

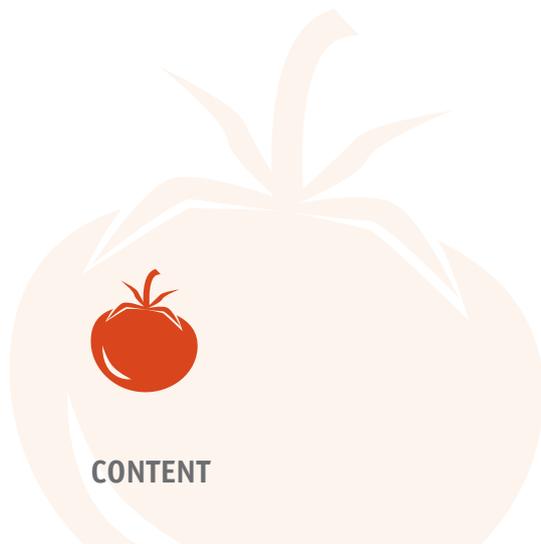
# BIODIVERSITY FACT SHEET



## Vegetable Production

Cultivation of Vegetables





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## 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.

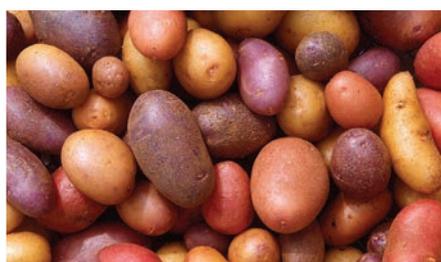


## 2. AGRICULTURE AND BIODIVERSITY

### 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 glo-

balized 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 Neolithic, 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 Europe 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 pro-

duction 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

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).



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### 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 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.



### 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 led 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



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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 hartsickle *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/m<sup>2</sup> 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 neonicotinoids. 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.



### 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.



#### 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.

4.4

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.

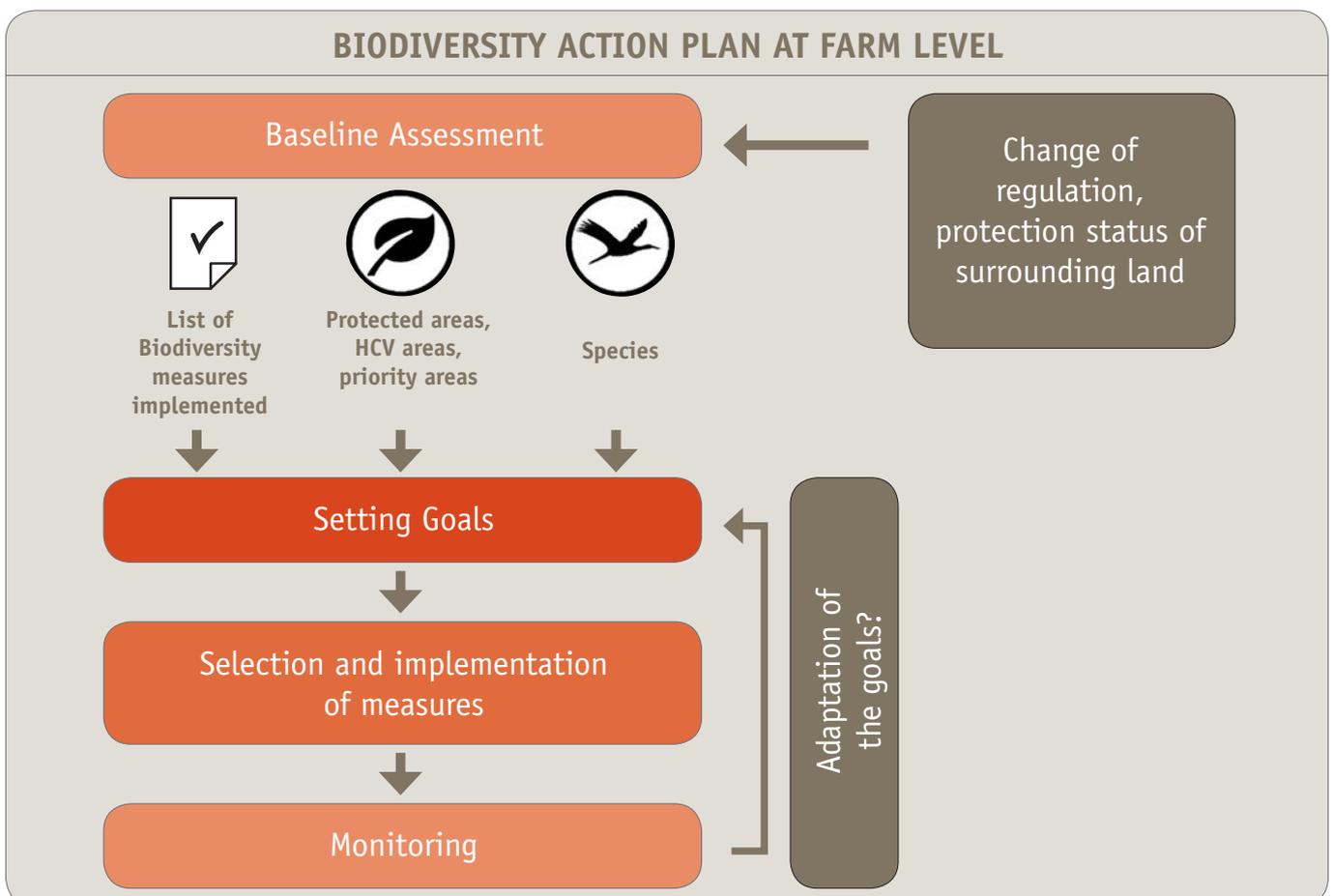
### 3. Selection, time line and implementation of measures for enhancing biodiversity

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](http://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:



We appreciate the support of our partner standards and companies:



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