However, it has to be considered that the breakdown of organic substances into organic matter will only happen if soil organisms can work properly, and this means not only ensuring the input of enough organic substances but also the suitable conditions (moisture and moderate temperatures). When this happens, only the nutrients exported with the fruit have to be replaced in the longer term. Depending on the soil nutrient content, nutrient supplementation should be performed at shorter or longer intervals. Due to the complexity and the many positive effects on soil fertility and structure, the general recommendation is to use organic fertiliser instead, or in combination with mineral fertilisers. In addition, reusing materials and closing nutrient loops by re-using farming leftovers is growing significantly, as several substances from vineyards (pruning, winemaking leftovers, etc.) and olive mills can be composted or transformed into interesting materials from a fertilisation point of view.

The nutrient requirements of the fruit are not distributed evenly throughout the growing season. Fertilisers should therefore be adapted to this process and the actual needs of the plant. In the case of drip irrigated vineyards and olive groves, there is a good opportunity to deliver the right amount of nutrients at the right moment, as the control on nutrient management is in this case excellent. When the crops are rainfed, fertilisers are commonly applied once a year.

Ground cover prevents soil erosion, improves driveability and reduces nitrate leaching in periods of high rainfall. In addition, it can be a good source of biomass, nutrients, a niche for natural pest controllers and can keep moist the first layer of the soil to improve the development of soil decomposers. A stable soil structure (through humus supply, ground cover and avoiding compaction) enables the development of water and nutrient reserves through intensive rooting. There is a growing number of successful experiences in establishing ground cover in olive groves and vineyards. Seed mixtures adapted to different soils and climates are available, as well as decision-support tools for assessing the best date for removing it and avoiding water competition with crops.

Options to meet nutrient demand of an olive grove yielding 3,000 kg/ha/year	
OPTION 1. Young cover crop, crop residues not incorporated	Sheep manure: 9,000 kg/ha/year
OPTION 2. Young cover crop, crop residues not incorporated	Sheep manure: 4,500 kg/ha/year Potassium sulphate: 100 kg/ha/year
OPTION 3. Young cover crop, crop residues incorporated	Alperujo (solid waste olive milling) compost: 2,500 kg/ha/year
OPTION 4. Mature cover crop, crop residues incorporated	Alperujo (solid waste olive milling) compost: 2,500 kg/ha/every 3 years Potassium sulphate: 130 kg/ha/year

Mineral fertilisation is always an option but should be regarded as a supplement to the nutrition obtained thanks to the above-mentioned aspects. In that case, a fertilisation plan should be put in place, taking into consideration all the nutrient inputs (nutrients available in the soil, mineral and organic substances added, ground cover estimated contribution, pruning incorporated, etc.) and outputs (nutrient exports in grapes and olives – realistically estimating the yield, nutrients in pruning if exported out of the crop, etc.). These figures will assist in understanding the crop real needs. This can be calculated again once the harvest is over, therefore correcting figures and adjusting them to reality. Such calculations, known as a post-harvest nutrient balance, helps to fine-tune nutrient management in the long-term.

4.3 Pest control and plant protection

Botrytis cinerea on grapes, CC Tom Maack

Maintaining the health of permanent crops to produce high-quality olives and grapes is the key objective of farmers. To ensure this, variety characteristics, choice of rootstocks and crop-specific measures are combined with crop protection measures. Pests and diseases can have a considerable impact on the economic output of a farm. Insects harm plants and fungal, bacterial and viral infections decrease yields and can lead to complete crop failure. For plant health and targeted plant protection measures, various individual methods and combinations are possible.

Integrated Pest Management – Plant protection is based on several principles in integrated pest management (IPM). Pests, diseases and weeds are kept below a defined threshold with gentle methods and the necessary control measures are coordinated. The natural factors that can limit the pathogens are included in such a regulatory system (e.g. beneficials, susceptibility of the varieties, weather). Every farmer must be able to decide on the necessary measures on the basis of his own checks although guidelines with defined thresholds exist. Therefore, he should improve his knowledge of diseases, pests, beneficials and damage thresholds, e.g. by regular participation in training and advisory events. When using pesticides, the amount of active matter applied needs to be adjusted to the degree of infection. Preventive and calendar spraying, i.e. the application of pesticides without any reported signs of diseases or risk assessment, was common in the past and is now prohibited in Europe. Spot applications rather than comprehensive field treatments are recommended.

Fungicides, bactericides, etc. – Fungal infections and the application of fungicides may be a challenge to permanent crops in wet conditions, but in Mediterranean climates fungal diseases are much less frequent than in Central Europe or the Atlantic area. They are ideally managed with monitoring systems and prediction models, which assess the risk of infection and provide advice to farmers. According to integrated pest management regulations, farmers have to monitor diseases and may only apply fungicides (and other pesticides) if an economic loss is outbalanced. Targeting diseases inefficiently can lead to resistances, meaning that a disease becomes insensitive to a particular fungicide.

In vineyards, oidium, mildew and botrytis are probably the most well-known fungal diseases. Oidium and mildew affect leaves and plant development, but botrytis is feared for severely reducing the quality of bunches of grapes. However, wood fungal diseases are becoming the main concern due to their rapid spread, severity of attacks, and for not having curative solutions. Wood fungal diseases highlight the importance of addressing prevention and understanding the crop in a holistic way. Good soil conditions, appropriate plant nutrition, the selection of adapted varieties, the correct irrigation performance (if water is used) are known to have a direct correlation with the propagation of such diseases.

In olives, the main fungi problems are: the peacock spot of olive (*Fusicladium oleagineum*), the black scale (*Saissetia oleae*), and the sooty mould in olive trees (*Capnodium* spp., *Limacinula* spp., *Aureobasidium* spp.). The peacock spot is favoured by low temperatures and moist conditions during autumn, winter and spring. Peacock spot is also known as olive scab and leaf spot and is widespread in all the major olive growing regions of the world. Symptoms have been found to occur mainly on leaves and appear as dark green to black spots surrounded by a yellow halo similar to the eye spot on peacock's feathers. Crop losses arise mostly from defoliation of infected trees, poor growth and dieback of defoliated branches and reduced fruit yield. Severe infestations of black scale (*Saissetia oleae*) will stunt growth, cause early leaf-drop, branch dieback and a lack of fruit. The scales produce honeydew on which sooty mould grows. This black powdery coating interferes with photosynthesis, reduces tree vigour and yield and can taint the oil. The mould must be washed off the fruit before processing. Regarding bacteria, the main infection for olives is the olive knot, caused by *Pseudomonas syringae* pv. *savastanoi* that has affected olive trees since ancient times. All cultivars are susceptible, and damage can be severe. They can appear on twigs, branches, trunks, leaves, or fruit stems. Galls interfere with the transport of water and sugar, causing defoliation and death of twigs and branches. Olive knot can kill trees if infections occur on and girdle the trunks of young trees through injury by mechanical harvesters. It reduces tree productivity by girdling twigs and branches and causing dieback. Bacteria survive in the knots and are readily spread by water at all times of the year. Olive knot is difficult to control. Prevention is the only reliable strategy.

The latest and most feared pest in olive groves is *Xyllela fastidiosa*, a bacterium that has been detected in several Mediterranean countries and can kill thousands of olive trees in a few days. Insects are vectors of this disease and this is a priority for most olive producers around the world. Current strategies are focused on isolating and burning infected trees, as no effective solutions has been found so far.

4.3

Insecticides and acaricides – Vineyards and olive groves have a large number of insect pests and mites, varying by region and production methods. Insecticides and acaricides are used to reduce such pests, in accordance with the processes described above. They have to be viewed as the last strategy to be applied if previous ones did not work. In the long term, following the IPM approach (based on cultural practices, prevention, holistic approach to crop, good understanding of pest thresholds, alternative methods, etc.) is much more efficient.

In Mediterranean vineyards, there are two main pests that are usually above critical thresholds. One of them is *Lobesia botrana*, a micro moth that destroys grapes. Although there are agrochemicals for controlling this pest, sexual confusion with pheromones is successfully used in many farms. Some experiences have shown that the moth can also be controlled by bat populations established in the vineyard by installing dedicated refuges. A pest that is becoming more common, according to conversations with farmers, is the green mosquito (*Empoasca vitis*). It affects vine leaves and reduce plants' health. Once again, apart from agrochemical treatments, there have been interesting experiences with biological control, by improving ecological infrastructures that are used as refuges by natural enemies and also by spraying an inert mineral coating that make insect feeding difficult. Red mites (*Tetranychus urticae*) and meaybugs (*Planococcus* spp.) can also reach pest levels.

For olives, the main pests are the olive fruit fly and the olive moth, also called the olive kernel borer. The olive fruit fly, *Bactrocera oleae*, poses a serious threat for all olive growers; it is considered the most damaging pest for olives in southern Europe, North Africa, the Middle East, and California. The adult olive fruit fly is rarely seen. It lays its eggs just under the skin of the olive fruit. The larvae feed on the olive flesh, leaving brown tracks and tunnels. The damaged fruit is susceptible to rot, can drop prematurely, and is useless as a table fruit. Usable olive oil can be made if the damage level is below about 10 %, but the risk of flavours being off and unacceptably high acidity rises as the damage level increases. The olive fruit fly is not difficult to control, but without such efforts, 100 % of the fruit may be damaged. The olive moths, *Prays oleae*, are tiny, greyish-silver insects. The life cycle of the olive moth includes several generations in a year's time. The first generation feeds on the flowers, the second feeds on the olive fruit, and the third generation eats the leaves. The flower generation can destroy all of the flowers on an infested olive tree, while the fruit generation causes affected trees to experience premature fruit-drop. The leaf-feeding moths rarely do any serious damage. To control olives fruit flies, organic insecticide (active ingredient: spinosad), kaolin clay and mass trapping are some of the alternatives to agrochemical treatments. For the Prays biological control, the borer is attacked by several parasitoids. These include the egg parasitoid *Trichogramma evanescens* (*Trichigrammatidae*), which in Egypt reduced pest attack by 43-70 %, and by the polyembryonic *Ageniaspis fuscicollis* (*Encyrtidae*). In Portugal and Spain, ants, predatory beetles and chrysopids feed on *P. oleae*. Predation by the latter may reach 34 % of the carpophagous generation. Chemical control includes Organophosphates and *Bacillus thuringiensis* compounds applied against the anthophagous stage larvae which may provide effective control.

Herbicides – The regulation of weed growth is also a major topic in olive and vine growing. Unwanted wild flora competes with the crop and can reduce yield and quality. However, under Mediterranean conditions and in rainfed crops, once the spring cover is removed, the lack of water reduces wild flora pressure and soil work helps to reduce the pressure even more. The number of herbicide applications is defined by the product used and the efficiency of the applied mechanical methods to reduce weeds. Thereby, herbicides are divided into contact and residual, total and specific. Residual products seal the ground and inhibit the development of wild plants; contact herbicides enter emerging plants and poison its metabolism. Total herbicides target any plant species (N.B. monocotyledonous like grass or maize and dicotyledonous plants have slightly diverging metabolisms), specific herbicides only some.

EFFECTS ON BIODIVERSITY

Despite the optimisations and regulations, the application of pesticides is common in conventional European agriculture. Every conventional crop is treated several times with a combination of active substances. The general purpose of pesticides is to erase biodiversity from the cropped area, preventing quick re-population and ideally keep the crop clean and healthy until the harvest. The efforts of the farmers mean this is achieved to a great extent and highly efficiently. Fields are free of wild flowers, and butterflies and bees are rarely seen for most of the summer.

Pesticides are a big environmental issue for water bodies and the environment in general and are thus criticised by NGOs and some authorities. Water legislation restricts the application of some extensively used herbicides, and those with high risks of leaching due to their application times. In winter, drain flow is the main transport mechanism; herbicides attached to soil particles can be introduced into water bodies during heavy rain. Careful application of pesticides is the key to minimising collateral damage. The efficiency of herbicides is directly linked to the surface of the plant targeted. Small droplets sprayed have the highest impact, but fine sprays lead to the highest drifts. Drift is also a matter of the distance between sprayer and plants.

Fungicides, bactericides, etc. – The direct effect on biodiversity here is not as obvious as in the other pesticides. The fungus, etc. species targeted are often poisonous to arthropods and are not absent from the food chain per se. However, even very specific chemicals have an impact on other, non-targeted fungus species, and thus an impact on, for example, the microflora and fauna of decomposers in the soils.

Insecticides – The purpose of insecticides is to erase pests and arthropod biodiversity permanently from the countryside. One current well-known example is neonicotinoides. This group of active substances targets the nervous system of insects. Far less effective, but still recognisable, these substances also affect non-target groups such as mammals and other animals. Several means of application can limit the impact on species not targeted by a treatment, e.g. spraying in the evening when pollinators will be less affected, or application methods that limit drift to adjacent landscapes, buffer strips along habitat edges, etc. One main issue of insecticides is that they not only affect the targeted pests and disease vectors but also beneficial insects such as pollinators. Selectivity in pesticides does not mean exclusiveness, so there is always a side effect on non-target insects.

Herbicides – Wild flowers form the basis of food chains in cultural landscapes. Consequently, if this basis is absent in crops and disturbed in adjacent areas, there will be less food for arthropods and any birdlife depending on that. Many species are almost extinct. Herbicides, working either as contact or systematic toxin, which is taken up by any plant part and transported within the plant, are highly effective in combating weeds. Glyphosate is an example for a total herbicide working as contact toxin. 0.1 ml/m² of active matter leads to the desired effect. Herbicides are mostly applied to combat already established weeds on the field, but some products are also used to seal the ground and to prevent the appearance of unwanted weeds. However, these pre-emergence herbicides can mostly be substituted by mechanical weeding techniques.

4.3

Long flowering period ecological infrastructure. © FGN

Very good agricultural practices to ensure more biodiversity

Integrated pest management is a reference found in European legislation, which aims at reducing or even preventing the use of pesticides. These measures should always guide farm management. A basic set of agricultural practices to reduce the risk of pests and diseases in crops includes the following aspects:

- Choosing a variety suitable for the farming site
- Use of resistant and disease-resistant varieties and seed and seedlings allowed by the standards
- Balanced nutrient and water balance of the soil, improving the proportion of organic matter in the soil
- Preventing the spreading of harmful organisms by field sanitation and hygiene measures (e.g. removal of affected plants or plant parts; regular cleansing of machinery and equipment; balanced soil fertility or water management)
- Another and very important aspect is the protection and promotion of important beneficial organisms, e.g. by planting and maintaining ecological structures in and around the cultivated areas. Or by the fact that the soil cover is kept as diverse as possible and has the longest possible flowering period.
- Monitoring plans must be available for arthropods. Pests and beneficial populations must be monitored weekly in their corresponding high season. Farmers need to be able to identify pests and the effects of beneficial organisms and calculate the damage thresholds accordingly. For pathogens (fungal, bacterial pathogens, viruses), the appropriate prognosis and diagnostic methods must be used.

If these measures have been implemented and defined thresholds for pest and disease infections are exceeded, the use of pesticides can be part of integrated pest management in non-organic farming. In organic farming, the approved pesticides and other biological methods such as the use of pheromones, etc. can be used.

In order to protect open water bodies, buffer zones must be installed and maintained along the edges of waterways and waterbodies (minimum width: 10 meters). The best available spraying techniques, i.e. devices, which inhibit or reduce the drift of pesticides to adjacent areas, should be used and spraying equipment should be calibrated at least every three years. Application of pesticides is limited to authorised employees only. The use of pesticides, which are dangerous to bees, pollinating insects, beneficial organisms, amphibians or fish should be prohibited. Furthermore, very harmful substances, e.g. Glyphosat, Diquat, Paraquat, Glufosinate ammonium, Indaziflam and the salt equivalent versions should not be allowed.

4.4 Water management and irrigation

Broken irrigation pipe of olive trees
© Deyan Georgiev, www.fotolia.com

Irrigation is essential for most agricultural production and agricultural water use accounts for a significant proportion of total water consumption (e.g. Spain 64 %, Greece 88 % and Portugal 80 %, according to Eurostat). France, Greece, Italy, Portugal and Spain account for 70 % of the total area equipped with irrigation technologies in the EU-27.

Permanent crops are irrigated somewhat less than other crops, but water is directly related with yields and intensity of the crop system. Irrigated olive groves and vineyards can very easily multiply by 4–5 the yields obtained in rainfed farms.

In terms of irrigation, two approaches can be distinguished. Some olive groves and vineyards are grown in such restrictive conditions that bad years (higher temperatures and less rainfall than average) can entail the complete loss of production. If this happens frequently over a period of time, the activity of these farms is no longer profitable and they are progressively abandoned. However, these extensive farms assume an interesting contribution for landscape diversification, biodiversity habitats, and act as highly efficient and cost-effective firebreaks. Regulated deficit irrigation or controlled irrigation is, in this case, a technique that allows farmers to use very small amounts of water (around 2,000-3,500 m^3/ha) that are not focused on increasing the yields, but more on maintaining stable and profitable yields. The other approach is definitely focused on increasing yields. In this case, as the productivity and pressure on the crop increases, there is also an increasing need for agricultural inputs. In other words, if the yield is going to be multiplied, it is very likely that plants will have more nutrient needs. It is also frequently the case that increased pressure in terms of growth will result in higher sensitivity to diseases and pests.

In both cases, to avoid undesired effects due to a lack or an excess of water, the irrigation strategy has to be well designed and all the related challenges well understood. Water availability for plants is not just a matter of irrigation (basically delivering water to roots). There are several factors that should be considered: is the soil healthy enough to retain water? Is the crop root system shallow or deep? Is the cover crop helping to retain water around the root system, is there competition with the crop? Is a bare soil avoiding water competition or is it creating conditions that make water uptake difficult? Do you know the moisture level where the root system is? Is the irrigation system you use adapted to the water needs of your crop/root system? As it can be seen, thinking that irrigation is only about delivering water to the crop is a rather simplistic approach.

EFFECTS ON BIODIVERSITY

Irrigation is an essential driving force in water use management in many regions and has a huge impact on the environment and biodiversity. Drawing water from groundwater, rivers, or lakes, irrigation systems redistribute this water, having numerous effects on biodiversity, foremost in Mediterranean areas. Building dams and channels reduces downstream river flows and changes the hydrology of entire river systems with impacts on all life in the watersheds. Over-extraction of water for agriculture can alter water habitats and limnic fauna from biodiverse communities to poor systems with only few species. Note that about half of the amphibian species in Europe are threatened.

Water tables may be altered as groundwater recharge in the area is increased on the irrigated areas, but may be reduced where water is taken. With changing hydrology, ecologically important wetlands or flood forests dry out, change their character or disappear completely. Such wetlands are core-habitats in arid and semi-arid landscapes, providing drinking water for many species, taking important roles, e.g. for bird migration, and having numerous other ecological functions. They represent habitats for a diverse fauna and flora, and rare plant species with a very high environmental value.


Water body nearby olive crops. © FGN

4.4

Very good agricultural practices to ensure more biodiversity

Agricultural cultivation should be adapted to regional and climatic conditions so that local or regional water resources, natural wetlands or regional protected areas are not overused or damaged. The link between water source and water use (ecosystem and ecosystem service) is crucial. In general, water use from open waters as well as groundwater bodies in Europe must comply with strict legal requirements. Regional governments and water authorities set withdrawal limits (legal compliance) and any withdrawal is subject to authorisation procedures.

The quality and functioning of protected aquatic areas must be safeguarded in every scenario. Watershed management plans released by regional nature protection authorities need to consider the impact of climate change and the actual water needs of agriculture in the area. These plans indicate the maximum sustainable water use per year as well as at certain times within the area.

The use of water from illegal sources such as unauthorised wells or unauthorised water extraction from ponds is not pursued in some parts of Europe, but this does not follow legal compliance regulations (as required by standards). Generally, farmers must follow legal requirements and should use the most efficient irrigation techniques available and applicable in the region (e.g. drip irrigation, reduced evaporation through evening irrigation).

The first step for good irrigation performance is being realistic regarding the plant material chosen and the expected yields. Vines and olive trees are rich in varieties, in most cases adapted to local soils and climate conditions. Local conditions and water availability limit yields and understanding these constraints is very important to avoid an overuse of water that will probably bring no benefits. The next step would be to know the amount of water used and this can be ascertained accurately (if you are on a water-meter) or estimated. This can give us a first insight into the balance between crop needs, the expected yield and the volume of water used. Even if these figures seem reasonable, there is still room for improvement. For optimising the water used, that is meeting crop needs with the minimum amount of water, the irrigation equipment and its use can be fine-tuned. For example, leaches should be controlled, more efficient systems can be used (drip irrigation instead of flood irrigation or sprinklers), irrigation time can be changed to prevent evapotranspiration, irrigation tape can be buried to supply water only to the root system, and maximising water efficiency, etc.

Technology can also help in the process of improving irrigation performance. For example, tensiometric probes (sensors at different depths) can help to understand water percolation and to assess how moisture is kept around the root system. Multispectral pictures taken with drones and satellites also help to detect leaches, over and under irrigated areas in the farm, irrigation homogeneity, problems related with salinization, etc.

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.

