SHOWCASE

Farming with Biodiversity

The SHOWCASE project

showcase.eu Follow SHOWCASE project on

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No862480.

Table of contents

CHAPTER 1

Biodiversity and why it matters

What is biodiversity?

Biodiversity on farmland is the rich variety of all living things within a farm's ecosystem **and the intricate ways they interact**. It extends beyond primary crops and livestock to encompass:

- **Genetic diversity:** The variation within a single crop or animal species, which can improve resilience to pests or disease.
- **Species diversity:** The full spectrum of different plants and animals present, including the variety of different crops grown and the different breeds or types of livestock raised. It also covers other wildlife like birds, mammals, and insects (both beneficial pollinators and pest controllers), down to the microscopic life in the soil, such as fungi and bacteria.
- **Ecosystem diversity:** The range of habitats on and around farms, including fields, hedges, woodlands and ponds, and how these different areas connect and function.

Consider it the **biological infrastructure** of a farm. A healthy and diverse biological community can support and strengthen a farm's natural processes, contributing to better soil health, water quality, **natural pest control**, and efficient pollination. Ultimately, robust biodiversity can enhance the **resilience and long-term productivity** of a farm system.

A declining resource

Farmland biodiversity is **quickly declining** throughout Europe, a trend that is **undermining the essential ecosystem services** that are vital for future food production. For example, reduced pollination can impact the yield of some crops, and fewer natural predators may result in pest numbers running out of control. Less diverse soil organisms can diminish soil health, making farms more vulnerable to extreme weather and increasing the need for external inputs. This means that declining biodiversity fundamentally impacts the **long-term sustainability and profitability of farming**.

Navigating the realities of nature-friendly farming

Whilst the benefits are clear, adopting nature-friendly practices is not always straightforward. The **real-world constraints and complexities** of farming can include:

- **Economic pressures:** Concerns about potential impacts on immediate yields and profits, especially if land needs to be taken out of direct production, or if new practices require upfront investment in time and energy.

- **Practicalities of management:** The need for new skills, knowledge, equipment, or increased labour to manage diverse habitats or different cropping systems.

- **Market demands:** Meeting specific buyer requirements that might not always align with diverse farming approaches. For example, retailers demanding uniform produce size and appearance which might favour monocultures over diverse varieties, or pressure to use specific conventional inputs to meet supply chain standards.

- **Changing Policies:** New or reworked policies often demand changes in farm management, and therefore, make it difficult for long-term planning and investments.

- **Wildlife challenges:** Dealing with problems created by certain wildlife. For example, deer grazing on newly planted crops, birds consuming ripening fruit, or weed growth competing with crops.

- **Social factors:** Operating within community norms or the influence of neighbouring farm practices.

- **Existing farm infrastructure and landscape:** Working with the current layout and conditions of farmland, such as slopes and soil quality.

To help reduce, or even avoid these potential barriers, it is important to make biodiversity management an integral part of farming while maintaining agricultural productivity or farm income. Nature-friendly farming is about finding **practical, beneficial ways to integrate nature that work for each specific farm**, while navigating practical real-world challenges.

Opportunities

New pathways to new income and greater resilience

Despite these challenges, nature-friendly farming can open up new opportunities and build long-term resilience on the farm. Farming **less intensively*** can support biodiversity, and can also open up new ways to earn. Even though it is clear that biodiversity management changes are associated with financial and non-financial costs, maintaining hedgerows or creating flower strips, might align with organic standards, qualify for agri-environmental subsidies or help sell into premium markets that value sustainable farming.

* The opposite of intensive farming is sometimes referred to as 'extensive farming'. For clarity of language, we refer to this as 'less intensive'.

