BIOGEA

Testing BIOdiversity Gain of European Agriculture with CAP greening

HANDBOOK

Green and Blue Infrastructure (GBI)

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1. Aim of handbook

The handbook has been produced by the team of BIOGEA project implemented in the period of December 2016 till February 2020. It is designed to provide you with important information regarding Green and Blue Infrastructure (GBI), its elements adopted under the greening measures of the CAP 2014-2021, and their interpretation at national level (Bulgaria).

According to the Strategy for Green Infrastructure (GI) (European Commission 2013) GBI is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings.

The overview of GBI features and their potential benefits / shortcomings for biodiversity, ecosystem services and agronomic benefits are presented.

2. The BIOGEA project

The BIOGEA project researches the impact of land use change on GBI in the agricultural landscape through policy analysis on the EU, national and local level, and biological monitoring and modelling in six case study areas in 3 Member States (Germany, Spain and Bulgaria). It comprises analysis of the implementation of CAP greening at the local level and field monitoring of GBI features, vegetation and birds.

The case study areas cover a range of agricultural systems represented by paired sites (more extensive and intensive systems) in each of the three Member States.

3. GBI features

The definition of GBI and its features is presented in Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009

Individual landscape features

I. Isolated trees



Photo: Antonia Schraml

Individual trees within parks, pastures or cropland have been a feature of agricultural landscapes for millennia and may be present for agronomic reasons (e.g. providing shelter) though they are not directly used for production. The benefits they provide may depend on the age of the tree, its structure and size.

Benefits / shortcomings for biodiversity

A wide range of species including birds, mammals and arthropods, depend on trees, isolated (or otherwise) for a food resource, shelter and/or nesting site. Old remnant trees which include a basal hollow (which can be used for roosting bats, nesting birds and climbing mammals) are particularly valuable. Tree architecture is therefore of great importance for use by birds. For less mobile species such as insects and plants, the links with other habitats may be more important.

Ecosystem services

The ecosystem services provided by groups of trees and hedges is likely to be greater, but even individual trees can provide a buffer against soil acidity, increase soil fertility and increase filtration of water into the soil. This may be particularly valuable in dry habitats.

Agronomic benefits



Photo: Elena D. Concepcion

Trees can provide benefits such as shelter or shade for stock.

The transfer of water through the trees root system can also be important for drought avoidance. On the other hand, the immediate production potential of the area directly around the tree may be reduced and harvesting made more difficult.

II. Trees in groups/ copses



Photo: Maria Topchieva

Areas with groups of trees and / or woody shrubs and plants which are not used for agricultural production.

Benefits / shortcomings for biodiversity

Copses and shrubs are valuable for woodland birds, bats, arthropods and small mammals. On the other hand, they can provide a refuge for predators which can reduce the value of an area for wetland or grassland species. In general, they are more valuable if they are connected to other areas of habitat or to field boundaries.

Ecosystem services

Benefits include the reduction of wind-borne soil erosion and thus the amount and rate of soil runoff into watercourses. Overall water run-off may also be slowed thus contributing to flood prevention measures in susceptible areas.

Agronomic benefits

Benefits in terms of shelter, shade and moisture retention to individual trees. The productive area lost is however greater.

III. Ponds



Photo: Ina Aneva

Ponds can be permanent or seasonal small water bodies both natural and manmade. Natural pond systems provide a wide range of habitats including a range of depths and surface areas. Manmade ponds are unlikely to provide such a range of habitats but can still provide valuable ecosystem services.

Benefits / shortcomings for biodiversity

Ponds are important for a range of species such as amphibians, macroinvertebrates and macrophytes. In the Mediterranean region, temporary ponds, which dry up over the summer, are also a valuable habitat and are included as a specific habitat in the Habitats Directive.

Ecosystem services



Photo: Simeon Lukanov

Ponds can help to reduce run off and reduce erosion. They may act as a nutrient sink, absorbing phosphorus and nitrogen in more intensively farmed landscapes.

Agronomic benefits

Ponds can be of direct agronomic use for example for irrigation, livestock watering, erosion control and fire preparedness. They may also add to off-farm diversification activities such as tourism or aquaculture.

<u>In field features connected to productive agriculture</u>

IV. Permanent grasslands and pastures



Photo: Elena D. Concepcion

Grassland is land used to grow largely perennial grasses or other herbaceous forage (naturally or through cultivation).