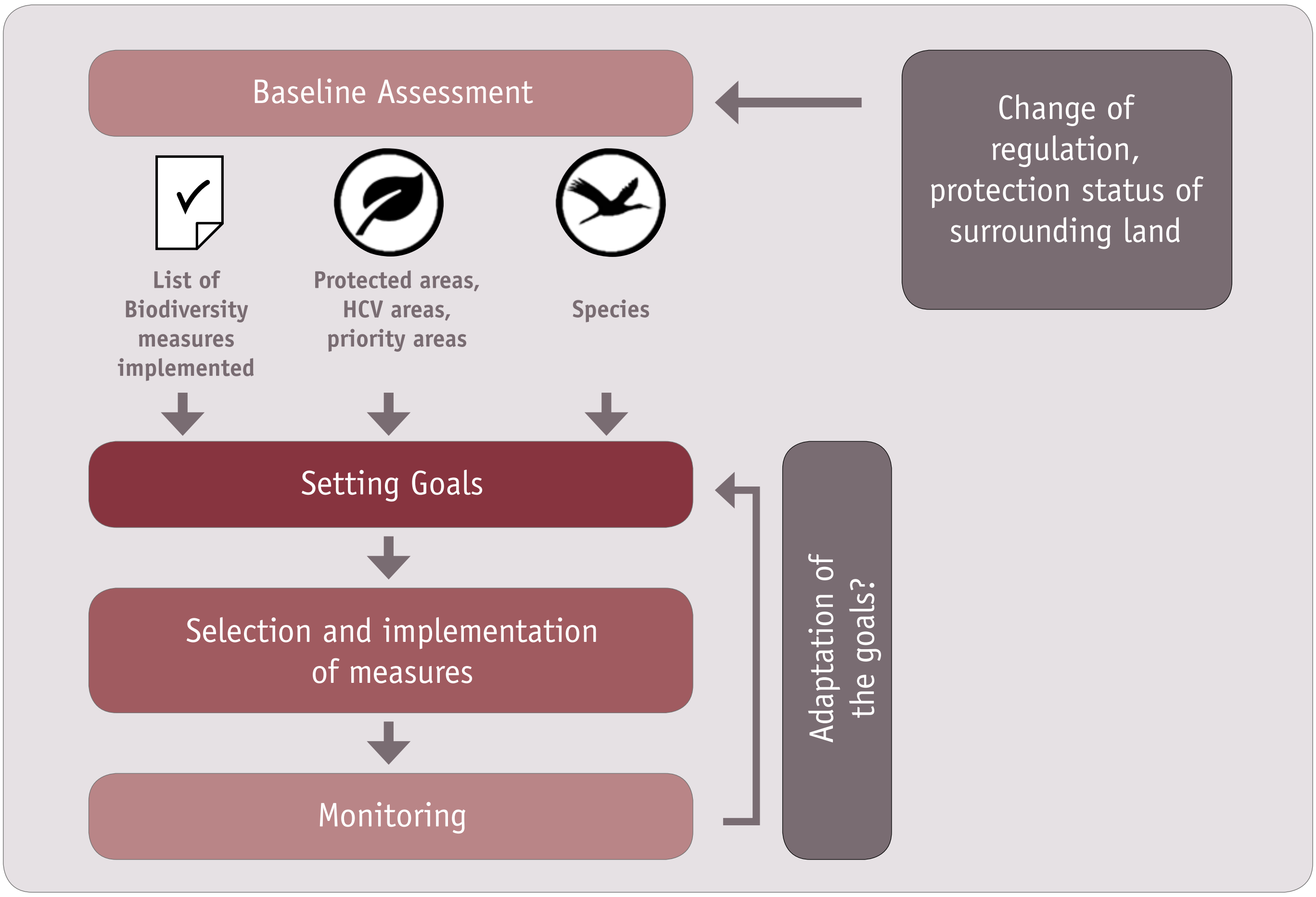
3. Selection, time line and implementation of measures for enhancing biodiversity

Some examples 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



6. 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:

We appreciate the support of our partner standards and companies:

IMPRINT

Author: Fundación Global Nature (FGN)
Editor: Global Nature Fund
Graphic Design: Didem Senturk, www.didemsenturk.de
Version: August 2018

Photo Credit: © Fundación Global Nature, p. 3,7,8,10, 13, 15
© Fotolia, www.fotolia.com
© Tom Maack, www.commons.wikimedia.org
© Pixabay, www.pixabay.com

The project is funded by:

EU LIFE Programme
LIFE15 GIE/DE/000737

Recognised as a core initiative by:

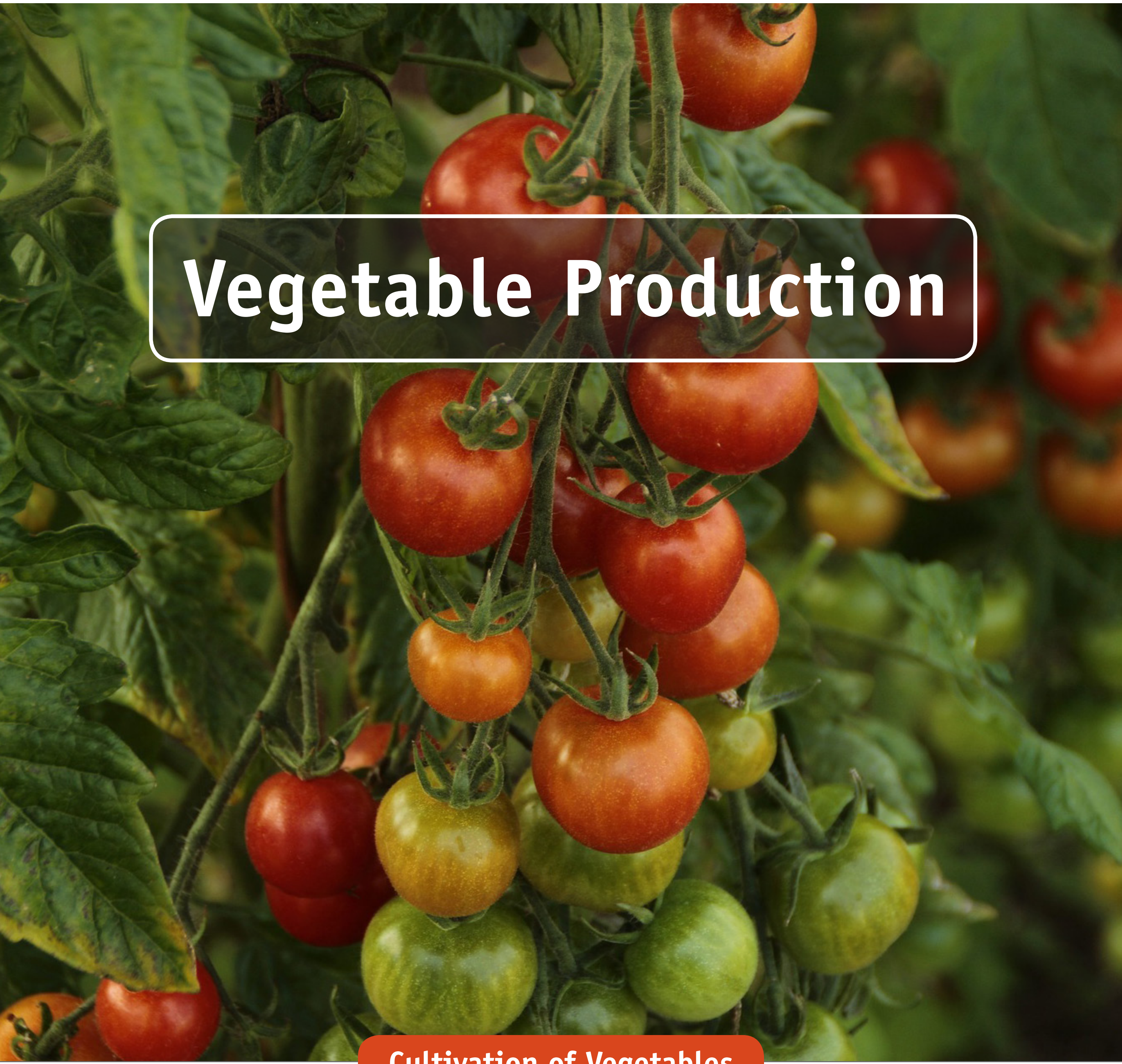
www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback

BIODIVERSITY FACT SHEET

FOOD & BIODIVERSITY



Vegetable Production

Cultivation of Vegetables

CONTENT

1. INTRODUCTION

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

In this Biodiversity Fact Sheet, we provide information on the impacts of the production of vegetables in temperate climate regions of the EU on biodiversity, as well as junctions to very good practices and biodiversity management. Biodiversity friendly agriculture depends on two main pillars, as the graph below illustrates. Within this paper, the aspects of "very good agricultural practices" will be discussed in each chapter, while the aspect of biodiversity management is described in more detail in the fifth chapter.

BIODIVERSITY FRIENDLY AGRICULTURE

Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides) **VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY**	Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors) **BIODIVERSITY MANAGEMENT**

The fact sheet targets people who assess the implementation of requirements regarding cultivation methods (standard advisors, co-operatives, suppliers) and people who take decisions on product quality, supply chain and sustainability aspects in food processing companies and retailers in the EU. We wish to raise understanding for the importance of biodiversity and related key ecosystem services as the fundamental basis for agricultural production. In this fact sheet, we focus on vegetable production in temperate climate regions of the EU.

2. AGRICULTURE AND BIODIVERSITY

Biodiversity loss: time for action

The loss of biodiversity is one of the biggest challenges of our time. Species loss driven by human activities is 1,000 times faster than under natural circumstances. Many ecosystems which provide us with essential resources are at risk of collapsing. The conservation and sustainable use of biodiversity is an environmental issue and at the same time a key requirement for nutrition, production processes, ecosystem services and overall good quality of life of mankind.



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 is causing large habitat losses. 70 % of species are threatened by the loss of their habitats. Particularly farmland fauna and flora has declined by up to 90 % due to more intensive land use, increased use of pesticides and over-fertilization.
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilizers containing nitrates and phosphates.
- **Overexploitation of forests, oceans, rivers and soils.** 30 % of species are threatened by overexploitation of habitats and resources.
- **Invasive alien species.** The introduction of alien species has led to the extinction of an increasing number of species. Currently around 22 % of species are threatened by invasive alien species.
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats.

Agriculture and biodiversity – A symbiosis

The main task for agriculture is to provide a secure food supply for the fast-growing world population in order to ensure stable livelihoods. Consumption patterns in industrialized and emerging economies have led to an intensification of agriculture and a more globalized food market, resulting in a vast exploitation of agricultural land, highly intensive production systems and a simplification of agricultural landscapes.

Agriculture depends on biodiversity and plays an important role in shaping biodiversity at the same time. Since the Neolitic, agriculture has significantly increased the diversity of landscapes and species within Europe. The European continent was previously covered with forest; 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-systems ever since. Currently more than 47 % or 210 million hectares of arable and grassland areas, which equates to almost half of the surface in Europe (EU-27), are used for agriculture. Consequently, 50 % of European species depend on agricultural habitats. This symbiotic and beneficial relationship between agriculture and biodiversity has been altered fundamentally since the 1950s.

The food sector can substantially contribute to biodiversity conservation. Appropriate integration of biodiversity as a factor into sourcing strategies will allow to evaluate risks for internal operations, brand management or legal and policy changes, will improve the product quality, and help to ensure a secure supply to retailers and final customers. A good strategy for biodiversity conservation, i.e. a positive biodiversity performance, opens opportunities regarding 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) presents the legal framework for agriculture in the European Union. It was based on the experience of hunger and starvation in Europa and targets on securing food supply for the population and the independence of European food supply from international markets. 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 references 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, which is ratified by all member states and directly transferred into national conservation laws.
- **Directive 2000/60/EC –** "Water Framework Directive" is targeted to improve the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, Cross compliance (CC) regulations address shortcomings concerning environmental issues of the CAP-philosophy described above. CC represents a first step towards environmentally friendly farming, forming a principle of linking receipt of CAP support by farmers to basic rules related to the protection of the environment (besides others). These regulations target general measures to reduce severe impacts of agriculture on the environment like erosion, nitrification, pollution of water bodies, landscape change and others. Conservationists only see a small improvement, if any, to biodiversity protection by the cross compliance regulations.

Since 2012, the CAP promotes the implementation of voluntary agro-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. Those encompass actions which directly focus 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 show positive effects of such measures on biodiversity (What Works in Conservation 2017).

The most recent CAP „REGULATIONS OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" (No. 1305/2013 - on support for rural development; No. 1306/2013 - on the financing, management and monitoring of the common agricultural policy; No. 1307/2013 - establishing rules for direct payments to farmers; No. 1308/2013 - establishing a common organisation of the markets for agricultural products), introduced in 2014, oblige farmers to implement "greening measures" when applying for direct payments. Hereby, biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. 30% of direct payments are tied to strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, especially to improve the use of natural resources. First assessments after two years indicate the necessity to adjust the current set of greening measures, as the effect on biodiversity is not apparent.

3. VEGETABLE PRODUCTION IN EUROPE

Vegetable farming as a production system includes a wide variety of crops. Consequently, the applied agricultural methods vary significantly. In this document, we try to include recommendations for all of them, except for vegetables grown under greenhouses. Although most of the recommendations may apply to vegetable production under greenhouses, this production system needs dedicated attention. The production of vegetables is part of a highly intensified production system and has a very significant weight within the agrifood industry all over Europe.

After Eurostat and according to the most recent farm structure survey (2013), almost 920,000 holdings grow fresh vegetables, which is 12.4 % of all European farms with an arable area. Nearly half (49.4 %) of those holdings are in just three countries: Romania (22.1 %), Poland (15.4 %) and Spain (11.9 %). The average plot surface for vegetable production is 1.7 ha, and more than 2 million hectares (2 % of EU arable land) are devoted to vegetable production, for fresh consumption or processing. Only 7.2 % of the total surface devoted to vegetables is covered by greenhouses or other types of covers, but this share is easily doubled in Spain and Italy. The following table shows the relative surface used for different EU vegetable production.

Among individual vegetable crops, tomatoes occupy the largest area, accounting for 11.7 % of the total vegetable area. The areas used

Vegetable group	Agricultural surface
Fruit vegetables (Melons, tomatoes, peppers, eggplants, courgettes, cucumbers and gherkins)	27.6 %
Root, tuber and bulb vegetables (carrots, radishes, onions, shallots and garlic)	18.8 %
Leafy and stalked vegetables (lettuce, spinach, chicory, endives, asparagus, artichokes)	17.8 %
Fresh pulses (peas and beans)	13 %
Brassica family vegetables (cabbages, cauliflowers and broccoli)	12.4 %
Strawberries	4.9 %
Others	5.5 %

to grow tomatoes are predominately in Italy (41.9 %) and Spain (22.8 %). Organic vegetable farming is practised on 2.5 % of EU holdings cultivating fresh vegetables and on 5.3 % of the area dedicated to these crops. 12.6 % of all certified organic farms grow organic fresh vegetables. The average yield per hectare varies for different crops and even for different varieties of the same crop. For most of the crops, an intensification process has occurred over the last decades resulting in higher yields but also in a more intensive use of agronomic inputs. Irrigation is a critical element in vegetable production. It is used more intensively in Mediterranean semiarid areas, which concentrate a significant part of the EU production and where irrigation is an absolute need for production. In most northern EU countries vegetables are rain fed or supported by only low amounts of water. However, vegetable production is, in some cases, very specialised and it is common to find skilled farmers and advisory structures that play an important role in reducing the environmental impact.

Vegetable consumption is not as high as it should be, according to nutritionists' recommendations, but in the EU-28 two thirds of the population consume at least one portion of fruits and vegetables daily. The internal trade flow is around EUR 33.4 billion and the external is EUR 4.7 billion (these figures also include fruit production).

4. CULTIVATION OF VEGETABLES AND IMPACTS ON BIODIVERSITY

In the following pages, you may find the most important impacts on biodiversity and measures for avoiding them. They are organized into different categories (soil, water, nutrient management, etc.) for a better comprehension. Excellence practices are provided at the end of each section.

4.1 Soil preparation and seeding/planting

In vegetable production, soils are usually managed intensively. Most vegetables require fine preparation and land levelling for optimum use of water. For some vegetables and herbs, such as leaf and baby-leaf crops, soil preparation can be even more intense due to the small size of plants and a zero-tolerance policy with foreign bodies during harvest. Soil preparation can happen in any time of the year, due to the variety of vegetable production calendars. Conventional (=deep) and reduced (=superficial) tillage are the most common practices, with a growing awareness among farmers of the benefits that reduced tillage delivers. Direct seeding experiences are still uncommon for most vegetables. The number of soil operations is very variable, but usually includes one or several passes for land preparation after the previous crop (that can include also early applications of fertilizers), weed treatments (mechanical or using agrochemicals) and seeding/planting. In semiarid Mediterranean regions, it is common to add an additional pass if rainfall is expected in order to superficially break the crust created after drought periods. This helps to increase water absorption and to avoid a fast run-off, especially when rainfall is intense.

EFFECTS ON BIODIVERSITY

Soil should not be considered just as a substrate to hold crops, but a complex organism that shall be kept alive to benefit from the ecological services that it can deliver. According to the German Federal Environment Agency, "a gram of soil contains billions of microorganisms: bacteria, fungi, algae and protozoans. A mere one square meter of soil is home to anywhere from hundreds of thousands to millions of soil fauna such as nematodes, earthworms, mites, woodlice, springtail, and insect larvae. A hectare of soil rooting layers contains around 15 tons of live weight – the equivalent of around 20 cows. In other words, immeasurably more organisms live in the soil than on it. Soil ecology plays a key role in natural soil functions. The biological processes in soil ecosystems e.g. integrate plant residues into the soil, shred them, break them down and release fixed nutrients as minerals for plant growth. Soil organisms create favourable physical conditions in the soil: storing and mixing soil materials (bioturbation) and sticking the soil particles together through mucus secretion (revegetation), makes soil organisms instrumental for the formation of soil pore systems. Soil organisms form stable clay-humus complexes with high water and nutrient storage capacity, and create a fine-grained, quasi erosion-resistant crumb structure. These organisms can, to some extent, mitigate the harmful effects of organic substances on soil, groundwater, and the food chain.

In general, soil treatments affect biodiversity negatively, as the natural processes described above are interrupted. Oxygen, UV radiation and heat will meet the soil, particularly turning the soil by ploughing and resulting furrows lead to severe edge effects for life in the soils. Humificating processes, which take place under exclusion of oxygen, will be hindered; the natural soil pore system is disrupted. Each treatment affects biological diversity within the soil and the fauna and flora above ground to a different extent.

4.1

Very good agricultural practices to ensure more biodiversity

Superficial treatments are usually less harmful than ploughing. It is thus a trade-off for the farmer between preventing soil-borne diseases and soil biodiversity. Earthworms, spiders and ground beetles are less affected by mulch-seeding and direct-seeding compared to conventional ploughing. Ground beetles are supported in terms of increasing species and population sizes by conservational soil preparation. Avoiding ploughing the upper soil layer (0 to 30 cm) leads to a significant increase of small invertebrates, which form the basis for soil food chains. With increased biological activity on the field, the self-regulation of the soil ecosystems rises, leading to a faster decomposition of organic material. A diverse predator community will also reduce the risk of pests and diseases caused by prey-species.

Mechanical soil preparation is an environmentally friendly option to reduce wild flora competing with the crop in early stages. This helps reducing the intake of herbicides and negative environmental consequences of agrochemicals.

4.2 Nutrient management and fertilization

© Countrypixel, www.stock.adobe.com

Soil fertility, climatic conditions and the characteristics of the type have great influence on the nutrient demand of vegetables and their yield. Fertile soils can deliver a large proportion (30 to 60 %) of the needed nutrients. On the one hand, vegetables are demanding crops in terms of nutrients, some of them being the most important nitrogen (N) consumers among the EU crops. On the other hand, most vegetables are very sensitive to over-fertilization that usually leads to unbalanced growth and a plant more prone to diseases and a decrease in product quality. This results in lower yields, more farming inputs needed or sometimes the specifications required by markets are not met. All the above mentioned shall be considered into the nutrient balance and fertilization strategy. In integrated crop management, soil analyses determine N and for some vegetables tissue analysis can also provide relevant figures. Applications of fertilizers shall therefore be calculated with respect to the described inputs and outputs.

Nitrogen is the most limiting nutrient in terms of yield for vegetable production but some crops have also other macronutrients and micronutrients requirements. Foliar applications are a common practice.

It's good to apply organic manure, especially in organic production, but it is sometimes rejected in some crops (i.e. leaf crops) as bacteriological contamination may occur and the agrifood industry has a zero-tolerance policy. Both liquid and solid mineral fertilizers are used with different techniques, such as spreading with tractors or fertirrigation (injection of fertilizers through irrigation tapes).

EFFECTS ON BIODIVERSITY

Two aspects need consideration regarding the effect of fertilization on biodiversity. The first is about changes in the trophic state of plant communities, the second affects run-offs into the environment, including pollution with nitrogen and phosphorous.

Plant communities are determined by biotic and abiotic factors, such as soil quality, precipitation, competition with other vegetation etc. Crops are no naturally composed plant communities, so this concept cannot be applied here. There is a huge diversity of wild plants that naturally naturally grow on vegetable fields. However, over-fertilization entails the setting of a nitrophilous (=nitrogen loving) community of plants that is perfectly adapted to live with crops. The Chenopodiaceae (Chenopodium, Amaranthus, etc.) and Urticaceae (Urtica) families are just two examples of nitrophilous plants. Some of these species are also very resistant to herbicides. This entails not only a change in the plant community but a simplification and global loss of biodiversity.

Nutrient (superficial or subsuperficial) run-offs to water bodies result in a dramatic change of the conditions called eutrophication. This entails changes in water chemistry and limnic organisms, leading to a small set of species, tolerant to water pollution, and once again a simplification of the system.

4.2

Very good agricultural practices to ensure more biodiversity

Diversified crop rotations improve soil biodiversity and soil fertility. This is one of the key issues in vegetable production and, as a rule of thumb, vegetables from the same botanical family (therefore with similar nutrient requirements and the same soil-borne diseases) shall never be repeated in subsequent years in the same plot. Much better, long rotation shall be used to avoid nutrient depletion and recurrent pest-related problems. Consultants often recommend five to seven years between the same crop or related crops (e.g. carrots and parsley).

Different techniques, according to crops possibilities, shall be used to prevent organic matter depletion and to improve soil structure and biota, such as manure or compost additions, cover crops use and the incorporation of crop residues. If combined with reduced tillage techniques and if a reduction in the number of tractor passes can be achieved, benefits shall be visible in the short term.