Broader benefits

Why biodiversity matters to everyone

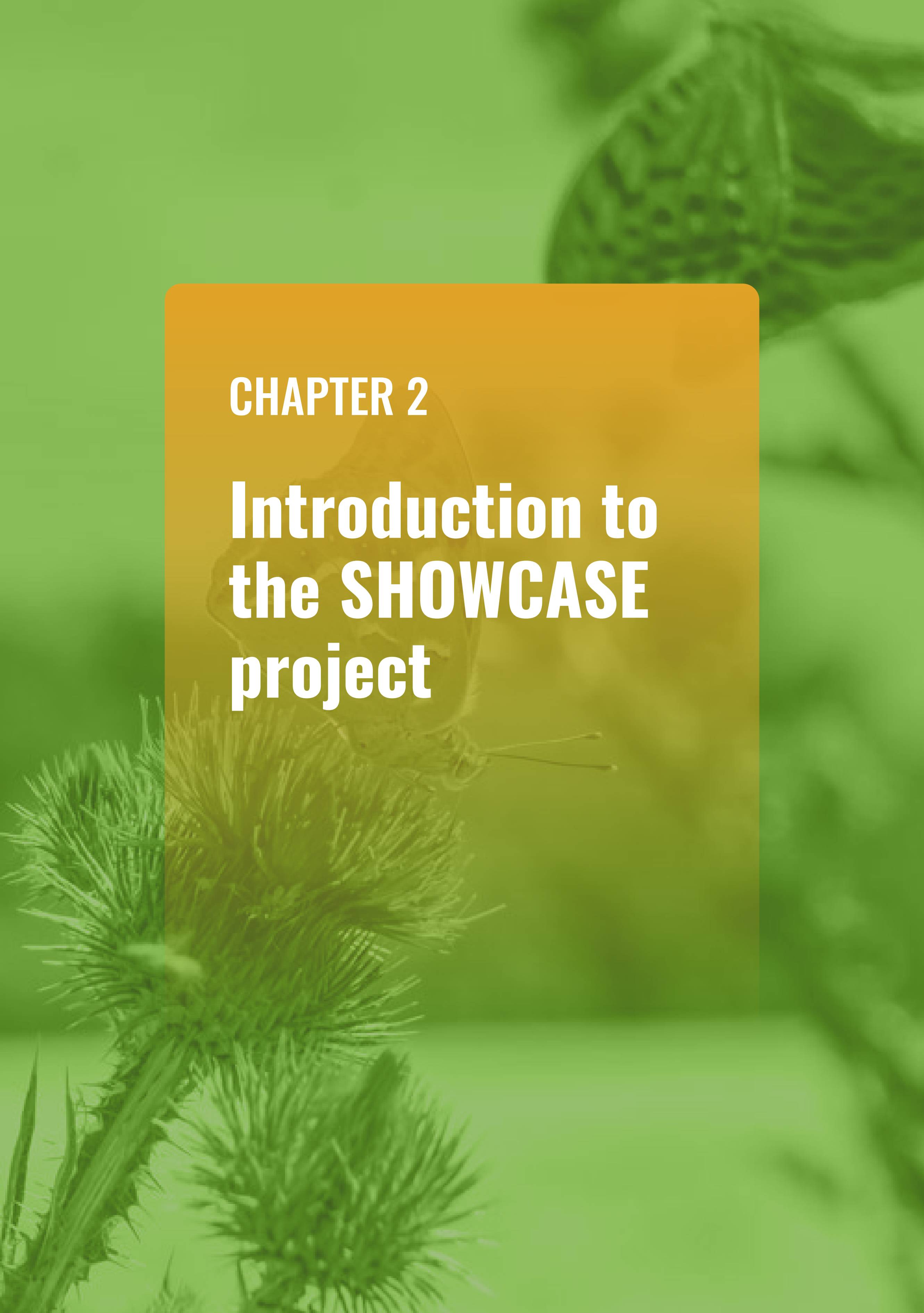
The benefits of biodiversity reach far beyond the farm gate. A biodiverse agricultural landscape can help keep food production steady and less dependent on synthetic inputs. Practices like planting cover crops, looking after hedgerows and creating flower strips directly improve the soil's health and fertility. This makes the farm better able to handle climate change impacts, like droughts or floods. Healthy soils and plants can capture and store carbon, and landscapes with a mixture of habitats for wildlife can better tolerate the effects of extreme weather. A biodiverse system is therefore a more stable system, more resilient to diseases, pest outbreaks and the pressures of a changing climate. **This stability is a direct result of diverse habitats and species,** which create redundancy and a web of interactions that **prevents a single disease or pest from wiping out the entire system,** a key weakness of a simplified monoculture.

The cultural benefits of biodiversity

Biodiversity also has cultural and social benefits, as many traditional farming landscapes are shaped by diverse crops, animals and practices to form part of Europe's rich rural heritage. Rural landscapes can carry historical and aesthetic value, bringing people together in rural areas and offering the opportunity to learn and relax. Spending time in nature helps to improve well-being, foster environmental awareness, and strengthen the connection between rural and urban communities.

Supporting the shift to nature-friendly farming

To successfully integrate biodiversity into farming, **practical support, clear examples, and informative research are needed**. The SHOWCASE project has contributed to all of these to help inform and drive effective approaches that work on the ground.



CHAPTER 2

Introduction to the SHOWCASE project

What is the SHOWCASE project?

The **SHOWCASE project** focuses on **integrating biodiversity into everyday farming** to understand its practical value. It explores how payments, advice and policy measures can support on-farm biodiversity, and tests ways to implement biodiversity-friendly farming.

The main approach was to set up a network of farmers, advisors, local people and researchers at 11 'Experimental Biodiversity Areas' (EBAs, **Figure 1**) across 10 European countries (sometimes building on existing national projects or initiatives focused on farmland biodiversity). The goal was to build local groups, called communities of practice, where people could work together to test and improve new ideas for boosting biodiversity whilst strengthening farm productivity.

Research on real farms with commercial farmers

SHOWCASE conducted research on a wide range of farms, from grasslands to orchards. These ranged from intensive (using high inputs like fertilisers, pesticides and machinery for as high yield as possible) to less intensive (**Table 1**, **Figure 1**).

Table 1: The countries and systems covered by SHOWCASE.

