In collaboration with

POLICY BRIEF

Green infrastructure within agricultural landscapes strengthens the supply of ecosystem services

Main findings

- **Agricultural landscapes in Europe are becoming increasingly simplified**, due to agriculture intensification that entails farming only few crops/plants and the expansion of mass-flowering crops used for biofuel production. Landscape homogenization, notably loss of semi-natural habitats, leads to biodiversity loss, which in turn can have negative impacts on ecosystem services.
- **Increasing landscape diversity through green infrastructure (GI) can improve the supply of ecosystem services** by restoring biodiversity.
- In particular, **pollination and biological pest control services are greatly enhanced** by the integration of natural and semi-natural habitat patches within agricultural landscapes, as well as by high edge density and small field size.
- **Current EU and national agricultural policies do not effectively support GI implementation in Member States,** as farmers consider implementation costs to outweigh potential – and often unknown – benefits.

Key policy recommendations

- Set **quantitative and qualitative targets for agricultural landscape heterogeneity** (e.g. integration of hedgerows, forest patches, ponds, grassland patches), particularly in landscapes with a high cover of mass-flowering crops.
- **Increase awareness of evidence for GIs' long-term benefits to ecosystem services,** and develop exchanges around best practice. Involve farmers in the design of **locally adapted GI conservation and development policies.**
- **Fund agricultural practices' adaptation to GI directly**, through direct payments, under CAP Pillar I, and relevant research under the EU Framework Programmes. Conversely, consider phasing out area-based payments, which deter farmers from maintaining GI, to replace them with payments for public goods (including GI).
- Make GI restoration and enhancement a **key feature of the future CAP greening measures**, in particular in voluntary eco-schemes under CAP Pillar I and in agri-environment-climate payments under CAP Pillar II.

Context

Agricultural production relies on ecological processes, including key functions depending on field edges and other semi-natural habitats (SNH). Biodiversity underpins these functions. In many agricultural systems, these functions have been degraded, leading to the loss of ecosystem services such as biological pest control and pollination. This is partly due to the over-application of agrochemicals and strong reduction of landscape heterogeneity.

For instance, Mass-Flowering Crops (MFCs) are crops that provide abundant floral resources during their short simultaneous bloom period, such as oilseed rape and sunflowers. They require intensive management practices (e.g. application of agrochemicals), and their cropping area is currently expanding in Europe. This is partially driven by the increasing demand for biofuels and the related rise in subsidies (Holzschuch and co-workers 2016).

Green Infrastructures (GI) are networks of multifunctional natural and semi-natural areas – along with other environmental features – designed or preserved and managed to support ecosystem service delivery and biodiversity conservation. In agricultural landscapes, GI have a key role to play in biological pest control and pollination services. The EU GI strategy is part of the wider EU 2020 Biodiversity Strategy, which aims to halt the loss of biodiversity and ecosystems in the EU. In particular, the GI Strategy contributes to the EU's efforts to restore biodiversity in agricultural landscapes.

Biological pest control reduces the need for agrochemical inputs and thus represents an important ecosystem service. It also fosters natural food webs and enhances biodiversity. Similarly, pollination services are essential to maintain or even enhance current crop yields. The presence of GI increases landscape heterogeneity, which improves pollination and biological pest control services by maintaining biological diversity.

The EU Common Agricultural Policy (CAP) 2014-2020 introduced three greening measures supporting the uptake of GI within agricultural landscapes: the maintenance of permanent grasslands, crop diversification and the establishment of ecological focus areas such as hedgerows or field margins (Schmidt & Hauck 2017). Implementation of these measures is however hindered by insufficient knowledge of GI benefits, as well as costs incurred by farmers to develop GI, which are found to be higher than EU financial incentives. Costs of GI development and conservation include loss of productive land, maintenance requirements, and obstruction of optimal workflows, for example due to modern machinery often being built for large fields.

Ongoing negotiations for the post 2020-CAP provide a good opportunity to better integrate GI and to ensure proper implementation of relevant conservation and restoration measures.

This brief considers how the results of BiodivERsA-funded projects – and one BiodivERsA/FACCE-JPI-funded project – are helping to build up the scientific evidence base that supports the conservation of, planning for and adoption of GI, with a view to enhancing ecosystem services such as pollination and biological pest control in European agricultural landscapes. It uses results from the research projects EC21C, FarmLand, ECODEAL, APPEAL, SmallForest, and CONNECT. Results from one European Commission-funded piece of research were also considered (STEP). This brief complements an earlier BiodivERsA brief on how EU agriculture policy can strengthen biodiversity and ecosystem services by diversifying agricultural landscapes.