Cover crops can be useful to improve soil organic matter, avoid erosion, improve structure, to disrupt wild flora natural cycles among other benefits. In climates with water availability, cover crops are increasingly being adopted and in some EU countries, these covers are even mandatory under certain situations, mainly for avoiding nitrates leaching. Another option is mulching, but incorporating crop residues is the preferred and most common practice, as fungal diseases under wet climate may be critical. When harvested, some vegetables leave a very significant amount of biomass with interesting nutrient contents on the field. Its incorporation entails multiple benefits.

To further decrease the possibility of nutrients run-off, the use of buffer strips and similar grassy/woody structures proved to be suitable. Beside water bodies, please remember that it is mandatory to respect a strip (minimum 10 meters) without fertilizer application.

Finally, criteria for optimal soil fertility and fertilization should be based on standards that require nutrient balances and provide proven methods, standards should define crop-specific nutrient limits, combined with tolerance thresholds and time references and the fertilizer used should be documented in detail and under the legal regulations. When using organic fertilizers, the nutrient richness of such materials has to be known before being applied and, when reference values are available, tissue analysis can be very helpful to understand the plant performance.

If possible, nutrient application shall be divided as much as possible to deliver to the plants the exact amount and proportion of nutrients needed at each growing stage. If this is not possible, at least in early treatments (when there are no plants or they are so small that their root systems cannot uptake nutrients efficiently) a maximum of one third of total amount of N used during the crop shall be applied.

4.3 Pest control and plant protection

From an ecological point of view, any crop is a monoculture, poor in complexity, biodiverse food chains and with very limited predator diversity (spiders, bugs, etc.). Agriculture is about obtaining reasonable yields and competitiveness, and this has lead historically to such simplified models of plants habitats. And of course, it has a counterpart: pests and diseases find themselves in a very simplified habitat without enemies or controllers and therefore they can have a considerable impact on the economic output of a farm.

Integrated Pest Management – It shall be considered the only way to approach pest management, not only for biodiversity protection but as a consistent strategy for facing pests and diseases. All vegetable crops under such simplified ecological conditions suffer from diseases, pests and wild flora competition. Thereby, close monitoring of the pest levels, cultural practices (e.g., crop rotation, tillage or non-tillage, water and nutrient management, seeding rates and depths) and biological control tactics are combined with the judicious use of pesticides. Crop rotation e.g. focuses on the reduction of infections in the crop by reducing build-ups of insect pests, weeds, nematodes or other soil-borne diseases. Pesticides should only be applied when pests and diseases exceed economic thresholds (when they have an effect on profitability). The amount of active matter applied needs to be adjusted to the degree of infection. Preventive and calendar spraying, i.e. application of pesticides without reported signs of diseases or risk assessment, was common in the past and is now prohibited in Europe. Spot applications rather than comprehensive field treatments are recommended. Many growers employ preventive pest management strategies such as planting certified seed, using appropriate resistant varieties, manipulating planting date, modifying fertilization and irrigation.

Herbicides – In early stages of vegetable production, competition with wild flora can be an issue and pre-emergence herbicides are used. Having one or two applications is the most common procedure. Contact herbicides are also used as well as specific ones (broad-leaf, thin-leaf) according to the plants targeted. When the crop is established, in most cases wild plants competition is not an issue and herbicide treatments are both more difficult to be applied and less efficient. Mechanical removal of wild flora is another common technique and preferred over the use of herbicides.

Insecticides – Vegetables have a large number of insect pests, varying by crop, region and production methods. Pests can have a more significant impact on yields than wild flora, not only by reducing the yield itself but because the final product does not meet the contracted specifications (size, shape, colour, etc.). Insecticides are used to reduce such pests, in accordance with the processes described above.

Fungicides, bactericides etc. – Fungal infections and the application of fungicides is ideally managed with monitoring systems and prediction models, which assess the risk of infection and provide advice to farmers. According to the integrated pest management regulations, farmers have to monitor diseases and may only apply fungicides (and other pesticides), if the economic loss is outbalanced. Targeting diseases inefficiently can lead to resistances, meaning that a disease becomes insensitive to a particular fungicide.

EFFECTS ON BIODIVERSITY

Despite the optimizations and regulations, the application of pesticides is common in conventional European agriculture. Every conventional crop is treated several times with a combination of active substances, along with the criteria and regulations described above. The pesticides purpose in general is to erase biodiversity from the cropped area, preventing quick re-population and ideally keeping the crop clean and sane until the harvest. Despite the efforts of farmers, this is achieved to a very large extend and very efficiently. Fields are clean from wild flowers and butterflies are hardly ever seen during the summer. Statistically, out of 100 farmland birds breeding in 1995, only 20 are left on a given area.

Pesticides are a big environmental issue for water bodies and the environment in general. In rainy periods, drain flow is the main transport mechanism; herbicides attached to soil particles can be introduced into water bodies during intense rains. Careful application of pesticides is the key to minimise collateral damages. The efficiency of the herbicides is directly interlinked with the surface of the plant targeted. Small droplets sprayed have the highest impact, but fine sprays lead to the highest drifts. Drift is also a matter of the distance between sprayer and plants.

Herbicides – Wild flowers form the basis of food chains in arable landscapes. Consequently, if this basis is absent in crops and disturbed in adjacent areas, there will be few food for arthropods and any birdlife depending on that. As mentioned above, plants, once common, like hurtsickle Centaurea cyanus, C. depressa and corn rose Papaver rhoeas declined by 75 % in species numbers and 95 % in population sizes. Many typical farmland species are almost extinct in many agricultural landscapes. Herbicides, working either as contact or systematic toxin, which is taken up by any plant part and transported within the plant, are very effective in combating weeds. Glyphosate is an example for a total herbicide working as contact toxin. 0,1 ml/m² of active matter suffices to keep the crops free from competitive plants. Estimates by NGOs indicate that 75 % of arable land in Central Europe is treated with glyphosate once a year. Herbicides are mostly applied to combat already established weeds on the field, but some products are also used to seal the ground and to prevent the upcoming of unwanted weeds. However, these pre-emergence herbicides can be substituted by mechanical weeding techniques. Mechanical weeding may have however higher costs.

Insecticides – the purpose of Insecticides is to erase pests and arthropod biodiversity from arable countryside. One current well-known example is neonicotinoides. This group of active substances targets the nervous system of insects. Far less effective, but still recognizable, these substances also affect non-target groups like mammals and other animals. Several means of application can limit the impact on species not targeted by a treatment. Spot application methods limit the drift to adjacent landscapes as well as buffer strips along habitat edges etc. One main issue of insecticides is that they affect the targeted pests and disease vectors, but beneficial insects such as pollinators, too.So, selectivity in pesticides does not mean exclusiveness, so the effect on a target group can be 100 % and only 10 % in others, which can be a significant threat for rare species. In summary, a majority of cultivated land is free from animal biodiversity for most of the year and especially in spring and summer when most insects and arthropods breed.

Fungicides, bactericides, etc. – Even very specific fungicides have an impact on other, non-targeted fungus species, and thus an impact on e.g. microflora and –fauna of decomposers in the soils.

4.3

Very good agricultural practices to ensure more biodiversity

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. A set of agricultural practices to reduce the risk of pests and diseases in crops includes the following:

- intercropping
- crop rotation
- adequate cultivation techniques like
  - seedbed sanitation
  - sowing dates and densities
  - conservation tillage
- use of pest resistant/tolerant cultivars adapted to the region of cultivation
- certified seed and planting material
- optimal use of organic matter
- preventing the spreading of harmful organisms by field sanitation and hygiene measures, e.g.
  - removal of affected plants or plant parts
  - regular cleaning of machinery and equipment
  - balanced soil fertility or water management
- promotion of beneficial organisms

If these measures have been implemented and defined thresholds for pest and disease infections are exceeded, the use of pesticides can be part of an integrated pest management in non-organic farming. In order to protect open water bodies, buffer zones must be installed and maintained along the edges of waterways and waterbodies (minimum width: 10 meters). The best available spraying techniques, i.e. devices which inhibit or reduce drift of pesticides to adjacent areas, should be used and spraying equipment should be calibrated at least every three years. Application of pesticides is limited to authorized and trained employees only (National authorities designate official trainers). Mechanical weeding in early stages of crop growth is recommended 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 (e.g. Glyphosat, Diquat, Paraquat, Glufosinate ammonium, Indaziflam and the salt equivalent versions) should not be allowed.

Agrobiodiversity

Traditional varieties and breeds have the potential to thrive in their regions and can be key to Food Sovereignty and local development. It is fundamental to widely and clearly publicize the role of agro-ecological farmers as guardians of biodiversity and landscapes. The development and spread of genetic selection, devised to create commercial hybrid varieties, has led to a loss in variety and seed privatisation.

More tolerance to imperfect products

A huge number of agrochemical treatments is related to product specifications, the minimum requirements that companies or retailers demand. This includes minimum size, shape, colour, no signs of damage, etc. A vegetable with slightly decoloured parts, a bug mark or a non-perfect shape is automatically rejected or its price reduced in up to 80 %. The problem is that although being perfectly fine from the sanitary and nutritional point of view, they are declassified, while their production entailed the use of agronomic inputs, energy and emissions ... and an impact on biodiversity. To avoid such situations, the trend is „securing" perfect vegetables with even more agrochemical applications, leading to a non-sense situation.

4.4 Water management and irrigation

Vegetable farming includes a wide variety of crops in a wide geographical distribution. In addition, some vegetable crops are demanding high amount of water, but there are a lot of differences in water management and irrigation systems depending on the locations. In temperate climate regions of the EU, vegetable production is mainly rain fed, with small water contributions, when necessary. In Mediterranean countries , vegetables are irrigated regularly during all the stages of the crop.

Agricultural water extraction accounts for less than 1 % of total extraction in Belgium (0.1 %), Germany (0.5 %), and The Netherlands (0.8 %). However, droughts are expected to occur more frequently and will also affect Europe's temperate regions. This would lead to an increase in the demand for irrigation in many crops, including vegetables.

It is important to notice that over-irrigation leads not only to water resources depletion, but also to a more vulnerable agroecosystem in terms of diseases.

According to many climate models, water availability and efficiency will be a cornerstone for competitiveness in the coming years, as yields may fall under productivity thresholds. Today, in Southern European countries, irrigation is essential in agricultural production and agricultural water use makes up a substantial proportion of total water use (e.g. Spain 64 %, Greece 88 %, and Portugal 80 %) (OECD/Eurostat Joint Questionnaire on Inland waters). France, Greece, Italy, Portugal and Spain account for 70 % of the total area equipped with irrigation techniques in EU-28.

EFFECTS ON BIODIVERSITY

Irrigation is an essential driving force in water use management in many regions and has a huge impact on environment and biodiversity. Drawing water from groundwater, rivers, lakes or overland flow, irrigation systems redistribute this water, having diverse effects on biodiversity. Building dams and channels reduces downstream river flows and changes the hydrology of entire river systems with impacts on all life in the watersheds. Over-extraction of water for agriculture can alter water habitats and limnic fauna from biodiverse communities to poor systems with only few species. Note that about half of the amphibian species in Europe are threatened.

Water tables are altered as groundwater recharge in the area is increased on the irrigated areas, but may be reduced where the water is taken. With changing hydrology, ecologically important wetlands or flood forests dry out, change the character or disappear completely. Such wetlands are core-habitats in arid and semi-arid landscapes, providing drinking water to many species, taking important roles e.g. for bird migration, and have numerous other ecological functions. Rain fed cereal areas in semi-arid areas are habitats for a diverse community of fauna and flora, including endangered steppe birds, rare plant species with very high environmental value. Here, irrigation can cause another problem for biodiversity:irrigated crops often grow more dense, quicker and higher. This has consequences for many species, e.g. in terms of breeding sites, movement inside the crops, bare grounds for foraging etc.

4.4

Very good agricultural practices to ensure more biodiversity

Agricultural cultivation should be adapted to the regional and climatic conditions, so that local or regional water resources, natural wetlands or regional protected areas are not overused or damaged. The link between water source and water-use (ecosystem and ecosystem service) is critical. In general, water-use from open waters as well as groundwater bodies in Europe has to be in compliance with strict legal requirements. Regional governments and water authorities set withdrawal limits (legal compliance) and any withdrawal is subject of authorisation procedures. The quality and functioning of protected aquatic areas must be safeguarded in every scenario. Watershed management plans released by regional nature protection authorities need to consider the impact of climate change and the actual water needs of the agriculture in the area. These plans indicate the maximum sustainable water use per year as well as per certain times within the area.

Use of water from illegal sources such as unauthorized wells or unauthorized water extraction from ponds, is not pursued in some parts of Europe, but does not follow legal compliance regulations, which are prescribed in any standard. Generally, farmers must follow legal requirements and should use the most efficient irrigation techniques available and applicable in the region (e.g. drip irrigation, reduced evaporation through evening irrigation).

In any case, standards should support farmers to go beyond legal compliance. Promoting more efficient irrigation systems and other agricultural practices should be a priority in the future; encouraging farmers to take into account and monitor the water used for their own (agronomic) benefit and for the environment. The following is a list of some these agricultural practices:

Irrigation recording sheet: the first and basic step for monitoring the water use is an Irrigation Recording Sheet that can be easily integrated into the Farm Register Book. Even if this is a very basic measure, it is not very widespread even though it is a basic step towards accuracy for knowing the actual volume of water used

Best irrigation systems: depending of the water requirements of each crop and the region where it is cultivated, the most efficient systems should be promoted. Semi-buried or buried drip irrigation could be an example for a good practice for some vegetables in Mediterranean areas. Water is released closer to the root system and therefore, this technique optimizes water distribution. Evapotranspiration is also reduced to the minimum. The implementation provokes even more benefits: wild animals (especially birds and mammals) do not damage the tubing, the risk of wind blowing the tubing is reduced and fungal diseases in the plant neck decreased.

Decision-support tools for irrigation: Several technologies can be used to help farmers to make a decision regarding the irrigation of their crops. The very basic one included in this measure is a water meter. A more advanced level would be using any of the available technologies (commonly known as water sensors) that measure the soil moisture at different depths, allowing the farmer to know the water needs of the plants with high accuracy.

5. BIODIVERSITY MANAGEMENT

A tool proposed to improve biodiversity 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 process to develop it. A good BAP 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, to define measurable goals, to 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 the improvement. The aim is to identify the main impacts the farming activities have on biodiversity, which should be avoided, and the main opportunities existing to protect/enhance biodiversity.

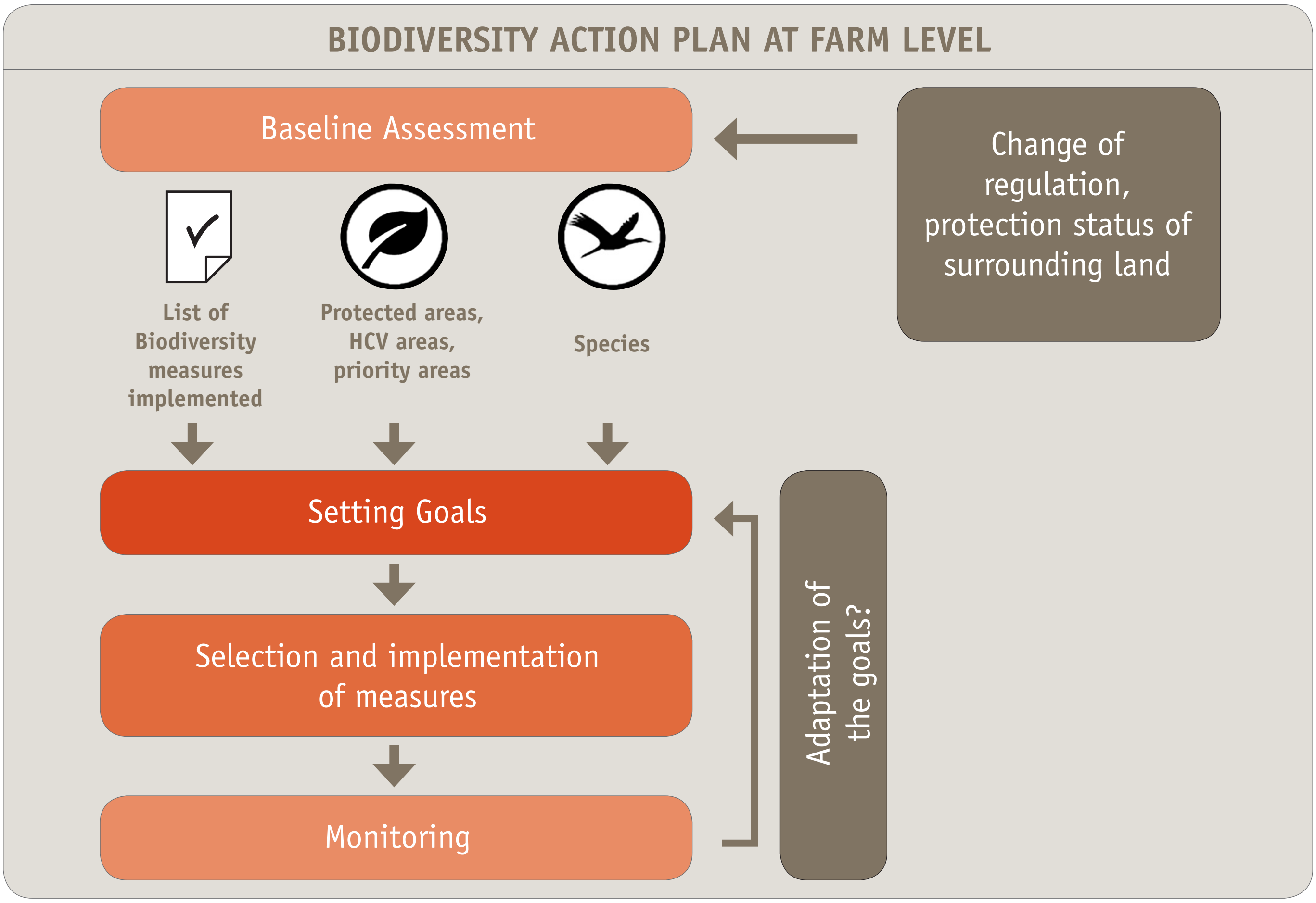
3. Selection, time line and implementation of measures for enhancing biodiversity

Some examples 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 (utilized agricultural area) is used to provide semi-natural habitats.
- **Establishment of Biotope corridors:** Specified areas for biodiversity on the farm will be connected with habitat corridors like 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 regeneration rate of grassland is respected in the 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



6. OVERVIEW OF THE EU LIFE PROJECT

Food producers and retailers are highly dependent on biodiversity and ecosystem services but 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, 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 of advisors and certifiers of standards as well as product and quality manager of companies

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

The project has been endorsed as "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:

Global Nature Fund · Bodensee Stiftung – Internationale Stiftung für Natur und Kultur · TÉCNICO LISBOA · FUNDACIÓN GLOBAL NATURE · auf! · A GOOD FOR good · Solagro

We appreciate the support of our partner standards and companies:

Nestlé – Good Food, Good Life · Kaufland · always inspiring more... symrise · UTZ – Better farming Better future · FAIRTRADE DEUTSCHLAND · Union for Ethical BioTrade – SOURCING WITH RESPECT · GESICHERTE QUALITÄT AUS KONTROLLIERTER ERZEUGUNG BADEN-WÜRTTEMBERG · Baden-Württemberg – MINISTERIUM FÜR LÄNDLICHEN RAUM UND VERBRAUCHERSCHUTZ

IMPRINT

Author: Fundación Global Nature
Editor: Global Nature Fund
Graphic Design: Didem Senturk, www.didemsenturk.de
Version: March 2018

Photo Credit: © Pixabay, www.pixabay.com
p. 3,8,11,12 © Fundación Global Nature
© Adobe Stock, www.stock.adobe.com

The project is supported by:

EU LIFE Programme
LIFE15 GIE/DE/000737

Recognised as core initiative of:

FOOD & BIODIVERSITY

www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback

BIODIVERSITY FACT SHEET

Arable Cropping

Cultivation of Wheat

CONTENT

1. INTRODUCTION

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

In this Biodiversity Fact Sheet, we provide information on the impacts of the production of wheat in temperate climate regions of the EU on biodiversity, as well as junctions to very good practices and biodiversity management. Biodiversity friendly agriculture depends on two main pillars, as the graph below illustrates. Within this paper, the aspects of "very good agricultural practices" will be discussed in each chapter, while the aspect of biodiversity management is described in more detail in the fifth chapter.

BIODIVERSITY FRIENDLY AGRICULTURE

Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides) **VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY**	Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors) **BIODIVERSITY MANAGEMENT**

The fact sheet targets people who assess the implementation of requirements regarding cultivation methods (standard advisors, co-operatives, suppliers) and people who take decisions on product quality, supply chain and sustainability aspects in food processing companies and retailers in the EU. We wish to raise understanding for the importance of biodiversity and related key ecosystem services as the fundamental basis for agricultural production. In this fact sheet, we focus on root crop production in temperate climate regions of the EU.

2. AGRICULTURE AND BIODIVERSITY

Biodiversity loss: time for action

The loss of biodiversity is one of the biggest challenges of our time. Species loss driven by human interventions happens around 1,000 times faster than under natural circumstances. Many ecosystems, which provide us with essential resources, are at the risk of collapsing. The conservation and sustainable use of biodiversity is not only an environmental issue. It is a key requirement for nutrition and other ecosystem services such as water, clean air and micro-climate, the basis for production processes and overall good quality of life of mankind.



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 is causing large habitat losses. 70 % of species are threatened by the loss of their habitats. Particularly farmland fauna and flora has declined by up to 90 % due to more intensive land use, increased use of pesticides and over-fertilization.
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilizers containing nitrates and phosphates.
- **Overexploitation of forests, oceans, rivers and soils.** 30 % of species are threatened by overexploitation of habitats and resources.
- **Invasive alien species.** The introduction of alien species has led to the extinction of an increasing number of species. Currently around 22 % of species are threatened by invasive alien species.
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats.