Pastures are grassy or wooded areas, moorland or heathland generally used for grazing.

Permanent grasslands in Europe differ widely in their vegetation composition and in the farming systems linked to them. Some of the main types are:

- Silvopastoral (can be considered as agroforestry);
- Scrubs: high biomass, low nutritional quality
- Scrubs and herbaceous: medium-high biomass, medium nutritional quality;
- Natural herbaceous with heathlands: medium biomass;
- Natural and improved vegetation: medium biomass;
- Improved vegetation: high quantity and quality of nutritional biomass.

Benefits / shortcomings for biodiversity

A wide range of birds, invertebrates and mammal species use different types of grassland as their main habitats depending on the species present and intensity of management.

Biodiversity benefits are expected where grasslands are maintained over the longer term with limited inputs of fertilisers and plant protection products. Regular ploughing or reseeding will damage the biodiversity value of permanent grasslands, however, the overall impacts on vegetation and associated animal communities of restoring/creating grassland vary according to local circumstances (e.g. soil type, vegetation type and condition, stocking rate, climate, historical management and current management objectives) and the scale considered (from field to farm or region).

Ecosystem services

Land that is maintained as permanent grassland and not ploughed or reseeded, potentially has climate mitigation benefits through the maintenance of carbon stores in the soil.

Depending on the type of livestock production occurring on the land, it could however, result in net GHG emissions.

Grasslands may improve water regulation and filtration (reduce water surface flow and improve infiltration to the soil; provide increased water retention and storage of water during temporary floods; protect water quality by trapping sediments and assimilating nutrients) compared with cropped land.

Agronomic benefits

Dairy production is the most profitable way of grassland utilisation, followed by livestock meat production. There is likely to be a trade-off between the nutritional quality and quantity of the biomass produced for animals and the value of grasslands for biodiversity and ecosystem services. That said, some HNV grasslands have agronomic advantages. They often occur in areas with little other agronomic value and the quality of the final product (e.g. specialised cheeses and meats) is often high.

V. Agroforestry systems including traditional orchards



Photo: Simeon Lukanov

Land-use systems in which trees are grown in combination with agriculture on the same land with a maximum number of trees per hectare.

Benefits / shortcomings for biodiversity

Agroforestry systems provide habitat for a diverse range of wildlife and show high levels of plant, arthropod, earthworm and vertebrate diversity from plot to landscape scales.

Traditional orchards offer different ecological niches (in/on trees, on meadows) as habitat for several species, from tree-dependent or forest species to specialists of semi-open and open landscapes. A German case study found the potential for plant biodiversity being higher in mown orchards than in grazed or abandoned ones, but no effects on wasps or bees.

Ecosystem services

Agro-forestry systems can show additional carbon sequestration compared to agricultural land without trees. In comparison with crops, they show reduced input needs, reduced erosion and improved soil structure and fertility. They can potentially provide water quality protection because of the rooting system of trees

that captures nitrate in the ground and may protect against nitrate pollution in ground water.

A positive impact is expected on crop pest controlling. Agro-forestry can provide landscape and have recreational value compared with intensively cropped fields.

Agronomic benefits

Production diversification, with at least two products instead of one (fruits, timber, crops, livestock production especially) and a mix of trees and crops is expected to increase productivity. Studies suggest that ago-forestry can bring important economic benefit with the appropriate choice of species and management depending on the regional context. Production costs may be lower because of reduced input needs and may thus enhance profitability of the systems.

Traditional orchards require low inputs, low labour but also lower fruit production (10t/ha of apples) compared to more intensive practices (30-50t/ha). This can be to some extent compensated through grass production and a longer life cycle. Profitability has a potentially high dependence on processing and valorisation by farmers (direct market).

VI. Short rotation coppice (SRC)



Photo: Internet

Densely planted areas, with specific, fast growing tree species (e.g. willow or poplar) for production of wood harvested on a 2-5 years cycle usually for production of energy. Eight-metre wide rides along the crops as well as headlands at the end of each area are required for machinery access, which may be sown with grass.

Benefits / shortcomings for biodiversity

Dicks et al. captured no evidence for the effects of managing short-rotation coppice to benefit wildlife. SRC can however create additional landscape structure and habitat for wildlife and can be useful for connectivity when spatially combined with other landscape elements such as hedges, trees in line and in field trees.