Farming System	Description	Country Examples
Intensive arable cropping	Areas dominated by large-scale cereal and crop production.	Switzerland, United Kingdom
Arable farming with livestock, grassland or woodland	Mainly arable farming with some integration of grazing land or small woodland areas.	France, Sweden, Hungary
Intensive mixed farming	Areas with both intensive arable cropping and intensive livestock production.	Netherlands
Predominantly grassland with some arable cropping	Grassland-based systems that also include some arable crop production.	Hungary
Extensive grassland systems	Low-input grassland farming focused more on pasture and hay meadows than on crop production.	Estonia, Romania
Permanent tree crops	Landscapes dominated by orchards or olive groves.	Portugal, Spain

Figure 1: Map of the Experimental Biodiversity Areas (EBAs) of the SHOWCASE project. EBAs are located across many different types of farmland and farm types found in Europe.

Learning and sharing across regions

In each area, representatives of a mixture of groups (farmers, researchers, extension workers, local people, advisors, and others) have come together to identify and prioritise the main local or regional issues affecting both biodiversity and farm productivity to design and test biodiversity-friendly practices that fit their local conditions. The EBAs also serve as hubs for sharing local and national knowledge, and some act as demonstration farms.

Summary of different trial treatments

We tested different trial treatments (**Table 2**, **Figure 2**) and measured the effect on biodiversity, and in some cases, farm productivity.

Table 2: The trial treatments across countries. Each trial ran in 2022 and 2023 except for in the Netherlands and Estonia which started a year prior. More details are available in the full case studies.[1] Planting a secondary plant with the crop to improve soil health and control weeds.

Trial treatment	Crop	Country
Sowing wildflower strips between rows of trees	Stone fruit	Spain
	Olives	Portugal
Growing cover crops (no cover crops, frost-hardy cover crops, frost-sensitive cover crops)	Intensive arable crops (wheat, barley, oats)	United Kingdom
Reducing management intensity (fertiliser application/number of cuts) of grasslands, introducing thicket hedges or growing lupin)	Mixed arable and livestock	Netherlands
Reducing management intensity (using fewer synthetic fertilisers and pesticides, planting flower borders next to crops, under-sowing[1] and/or choosing locally adapted crop varieties)	Intensive arable crops (wheat, oilseed rape, barley),	Switzerland
Reducing management intensity using **less pesticide** and synthetic nitrogen on conventional farms. **Reducing soil work** on organic farms by avoiding deep ploughing, using mechanical weeding and reducing tillage	Cereals such as wheat (conventional and organic)	France
Planting flower borders next to crops	Arable crops (wheat, sunflower, corn, barley)	Hungary
Overseeding fallow land with native flowers	Grasslands	
Removing shrubs to maintain grasslands (compared to high density non-managed areas of shrubs)	Grasslands (grazing and hay meadows, mown once annually)	Romania
Grazing coastal grasslands instead of abandoning	Grasslands	Estonia

[1]Planting a secondary plant with the crop to improve soil health and control weeds