Agriculture and biodiversity – A symbiosis

The main task of agriculture is to provide a secure food supply for a fast-growing world population in order to ensure stable livelihoods. Consumption patterns in industrialized and emerging economies have led to an intensification of agriculture and a more globalized food market, resulting in a vast exploitation of agricultural land, highly intensive production systems and a simplification of agricultural landscapes.

Agriculture depends on biodiversity and at the same time plays an important role in shaping it. Since the Neolithic Age until the start of the 20th century, agriculture significantly increased the diversity of landscapes and species within Europe. The European continent was previously covered with forest; 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-systems ever since. Currently more than 210 million hectares of arable and grassland areas, which equates to almost half of the surface in Europe (EU-28), are used for agriculture. Consequently, 50 % of European species depend on agricultural habitats. This symbiotic and beneficial relationship between agriculture and biodiversity has altered fundamentally over the last decades towards a massive loss of biodiversity on agricultural land and its surroundings due to a non-sustainable agricultural production.

Standards and companies of the food sector play an important role for agricultural production. Therefore, they can substantially contribute to biodiversity conservation on the farm and its surroundings. The continuous propagation of standards and procurement guidelines shows the large scale of effect they have on production level. Appropriate integration of biodiversity as a sustainability and quality factor into sourcing strategies will recover and secure biodiversity within our agricultural landscapes. At the same time it facilitates the evaluation of risks for internal operations, brand management or legal and policy changes, improves the product quality, and helps to ensure a secure supply chain. A good strategy for biodiversity conservation, i.e. a positive biodiversity performance, creates opportunities regarding differentiation in the market, value proposition and meeting stakeholder expectations and consumers' demands.

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) presents the legal framework for agriculture in the European Union. It was based on the experience of hunger and starvation in Europa and targets on securing food supply for the population and the independence of European food supply from international markets. 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 references 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, which is ratified by all member states and directly transferred into national conservation laws.
- **Directive 2000/60/EC –** "Water Framework Directive" is targeted to improve the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, Cross compliance (CC) regulations address shortcomings concerning environmental issues of the CAP-philosophy described above. CC represents a first step towards environmentally friendly farming, forming a principle of linking receipt of CAP support by farmers to basic rules related to the protection of the environment (besides others). These regulations target general measures to reduce severe impacts of agriculture on the environment like erosion, nitrification, pollution of water bodies, landscape change and others. Conservationists only see a small improvement, if any, to biodiversity protection by the cross compliance regulations.

Since 2012, the CAP promotes the implementation of voluntary agro-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. Those encompass actions which directly focus 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 show positive effects of such measures on biodiversity (What Works in Conservation 2017).

The most recent CAP „REGULATIONS OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" (No. 1305/2013 - on support for rural development; No. 1306/2013 - on the financing, management and monitoring of the common agricultural policy; No. 1307/2013 - establishing rules for direct payments to farmers; No. 1308/2013 - establishing a common organisation of the markets for agricultural products), introduced in 2014, oblige farmers to implement "greening measures" when applying for direct payments. Hereby, biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. 30 % of direct payments are tied to strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, especially to improve the use of natural resources. First assessments after two years indicate the necessity to adjust the current set of greening measures, as the effect on biodiversity is not apparent.

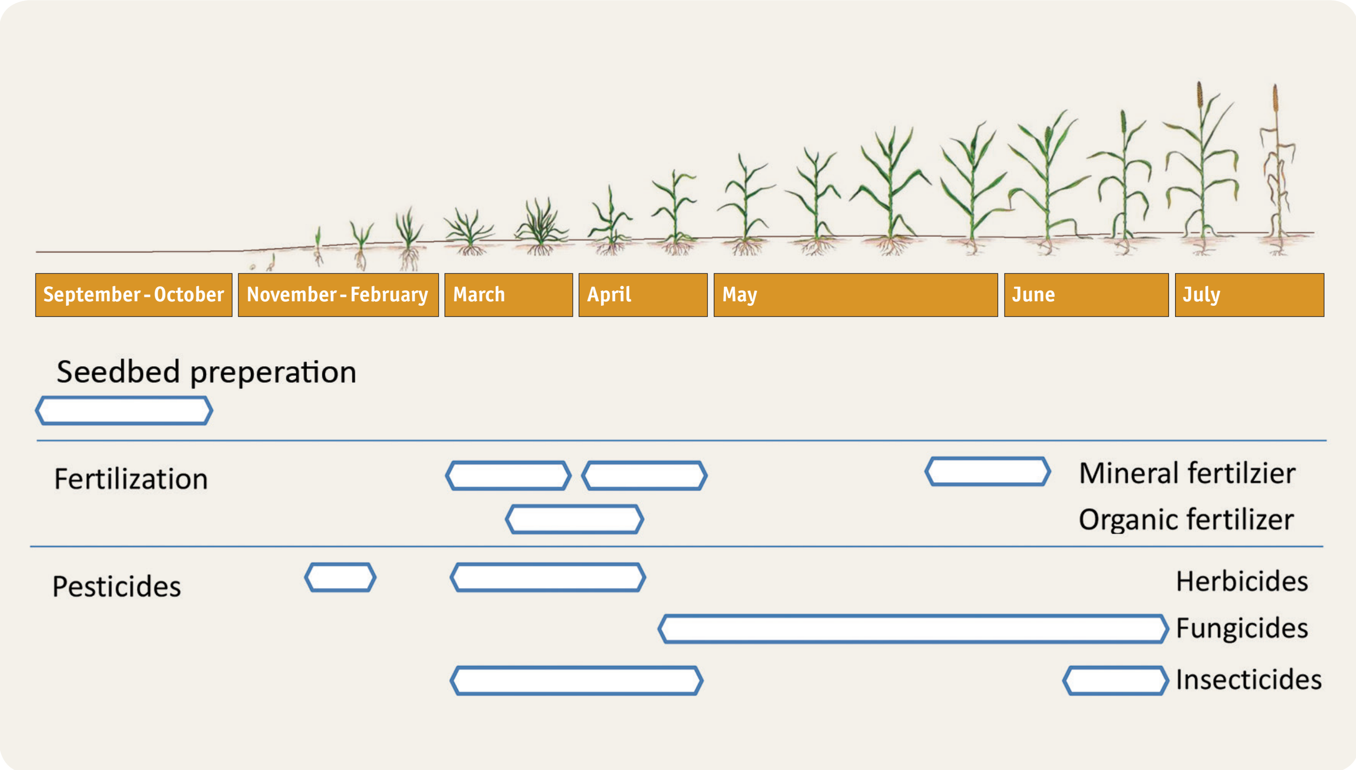
3. ARABLE FARMING IN EUROPE

Arable farming as a production system includes a variety of different crop types, ranging from foliage crops such as sugar beet to cereals. In this document, we focus on the cultivation of conventionally produced wheat as one of the most important crops in Europe. The production of wheat is part of a highly intensified production system and as such only leaves little space for biodiversity on the fields and also negatively influences the surrounding nature.

According to Eurostat, cereals (wheat, maize, barley, rye, oat and rice) make up the biggest contribution to the total crops produced in Europe. The annual yield of cereals (including rice) in the EU-28 is about 301 million tons (2017); this corresponds to a 11.6 % share of the global cereal production. Common wheat and spelt, barley, grain maize and corn-cob-mix (CCM) account for a high share (85.4 %) of the cereals produced in the EU-28. Compared to the 5-year average level, EU-28 cereal production increased by 5.7 % in 2017. This increase was driven by common wheat and spelt (14 %) as well as and barley (10 %). The biggest wheat producers in the EU-28 are France (56 million tons), Germany (52 million tons), and Poland (32 million tons).

The average yield per hectare of wheat varies strongly between countries, depending on biotic and abiotic factors, but mainly on the degree of agricultural intensification. Highest yields of wheat per hectare in Europe are obtained in northern Germany and the Ukraine and are ten times higher than in developing countries. In Semi-arid Mediterranean regions, where cereals are grown as rain fed crops, smaller yields are obtained. Technological advances in the preparation of soils, optimisation of sowing procedures, crop rotation and the use of fertilizers as well as improved harvesting techniques have contributed to a tremendous increase in wheat yields over the last decades. Today, higher yields can only be achieved with the use of new varieties that are more adapted to climatic conditions or resistant to diseases.

4. CULTIVATION OF WHEAT AND IMPACTS ON BIODIVERSITY



Wheat calendar with major cultivation treatments

Wheat is generally seeded in late autumn, fertilizer is applied early in the growing season in spring and once again in early summer. Herbicides are used when wheat plants are very small, fungicides in late spring and summer, depending on weather conditions. Insecticides against different pests are used in spring and again in summer.

4.1 Soil preparation and seeding

In arable cultivation systems, soils are treated with machinery up to three times to prepare the seedbed. Winter wheat is seeded between September and December after harvest of the previous crop. Usually the "mulch-seed" method is applied, i.e. loosening the upper soil level with a grubber and seeding with a seed drill. Direct seeding is applied less often, with seeds being placed directly into the residues of the previous crop. Deep ploughing is used to prepare the seedbed and aims to reduce soil-borne diseases, activate nutrient mineralization from organic matter and to loosen the soil. Ploughing is recommended once in a crop rotation system as a measure against soil-borne diseases. Nowadays, farmers plough when wheat is set after corn. After ploughing, the seedbed is prepared by using a whirl-harrow, and then wheat is seeded with a seed drill.

EFFECTS ON BIODIVERSITY

According to the German Federal Environment Agency, a gram of soil contains billions of microorganisms: bacteria, fungi, algae and protozoans. A mere one cubic meter of soil is home to anywhere from hundreds of thousands to millions of soil fauna such as nematodes, earthworms, mites, woodlice, springtail, and insect larvae. A hectare of soil rooting layers contains around 15 tons of live weight – the equivalent of around 20 cows. In other words, immeasurably more organisms live in the soil than on it. Soil ecology plays a key role for the natural soil functions. The biological processes in soil ecosystems e.g. fulfil functions such as the integration of plant residues into the soil, by shredding, breaking them down and releasing the previously fixed nutrients as minerals for plant growth. Soil organisms create favourable physical conditions in the soil: by storing and mixing soil materials (bioturbation) with sticking the soil particles together through mucus secretion (revegetation), soil organisms play an instrumental role for the formation of soil pore systems. Soil organisms form stable clay-humus complexes with high water and nutrient storage capacity, and create a fine-grained quasi erosion-resistant crumb structure. These organisms can, to some extent, mitigate the harmful effects of organic substances on soil, groundwater, and the food chain.

In general, soil treatments affect biodiversity negatively, as natural processes described above are interrupted. Oxygen, ultraviolet radiation and heat will come in contact with the soil, particularly when turning the soil by ploughing and its resulting furrows lead to severe edge effects for life in the soils. Humification processes, which take place under exclusion of oxygen, will be hindered; the natural soil pore system is disrupted. Each treatment affects biological diversity within the soil and the fauna and flora above the ground to a different extent. Farmland birds are not directly affected by soil treatments, as the breeding season starts after winter. Anyway, food can become so scarce in intensively farmed landscapes, that skylark territories are 40 times larger than in natural habitats. Consequently, many ground breeding birds show population decreases of up to 90 % in the last 20 years, e.g. lapwing (Vanellus vanellus), skylark (Alauda arvensis) and partridge (Perdix perdix).

In the past, stubbles and leftovers of the crop provided food for animals directly after the harvest, during winter and migration time. Today's effective harvest methods hardly leave grains for mice and other animals in winter. Consequently, in many European regions, barn owls (Tyto alba) and kestrel (Falco tinnunculus) show population declines as well. Soil preparation usually takes place directly after harvest and thus limits the food supply and in winter changes arable land to areas without much potential for biodiversity.

4.1

Very good agricultural practices to ensure more biodiversity

Superficial treatments are less harmful than ploughing. It is thus a trade-off for the farmer between preventing soil-borne diseases and soil biodiversity. Earthworms, spiders and ground beetles are less affected by mulch-seeding and direct-seeding compared to conventional ploughing. Ground beetles are supported in terms of increasing species and population sizes by conservational soil preparation. Avoiding ploughing the upper soil layer (0 to 30 cm) leads to a significant increase of small invertebrates, which form the basis for soil food chains. With increased biological activity on the field, the self-regulation of the soil ecosystems rises, leading to a faster decomposition of organic material. A diverse predator community will also reduce the risk of pests and diseases caused by prey-species.

4.2 Nutrient management and fertilization

© Wolfgang Jargstorff, www.stock.adobe.com

Soil fertility, climatic conditions and the characteristics of the cultivar have great influence on the nutrient demand of wheat and its yield. Wheat is modest concerning the quality of the soils, but fertile clay soils with beneficial structure and porous subsoil provide highest yields. Fertile soils can deliver around one-third of the needed nutrients. This influences the nutrient balance and fertilization strategy. In an integrated crop management, soil analyses determine N-min values in spring, which provide the basis for calculating the required nitrogen supply. Wheat needs between 200 and 250 kg of N per hectare in favourable abiotic conditions. In areas with lower yields, N intake is much lower. Nitrogen provided by the soil (N-min values) is subtracted from that calculated intake. Applications of fertilizers should be divided into at least two or three treatments, according to region, soil type and precipitation. The first dose of fertilizer is applied in early spring before the vegetation period starts, the second close to the main vegetation period of wheat.

Organic manure is usually applied as slurry in spring and complements the intake of chemical and mineral fertilizers. Modern machines use strip application with tubes that spread the matter directly on the ground. The largest amount of fertilizers is applied in an optimized mixture of phosphorus, potassium and sulphur (macronutrients), usually applied in combination with nitrogen. Some micronutrients are needed to sustain plant growth and are applied to the mature crop by foliage spraying.

EFFECTS ON BIODIVERSITY

Two aspects must be taken into account with regard to the effects of fertilization on biodiversity. The first is about changes in the trophic state of plant communities, the second affects run-offs into the environment, including pollution with nitrogen and phosphorous.

Plant communities are composed by biotic and abiotic factors such as soil quality, precipitation, competition with other vegetation etc. Crops are no naturally composed plant communities, so this concept cannot be applied here. There is a set of about 300 wild flowers species (Central & Western Europe) accompanying cereal production, hurtsickle (Centaurea cyanus) and corn rose (Papaver rhoeas) representing the most common ones. Scientists observed a significant decline in flora typical for cereal crops, e.g. hurtsickle and corn rose. This expresses in a 75 % decline in species numbers and 95 % in population sizes. This is largely attributed to the intensification of agriculture and changed nutrition management.

Excessive fertilization with pollution of soils and water bodies by nitrogen and phosphorus leakage is not an issue for the adopted fertilization methods fulfilling the regulations of integrated production. In integrated farming, as described above, the crop will consume applied fertilizers for plant growth; some remnants can be absorbed by the soil. Pollution caused by manure and slurry and the severe impacts on soils and water bodies is mainly an issue of disposing manure from intensive livestock farming and meat production outside the growing season. “Accidents” can easily destroy the entire life in a stream and it will take a long time to re-establish that. Also, moderate manure disposals lead to significant changes in limnic organisms with a small set of species tolerant to water pollution dominating the species composition.

Hence, even with a good nutrient management on the field, plant communities of buffer stripes along pathways, hedges, and creeks are regularly influenced by nutrients from adjacent crops. This is indicated by nutrient-tolerant plants like stinging nettle (Urtica dioica). In addition, alien invasive plants, e.g. fleece flower (Fallopia japonica) and bee-bums (Impatiens glandulifera) benefit from nutrient efflux and cover vast areas along riparian buffer stripes.

More nutrients lead to higher biomass production and therefore to a higher food supply for herbivorous arthropods at the first glance. Some more generalist species can benefit from this increase in biomass and show increasing populations. Biodiversity on the other hand is not driven by generalists, but by specialized species occupying a huge number of ecological niches. Long-term studies show a significant and strong decrease of many species typical for agricultural landscapes and ecological niches within these landscapes.

4.2

Very good agricultural practices to ensure more biodiversity

Diversified crop rotations improve soil biodiversity and soil fertility. Crop rotation fulfils the requirement for preventing soil damage, i.e. caused by erosion and compaction, which is essential to keep the soil in good conditions. EU Cross Compliance regulations give many, but not exhaustive regulations to prevent erosion and degradations of soils.

One way to improve the quality of soil and to increase the amount of humus in the long term is to regularly apply organic matter in form of manure, compost or cover crops. In general, it is recommended to use organic fertilizer instead of mineral fertilizers due to the complexity of such substances and multiple positive effects on soil fertility and structure. It is important that these fertilizers are applied according to some basic rules, which aim at prohibiting the nutrient run-off into waterbodies. Manure is not applied on…

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

To further decrease the risk of run-off, a minimum distance of one meter (with precision application machinery) and four meter with common application machinery towards water bodies must be ensured. Furthermore, farmers should be able to store their own manure for nine month in order to prevent any situation where manure is applied on the field due to a lack of storage facilities. In 2017, this situation arose in Northern-Germany after enduring rainfalls that were preventing the application of manure for over six months.

The sustainable use of soils is based on a balanced nutrient application and extraction. To achieve this, farmers have different farm management tools, such as the farm gate nutrient balance. Certified farms are often required to fulfil prescribed nutrient limits, given by the standard or procurement guideline, which go beyond the legal requirements. These are efficient tools to regulate the farming inputs. At best, the nutrient limits are crop-specific and adopted to regional circumstances.

4.3 Pest control and plant protection

From an ecological point of view, crops like wheat are a monoculture without biodiverse food chains, because comparably few species feed on the crop in limited time periods, and consequently a very limited diversity of arthropod predators (spiders, bugs, etc.) can evolve. Pests and diseases can have a considerable impact on the economic output of a farm. Wild flowers compete with the farmed crops, insects harm plants, fungal, bacterial and viral infections decrease yields and can lead to a complete crop failure in humid periods during the summer.

Integrated Pest Management – Cereal farmers have to apply an integrated pest management to cope with diseases, pests, and weeds. Thereby, close monitoring of the pest levels, cultural practices (e.g. crop rotation, tillage or non-tillage, water and nutrient management, seeding rates and depths) and biological control tactics are combined with the judicious use of pesticides. Crop rotation e.g. focuses on the reduction of crop infections by reducing build-ups of insect pests, weeds, nematodes or other soil-borne diseases. Pesticides should only be applied when pests and diseases exceed economic thresholds. The amount of active matter applied needs to be adjusted to the degree of infection. Preventive and calendar spraying, i.e. the application of pesticides without reported signs of diseases or risk assessment, was common in the past and is now prohibited in Europe. Spot applications rather than comprehensive field treatments are recommended. Many growers employ preventive pest management strategies such as planting certified seed, using appropriate resistant varieties, manipulating planting date, modifying fertilization and irrigation.

Herbicides – For wheat, competition with wild flora is the biggest issue in crop management and herbicides make up a high proportion of costs. Due to the large areas of wheat cultivation, most herbicides applied in Europe are used on wheat. The number of herbicide applications is defined by the product used and the efficiency of the applied mechanical methods to reduce weeds. Thereby, herbicides are divided into contact and residual, total and specific. Residual products seal the ground and inhibit development of wild plants; contact herbicides enter emerging plants and poison its metabolism. Total herbicides target any plant species (note that e.g. monocotyledonous like grass or maize and dicotyledonous plants have slightly diverging metabolisms), specific herbicides only some. In wheat, herbicides (often total herbicides) are applied once in autumn to target grasses and wild flowers. Depending on the active substance chosen, a second treatment may be due in spring.

Insecticides – Wheat has a large number of insect pests, varying by region and production methods. Most pests are of minor importance with insignificant yield losses. The most harmful pests occur annually and cause severe yield losses. Insecticides are used to reduce such pests, in accordance with the processes described above. The application of insecticides is bound to the annual population development of a given pest and might not be needed in some years, while in others several applications are due. Broadband insecticides target any arthropod/insect, ovicides, larvicides or acaricides only some stages or groups of species.

Fungicides, bactericides etc. – Fungal infections and the application of fungicides is ideally managed with monitoring systems and prediction models, which assess the risk of infection and provide advice to farmers. According to the integrated pest management regulations, farmers have to monitor diseases and may only apply fungicides (and other pesticides), if the economic loss is outbalanced. Targeting diseases inefficiently can lead to resistances, meaning that a disease becomes insensitive to a particular fungicide. Fungicides are commonly applied up to three times in spring.

EFFECTS ON BIODIVERSITY

Despite the optimizations and regulations, the application of pesticides is common in conventional European agriculture. Every conventional crop is treated several times with a combination of active substances, along with the criteria and regulations described above. The pesticides purpose in general is to erase biodiversity from the cropped area, preventing quick re-population and ideally keep the crop clean and sane until the harvest. Despite the efforts of the farmers, this is achieved to a very large extend and very efficiently. Fields are clean from wild flowers and butterflies are hardly ever seen in most of the summer. Statistically in the EU, out of 100 farmland birds breeding in 1995, only 20 are left on a given area.

Pesticides are a big environmental issue for water bodies and the environment in general. Water legislation restricts the application of some extensively used herbicides, and those with high risks of leaching due to their application times. In winter, drain flow is the main transport mechanism; herbicides attached to soil particles can be introduced into water bodies during heavy rains. Careful application of pesticides is the key to minimize collateral damages. The efficiency of the herbicides is directly interlinked with the surface of the plant targeted. Small droplets sprayed have the highest impact, but fine sprays lead to the highest drifts.