Key results

Landscape spatial heterogeneity increases biological pest control effects

Existing research indicates that biological control of pests by natural enemies is higher in landscapes that integrate GI elements such as grasslands, woodlands or water bodies. Jonsson and co-workers (2014) developed a model to map biological control of aphids across cereal fields in different Swedish agricultural landscapes with varying complexity. The model, validated with independent data, predicted the biological control effect to be highest in landscapes with a high proportion of non-crop land and with a high proportion of grasslands. Kalda and co-workers (2015), assessing diversity and activity of bats in southern Estonia, also found insectivorous bat activity to be higher in agricultural landscapes containing woodland patches and water bodies, compared with homogeneous landscapes.

Field size and the presence of field boundaries also significantly affect biological pest control. Bosem Baillod and co-workers (2017) found that landscapes composed of small fields with high amounts of grassy field boundaries can help reduce cereal aphid densities. Maintenance of small-sized farms, which on average have smaller fields, was called for by the authors. Similarly, Martin and co-workers (2019) found through a synthesis of European studies that in landscapes with high edge density, 44% of natural enemy species reached highest abundances and pest control improved 1.4-fold.

Integration of Green Infrastructure within Mass-Flowering Crops optimises pollination services

Mass-Flowering Crops (MFCs) are increasingly cultivated in Europe (Holzschuh and co-workers 2016). They include oilseed rape, sunflower and orange. Mass-flowering events result in significant temporary attraction of pollinators to MFCs during their short – but highly productive – flowering period (Riedinger and co-workers 2015).

Holzschuh and co-workers (2016) found that an increase in MFC cover at the landscape scale reduces local pollinator density (bumblebees, solitary bees, managed honeybees and hoverflies) during the year of the increase. Previous studies have found that a decrease in pollinator density leads to a decrease in yield quantity and quality and should therefore be avoided. This decrease is due to a dilution effect: as pollinators are disproportionately attracted to MFCs, they will scatter through the landscape to follow an MFC cover increase, rather than clustering within a small MFC field. Findings suggest that to counter this effect, the expansion of MFC cover needs to be accompanied by pollinator-supporting practices, such as a matching increase in GI across the landscape.

Similar results were obtained by Riedinger and co-workers (2015), who concluded that although positive effects of oilseed rape on non-bumblebee bees occur, they cannot currently compensate for negative dilution effects. This is because bee populations are limited e.g. by nesting sites, which could be promoted by GI.

Holzschuh and co-workers (2016) and Magrach and co-workers (2017) found that MFCs attract pollinators away from adjacent semi-natural habitats and grasslands. To avoid the disturbance of plant-pollinator networks in neighbouring habitats, a balance must be reached between MFC cover and the surrounding GI (Magrach and co-workers 2017). This was also found by Riedinger and co-workers (2014), who advised that optimal management practices to maximise pollinator density should include mixing MFCs with different phenologies (e.g. early oilseed rape and late sunflower) and semi-natural habitats providing more constant resources.

Green Infrastructure can enhance pollinators' visitation probability

Improving GI can support an increase in pollination services across European agricultural landscapes. Pollinator model-based mapping by Schulp and co-workers (2014) showed that the presence of green linear elements such as hedgerows and tree lines increased pollinator visitation probability in agricultural areas in large parts of the EU. Presence of SNH also significantly increased probability of pollinator visitation. Additionally, Martin and co-workers (2019) found that throughout Europe, landscapes with high edge density increase pollinators' abundance and improve pollination.

Schulp and co-workers (2014) created a map of areas where enhancing green infrastructure could improve the supply of pollination services by wild bees (see Figure 1). The method combines crop areas requiring pollination for optimal production (demand) with both bee habitat and the visitation probability of a bee from the wild habitat into the crop. The map shows the hotspots of pollinator demand across the EU, and shows in black the areas which do not have enough pollinators for optimal crop yields.

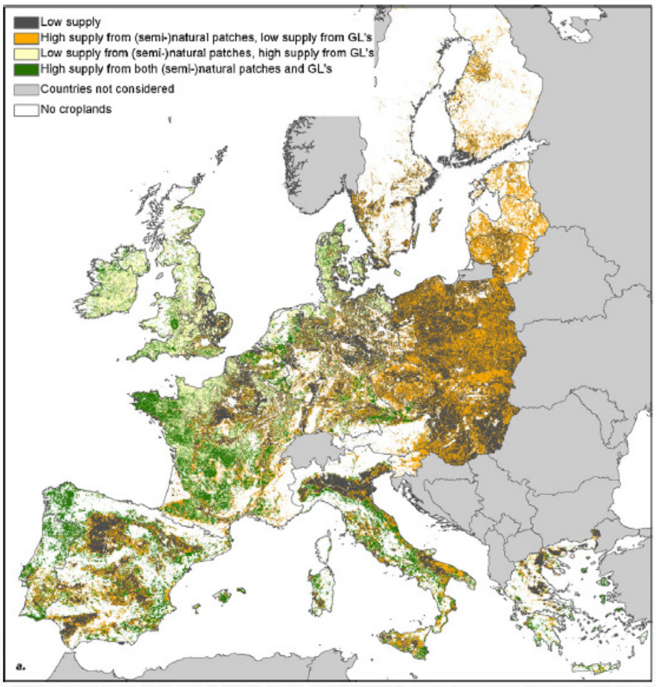

Figure 1 – from Schulp and co-workers (2014).