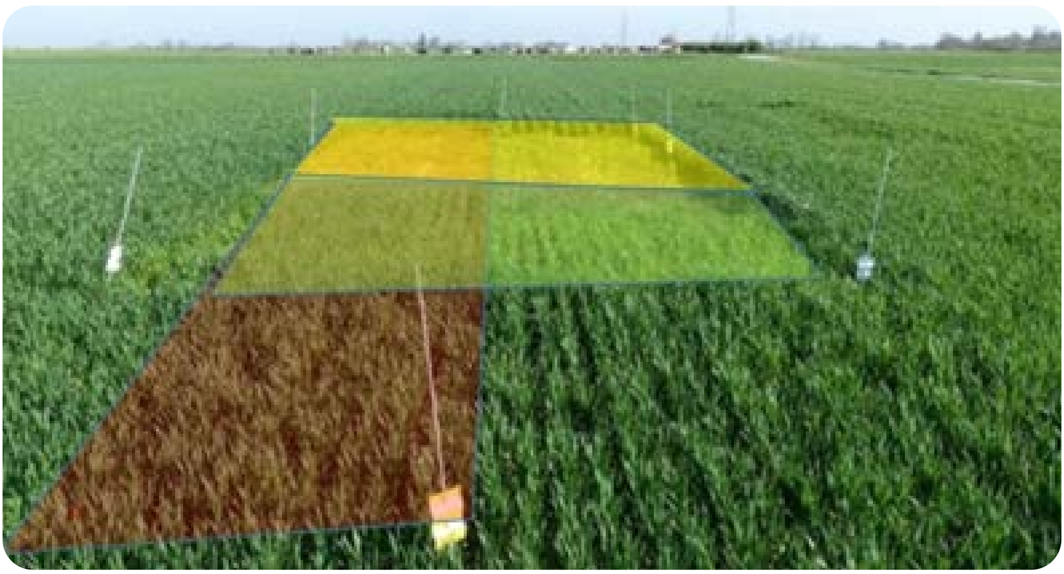
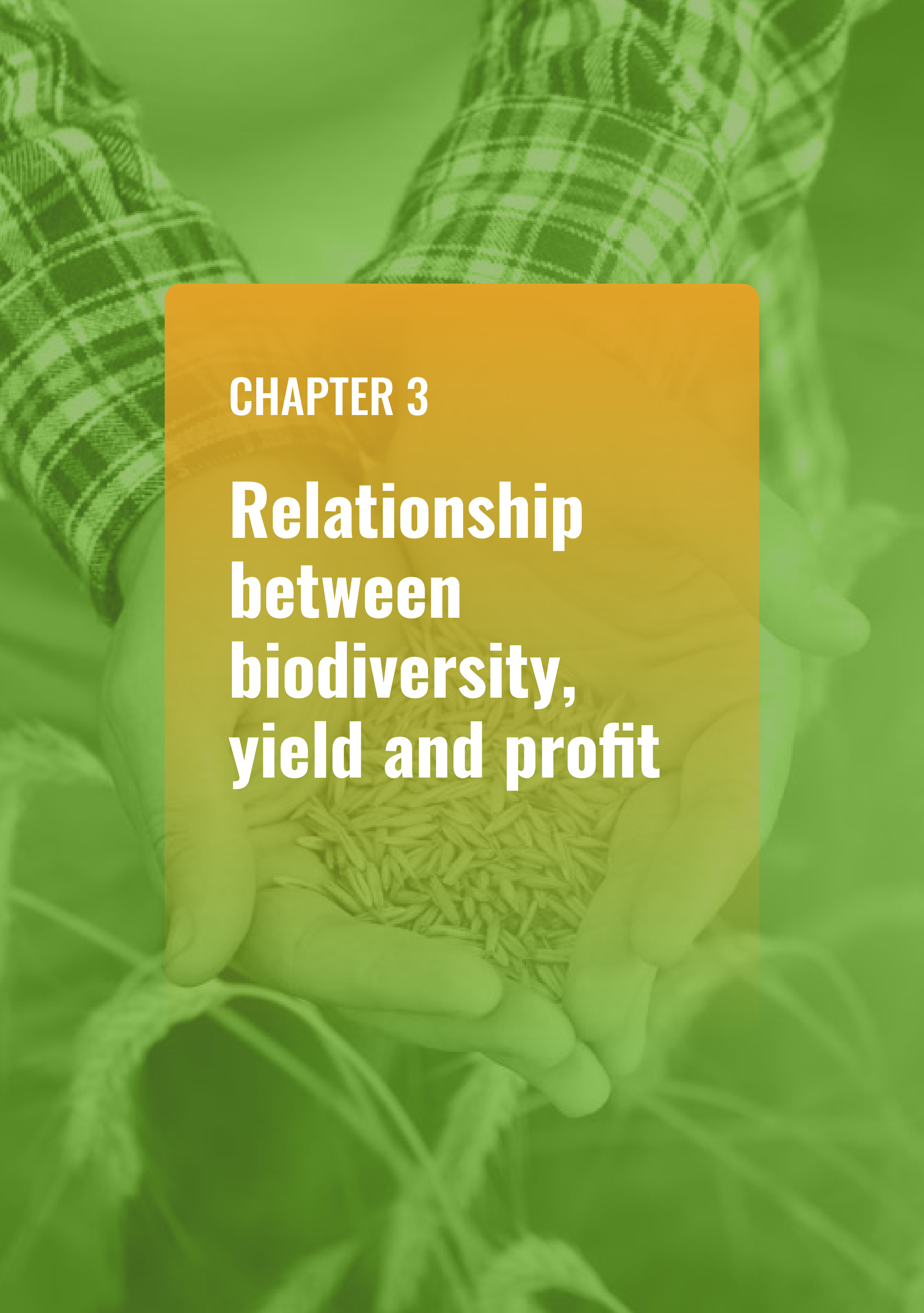


Figure 2: Two examples of trial fields. Above, olive orchards in Portugal with flower strips sown between tree rows compared to unsown. Photos by José Herrera. Below, examples of plots in a two-factorial design within a wheat field. All plots on the left received reduced nitrogen (red), plots on the right received reduced herbicide (green). The upper plots were left unsown (yellow) to estimate weed diversity and abundance from the seed bank. Photo by Zone Atelier Plaine and Val de Sevre.



CHAPTER 3

Relationship between biodiversity, yield and profit

The effects of nature-friendly management practices on biodiversity, yield and profit varied depending upon the specific context (**Table 3**). In all cases at least one component of biodiversity was enhanced, whereas yield remained stable or decreased, and in all but one case there was expected to be a net financial cost to the intervention.

To measure biodiversity, we recorded the number of species of bees, spiders. Earthworms promote soil health, bees are key pollinators and spiders are important for pest control, all of which can increase crop yield and farm profits. We also recorded the diversity of plant species.

Table 3: The biodiversity, yield and economic effects of each trial where yield was estimated. Arrows show direction of change. Solid arrows indicate that this factor was directly assessed; outlined arrows indicate impacts were not directly measured. For the UK, Portugal, and Spain, economic impact was assumed to be negative overall due to the cost of implementing the practice. For Switzerland, it was also assumed to be negative, given both reduced yield and implementation costs.