A negative impact on biodiversity is to expect if planted on species-rich meadows or fallow land or open areas used as resting spaces for wildlife.

Ecosystem services

When planted on productive land, the following benefits can arise for ecosystem services:

- protection against erosion and improvement of soil organic matter content;

- protection of water quality because of reduced use of pesticides and fertilisers;
- reduction of emission of nitrous oxide and storage of carbon in soil and by accumulation of litter material.

Negative impacts can be expected on sites with a sensitive water balance (strong water demand of short-rotation coppice plantations).

Agronomic benefits

Production of wood; can be an economically beneficial option on low-yield sites; the work load is high when agricultural production work load is low so that it may well fit in the farming system from a timing point of view.

Some positive impacts on erosion protection of the soils in near fields can be expected. The measure requires multi-year commitment so only likely to be viable where a long-term market locally is secured.

VII. Catch-crops or green cover



Photo: Simeon Lukanov

Mixture of productive crops and/or grass planted on a temporary basis following a productive crop to protect soils and use available nutrients during the autumn winter.

Benefits / shortcomings for biodiversity

Generally low effects on biodiversity compared to other Ecologically Focused Areas (EFA). Provide food and refuge for wildlife compared to bare land; provide food for insects if it comes to flower in late summer – however limited use for insects at that period of the year.

Negative impacts of catch-crops for insects or small mammals e.g. when sowed directly after the harvest of the main crop (lack of resources such as pollen) and because of soil ploughing in preparation of the catch crop.

Catch-crops stay in place for a relatively short time and do not allow insects and other wildlife to find habitat for reproduction.



Photo: Simeon Lukanov

Ecosystem services

Contribute to protection of soil against erosion and improvement of soil structure and soil organic matter content.

Reduce nutrient leakages and potential for reduced pesticides use if green cover is maintained (because of reduction of weed growth).

Agronomic benefits

Interesting for farming systems with small areas, good water resources and rotation of appropriate crops (main crop and catch- crop have to be combined appropriately) brings benefits in form of agronomic production on the area. Limit soil erosion and improve soil conditions but can induce pest/diseases.

VIII. Nitrogen fixing crops



Photo: Simeon Lukanov

Productive leguminous plants, including e.g. lupin (*Lupinus*), clover (*Trifolium*), alfalfa (*Medicago*) or beans like *Vicia faba*. These contain symbiotic bacteria *Rhizobia,* within the nodules of their root systems, producing nitrogen compounds that help the plant to grow and compete with other plants. The nitrogen is released to the soil after the plant dies, thus acting as a fertiliser.

Benefits / shortcomings for biodiversity

The relevance of legume crops for protecting biodiversity is low in comparison to other GBI features such as field margins or buffer strips and are not considered as generally having a high biodiversity value. Impacts depend on the flowering habits of different legume plants, some of which are favourable for pollinating insects and therefore contribute to the maintenance of wild and domestic bees. There may also be benefits to soil fauna diversity and diversity of small mammals, birds and insects

Ecosystem services

Impacts on ecosystem services are limited when compared with the impacts of other GBI features such as landscape elements in

field or on small scale (hedges, isolated trees, field margins, etc.). Improved water infiltration, reducing or increasing effect on nitrate leaching depending on management of crop residues and use of other crops after the nitrogen-fixing crop as well as depending on location of the n- fixing crop. Reduction in CO2 emissions and increased soil carbon sequestration compared with other crops. Improvement of soil structure, soil organic matter content and nitrogen fertilization of the soil.



Photo: Elena D. Concepcion

Agronomic benefits

High protein grain for food and feed.

Lower crop yield of protein crop (compared with cereals) but increased yields of subsequent non-legume crops (depending on crop combination and farming system) because of the expected reduction in pest and diseases and the improvement of soil properties such as fertilization of the soil as well as organic matter content and structure.

The combination of nitrogen-fixing crops with other crops within a farming system has to be considered (e.g. take into account pre-crop and break-crop effects of legumes).

IX. Land lying fallow



Land without any crop production or grazing for at least 6 months, maintained for production in the following years.

Photo: Simeon Lukanov

Benefits / shortcomings for biodiversity

Higher densities of farmland birds have been observed in case studies of fallow land for providing nest and food opportunities for birds, insects and small mammals as well as small game. Potential for natural regeneration of wild plants, as well as potential to improve connectivity of semi-natural and natural landscape elements. Bare land has little biodiversity value.

