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

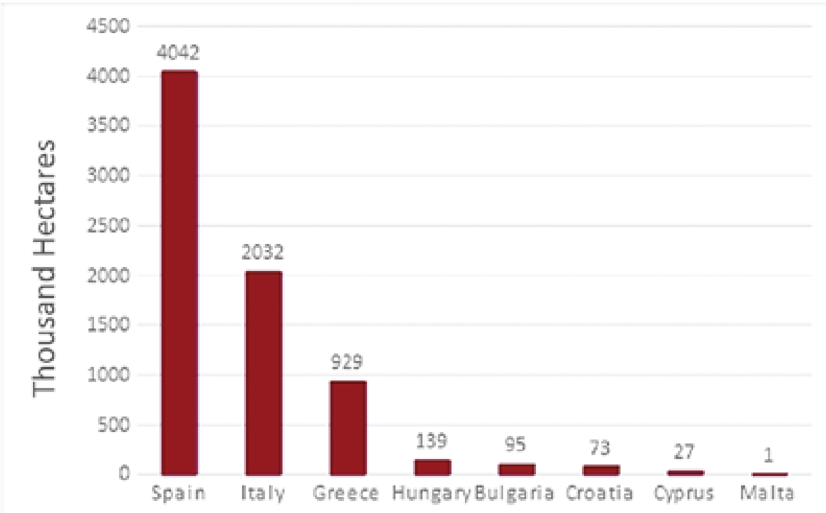
Permanent crops include a variety of different cultures. They are characterised by the fact that they are not included in crop rotation. Once planted, they remain on the land for at least five years and provide recurring yields.

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.

Long flowering period ecological infrastructure. © FGN

4.3

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

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.

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

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.

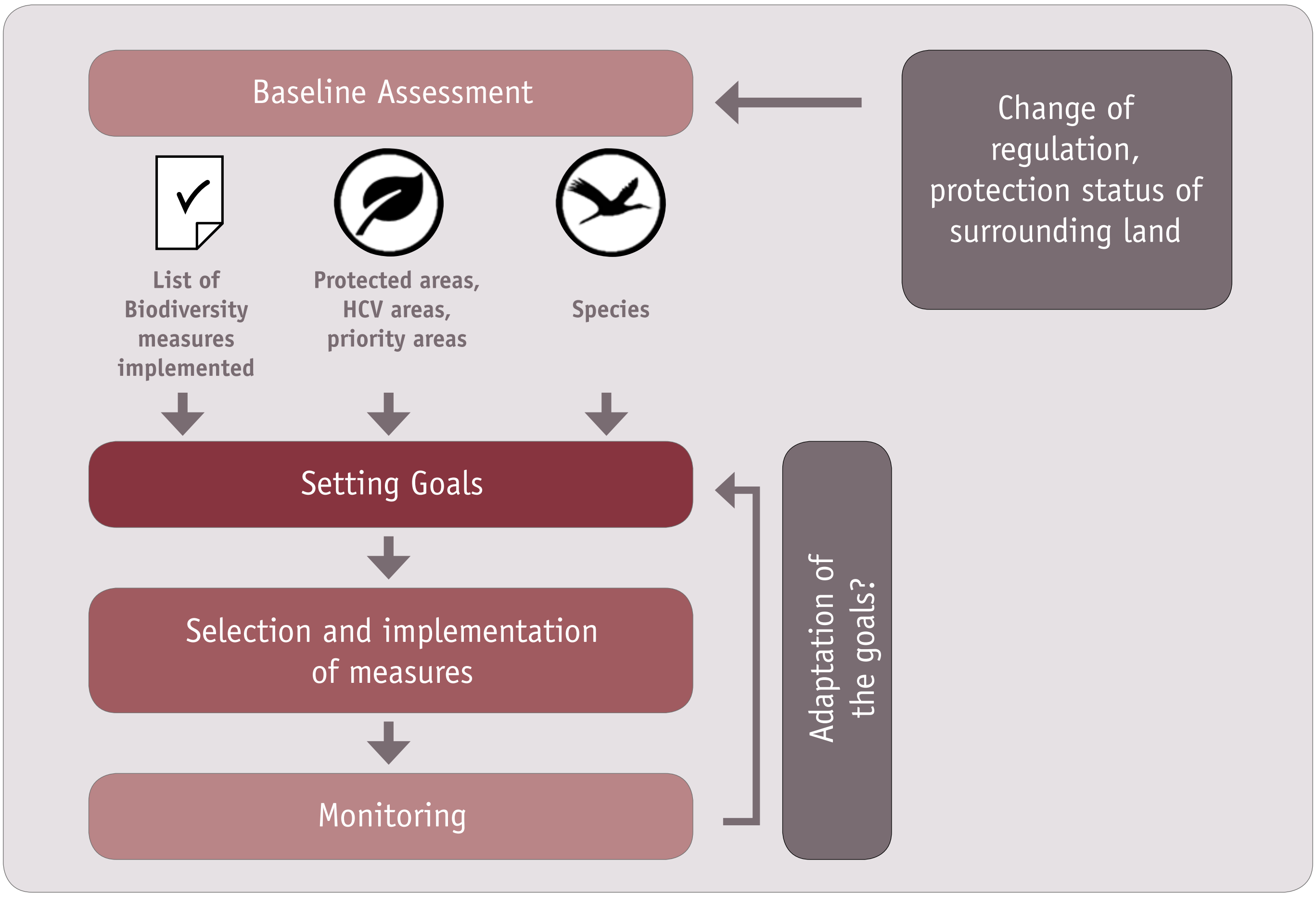
3. Selection, time line and implementation of measures for enhancing biodiversity

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:

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 Baden-Württemberg · Baden-Württemberg Ministerium für Ländlichen Raum und Verbraucherschutz

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