Country	Trial treatment	Biodiversity benefits	Impact on yield	Economic impact
Spain	Sowing wildflower strips between orchard trees	Higher numbers and diversity of plants, pollinators, and spiders	No change	Not incurred but not quantified
Portugal	Sowing wildflower strips between orchard trees	Higher diversity and biomass of plants, and higher diversity and abundance of bees, spiders and plants	Not measured	Not incurred but not quantified
United Kingdom	Planting cover crops	More plant cover, spiders and earthworms More spider diversity	No change	Not measured
Netherlands	Reduced fertiliser and cuts (grassland)	Exponential increase in plant and invertebrate diversity	Proportional reductions in yield	Lower management costs did not compensate for lower income
	Crop rotation with lupins	More lupin-visiting bumblebees in surrounding landscape after bloom	Not measured	Not measured
Switzerland	75% pesticide reduction	Higher diversity of bees and spiders (mainly at field edges).	Lower across crops	Not measured
France	Reduced pesticide and nitrogen (wheat)	Higher spider numbers and diversity	Slight (non-significant) decrease	Higher profits (Figure 3) Conventional Organic

What biodiversity benefits did we find?

- **Spain**: Flower strips led to 10 times more pollinators and double the number of spider species, while also having 100 times more flowers than control areas.

- **Portugal**: Flower strips led to higher diversity and biomass of plants, and higher richness and abundance of bees, spiders and plants in both study years.

- **United Kingdom**: Planting cover crops doubled plant cover and doubled or tripled plant biomass in the plots relative to the controls. Spider numbers increased by 40% and the diversity of spider families by 25%. The number of earthworm numbers also increased by 40% and their biomass by 50%, not just during cover cropping, but also during the following crop.

- **Netherlands**: Reducing management intensity of grasslands led to an exponential increase in plant and invertebrate diversity. Growing lupins as part of the crop rotation increased lupin-visiting bumblebee numbers in the surrounding landscape after flowering by approximately 75%.

- **Switzerland**: Positive effects on spider and bee diversity were largely confined to the diverse plant communities in field borders, highlighting the importance of placing trials where they can most benefit adjacent crops (e.g., bees for pollination and spiders for pest control).

- **France**: Wheat fields using less pesticide and nitrogen had 20% more spiders, both in numbers and species, compared to controls. The same increase was observed in organic fields that had less soil work.

How farming with biodiversity affected yield

Farming with biodiversity had different effects on yield in different countries, but most farmers saw little or no loss in production.

- **Spain**: Flower strips between trees did not affect orchard fruit yield.
- **United Kingdom**: Cover cropping did not make a difference to cereal yields after one year (though benefits may accrue over time).
- **Netherlands**: Reducing grassland management intensity led to approximately proportional reductions in yield. Yield was not measured for the lupin crop rotation since it was often ploughed in, not harvested.
- **Switzerland**: Where pesticide use was reduced by 75%, yields fell by 11% in barley, 8% in wheat, and 18% in oilseed rape.
- **France**: Where pesticides and nitrogen were reduced on average by 50%, wheat yield was slightly lower in the trial fields compared to the control fields (down 4% on conventional farms and down 8% on organic farms), but this difference was not statistically significant (**Figure 3**).

Overall, yield losses only occurred where input reductions were high.

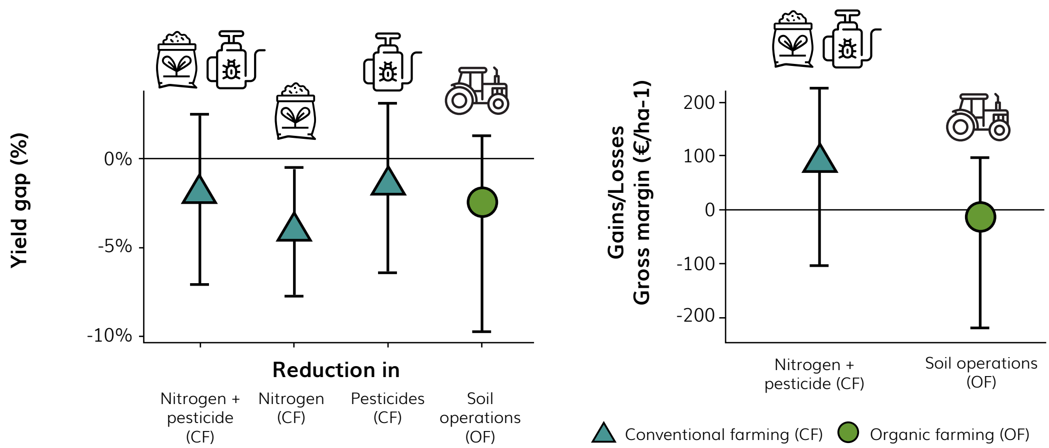


Figure 3: Changes in yield (left) and profit (right) between trial farms (using less nitrogen, pesticide and soil work) and control farms (business as usual) in conventional (blue) and organic (green) wheat fields (2022 and 2023) in France. Yields dropped less than 5% on average, but in conventional farms, profits went up by around €95/ha, due to lower input costs. The vertical bars represent the spread around the average (standard deviation).