Herbicides – Wild flowers form the basis of food chains in arable landscapes. As mentioned above, plants that once were common, like hurtsickle (Centaurea cyanus) and corn rose (Papaver rhoeas), declined by 75 % in species numbers and 95 % in population sizes. Many typical farmland species are almost extinct in many agricultural landscapes. Herbicides, working either as contact or systematic toxin, which is taken up by any plant part and transported within the plant, are very effective in combating weeds. Glyphosate is an example for a total herbicide working as contact toxin. 0,1 ml/m² of active matter leads to the desired effect. Estimations by NGOs indicate that 75 % of arable land in Central Europe is treated with glyphosate once a year. Herbicides are mostly applied to combat already established weeds on the field, but some products are also used to seal the ground and to prevent the upcoming of unwanted weeds. However, these pre-emergence herbicides can mostly be substituted by mechanical weeding techniques.

Insecticides – The purpose of insecticides is to erase pests and arthropod biodiversity from arable countryside. One current well-known example is neonicotinoides. This group of active substances targets the nervous system of insects. Far less effective, but still recognizable, these substances also affect non-target groups like mammals and other animals. Several means of application can limit the impact on species not targeted by a treatment, e.g. spraying in the evening when pollinators will be affected less, or application methods that limit drift to adjacent landscapes, buffer strips along habitat edges, etc. Selectivity in pesticides does not mean exclusiveness, so the effect on a target group can be 100 % and only 10 % in others, but some impact will remain. In summary, the majority of land cultivated with wheat and other cereals is free from animal biodiversity for most of the year and especially in spring and summer when most insects and arthropods breed.

Fungicides, bactericides, etc. – The direct effect on biodiversity here is not as obvious as in the other pesticides. The fungus etc. species targeted are often poisonous to arthropods, too, and are not missing in the food chain per se. However, even very specific chemicals have an impact on other, non-targeted fungus species, and thus an impact on e.g. the microflora and -fauna of decomposers in the soils.

4.3

Very good agricultural practices to ensure more biodiversity

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. A basic set of agricultural practices to reduce the risk of pests and diseases in crops includes the following:

- intercropping
- crop rotation
- adequate cultivation techniques like
  - seedbed sanitation
  - sowing dates and densities
  - conservation tillage,
- use of pest resistant/tolerant cultivars adapted to the region of cultivation (traditional cultivars)
- certified seed and planting material
- optimal use of organic matter
- preventing the spreading of harmful organisms by field sanitation and hygiene measures, e.g.
  - removal of affected plants or plant parts
  - regular cleansing of machinery and equipment
  - balanced soil fertility or water management,
- promotion of beneficial organisms

If these measures have been implemented and defined thresholds for pest and disease infections are exceeded, the use of pesticides can be part of an integrated pest management in non-organic farming. In order to protect open water bodies, buffer zones must be installed and maintained along the edges of waterways and waterbodies (minimum width: 10 meters). The best available spraying techniques, i.e. devices, which inhibit or reduce drift of pesticides to adjacent areas, should be used and spraying equipment should be calibrated at least every three years.

Application of pesticides is limited to authorized employees only. Mechanical weeding in early stages of crop growth is recommended 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, e.g. Glyphosat, Diquat, Paraquat, Glufosinate ammonium, Indaziflam and the salt equivalent versions should not be allowed.

4.4 Water management and irrigation

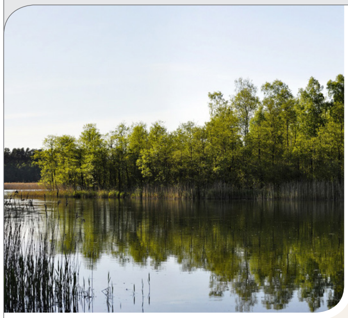
Wheat is grown as „rain fed crop" in Central Europe which means that in Central and Northern Europe wheat is generally not irrigated due to favourable precipitation patterns. In these regions, temporary irrigation is used to increase yield in dry summers during sensitive stages of plant growth. However, the required investment amounts in (new) irrigation machinery and rights for the use of water outweighs the increase in yield. Agricultural water extraction accounts for less than 1 % of total extraction in Belgium (0.1 %), Germany (0.5 %), and The Netherlands (0.8 %). However, the impact of irrigation will likely increase with the rise in global wheat prices and changing precipitation patterns following global warming. Droughts are expected to occur more frequently and will also affect Europe's temperate regions. This would lead to an increase in the demand for irrigation in many crops, including wheat.

In the Mediterranean countries, wheat crops are irrigated more regularly, with significant consequences for yields. Irrigation can be due during all stages of the crop, starting with the emerging phase. According to many climate models, rain fed wheat in semi-arid areas is more vulnerable to climate change. Water availability and efficiency will be a cornerstone for competitiveness in the coming years, as yields may fall under productivity thresholds. Today, in Southern European countries, irrigation is essential in agricultural production and agricultural water use makes up a substantial proportion of total water use (e.g. Spain 64 %, Greece 88 %, and Portugal 80%, according to Eurostat. France, Greece, Italy, Portugal and Spain account for 70 % of the total area equipped with irrigation techniques in EU-27.)

EFFECTS ON BIODIVERSITY

Irrigation is an essential driving force in water use management in many regions and has a huge impact on environment and biodiversity. Drawing water from groundwater, rivers, lakes or overland flow, irrigation systems redistribute this water, having numerus effects on biodiversity, foremost in Mediterranean areas. Building dams and channels reduces downstream river flows and changes the hydrology of entire river systems with impacts on all life in the watersheds. Over-extraction of water for agriculture can alter water habitats and limnic fauna from biodiverse communities to poor systems with only few species. Note that about half of the amphibian species in Europe are threatened.

Water tables may be altered as groundwater recharge in the area is increased on the irrigated areas, but may be reduced where the water is taken. With changing hydrology, ecologically important wetlands or flood forests dry out, change the character or disappear completely. Such wetlands are core-habitats in arid and semi-arid landscapes, providing drinking water for many species, taking important roles e.g. for bird migration, and having numerous other ecological functions. Rain fed cereal areas in semi-arid areas are habitats for a diverse community of fauna and flora, including endangered steppe birds and rare plant species with very high environmental value. Here, irrigation can cause another problem for biodiversity: irrigated crops often grow more dense, quicker and higher. This has consequences for many species, e.g. in terms of breeding sites, movement inside the crops, bare grounds for foraging etc.



4.4

Very good agricultural practices to ensure more biodiversity

Agricultural cultivation should be adapted to the regional and climatic conditions, so that local or regional water resources, natural wetlands or regional protected areas are not overused or damaged. The link between water source and water use (ecosystem and ecosystem service) is critical. In general, water use from open waters as well as groundwater bodies in Europe has to be in compliance with strict legal requirements. Regional governments and water authorities set withdrawal limits (legal compliance) and any withdrawal is subject of authorisation procedures. The quality and functioning of protected aquatic areas must be safeguarded in every scenario. Watershed management plans released by regional nature protection authorities need to consider the impact of climate change and the actual water needs of the agriculture in the area. These plans indicate the maximum sustainable water use per year as well as per certain times within the area.

Use of water from illegal sources such as unauthorized wells or unauthorized water extraction from ponds, is not pursued in some parts of Europe, but does not follow legal compliance regulations, which are prescribed in any standard. Generally, farmers must follow legal requirements and should use the most efficient irrigation techniques available and applicable in the region (e.g. drip irrigation, reduced evaporation through evening irrigation).

5. BIODIVERSITY MANAGEMENT

A tool 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, to define measurable goals, to 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 the improvement. The aim is to identify the main impacts the farming activities have on biodiversity, which should be avoided, and the main opportunities existing to protect/enhance biodiversity.

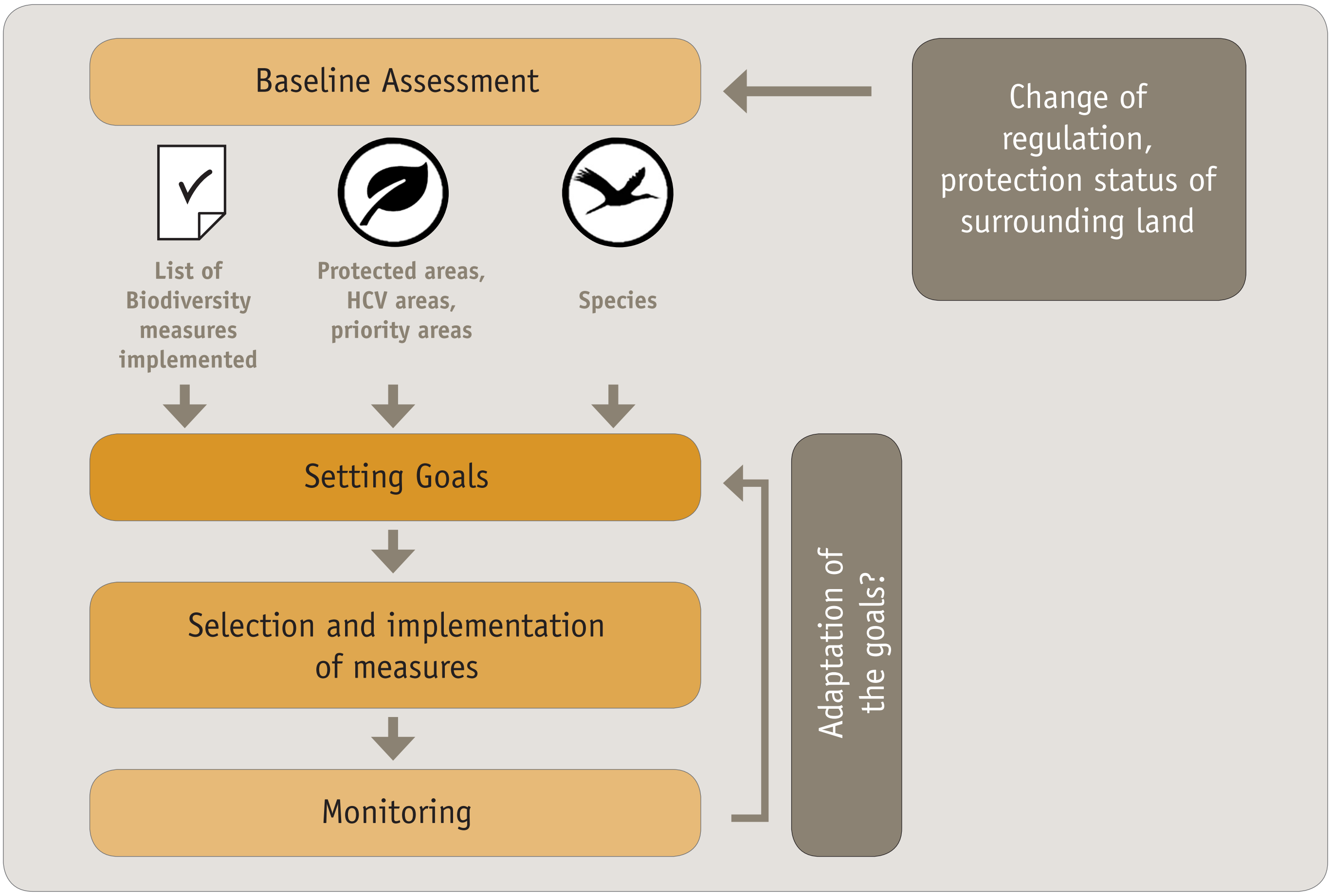
3. Selection, time line and implementation of measures for enhancing biodiversity

Some examples 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 (utilized agricultural area) is used to provide semi-natural habitats.
- **Establishment of Biotope corridors:** Specified areas for biodiversity on the farm will be connected with habitat corridors like 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 regeneration rate of grassland is respected in the 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



6. OVERVIEW OF THE EU LIFE PROJECT

Food producers and retailers are highly dependent on biodiversity and ecosystem services but 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, 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 of advisors and certifiers of standards as well as product and quality manager of companies

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

The project has been endorsed as "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:

Global Nature Fund | Bodensee Stiftung, Internationale Stiftung für Natur und Kultur | Técnico Lisboa | Fundación Global Nature | auf! | A good for good | Solagro

We appreciate the support of our partner standards and companies:

Nestlé Good Food, Good Life | Kaufland | symrise always inspiring more... | UTZ Better farming Better future | Fairtrade Deutschland | Union for Ethical BioTrade Sourcing with Respect | Gesicherte Qualität aus kontrollierter Erzeugung Baden-Württemberg | Baden-Württemberg Ministerium für Ländlichen Raum und Verbraucherschutz

IMPRINT

Author: Global Nature Fund
Editor: Global Nature Fund
Graphic Design: Didem Senturk, www.didemsenturk.de
Version: March 2018

Photo Credit: © Pixabay, www.pixabay.com
© Fotolia, www.fotolia.com
© Adobe Stock, www.stock-adobe.com

The project is supported by:

EU LIFE Programme
LIFE15 GIE/DE/000737

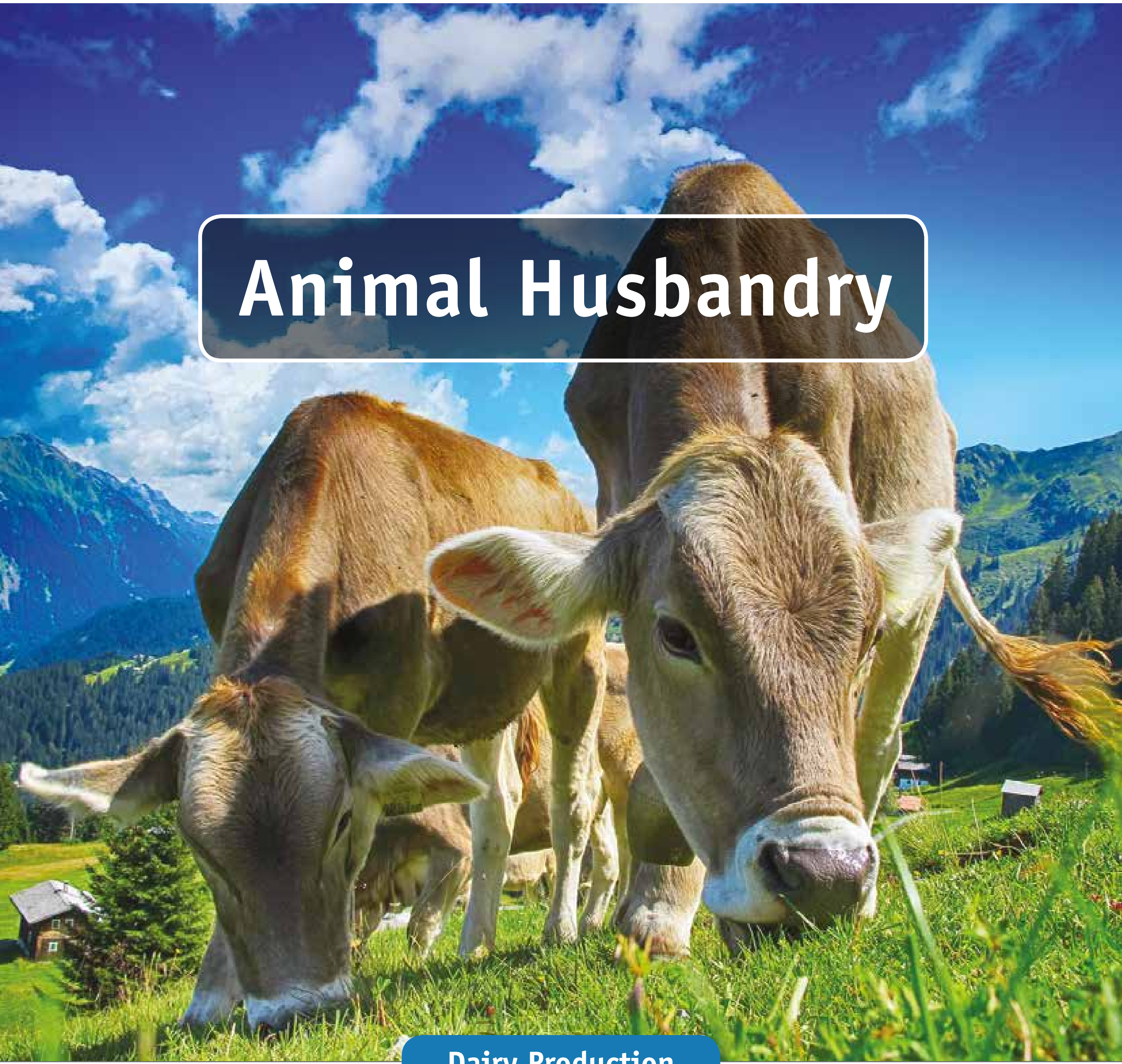
Recognised as core initiative of:

www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback

BIODIVERSITY FACT SHEET



Animal Husbandry

Dairy 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 dairy 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.

BIODIVERSITY FRIENDLY AGRICULTURE

Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides)	Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors)
VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY	**BIODIVERSITY MANAGEMENT**

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 biggest challenges of our time. Species loss driven by human intervention occurs around 1,000 times faster than under natural circumstances. Many ecosystems that provide us with essential resources are at risk of collapsing.

Conservation and the sustainable use of biodiversity is an environmental issue and, at the same time, a key requirement for nutrition, production processes, ecosystem services and the overall good quality of life for mankind.



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. 70 % of species are threatened by the loss of their habitats. In particular, farmland flora and fauna has declined by up to 90 % due to more intensive land use, the high use of pesticides and over-fertilisation.
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilisers containing nitrates and phosphates.
- **Overexploitation of forests, oceans, rivers and soils.** 30 % of species are threatened by overexploitation of habitats and resources.
- **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.
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats.

Animal husbandry and biodiversity – a symbiosis

The main task of animal husbandry is to provide a secure protein supply for a fast-growing world population in order to ensure stable livelihoods. Consumption patterns in industrialised and emerging economies have led to an intensification of animal husbandry and a more globalised food market, resulting in enormous changes in the use of agricultural land, grassland and pastures, highly intensive production systems, and worldwide traffic of animal food and animal products.

The production of animal food – thus animal husbandry in general – depends on biodiversity while also playing an important role in shaping biodiversity. Since the Neolithic age, agriculture and animal husbandry have significantly increased the diversity of landscapes and species within Europe. The European continent used to be 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 has been closely linked to agro-systems ever since. Currently, European farmers use more than 47 % or 210 million hectares of arable and grassland areas, which equates to almost half of the surface in Europe (EU-27) for agriculture. Consequently, 50 % of European species depend on agricultural habitats. This symbiotic and beneficial relationship between agriculture and biodiversity has altered fundamentally since the 1950s.

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. It was based on the experience of hunger and starvation in Europe and targets on securing the supply of food for the population and the independence of European food supply from international markets. 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 as well as 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 the 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, which has been ratified by all member states and directly transferred into national conservation laws.
- **Directive 2000/60/EC –** "Water Framework Directive" aims to improve the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, cross-compliance (CC) regulations address any shortcomings in relation to environmental issues of the CAP philosophy described above. CC represents a first step towards environmentally-friendly farming, forming a principle for linking the receipt of CAP support by farmers with basic rules related to the protection of the environment (besides others). These regulations target general measures to reduce the severe impacts of agriculture on the environment such as erosion, nitrification, pollution of water bodies, landscape change and others. Conservationists only see a small improvement, if any, to biodiversity protection by the cross compliance regulations.

Since 2012, the CAP has promoted the implementation of voluntary agro-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 measure, encompassing actions, which directly focus on the protection and conservation of agro-biodiversity. Farmers can sow flowering strips, set aside fields temporarily or permanently, organise buffer strips along open waters, plant hedgerows and others. Studies show positive effects of such measures on biodiversity (What Works in Conservation 2017).

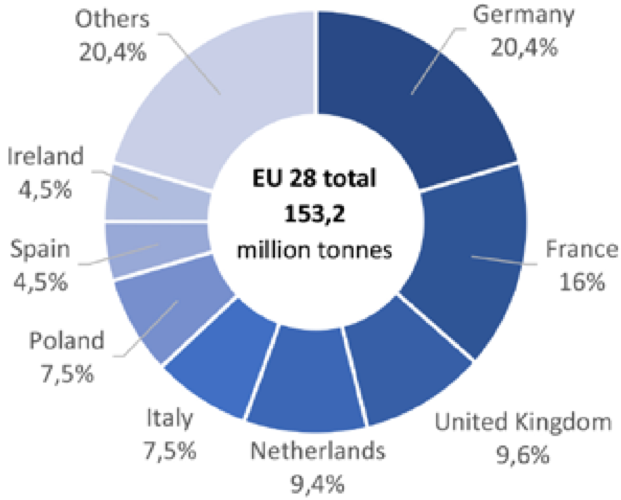
The most recent CAP "REGULATIONS OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" (No. 1305/2013 - on support for rural development; No. 1306/2013 - on the financing, management and monitoring of the common agricultural policy; No. 1307/2013 - establishing rules for direct payments to farmers; No. 1308/2013 - establishing a common organisation of the markets for agricultural products), introduced in 2014, oblige farmers to implement "greening measures" when applying for direct payments. Hereby, biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. 30 % of direct payments are tied to strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, especially to improve the use of natural resources. First assessments after two years indicate the necessity to adjust the current set of greening measures, as the effect on biodiversity is not apparent.

3. DAIRY PRODUCTION IN EUROPE

Dairy production is very important within the European Union from an economical point of view: milk accounts for 14 % of the EU agricultural output, more than any other single product. Every single member state produces milk. Particularly for Germany, France, the United Kingdom, Poland, the Netherlands and Italy, dairy production plays a significant role in the agricultural economy. These countries account for around 70 % of the EU dairy production (see graph on the right). Europe contributes to one third of the world milk production, with 165 million tons per year. Until 2015, the production of milk in the EU was a matter of quota and complex regulations, including pricing.

While the number of cows has decreased to 23 million over the last few decades, the average milk production per cow increased to 6,700 kg annually. The most important dairy cow breed is Friesian-Holstein with a yearly production of up to 10,000 kg.