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Current EU and national agricultural policies do not efficiently support GI implementation

In a study aimed at identifying key stakeholders in agricultural biodiversity governance in Germany, Hauck and co-workers (2016) found through multiple interviews that farmers were considered as the most important actors. However, the study also found that farmers' decisions were strongly influenced by landowners, who forbid changes in land use or preferred to keep the landscape 'tidy', both of which hinder GI development. CAP direct payments were also strongly influential in farmers' decisions regarding GI implementation.

In another case study in Germany, Schmidt and Hauck (2017) found that current EU incentives (e.g. greening measures) to develop GI were outweighed by implementation costs. In particular, using land for GI means losing productive area and thus income. GI also requires maintenance, increasing farmers' working hours. Further, modern machinery is not adapted to small, diverse fields. Overall, farmers' lack of knowledge on the long-term benefits of GI, coupled with the lack of reliability and flexibility of EU GI policies – often too rigid to be practically feasible – result in low GI implementation locally.

Policy recommendations

Scientific evidence from the BiodivERsA- and BiodivERsA/FACCE-JPI funded projects shows that Green Infrastructure (GI) can contribute to the EU 7th Environment Action programme's objective of protecting, conserving and enhancing the Union's natural capital, by strengthening ecosystem services such as pollination and biological pest control. EU agricultural policy should thus be improved to strengthen the implementation of the EU GI Strategy. Specifically, the 2020 CAP reform represents a good opportunity to make GI integration a priority in agricultural landscape management, notably through the new eco-schemes[1]. CAP greening measures should be reviewed to more effectively support GI maintenance and restoration.

Several actions can be considered:

- **Set policy targets for landscape heterogeneity** (e.g. integration of hedgerows, forest patches, ponds, grassland patches, division of landscape into small fields) in support of pest control and pollination services. Financial support should help to cover costs of GI implementation (e.g. loss of productive area), potentially under CAP Pillar I direct payments, and reward landscape-scale cooperation for habitat quality and connectivity.
- **Highlight GI development as a key agricultural practice beneficial to the environment** under the proposed CAP Pillar I eco-schemes to encourage adoption by Member States. GI implementation should also be included in agri-environment-climate commitments under Pillar II.
- **Improve communication on GI to raise awareness of its benefits,** both to farmers and to local communities. This is essential to ensure GI implementation, especially in the context of the voluntary eco-schemes proposed for the new CAP. This could be done under the Farm Advisory Services (FAS) scheme, provided it is extended to all CAP intervention types. Local knowledge should also be used to build locally-adapted GI implementation options.
- **Direct part of the EU research budget for innovation in agriculture** (e.g. agricultural European Innovation Partnership, EIP-AGRI) **towards adaptation of current farming practices to promote uptake and maintenance of GI** (e.g. machinery).
- **Phase out harmful subsidies that are a disincentive to GI development** (e.g. direct payments based on land area). Consider replacing them with payments based on support to public goods e.g. GI and biodiversity.

[1] Payment schemes for care of the environment and climate resilience, which will be funded from Member States' direct payment budgets under CAP Pillar I. They will have to be made available by Member States, but farmers can choose to participate or not.

Links to sources

EC21C project website
FarmLand project website
ECODEAL project website
APPEAL project website
SmallForest project website
CONNECT project website
STEP project website

Scientific publications used in this policy brief can be found in the Information Sheet of this briefing, downloadable from: www.biodiversa.org/policybriefs

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About this policy brief

This Policy Brief is part of a series aiming to inform policy-makers on the key results of 5 BiodivERsA-funded projects, and one BiodivERsA/FACCE JPI--funded project, and provide recommendations to policy-makers based on research results. One EC funded project was also considered.

The series of BiodivERsA Policy Briefs can be found at www.biodiversa.org/policybriefs.

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The key research results presented here were validated by researchers from the EC21C, FarmLand, ECODEAL, APPEAL, SmallForest and CONNECT research projects.

The policy recommendations made do not necessarily reflect the views of all BiodivERsA partners.

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