How farming with biodiversity affected economics

- **France**: Conventional farms that reduced pesticides and nitrogen increased profits by €95/ha on average (up to €252 in 2022), thanks to lower input costs. In organic farms, reducing mechanical weeding or tillage had no effect on profit as costs were already low.

- **Spain, United Kingdom and Switzerland**: These trials did not show a yield gap (see above), but the cost of the trial was not directly measured so the net financial impact was unknown but expected to be negative.

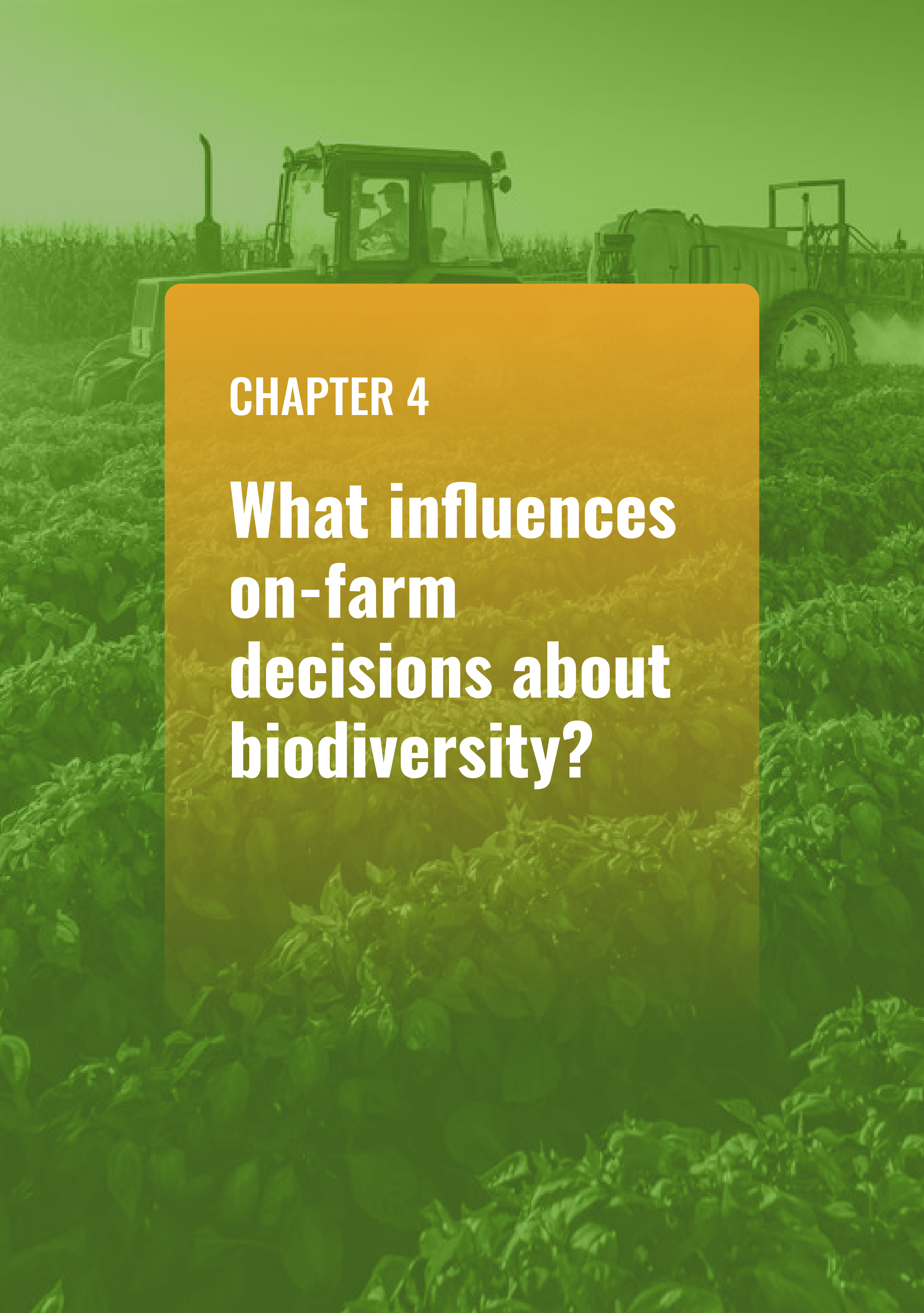
- **Netherlands**: Managing grasslands less intensively reduced costs for farmers but reduced income even more due to lower yield.

Summary

Overall, **nature-friendly farming boosted biodiversity in all countries**. Where yield was measured, **most trials showed little or no yield loss**, unless input reductions were extremely high (e.g., Switzerland). Where yield was not measured, gains were unlikely, as costs were incurred without production improvements.