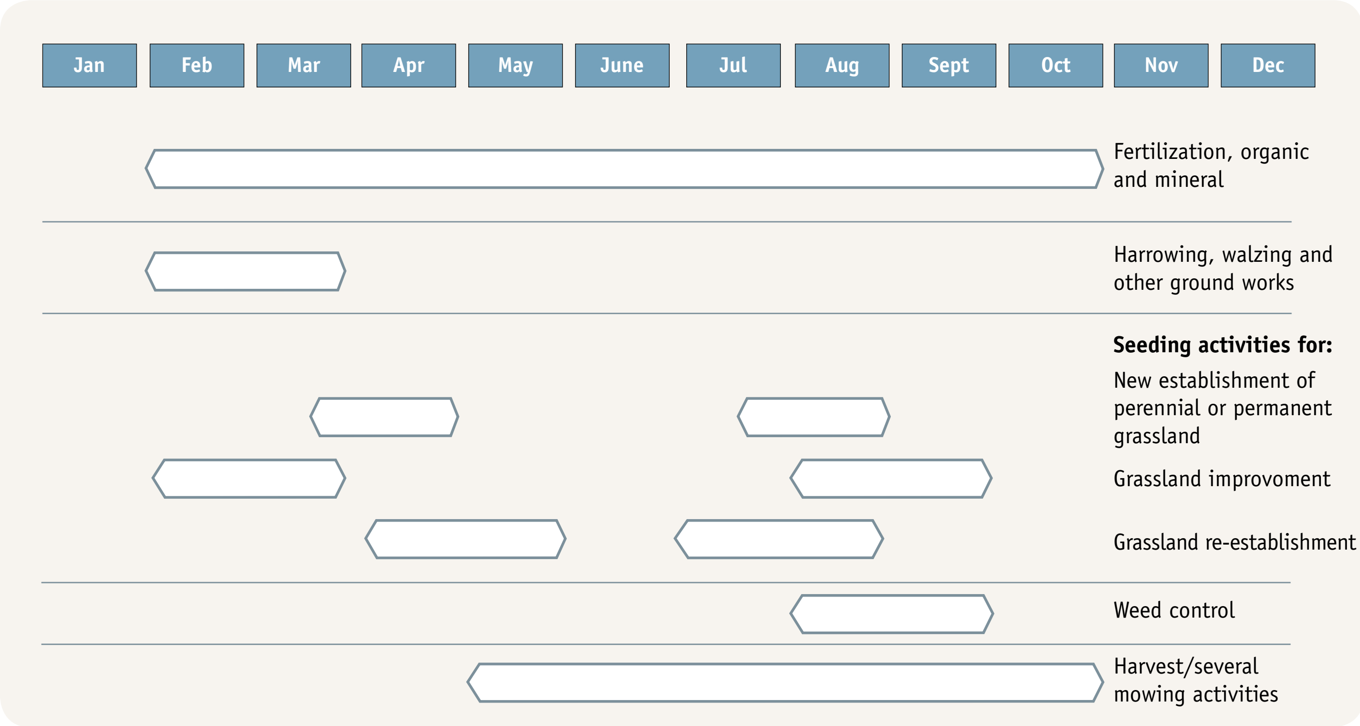
According to Eurostat, 33 % of arable land worldwide is used for the production of animal fodder, 60 % within the European Union. Of this area, some 50 % is grassland (33 % permanent grasslands and pastures), while the other part is arable land. The surface area required to feed all animals has steadily increased over the last few decades following higher demands for dairy produce and meat on the world market. Nowadays, many of the crops produced in intensive agricultural systems is assigned to be used as fodder.



Collection of cows' milk by dairies, 2016 Source: Eurostat

The same applies to the extension of arable land, often into pristine ecosystems, which is regularly related to fodder production, e.g. soy in Brazil. This development can be seen in the US, Brazil and Argentina.

4. PRODUCTION OF ANIMAL FOOD AND IMPACTS ON BIODIVERSITY



Chronogram detailing the usual application of major cultivation treatments in permanent or perennial grasslands.

Permanent and perennial grassland is usually fertilised with manure from February to the end of October. Other fertilisers can be applied from mid-January to mid-December. If permanent grassland needs to be improved, the related mechanical groundwork, such as harrowing, rolling, etc. take place in February and March; if new seeds need applying to keep up high value grassland or to improve it, grass seeds are sown from February to March or from August to September. Fragmented grasslands are re-established either in April/May or July/August. Grass is mainly harvested from May to October. If necessary, actions to combat problematic weeds are taken in August/September. Weeds are mostly supressed by frequent cutting.

4.1 Soil preparation and seeding

The seeding of permanent or perennial grasslands may take place for three main purposes:

1. Establishing new grasslands. These are frequently the perennial components of crop rotations and rarely truly permanent grasslands. Seeding may take place in spring (March/April) or summer (August). A conventional seeding approach is usually applied, using a plough and further soil preparation steps in order to arrange the seedbed.

2. Re-establishing permanent grasslands after weeds or other undesired grass species have freely developed and covered more than 50 % of the area. This operation is usually performed when mechanical weeding strategies or herbicides are not acceptable options. This is generally done during summer and may or may not include soil preparation measures. If a farmer chooses to prepare the seedbed mechanically, the grassland is tilled, harrowed and seeded. There are strict regulations regarding when and where he is allowed to till permanent grasslands. Alternatively, this may be done through direct seeding. This approach goes hand in hand with the use of total herbicides to devitalise the old grass community.

3. Improving existing permanent grasslands in order to amend fragmented pastures or meadows. This is carried out early in spring or in late summer, depending on the local weather conditions and water availability. The established permanent grassland can be improved by applying seeds using a fertiliser sprayer or with a direct-seeding drill, which places the seeds in the soil.

EFFECTS ON BIODIVERSITY

According to the German Federal Environment Agency, one gram of soil contains billions of microorganisms: bacteria, fungi, algae and protozoans. A mere one square metre of soil is home to anywhere from hundreds of thousands to millions of soil fauna such as nematodes, earthworms, mites, woodlice, springtail, and insect larvae. A hectare of soil rooting layers contains around 15 tons of live weight – the equivalent of around 20 cows. In other words, immeasurably more organisms live in the soil than on it.

Soil ecology plays a key role in natural soil functions. The biological processes in soil ecosystems include integrating plant residues into the soil, shredding them, breaking them down and releasing fixed nutrients as minerals for plant growth. Soil organisms create favourable physical conditions in the soil: by storing and mixing soil materials (bioturbation) together with the cementing of soil particles through mucus secretion (revegetation), making soil organisms instrumental for the formation of soil pore systems. Soil organisms form stable clay-humus complexes with high water and nutrient storage capacity, and create a fine-grained, quasi erosion-resistant crumb structure. These organisms can, to some extent, mitigate the harmful effects of organic substances on soil, groundwater, and the food chain.

In general, soil treatments have an adverse effect on biodiversity, as the natural processes described above are interrupted. Oxygen, UV radiation and heat will come in contact with the soil, particularly when turning the soil by ploughing the resulting furrows lead to severe adverse effects for life in the soil. Humification processes, which take place under the exclusion of oxygen, are hindered and the natural soil pore system is disrupted. Each treatment affects biological diversity within the soil and the flora and fauna above ground to a different extent.

The use of glyphosate in order to devitalise permanent grassland prior to its re-establishment via direct seeding has catastrophic effects on biodiversity. Any total herbicide targets all plants on the field non-specifically, washing away the established flora and with that destroying the overall food supply for a great number of insects and animal, which can result in the breakdown of complete food chains.

4.1

Very good agricultural practices to ensure more biodiversity

Superficial treatments are usually less harmful than ploughing. Earthworms, spiders and ground beetles are less affected by mulch seeding and direct seeding compared to conventional ploughing.

Small invertebrates, which form the basis for soil food chains, are supported by conservation-oriented soil preparation, resulting in increasing species and population sizes and increasing the self-regulation of the soil ecosystem.

Mulch seeding with its mechanical soil preparation is an environmentally-friendly option to reduce wild flora competing with crops in early stages. This helps to reduce the intake of herbicides and negative environmental consequences of agrochemicals.

4.2 Nutrient management and fertilisation in grassland

The yield and the quality (protein content) of the grass determines the application of nitrogen (N) fertilisers on grasslands. If grassland is used as pasture, the maximum amount of N is around 130 kg/ha as the nutrient input through the manure of the grazing animals contributes significantly to the total N supply. Meadows on the other hand, depending on the production intensity, may need up to 300 kg N/ha, if they are managed to the greatest intensity possible. On such meadows, it is permitted to apply 170 kg/N in the form of organic substances. Both pastures and meadows also need a reasonable supply of phosphorus, sulphur, magnesium and potassium. The complementary use of mineral fertilisers is advisable.

The most important source of nutrients in grassland is organic fertiliser in the form of manure. The optimal time of application is defined by the growth habits of the grass as well as pasture management. Generally, manure should be applied in cold, moist and cloudy weather. This reduces the evaporation of ammonia and is beneficial for high utilisation of the manure-N by the grass. Starting in February, manure can be applied on soils that are free of snow, not saturated by moisture or deeply frozen.

EFFECTS ON BIODIVERSITY

There are at least two main types of effects, driven by fertilisation practices, on biodiversity. The first refers to changes in the trophic state of plant and animal communities and the second refers to changes in global nutrient cycles, mostly due to nutrient run-offs into the surrounding environment and the diffuse pollution, caused by nitrogen and phosphorous, that follows.

In integrated farming, the crop will consume all fertilisers for its growth; some remnants might be absorbed by the soil and are available later. The application of fertilisers will favour fodder plants and disadvantage natural vegetation, which often benefit from poor soils. Plant communities are composed of biotic and abiotic factors, such as soil, precipitation, competition with other vegetation, etc. Grassland as such is very diverse in plant and animal species. Around one third of fern species and flowering plants mainly occur in grasslands. These represent about one third of the endangered fern species and flower plants in general. In healthy native systems, the competition for limited resources is relatively high and thus plants fill ecological niches, leading to great plant diversity across a pasture. Plants compete for soil type, soil nutrients, light, water, and space. By increasing the availability of a limited resource, such as nitrogen, through artificial fertilisation, this competitive factor is reduced, as the nutrient is easier to acquire. This supports plants with high demands of nutrients. Often, species that benefit from nitrogen fertilisation tend to be the non-native cool season grasses.

Pollution caused by organic fertiliser on arable land and adjacent habitats and its severe impacts on soils and water bodies is an issue of areal disposal of organic matter, not of fertilising. One example is the application of manure outside the growing season as well as the distribution of greater amounts of manure than necessary. The introduction of nitrogen in waterbodies can destroy the entire life in it and it will take a long time to re-establish natural conditions. The steady impact of moderate manure disposals lead to significant changes in limnic organisms, leading to a small set of species tolerant to water pollution. Water bodies in regions with intensive dairy and meat production suffer from this effect. Algae blooms and fish die-offs occur regularly in such waters, which are far from complying with the EU Water Framework Directive.

More nutrients lead to higher biomass production and therefore to a higher food supply for herbivorous arthropods. Generalist species can benefit from this increase in biomass and show increasing populations. Biodiversity on the other hand is not driven by generalists, but by specialised species occupying a huge number of ecological niches. Long-term studies show a significant and strong decrease of species typical for agricultural landscapes and ecological niches within landscapes, suffering from too much nitrogen being available.

© Countrypixel, www.stock.adobe.com

4.2

Very good agricultural practices to ensure more biodiversity

Due to the complexity of organic fertilisers and their multiple benefits for the environment, mineral fertiliser should be avoided as much as possible. This may mean that different kinds of organic matter have to be used. It is important that these fertilisers 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.

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 manure when facing sudden events and due to a lack of storage facilities. In 2017, such a situation arose in Northern Germany after enduring rainfalls made it impossible to apply manure for over six months.

Finally, the criteria for optimal soil fertility and fertilisation 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 fertilisers used should be documented in detail and according to legal regulations. Currently, the EU Nitrates Directive (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. Redelivery of the organic N fractions must be respected in the following years and the ammonium amounts must be accounted for since the moment of fertilisation for each crop. Standards and companies may define retention periods for the application of organic fertilisers 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, grasslands should be managed extensively. A reduction in fertilisation and plant protection substances results in a greater abundance of species such as birds that also use grasslands as foraging habitats.

4.3 Wild flora management

From an ecologist's point of view, grassland, especially extensively managed grassland is a diversified polyculture, including many different grasses, herbs, legumes and flowers. Even intensively managed meadows consist of a plant community made up of grasses and herbs, although the diversity of different species is strongly reduced by the related management. In intensive meadows, grasses are clustered according to their dietary value for the cows. Plants not regarded as valuable such as (canes, sorrels, nettles, thistles) as well as plants, toxic for cows (marsh horsetail, common buttercup, benweed) are combated. Farmers commonly do that with mechanical methods as a first step. These measures include levelling, harrowing, rolling, mowing and mulching. Since herbicides have a negative side effect on the established grasses, the chemical combating of wild flora occurs infrequently and mainly if wild flora cannot be controlled by mechanical measures or if highly problematic plants have established. Often a fragmented sod is the reason for unwanted plants spreading, therefore, sustainable grassland management and control of wild flora includes reseeding.

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 (note that monocotyledonous species, such as grass species or maize, and dicotyledonous species have slightly different metabolisms). Specific herbicides target only particular plant species. Herbicides are very effective and glyphosate is an example of total herbicide working as 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 devitalise 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 criticised by NGOs and regulating authorities. Water legislation restricts the application of some extensively used herbicides, as well as those with high risks of leaching due to their application times. A careful application of pesticides is essential to minimise collateral damages.

With regard to 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 will be available for many animal species, such as arthropods and birds, which are dependent on that food source. 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 undesired wild flora also generates strong negative impacts. These treatments are usually applied over 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 skylark (*Alauda arvensis*) are often destroyed by these measures. The negative impact on amphibians, insects and arthropods, and the resulting decline in population, ultimately reduces the availability of food for other vertebrate species.

4.3

Very good agricultural practices to ensure more biodiversity

Many agricultural activities today directly impact biodiversity negatively. Mechanical measures to reduce wild flora have less negative effects on the environment compared to the use of herbicides, as no active matter remains in the soil, in the plant and can leak out to other habitats.

4.4 Mowing

Farmers mow intensively used permanent grassland and alternating grassland up to seven times a year, depending on the speed of growth and length of the growing season. Starting from the first cut, which in temperate climate regions of Central Europe takes place in May, such grasslands are cut every four to six weeks. Vegetation period and mowing time vary considerably with the geographical latitude. Mowing of fodder as a catch crop, e.g. clover grass, is done after flowering; clover can flower several times a year. Besides this crop is 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 grassland is usually mowed twice and only 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 impact biodiversity. Some plant species are unable to flower in such grasslands due to frequent mowing. This drastically reduces the value for insects. Furthermore, ground insects are regularly eliminated and cannot reproduce sufficiently. Finally, mowing frequencies of four to six weeks are critical for ground breeding birds, since this does not allow enough time for the breeding and raising young.

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 mowing is hardly documented, but in Germany it is estimated that at least 500 thousand animals die every year. About 90 thousand of these are deer fawns.

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. 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. In general, bar mowers cause much less damage to animals than rotary mowers. That's why bar mowers are used on most protected grassland. If there is no alternative to rotary mowers, timing, pattern and cutting height can help to reduce the severe impact of mowing on biodiversity:

1. Strategically delaying the mowing season. If the first mowing is delayed by some weeks (e.g. until mid-July), then the breeding season of many wild animal species, such as birds that breed in meadows or insects, is avoided. Where birds are concerned, this measure will mostly benefit the first brood, as chicks usually start fledging in May. Insects benefit mostly from plant species that have an opportunity to flower before the first mowing.

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. For example, Eurasian skylarks (*Alauda arvensis*) have a higher productivity on sites with raised cutting height.

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. Bar mowers cause less damage to animals than rotary mowers.

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 during cloudy weather. The same applies to the early morning and evening. Therefore, mowing should preferably be carried out at such times or under such weather conditions. For silage, cloudy weather is not an issue, but for haying it may be.

2. Mowing different areas at 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 (Figure a), which drove fleeing animals into the inner circle, where they eventually became victims. Alternatively, the following mowing regimes must be selected:

A. In order to prevent animal death, mowing should start from the middle of the field and continue towards the sides (Figure b). This pattern drives animals away from the danger and has proved to be highly effective;

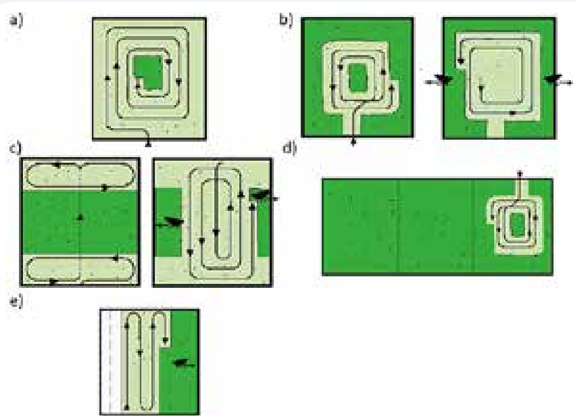
B. If a field is very wide, but long, the best mowing regime starts with cutting the field extremes (Figure c). Animals withdraw towards the middle of the field, which afterwards is mown from the inside to the outside;

C. Very large grasslands can be split into several parcels and each of these should be mown from inside to outside (Figure d);

D. Finally, if a field lies next to a road or any other infrastructure that constitutes a boundary or holds danger for fleeing animals, it should be mown in a way that drives animals away from it (Figure e).

After mowing, many grassland animals 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 for these animals. The strips 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 overwintering habitat. Such strips should be at least 6 metres wide and should be implemented on fields larger than 0.5 ha.

Close collaboration between farmers and hunters have also become more frequent. If a hunter comes to the grassland prior to the mowing and chases the animals away, this can be very effective. Dummies may be strategically placed on the field for the same purpose, but this has proved to be less effective.



In the past, pastures were often mowed in concentric circles inwards, causing considerable animal deaths. In order to prevent this, the mowing regime can be changed into a more biodiversity-friendly practice by adopting adequate mowing patterns that allow shelter for fleeing animals.
Source: Landesjagdverband NRW

4.5 Grazing

While granivores (e.g. pigs and 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 fed with harvested fodder, or outdoors – grazing directly on pastures and grasslands. Some basic grazing systems are:

A. continuous (the pasture is not divided into sub-pastures or paddocks and 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 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).

EFFECTS ON BIODIVERSITY

Grazing, by either wild herbivores or domestic species, can have positve and negative impact on biodiversity.

Domestic herbivory in the past allowed unique biodiversity to evolve, take shape and adapt in grassland-related habitats where, historically, grazing has been present for a long time. Therefore, maintaining the high levels of biodiversity observable in European natural and semi-natural grasslands requires well-managed grazing to continue.

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). Such high 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. Grazing 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), and of wild animal species that made use of that vegetation.

4.5

Very good agricultural practices to ensure more biodiversity

Taking these aspects into consideration, grazing livestock densities should respect a maximum of 1.4 LU/ha of fodder surface. Farms with higher stocking densities must work towards reducing density values in order to match this limit, within a given period. Farms with lower stocking densities should keep to these lower densities. Overall, livestock density values should be subject to a continuous reduction over time, until the optimum level is reached.

A grazing strategy that reduces the impact on the grassland and on biodiversity should be adopted. When invasive and undesired grassland species are to be controlled, applying flash-grazing is preferred (instead of mechanical or chemical control methods). If a reduction in the overall livestock density is not viable, the application of rotational grazing is recommended.

4.6 Fodder production overseas: soy

The EU imports around 35 million tons of soy, mainly from South America, which accounts for 35 % of worldwide soy trade. Brazil, Argentina, Paraguay, Uruguay and Bolivia produce over 50 % of the world soy on around 55 to 60 million hectares, an area equalling the approximate size of Spain, Sweden, France or the Ukraine. Overall, 80 % of soy produced is exported from these countries. Soy production grew considerably over that last four decades. The first 12 ha were harvested in Mato Grosso in 1970, today around 6 million ha are cultivated with soy there. The area is still extending, Brazil is currently offering a further 50 million hectares for planting with soy, mainly in Mato Grosso.

4.6

The soy coming from these countries is genetically modified (GMO) to a degree of 95 %. Production follows a round-up-ready system. This means very basic soil treatment, no crop rotation, the extensive use of pesticides, mainly glyphosate, and a highly effective, industrialised agriculture. GM crops must be certified before they can be legally imported into the European Union due to considerable reluctance on the part of suppliers and consumers to use GM products for consumer or animal use.

EFFECTS ON BIODIVERSITY

Soy production used to be one of the main drivers in the loss of primary Amazonas and Pantanal rainforest and unique wetlands. Environmental organisations have reported that soybean cultivation has destroyed vast areas of the Amazon rainforest, and has led to further deforestation. Since 2006, a memorandum on saving tropical rain forests has helped to ease the pressure, but a great deal of Amazonian and Pantanal forest still gets lost due to deforestation for soy production.

CAP regulations do not apply in South America agriculture. The use of GMO in general is extensively discussed among environmentalists and agronomists. Problems with EU compliance rules and cross-contamination of non-GM stocks have caused shipments to be rejected and have put a premium on non-GM soy today. What that specifically means is that production in South America causes high intakes of pesticides into the environment and is accompanied by all negative impacts of intensive agriculture (compare with the Wheat and Sugar Beet Fact Sheet).

4.6

Very good agricultural practices to ensure more biodiversity

In general, fodder production in Europe has advantages compared with production in South America, in terms of biodiversity and environmental concerns, as European legislation does not apply abroad. If guaranteed GMO-free production is required, it is better not to use any soy products from overseas. Even crops certified according to sustainable agricultural standards do not necessarily guarantee GMO-free production. For very good agricultural practices in agriculture, please compare with the Wheat and Sugar Beet Fact Sheet.

4.7 Further environmental effects of dairy production

Dairy production directly and indirectly affects the environment. Besides the obvious side-effects of grassland management, dairy production also causes light and noise pollution as well as the production of greenhouse gas emissions.