Ecosystem services

Soil protection, especially in land lying fallow for several years.

Protection of water quality because of no use of pesticides and fertilisers. Storage of nutrients especially in land lying fallow for several years, due to the continuous green cover.

Agronomic benefits



Photo: Elena D. Concepcion

Can be used by farmers as a component of crop diversification and built into a rotation.

Can reduce pests and crop disease outbreaks.

Productive area is reduced if land is lying fallow, but the costs are also reduced (especially for land lying fallow with natural grass regeneration/growth).

Connective features

X. Grassy strips – buffer strips, field margins, strips along forest edges



Photo: Ina Aneva

Often in the form of margins between a field and a boundary structure such as water body, hedge, fence, road or wood. Can be left to regenerate naturally, or sown, typically with a grass-rich or floristically enhanced seed mixture. Can therefore contain a variety of plant communities in a variety of structures.

Benefits / shortcomings for biodiversity

Relatively undisturbed habitat for farmland species. Wider range of plants, birds, mammals and insects than cropped areas. This is generally due to a higher plant species richness due to less intensive management. Foraging space for breeding and wintering birds providing a range of plant and invertebrate food sources. Can also promote connectivity between areas of semi-natural landscapes and provide corridors for small species such as butterflies and moths.

Ecosystem services

Can help control sediment, phosphorus, nitrogen and pesticide losses to surface waters. In particular, useful for controlling runoff from farmed fields and removing nitrogen in the proximity of watercourse. Small potential to sequester carbon compared with a cropped field.

Agronomic benefits

Can reduce the area available for production and present a weed risk. Margins are however often located on less productive land at the edges of other features. Margins can also act as a source for pollinators and both invertebrate pests but also natural pest controllers (biological control).

XI. Woody strips and hedges



Photo: Simeon Lukanov

Hedgerows or woody strips can be made up of a range of woody species. Their impacts on biodiversity and ecosystem services depend on their age and structure, the species and diversity of different species of which they are made up, their placement (e.g. whether they are connected to other wildlife areas) and their management. In general they are cut every two years outside the bird breeding season and are not sprayed with plant protection products.

Benefits / shortcomings for biodiversity

Pollinators, bumblebees and butterflies prefer to follow features such as hedgerows rather than cross open land. Insects, birds and bats benefit from a dense shrubby layer within a hedge as well as individual trees. A hedgerow composed of many tree species is likely to benefit a wider range of animal species.

Flowering plants within hedgerows have significant benefits for pollinators.

Ecosystem services



Photo: Simeon Lukanov

Overall more likely to provide ecosystem services compared with no hedge in an agricultural landscape. May reduce soil erosion and nitrogen runoff.

Hedges take up nitrogen and then release it to the soil again when the leaves fall. They also have the potential to sequester carbon to a slightly larger extent than grassy strips without woody vegetation.

Agronomic benefits

May reduce crop production near the edge of the hedge. Protect crops or animals against wind and its effects and mitigate excess heat. In windy areas, the overall effect on crop production is judged to be beneficial.

XII. Walls, ditches, terraces



Photo: Elena D. Concepcion

Common in areas where rocky outcrops are a feature.

Sometimes have an earth bank at the bottom. Older walls which have been left to develop lichens without too much interference are likely to provide greatest benefits. In Southern Europe, terraces are more common and again benefits are likely to be linked to age and condition. Ditches are artificial features.

Benefits / shortcomings for biodiversity

Walls and terraces may provide a niche habitat for certain plant species and where left over longer time periods, for insects and foraging farmland birds.

Ditches can provide some benefits of aquatic biodiversity in an otherwise intensively farmed landscape depending on the extent to which pesticides and herbicides are used nearby. All are linear features which can provide corridors for smaller invertebrates in an otherwise open landscape.

Ecosystem services



Photo: Elena D. Concepcion

Walls and terraces can potentially provide some sediment control though this depends on their management and the amount of vegetation surrounding them.

Depending on how they are located, ditches can increase run-off. They can also potentially increase release of carbon from pasture if this leads to a drying out of carbon rich soils.

Agronomic benefits

Walls, terraces and ditches have clear agronomic purposes though they may not always fit with modern farming practice.

As with hedges, they have the potential to provide shelter from wind and sun. Ditches are used to drain productive land though if they are frequently cleared, this is likely to reduce their potential environmental benefits.