Only in France did a trial improve both farm biodiversity and income, despite a small yield drop in both organic and conventional systems. **Whether a trial improved farm income depended on the cost of implementing it**. For example, the additional cost of a cover crop (e.g. UK) or seed mixes for margins or inter-rows (e.g., Portugal, Spain, Switzerland) decreased net profit margin, whereas using less pesticide (e.g., France) increased net profit margin due to the effect of savings. Some practices, like managing grasslands less intensively in the Netherlands, had reduced income due to reduced yields (through reduced fertiliser and mowing). **A detailed cost benefit analysis can help inform a farmer on the net cost or saving of a given wildlife-friendly practice**.

Despite the potential short-term costs of implementing nature-friendly practices, in the longer-term **increased biodiversity can contribute to greater resilience**, helping farmers to **cope better** with problems like extreme weather, pests or climate change. If the costs of external inputs (like fertilisers and pesticides) increase in the future, nature-friendly practices could become more profitable overall as they often rely less on these costly external inputs. The effects of interventions on both biodiversity and productivity also depend on the amount of natural areas in the surrounding landscape. Many benefits of biodiverse farmland can take time to appear, so it is important to evaluate the longer-term effects of nature-friendly farming.



CHAPTER 4

What influences on-farm decisions about biodiversity?

Policy support

A wide range of policy tools can help support biodiversity in farming. In the EU, two main policies set the foundation: the EU Nature Directives and the **Common Agricultural Policy (CAP)**, which influences around 84% of EU farmland. Despite this, much of the CAP's potential to support biodiversity remains untapped. However, the latest CAP includes new features called **Eco-schemes** (payment schemes in agriculture aiming to protect the environment and climate). Of the 45 proposed practices, 20 focus directly on biodiversity, especially through:

- **Agroecology** (nature-friendly farming focusing on natural processes)
- **Agroforestry** (combining trees with other crops or livestock)
- **High-nature-value farming** (low-input farming with rich habitats for wildlife)

Some of our EBAs were not in the EU, and their equivalent policies include **England's Environmental Management Scheme** and **Switzerland's Biodiversity Promoting Areas and Ecological Compensation Areas**.

Getting paid for nature-friendly farming

For farmers and agribusiness, the adoption of biodiversity-friendly practices, reducing productivity or reducing the production area, are often considered a threat that reduces the "room for manoeuvre", agricultural competitiveness, or economic viability of the farms. SHOWCASE shows that **farmers experience both financial and non-financial costs when implementing biodiversity measures**. For example, farmers can be impacted by:

- Feelings that government rules or support might change unexpectedly, making it feel risky for to invest time and money in new, long-term practices.
- Unproductiveness
- Lack of support
- Administrative burden
- Underpayment
- Social non-conformity

SHOWCASE found that **compensation payments provided by policy schemes supporting biodiversity friendly farming practices were extremely important for farmers**, as these payments impact the farm economic outcomes. When these programs end, farmers face an immediate negative impact on their income, which in turn makes it difficult to maintain the biodiversity measures. Farmers need carefully designed, stable and adequate policy schemes providing Payments for Environmental Services (PES) to compensate or reward them for biodiversity management. In the current policy landscape, such payments target three main areas:

1. Making intensive farms more biodiversity-friendly
2. Preserving less-intensive systems at risk of abandonment or intensification
3. Maintaining or restoring habitats for biodiversity

Results-based approaches are increasingly gaining attention, meaning that farmers get paid for actual improvements in biodiversity, and not just implementing a practice. **These may make policies more effective but can be challenging in practice, particularly as climate change affects when and where which species may be active**.

Game changers for farmer decision-making

Whether a farmer takes part in measures and programs depends not only on the incentive payments, but also on their values, farm setup, the broader community and landscape context. SHOWCASE asked 700 farmers across Europe what makes them more likely to take part in programs and make biodiversity-friendly decisions. The four main reasons were:

1. **Supportive food chains**: Farmers are more likely to adopt biodiversity measures when they are part of supportive food systems. For instance, local "food hubs" can reconnect farmers and consumers, spread awareness about biodiversity-friendly products, and help develop markets that reward nature-friendly farming.

2. **Connecting habitats across farms**: Many farmers care about biodiversity beyond their fields. But connecting habitats requires funding, not just for implementation, but also ongoing maintenance. Providing connection bonuses for linking up habitats can increase the number of farmers taking part, and increase biodiversity effectiveness of measures through habitat connection.

3. **Access to trusted advice**: Independent advisors can play a crucial role in helping farmers understand and implement biodiversity measures. Knowledge gaps, especially around how actions lead to real biodiversity outcomes, remain a key barrier. Strengthening advisory services and farmer-to-farmer learning can improve uptake and effectiveness.