According to the EU Agricultural Outlook for agricultural markets and income 2017-2030, agriculture accounts for around 10 % of GHG emissions in total EU-28, including CO² and other non CO² (CH4 and N2O) emissions. By far the biggest part of non CO² emissions come from livestock. It is anticipated that this will stay relatively stable in the future, ending up at around 72 % of CH_4 and N_2O in 2030 from dairy and meat production.

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.

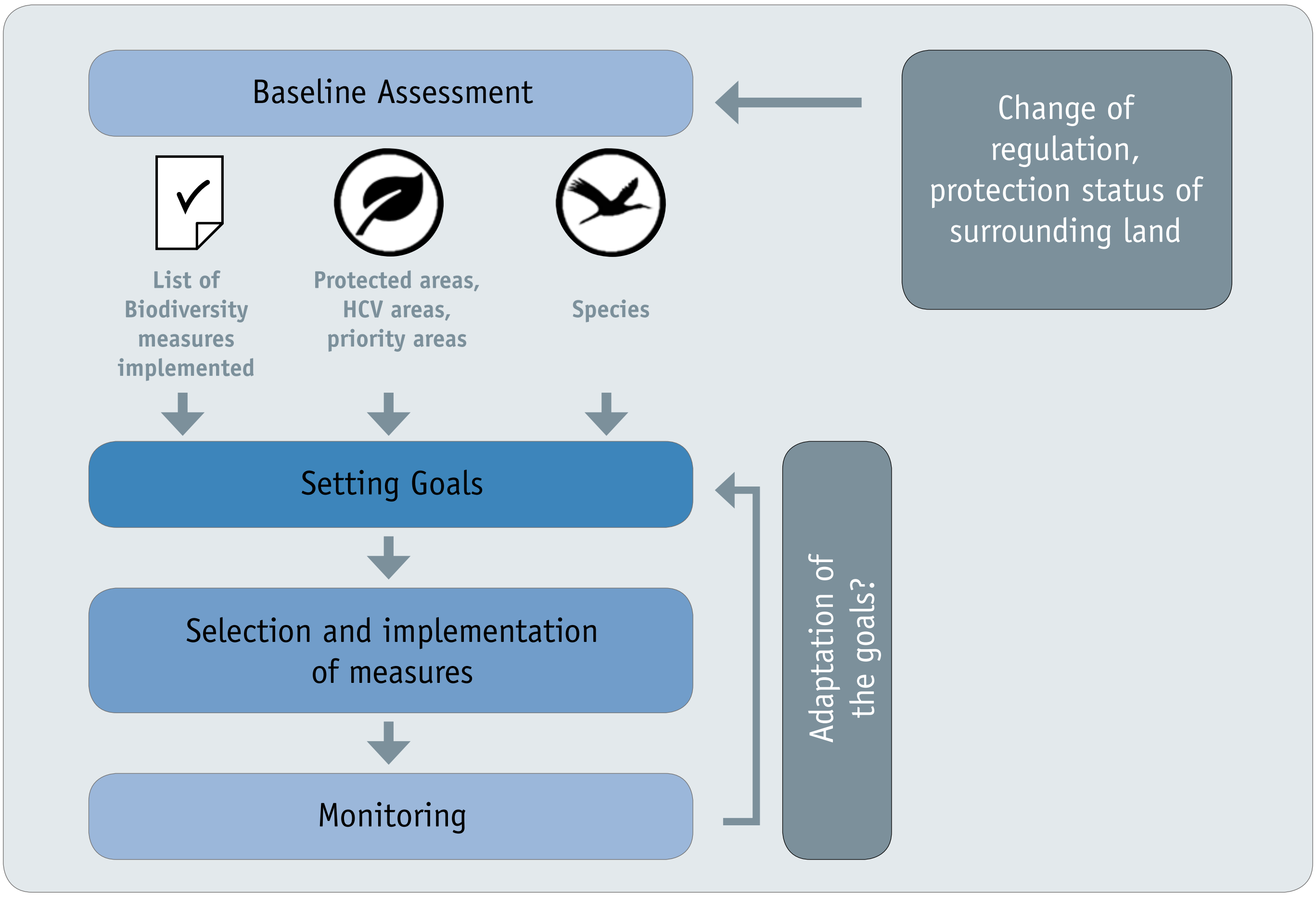
3. Selection, time line and implementation of measures for enhancing biodiversity

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



6. 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:

Global Nature Fund | Bodensee Stiftung Internationale Stiftung für Natur und Kultur | TÉCNICO LISBOA | FUNDACIÓN GLOBAL NATURE | auf! | A GOOD FOR good | Solagro

We appreciate the support of our partner standards and companies:

Nestlé Good Food, Good Life | Kaufland | always inspiring more... symrise | UTZ Better farming Better future | FAIRTRADE DEUTSCHLAND | Union for Ethical BioTrade SOURCING WITH RESPECT | GESICHERTE QUALITÄT BADEN-WÜRTTEMBERG | Baden-Württemberg MINISTERIUM FÜR LÄNDLICHEN RAUM UND VERBRAUCHERSCHUTZ

IMPRINT

Author: Global Nature Fund

Editor: Global Nature Fund

Graphic Design: Didem Senturk, www.didemsenturk.de

Version: April 2018

Photo Credit: © Adobe Stock, www.stock-adobe.com
© Fotolia, www.fotolia.com
© Pixabay, www.pixabay.com

The project is supported by:

EU LIFE Programme
LIFE15 GIE/DE/000737

Recognised as core initiative of:

www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback

BIODIVERSITY FACT SHEET

FOOD & BIODIVERSITY

Arable Cropping

Cultivation of Sugar Beet

CONTENT

1. INTRODUCTION

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

In this Biodiversity Fact Sheet, we provide information on the impacts of the production of root crops in temperate climate regions of the EU on biodiversity, as well as junctions to very good practices and biodiversity management. Biodiversity friendly agriculture depends on two main pillars, as the graph below illustrates. Within this paper, the aspects of "very good agricultural practices" will be discussed in each chapter, while the aspect of biodiversity management is described in more detail in the fifth chapter.

BIODIVERSITY FRIENDLY AGRICULTURE

Reduction of negative impacts on biodiversity and ecosystems (e.g. reduction of pesticides) **VERY GOOD AGRICULTURAL PRACTICES for MORE BIODIVERSITY**	Creation, protection or enhancement of habitats (e.g. creation of semi-natural habitats and biotope corridors) **BIODIVERSITY MANAGEMENT**

The fact sheet targets people who assess the implementation of requirements regarding cultivation methods (standard advisors, co-operatives, suppliers) and people who take decisions on product quality, supply chain and sustainability aspects in food processing companies and retailers in the EU. We wish to raise understanding for the importance of biodiversity and related key ecosystem services as the fundamental basis for agricultural production. In this fact sheet, we focus on root crop production in temperate climate regions of the EU.

2. AGRICULTURE AND BIODIVERSITY

Biodiversity loss: time for action

The loss of biodiversity is one of the biggest challenges of our time. Species loss driven by human interventions happens around 1,000 times faster than under natural circumstances. Many ecosystems, which provide us with essential resources, are at the risk of collapsing. The conservation and sustainable use of biodiversity is not only an environmental issue. It is a key requirement for nutrition and other ecosystem services such as water, clean air and micro-climate, the basis for production processes and overall good quality of life of mankind.

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 is causing large habitat losses. 70 % of species are threatened by the loss of their habitats. Particularly farmland fauna and flora has declined by up to 90 % due to more intensive land use, increased use of pesticides and over-fertilization.
- **Pollution.** 26 % of species are threatened by pollution from pesticides and fertilizers containing nitrates and phosphates.
- **Overexploitation of forests, oceans, rivers and soils.** 30 % of species are threatened by overexploitation of habitats and resources.
- **Invasive alien species.** The introduction of alien species has led to the extinction of an increasing number of species. Currently around 22 % of species are threatened by invasive alien species.
- **Climate change.** Shifts in habitats and species distribution due to climate change can be observed. Climate change interacts with and often exacerbates other threats.

Agriculture and biodiversity – A symbiosis

The main task of agriculture is to provide a secure food supply for a fast-growing world population in order to ensure stable livelihoods. Consumption patterns in industrialized and emerging economies have led to an intensification of agriculture and a more globalized food market, resulting in a vast exploitation of agricultural land, highly intensive production systems and a simplification of agricultural landscapes.

Agriculture depends on biodiversity and at the same time plays an important role in shaping it. Since the Neolithic Age until the start of the 20th century, agriculture significantly increased the diversity of landscapes and species within Europe. The European continent was previously covered with forest; 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-systems ever since. Currently more than 210 million hectares of arable and grassland areas, which equates to almost half of the surface in Europe (EU-28), are used for agriculture. Consequently, 50 % of European species depend on agricultural habitats. This symbiotic and beneficial relationship between agriculture and biodiversity has altered fundamentally over the last decades towards a massive loss of biodiversity on agricultural land and its surroundings due to a non-sustainable agricultural production.

Standards and companies of the food sector play an important role for agricultural production. Therefore, they can substantially contribute to biodiversity conservation on the farm and its surroundings. The continuous propagation of standards and procurement guidelines shows the large scale of effect they have on production level. Appropriate integration of biodiversity as a sustainability and quality factor into sourcing strategies will recover and secure biodiversity within our agricultural landscapes. At the same time it facilitates the evaluation of risks for internal operations, brand management or legal and policy changes, improves the product quality, and helps to ensure a secure supply chain. A good strategy for biodiversity conservation, i.e. a positive biodiversity performance, creates opportunities regarding differentiation in the market, value proposition and meeting stakeholder expectations and consumers' demands.

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) presents the legal framework for agriculture in the European Union. It was based on the experience of hunger and starvation in Europa and targets on securing food supply for the population and the independence of European food supply from international markets. 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 references 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, which is ratified by all member states and directly transferred into national conservation laws.
- **Directive 2000/60/EC –** "Water Framework Directive" is targeted to improve the state of water bodies in Europe and relates closely to biodiversity.

Since 2003, Cross compliance (CC) regulations address shortcomings concerning environmental issues of the CAP-philosophy described above. CC represents a first step towards environmentally friendly farming, forming a principle of linking receipt of CAP support by farmers to basic rules related to the protection of the environment (besides others). These regulations target general measures to reduce severe impacts of agriculture on the environment like erosion, nitrification, pollution of water bodies, landscape change and others. Conservationists only see a small improvement, if any, to biodiversity protection by the cross compliance regulations.

Since 2012, the CAP promotes the implementation of voluntary agro-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. Those encompass actions which directly focus 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 show positive effects of such measures on biodiversity (What Works in Conservation 2017).

The most recent CAP „REGULATIONS OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" (No. 1305/2013 - on support for rural development; No. 1306/2013 - on the financing, management and monitoring of the common agricultural policy; No. 1307/2013 - establishing rules for direct payments to farmers; No. 1308/2013 - establishing a common organisation of the markets for agricultural products), introduced in 2014, oblige farmers to implement "greening measures" when applying for direct payments. Hereby, biodiversity and clean water are explicitly targeted. Farmers have to fulfil criteria to diversify crops, maintain permanent pastures and preserve environmental reservoirs and landscapes. 30% of direct payments are tied to strengthening the environmental sustainability of agriculture and enhancing the efforts of farmers, especially to improve the use of natural resources. First assessments after two years indicate the necessity to adjust the current set of greening measures, as the effect on biodiversity is not apparent.

3. ROOT CROP FARMING IN EUROPE

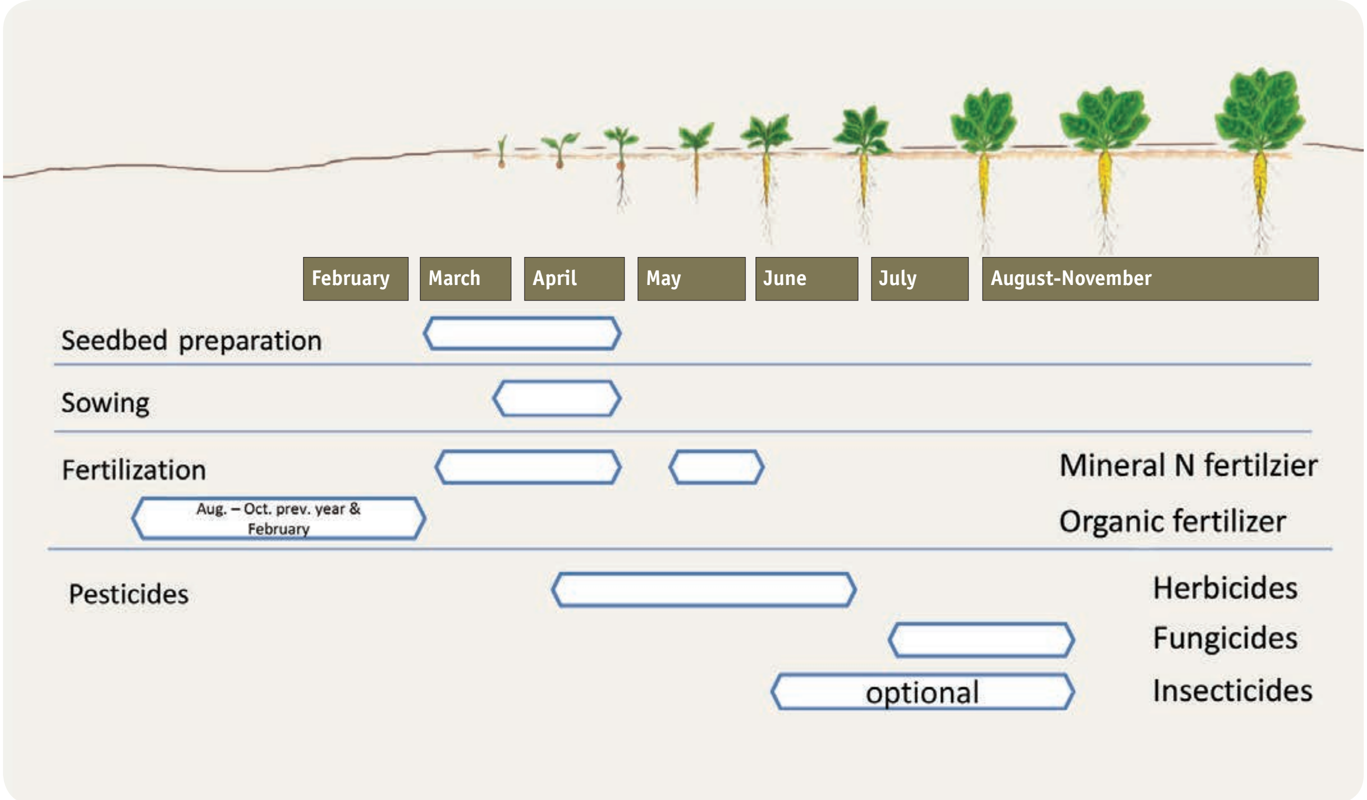
Root crop farming as production system includes different crop types, such as potatoes, sugar beet, maize, onions, carrots and other vegetables and herbs. Agricultural methods vary slightly from one crop to another, depending on the requirements of every plant species. In this document, we focus on the cultivation of conventional produced sugar beet. The production of sugar beet is part of a highly intensified production system. There is little space for biodiversity on the fields and additional negative impact on the surrounding nature.

Sugar beet can be grown on a wide range of soils with medium to slightly heavy texture. To achieve high yields and good product quality (i.e. a high sugar content) soils must show a high availability of nutrients, with high humus supplies and good water retention capacities. The ground should be plain and without soil wetness, thus most sugar beet crops are well drained. Key determinants are good rains in early autumn; dry weather in contrast will restrict growth. Frost and strong cold prior to the harvest also have major impact on the yield. The health of the crop is a result of the husbandry applied. In temperate regions, sugar beet has a growing season between 180 – 210 days/a, being seeded in spring and harvested in later autumn/beginning of winter.

According to Eurostat, the EU is the world's leading producer of sugar beet, with around 50 % of the global production. In 2016, the EU-28 produced 111.7 million tonnes of sugar beet. More than half of the EU-28 sugar beet was produced in France (31 %) and Germany (22.8 %) together. Poland (12.1 %) and the United Kingdom (5.1 %) were the next largest producers.

Over the las decades the yields of sugar beets more than doubled due to a more intensive production and achievements in the breeding of higher yielding varieties. Thereby, annual yields vary strongly, depending much on the weather conditions. Sugar beets contain about 20 % of sugar, which results in 16 % of crystal sugar after processing. The importance of sugar beet in the worldwide sugar production decreased from 43 % in the 1960s to 20 % today. Sugar cane today takes the larger portion, driven by ethanol production in Brazil and other South American countries, the production by area grew much faster in sugar cane than in sugar beet.

4. CULTIVATION OF SUGAR BEET AND IMPACTS ON BIODIVERSITY



Sugar beet calendar with major cultivation aspects

Sugar beets are seeded in spring (March/April), mineral fertilizer is applied before sugar beet is seeded and around the 4-leaf to 6-leaf stadium (May). Weed control occurs during the first growth stages, fungicides are used mostly in July until September. Insecticides are optional due to stained seeds and unregularly occurring pests.

4.1 Soil preparation and seeding

Sugar beets are seeded between Mid-March and Mid-April. Thereby, conventional seeding, mulch seeding and direct seeding technologies can be used. The conventional approach uses deep ploughing in autumn to loosen the soil before sugar beets are cultivated, to activate nutrient mineralization from organic matter and for soil hygiene purposes (reduction of weeds and soil born diseases). When mulch-seeding is applied, the ground is loosened with a grubber in spring before the farmer harrows the field to break down bigger soil clots. Thereafter, the sugar beets are seeded with a single-grain seed drill. When the needed machinery is present on the farm, direct seeding is possible, too. Mostly, sugar beets are placed in a distance of 20-22 cm from each other, having an inter-row space of 45-50 cm.

EFFECTS ON BIODIVERSITY

According to the German Federal Environment Agency, a gram of soil contains billions of microorganisms: bacteria, fungi, algae and protozoans. A mere one cubic meter of soil is home to anywhere from hundreds of thousands to millions of soil fauna such as nematodes, earthworms, mites, woodlice, springtail, and insect larvae. A hectare of soil rooting layers contains around 15 tons of live weight – the equivalent of around 20 cows. In other words, immeasurably more organisms live in the soil than on it. Soil ecology plays a key role in natural soil functions. The biological processes in soil ecosystems e.g. integrate plant residues into the soil, shred them, break them down and release fixed nutrients as minerals for plant growth. Soil organisms create favourable physical conditions in the soil: storing and mixing soil materials (bioturbation) with the cementing of soil particles through mucus secretion (revegetation), makes soil organisms instrumental for the formation of soil pore systems. Soil organisms form stable clay-humus complexes with high water and nutrient storage capacities, and create fine-grained, quasi erosion-resistant crumb structures. These organisms can, to some extent mitigate the harmful effects of organic substances on soil, groundwater, and the food chain.

In general, soil treatment affects biodiversity negatively, as it interrupts the natural processes described above. Oxygen, ultraviolet radiation and heat will strike the soil, particularly when turning the soil by ploughing and resulting furrows lead to severe edge effects for life in the soils. This hinders humification processes, which take place under exclusion of oxygen, and disrupts the natural soil pore system. Each treatment affects biological diversity within the soil and the fauna and flora above the ground to a different extent.

Farmland birds are affected by soil and seedbed preparations, as the breeding season starts after winter, where sugar beets are seeded and managed. Consequently, many ground breeding birds show decreases in population of up to 90 % in the last 20 years, e.g. lapwing (Vanellus vanellus), skylark (Alauda arvensis) and partridge (Perdix perdix).

4.1

Very good agricultural practices to ensure more biodiversity

Superficial treatments are usually less harmful than ploughing. It is thus a trade-off for the farmer between preventing soil-borne diseases and soil biodiversity. Earthworms, spiders and ground beetles are less affected by mulch-seeding and direct-seeding compared to conventional ploughing. Ground beetles are supported by conservational soil preparation, resulting in increasing species and population sizes. Avoiding ploughing the upper soil layer (0 to 30 cm) leads to a significant increase of small invertebrates, which form the basis for soil food chains. With increased biological activity on the field, the self-regulation of the soil ecosystems rises, leading to a faster decomposition of organic material. A diverse predator community will also reduce the risk of pests and diseases caused by prey-species.

4.2 Nutrient management and fertilization

© Countrypixel, www.stock.adobe.com

Soil fertility, climate conditions and the characteristics of the cultivar have great influence on the nutrient demand of sugar beet and its yield. Sugar beet is demanding concerning the quality of the soils. Fertile clay soils with porous subsoil provide highest yields. The higher the portion of nutrients the soils can deliver, the better the yield and quality of the beet (sugar content). Up to two third of nitrogen might come from the soils, influencing the nutrient balance and fertilization strategy. In integrated crop management, soil analyses determine N-min values before seeding, and provide the basis for calculating the required nitrogen supply. Sugar beet needs up to 250 kg of N per hectare. In areas with lower yields, N intake is much less. Nitrogen provided by the soil (N-min values) is subtracted from that calculated intake. Applications of fertilizers should be divided in two applications if overall donation is above 120 kg/ha, according to region, soil type and precipitation. The first dose of 60 kg N and other fertilizer is applied in early spring before the vegetation period, the second dose close to the main vegetation period after around 45 days.

When organic fertilizer (compost, manure etc.) is used, it may be applied in autumn after the harvest of the previous crop or, in case of manure, can also be applied shortly before sugar beets are seeded. It complements the use of chemical and mineral fertilizers. Thereby, mineral fertilizers are applied in an optimized mixture of phosphorus, potassium and sulphur (macronutrients), usually applied in combination with nitrogen. Besides the macronutrients, some micronutrients are needed to sustain plant growth and crop health and will be applied to the mature crop by foliage spraying.