Semi-natural elements

XIII. Wetlands



Photo: Internet

Wetlands can vary in their nature and hydrological make up. They include mires, bogs and fens. Since by their nature they are saturated by water either permanently or seasonally, they are entirely dependent on the surrounding hydrological regime and will be rapidly impacted by changes in management affecting water flow. Depending on their nature, they may be rainfall fed or linked to the surround river network.

Benefits / shortcomings for biodiversity

A wide range of protected species are highly dependent on wetlands including wetland birds such as the Eurasian curlew *Numenius arquata* and the bittern *Botaurus stellaris* or amphibians such as the European fire-bellied toad *Bombina bombina*. Most wetland species are declining though there have been some reversals thanks to targeted conservation actions funded to a large extent by the LIFE programme.

Ecosystem services

Wetlands can help stem water flows and absorb eroded materials and nutrients. Depending on their management, they can also potentially regulate how water is released downstream, mitigating

flood events. Wetlands such as bogs can also provide important climate regulation services. Again, depending on management, they can be either a significant source or a significant sink for greenhouse gases. In general, they are more likely to be a sink if they maintain their water levels and vegetative layers.

Agronomic benefits



Photo: Simeon Lukanov

Wetlands generally do not have a direct agronomic use though wet meadows are traditionally used for livestock grazing. The advantages they provide in terms of water storage may also have the benefit for the farmer that they protect more valuable cropland from flooding.

However, farmers may also prefer other water management techniques such as straightening rivers to maximise the most productive areas.

Converted wetlands can provide highly productive land for farming though this use conflicts with the provision of other ecosystem services.

XIV. Environmentally sensitive grassland



Photo: Simeon Lukanov

Environmentally sensitive grasslands are natural and seminatural (extensively managed) grasslands as opposed to other types of grassland which can be reseeded and ploughed. Grasslands are widely distributed in the EU, although natural grasslands only exist naturally above the treeline in mountain areas or at high latitudes; in other areas, grasslands are semi- natural and without human activity would transition into woodland.

Benefits / shortcomings for biodiversity

Permanent grasslands are of particular value for supporting biodiversity. A wide range of grasslands are included as protected habitats under the Habitats directive. Mediterranean grasslands for instance are a global biodiversity hotspot. Extensively managed grasslands can contain a wide range of plants and insect species and consequently a rich feeding sources for many birds and mammals.

Ecosystem services

Grasslands and pastures maintained over the long term, have a high potential for carbon sequestration, but with a large uncertainty. Below-ground organic materials of permanent soil cover (e.g. roots, soil invertebrates, etc.) represent an important carbon pool. Long term grassland and pasture can also help to regulate water flows and reduce erosion.

Agronomic benefits



Photo: Simeon Lukanov

Grasslands are mainly used for livestock production with potential for some limited biomass production. There are some evidences that environmentally sensitive grasslands grasslands can improve the flavour of agricultural products such as dairy products or meat. However, protein levels are lower and consequently such grasslands cannot maintain a high hedge of livestock.

XV. Heathland and shrub



Photo: Simeon Lukanov

This ecosystem type covers heathland, shrub and tundra (vegetation dominated by shrubs or dwarf shrubs), including moors and sclerophyllous vegetation including both coastal and inland types. They are mostly secondary ecosystems which rely on continued human management. In the case that they are natural ecosystems, they generally exist under unfavourable natural conditions which prevent tree growth (wet, cold or high latitude).

Benefits / shortcomings for biodiversity

Shrubs and heathland are important for a wide range of species. Nearly 143 species listed in the Habitats Directive are linked to heath and shrub ecosystems including reptiles, mammals and birds.

Shrubland is also often the first stage of natural succession after farming is abandoned. In these cases, species reliant on open land can be lost as shrubs return.

Ecosystem services

Shrublands can provide some benefits for the water environment in particular preventing runoff and erosion. They can also absorb carbon.

Heathlands and shrubs may sometimes present a fire risk.

Agronomic benefits

Shrubland and heathland have coexisted with farming activities for millennia and particular species of shrub and heath can provide valuable traditional fodder for livestock.

Other activities connected with those habitats include collection of fruit and use of woody material or reeds. As with hedges, shrubland can also provide habitat both for agricultural pests and for natural pest removers.

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BIOGEA project partners*:*

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