EFFECTS ON BIODIVERSITY

Two aspects need consideration concerning the effect of fertilization on biodiversity. The first is changes in the trophic state of plant communities, the second effects runoffs in the environment, including pollution with nitrogen and phosphorous. Plant communities are composed by biotic and abiotic factors such as soil quality, precipitation, competition with other vegetation etc. Crops are no naturally composed plant communities, so this concept cannot be applied here. The issue of excessive fertilization with pollution of soils and water bodies by nitrogen and phosphorus is not an issue of adopted fertilization methods along the regulations of integrated production. In integrated farming, as described above, the crop will consume applied fertilizers for plant growth; some remnants can be absorbed by the soil. Pollution caused by mist and slurry and the severe impacts on soils and water bodies is not that much a fertilizing issue, but an issue of disposing manure from intensive livestock farming and meet production outside the growing season. "Accidents" can easily destroy the entire life in a stream and it will take long time to re-establish that. Also moderate manure disposals lead to significant changes in limnic organisms, leading to a small set of species, tolerant to water pollution.

Hence, even with a good nutrient management on the field, plant communities of buffer stripes along pathways, hedges, and creeks are regularly influenced by nutrients from adjacent crops. This is indicated by nutrient-tolerant plants like stinging-nettle (Urtica dioica). In addition, alien invasive plants, e.g. Japanese knotweed (Fallopia japonica) and Himalayan balsam (Impatiens glandulifera) benefit from nutrient efflux and cover vast areas along riparian buffer stripes.

More nutrients lead to higher biomass production and therefore to a higher food supply for herbivorous arthropods at the first glance. Some more generalist species can benefit from this increase in biomass and show increasing populations. Biodiversity on the other hand is not driven by generalists, but by specialized species occupying a huge number of ecological niches. Long-term studies show a significant and strong decrease of many species typical for agricultural landscapes and ecological niches within these landscapes.

4.2

Very good agricultural practices to ensure more biodiversity

Diversified crop rotations improve soil biodiversity and soil fertility. Crop rotation fulfils the requirement for preventing soil damage, i.e. through erosion and compaction, which is essential to keep the soil in good conditions. EU Cross Compliance regulations give many, but not exhaustive regulations to prevent erosion and degradations of soils.

One way to improve the quality of soil and to increase the amount of humus in the long term is to regularly apply organic matter in form of manure, compost or cover crops. In general, it is recommended to use organic fertilizer instead of mineral fertilizers due to complexity of such substances and multiple positive effects on soil fertility and structure. It is important that these fertilizers are applied according to some basic rules, which aim at prohibiting the nutrient run-off in waterbodies. Manure is not applied on…

- …water saturated or flooded soils;
- … frozen soils;
- …soils, covered with snow.

To further decrease the possibility of run-offs, a minimum distance of one meter (with precision application machinery) and five meter with common application machinery towards water bodies must be ensured. Furthermore, farmers should be able to store their own manure for nine-month in order to avoid that manure is applied on the field due to a lack of storage facilities. In 2017, this situation arose in Northern-Germany after enduring rainfalls made it impossible to apply manure for over six month.

The sustainable use of soils is based on a balanced nutrient application and extraction. To achieve this, farmers have different farm management tools, such as the farm gate nutrient balance. Certified farms are often required to fulfil prescribed nutrient limits, given by the standard or procurement guideline, which go beyond the legal requirements. These are efficient tools to regulate the farming inputs. At best, the nutrient limits are crop-specific and adopted to regional circumstances.

4.3 Pest control and plant protection


© Countrypixel, www.stock.adobe.com

From an ecologist's point of view, crops like sugar beet are a monoculture poor in biodiversity, with comparably few species feeding on the crop, and consequently a very limited arthropod predators diversity (spiders, bugs, etc.). In such environment, pests and diseases can easily have a considerable impact on the economic output of a farm. Wild flowers compete with the farmed crops; insects harm plants, fungal, bacterial and viral infections decrease yields and can lead to a severe crop failure in humid periods during the summer.

Integrated Pest Management – Sugar beet farmers apply an integrated pest management of diseases, insects, and weeds. Thereby, close monitoring of the pest levels, cultural practices (e.g. crop rotation, tillage or non-tillage, water and nutrient management) and biological control tactics are combined with the judicious use of pesticides. Crop rotation e.g. focuses on the reduction of infections in the crop by reducing build-ups of insect pests, weeds, nematodes or other soil borne diseases. Pesticides must only be applied when pests and diseases exceed economic thresholds. The amount of active matter applied needs to be adjusted to the degree of infection. Preventive and calendar spraying, i.e. application of pesticides without signs of diseases or risk assessment, was common in the past and is now prohibited in Europe. Spot applications rather than comprehensive field treatments are recommended. Many growers employ preventive pest management strategies such as planting certified seed, using appropriate resistant varieties, manipulating planting date, modifying fertilization and irrigation. The most relevant pest for sugar beet are soil born nematodes (Heterodera schachtii), which are effectively reduced by a crop-rotation of at least five years. Other relevant pests are minimized by this rotation and appropriate soil preparation measures as well as. Often cereals are the crop prior to sugar beets. To reduce soil erosion, but also to reduce soil pathogens and nematodes, catch crops are a common measure.

Herbicides – For sugar beet, competition with wild flora in spring is the biggest issue in crop management and herbicides make up a high proportion of cost. The number of herbicide applications is defined by the product used and the efficiency of the applied mechanical methods to reduce weeds. While the amount of different herbicides seems great, they all base on only nine active ingredients, which can be divided into contact and residual, total and specific ones. Residual products seal the ground and inhibit development of wild plants; contact herbicides enter emerging plants and poison its metabolism. Total herbicides target any plant species (note that e.g. monocotyledonous like grass or maize and dicotyledonous plants, have slightly diverging metabolisms), specific herbicides only some. Herbicides are applied after germination of the beets. Depending on the active substance chosen, up to three treatments may be due later in spring.

Insecticides – The number of insect pests vary by region and production methods. Some diseases affect sugar beet and other related species, but the importance decreased in recent years, as a consequence of overall biodiversity loss. Insecticides are used to reduce pests if economically meaningful. The application of insecticides is bound to the annual population development of a given pest and might not be needed every year. Broadband insecticides target any arthropod/insect, ovicides, larvicides or acaricides only some stages or groups of species.

Fungicides, bactericides etc. – Fungal infections and the application of fungicides is ideally managed with monitoring systems and prediction models, which assesse the risk of infection and provide advice to farmers. According to the integrated pest management regulations, farmers have to monitor diseases and may only apply fungicides (and other pesticides) substances if the economic loss is outbalanced. The focus in sugar beet production lies on managing diseases, affecting the root system as well as those affecting the leaves. Targeting diseases inefficiently can lead to resistances, meaning that a disease becomes insensitive to a particular fungicide. Fungicides are commonly applied around July.

EFFECTS ON BIODIVERSITY

Despite the optimizations and regulations, the application of pesticides is common in conventional European agriculture. Fairly every conventional crop is treated several times with a combination of active substances, along with the criteria and regulations described above. The pesticides purpose in general is to erase biodiversity from the crops, preventing quick re-population and ideally keep the crop clean and sane until the harvest. Despite the efforts of the farmers, this is achieved to a very large extend and very efficiently. Fields are clean from wild flowers, butterflies are hardly ever seen in most of the summer. Statistically, out of 100 farmland birds breeding in 1995, only 20 are left on a given area.

Pesticides are a big environmental issue for water bodies and the environment in general and NGOs and some authorities thus criticize the extensive use. Water legislation restricts the application of some extensively used herbicides, and those with high risks of leaching due to their application times. In winter, drain flow is the main transport mechanism; herbicides attached to soil particles can be introduced into water bodies during heavy rains. Careful application of pesticides is the key to minimize such collateral damages. The efficiency of the herbicides is directly interlinked with the surface of the plant targeted. Small droplets sprayed have the highest impact, but fine sprays lead to the highest drifts. Drift is also a matter of the distance between sprayer and plants.

Herbicides – Wild flowers form the basis of food chains in arable landscapes. Many typical farmland species are almost extinct in many agricultural landscapes. Plants that once were common, like cornflower (Centaurea cyanus) and corn rose (Papaver rhoeas), declined by 75 % in species numbers and 95 % in population sizes. Herbicides, working either as contact or systematic toxin, which is taken up by any plant part and transported within the plant, are very effective in combating weeds. As an example Glyphosate, a total herbicide working as contact toxin, can be taken. Here, 0,1 ml/m² of active matter leads to the desired effect. Estimates by NGOs indicate that 75 % of arable land in Central Europe are treated once a year with glyphosate. Herbicides are mostly applied to combat already established weeds on the field, but some products are also used to seal the ground and to prevent the upcoming of unwanted weeds. However, these pre-emergence herbicides can mostly be substituted by mechanical weeding techniques.

Insecticides – the purpose of insecticides is to erase pests, arthropod biodiversity from arable countryside. As a current well-known example, neonicotinoides can be mentioned. This group of active substances targets the nervous system of insects. By far less effective, but still recognizable these substances also affect non-target groups like mammals, other animals and beneficial insects. Selectivity in pesticides does not mean exclusiveness, so the effect on a target group can be 100 % and only 10 % in others, but some impact will remain. In summary, the majority of land cultivated with sugar beet and other root crops is free from animal biodiversity for most of the year.

Fungicides, bactericides, etc. – The direct effect on biodiversity here is not as obvious as in other pesticides. The fungus etc. species targeted are often poisonous to arthropods, too and are not missing in the food chain per se. However, even very specific chemicals have an impact on other, non-targeted fungus species, and thus an impact on e.g. microflora and microfauna of decomposers in the soils.

4.3

Very good agricultural practices to ensure more biodiversity

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 and should be implemented consequently. A basic set of agricultural practices to reduce the risk of pests and diseases in crops includes the following.

- Intercropping
- crop rotation
- adequate cultivation techniques e.g.
  - seedbed sanitation
  - sowing dates and densities
  - conservation tillage),
- use of pest resistant/tolerant cultivars adapted to the region of cultivation (traditional cultivars)
- certified seed and planting material
- optimal use of organic matter
- preventing the spreading of harmful organisms by field sanitation and hygiene measures e.g.
  - removal of affected plants or plant parts
  - regular cleansing of machinery and equipment
  - balanced soil fertility or water management,
- promotion of beneficial organisms

If these measures have been implemented and defined thresholds for pest and disease infections are exceeded, the use of pesticides can be part of an integrated pest management in non-organic farming. In order to protect open water bodies, buffer zones must be installed and maintained along the edges of waterways and waterbodies (minimum width: 10 meters). The best available spraying techniques, i.e. devices, which inhibit or reduce drift of pesticides to adjacent areas, should be used and spraying equipment should be calibrated at least every three years. Application of pesticides is limited to authorized employees, only. Mechanical weeding in early stages of crop growth is recommended to substitute pre emergence herbicides. The use of pesticides, which are dangerous to bees, pollinating insects, beneficial organisms, amphibians or fish should be prohibited, just as very harmful substances (e.g. Glyphosat, Diquat, Paraquat, Glufosinate ammonium, Indaziflam and the salt equivalent versions) should not be allowed.

4.4 Water management and irrigation

Sugar beet is grown as „rain fed crop" in Central Europe which means sugar beet is generally not irrigated due to favourable precipitation patterns. In some regions, temporary irrigation is used to in dry summers during sensitive stages of plant growth. However, the required investment amounts in (new) irrigation machinery and rights for the use of water often outweighs the increase in yield. Agricultural water extraction accounts for less than 1 % of total extraction in Belgium (0.1 %), Germany (0.5 %), and The Netherlands (0.8 %). However, the impact of irrigation might increase with a rise in global sugar prices and changing precipitation patterns following global warming. Droughts are expected to occur more frequently and will also affect Europe's temperate regions. This would lead to an increase in the demand for irrigation in many crops, including sugar beet. In drier climates, sugar beet crops are irrigated more regularly, leading to significantly better yields. Irrigation can be due mostly in summer, when water supply is scarce. Very often, yields are just much lower in drier climates. According to many climate models, rain fed sugar beet in semi-arid areas is more vulnerable to climate change. Water availability and efficiency will be a cornerstone for competitiveness in the coming years. According to Eurostat, irrigation is essential in southern European countries, making up a substantial proportion of total water use (e.g. Spain 64 %, Greece 88 %, Portugal 80 %). France, Greece, Italy, Portugal and Spain account for 70 % of the total area equipped with irrigation techniques in EU-28.

EFFECTS ON BIODIVERSITY

Irrigation is an essential driving force in water use management in many regions and has a huge impact on environment and biodiversity. Drawing water from groundwater, rivers, lakes or overland flow, irrigation systems redistribute this water, having numerus effects on biodiversity. First and foremost in Mediterranean areas. Building dams and channels reduces downstream river flows and changes the hydrology of an entire river system with impacts on all life in the watershed. Water habitats and limnic fauna can be altered by over-extraction of water for agriculture, from biodiverse communities to poor systems with only few species. Note that about half of the amphibian species in Europe are threatened!

Water tables may be altered as groundwater recharge in the area is increased on the irrigated areas, but may be reduced where the water is taken. With changing hydrology, ecologically important wetlands or flood forests dry out, change the character or disappear completely. Such wetlands are core-habitats in arid and semi-arid landscapes, providing drinking water for many species, taking important roles e.g. in bird migration, and have numerous other ecological functions. Rain-fed cereal areas in semi-arid areas are habitats for a diverse community of fauna and flora, including endangered steppe birds, rare plant species, with very high environmental value. Here, irrigation can cause another problem for biodiversity. Irrigated crops often grow more dense, quicker and higher. This has consequences for many species, e.g. in terms of breeding sites, movement inside the crops, bare grounds for foraging etc.

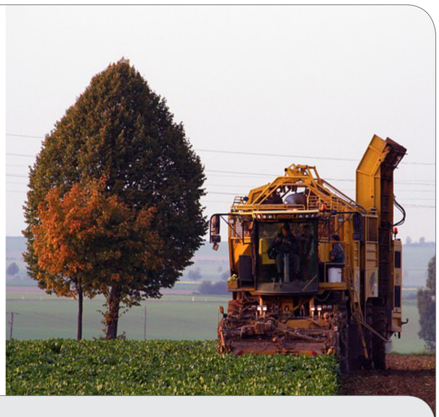
4.4

Very good agricultural practices to ensure more biodiversity

Agricultural cultivation must be adapted to the regional and climatic conditions. The goal is to safeguard protection of water resources, natural wetlands or protected areas from possible damages caused by overuse of water resources. The link between water source and water-use (ecosystem and ecosystem service) is critical. In general, water-use from open waters and groundwater bodies in Europe has to be in compliance with strict legal requirements. Regional governments and water authorities set withdrawal limits (legal compliance) and any withdrawal is subject of authorisation procedures. The quality and functioning of protected aquatic areas must be safeguarded in every scenario. Watershed management plans released by regional nature protection authorities need to consider the impact of climate change and the actual water needs of the agriculture in the area. These plans indicate the maximum sustainable water use per year as well as per certain times within the area. Use of water from illegal sources such as unauthorized wells or unauthorized water extraction from ponds, is not pursued in some parts of Europe, but does not follow legal compliance regulations, which are prescribed in any standard. Generally, farmers must follow legal requirements and should use the most efficient irrigation techniques available and applicable in the region (e.g. drip irrigation, reduced evaporation through evening irrigation).

4.5 Harvest

Sugar beets are harvested between September and January. The harvesting campaign is related to the processing of the sugar beets in the sugar factory and the idea to harvest only the amounts needed to keep up sugar production at a time. This ends up with a timeframe for the sugar beet harvest of around 120 days in favourable years. Harvesting losses account to 2.5 t/ha on average, which is 3 % of the yield. Harvest of sugar beet leaves the soil bare, being covered only by the beets leaves, which are chopped off the root. Sugar beet is thus an ideal pre-crop for many other crops, as the soil is already loosened and well prepared.



EFFECTS ON BIODIVERSITY

Harvest in general is a "catastrophic" event, seen from an ecological point of view: Landscape structure is altered on large areas; habitats are changed from monocultures to desert-like habitats. In the first decades of industrialized agriculture, this caused huge impacts on biodiversity. Since sugar beet is harvested over a long time period, the landscape effect of it is not as severe as it is for example in cereals. This is because the mosaic like harvesting leaves enough room for animals to withdraw to. Harvesting sugar beet leaves the soil bare and prone to erosion. Additionally, heavy harvesters cause soil compaction, having a negative effect on soil biodiversity. The first direct impact of soil compaction on biodiversity is the reduction of habitats for soil organisms, e.g. earthworms. Compaction damages earthworm tunnel structures and kills a great number of them. The abundance of micro-arthropods is higher in coarse soil than in fine-textured soil or compacted ones, too.

4.5

Very good agricultural practices to ensure more biodiversity

To reduce compaction, harvesting of sugar beets should happen when the soil is dry. This is also important for the loading of the piled beets. The ends of the fields, where sugar beet piles are established are more vulnerable to compactions since heavy machinery is used there twice. If a sugar beet pile is loaded late in December to January, the farmer is left with limited possibilities to seed a following crop on this area of the field. Here, flowering stripes can be established, which benefit insects, birds and smaller mammals in the coming year.

5. BIODIVERSITY MANAGEMENT

A tool proposed to improve biodiversity 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 process to develop it. A good BAP 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, to define measurable goals, to 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 the improvement. The aim is to identify the main impacts the farming activities have 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

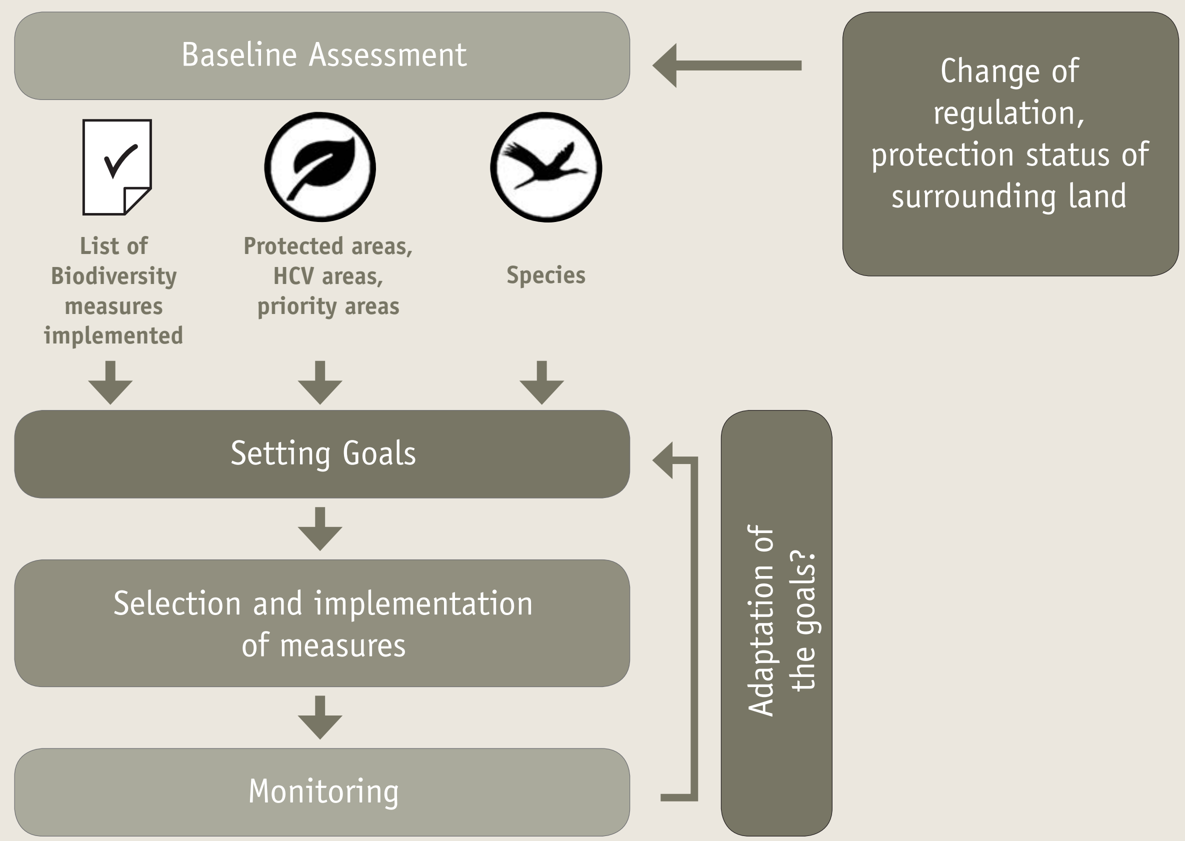
Some examples are:

- **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 (utilized agricultural area) is used to provide semi-natural habitats.
- **Establishment of Biotope corridors:** Specified areas for biodiversity on the farm will be connected with habitat corridors like 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 regeneration rate of grassland is respected in the 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

BIODIVERSITY ACTION PLAN AT FARM LEVEL



6. OVERVIEW OF THE EU LIFE PROJECT

Food producers and retailers are highly dependent on biodiversity and ecosystem services but 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, 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 of advisors and certifiers of standards as well as product and quality manager of companies

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

The project has been endorsed as "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:

We appreciate the support of our partner standards and companies:

IMPRINT

Author: Global Nature Fund

Editor: Global Nature Fund

Graphic Design: Didem Senturk, www.didemsenturk.de

Version: March 2018

Photo Credit: © Pixabay, www.pixabay.com
© Fotolia, www.fotolia.com
© Adobe Stock, www.stock.adobe.com

The project is supported by:

EU LIFE Programme
LIFE15 GIE/DE/000737

Deutsche
Bundesstiftung Umwelt
www.dbu.de

GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE

Fundación Biodiversidad 20 AÑOS

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'AGRICULTURE ET DE L'ALIMENTATION

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET SOLIDAIRE

Recognised as core initiative of:

10YFP Sustainable Food Systems PROGRAMME

FOOD & BIODIVERSITY

www.food-biodiversity.eu

Further information:
www.food-biodiversity.eu

We appreciate your feedback on this Biodiversity Fact Sheet:
www.business-biodiversity.eu/en/feedback