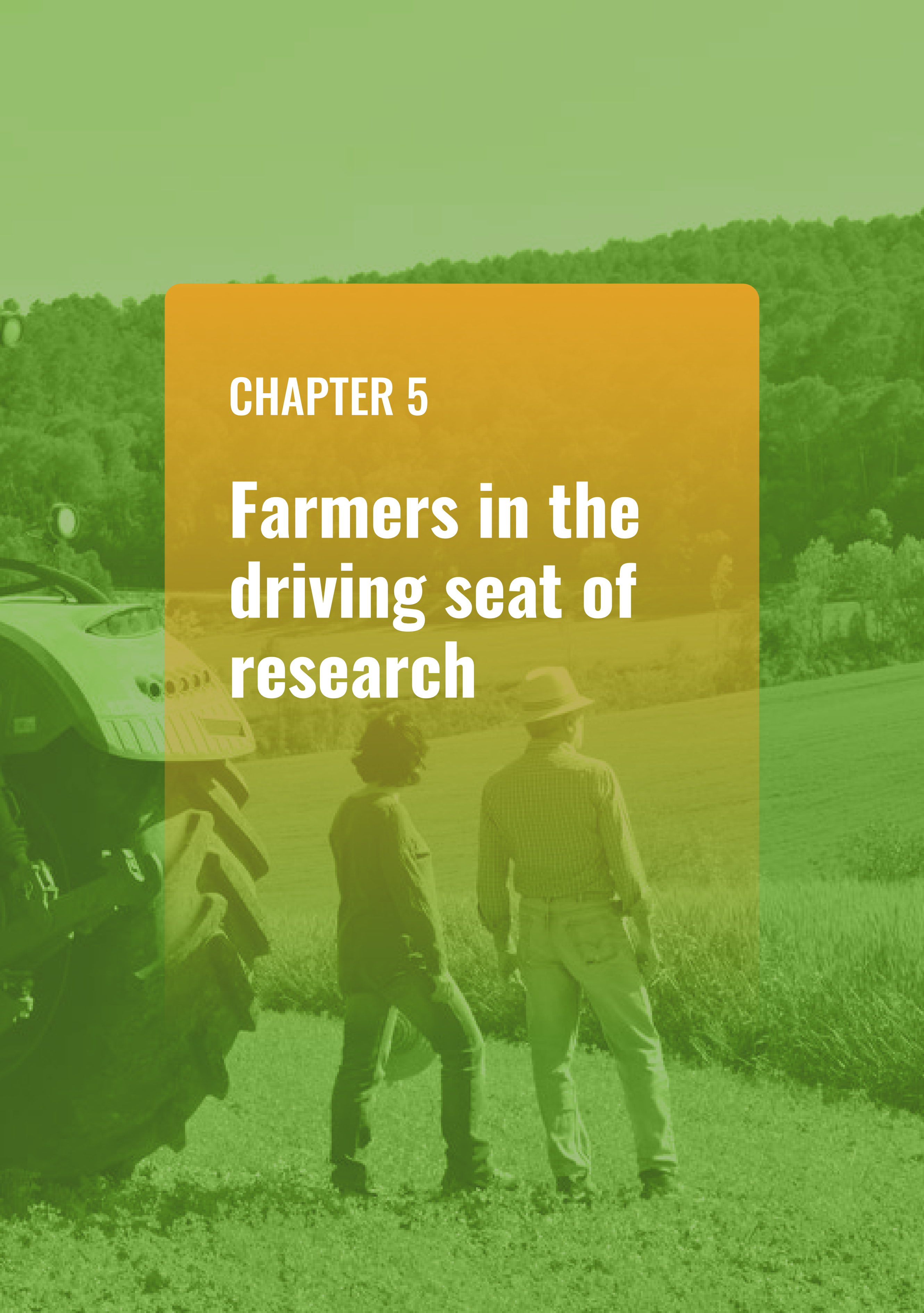
4. **Biodiversity labels and business models**: Most farmers are not motivated by biodiversity labels alone, but many are interested in business models that make sense and use clear biodiversity performance indicators. Labels should show clear results, and the EU organic label could be updated or extended to better reflect biodiversity efforts more clearly.

Challenges: trade-offs and skills gaps

Whilst SHOWCASE results from 10 countries show that biodiversity can provide real services, like better pollination and soil fertility. **Farmers still faced trade-offs**, such as higher costs, complexity, as well as risk and uncertainty. These trade-offs often put off farmers from making long-term changes. Farmers who value biodiversity for its **intrinsic worth**, not just for its benefits, are more likely to stick with biodiversity practices long-term. Still, many thought that they lacked the skills and know-how to monitor biodiversity or adapt practices effectively, and more support is needed.

What needs to change?

To improve adoption of biodiversity measures, **incentives must be better tailored to the recipient**. This means covering real costs, and ideally being competitive with commercial farming, reducing administrative burden, and **offering flexible, locally adapted schemes**. Collective and result-based approaches can improve cost-effectiveness and acceptance, especially at landscape scale. Education and skills training, alongside clear indicators and monitoring systems, are essential to empower farmers and strengthen biodiversity's role in future farming systems.



CHAPTER 5

Farmers in the driving seat of research

How involved can farmers be?

Scientists work with farmers in different ways when doing on-farm research. The level of farmer involvement can shape the research and affect farmers' experiences. Here we explore the different levels of involvement farmers can have in designing experiments on farms:

- **Farmer-led**: At one end, there are experiments that are led by farmers, where the farmers choose the research questions, methods, and what the results should focus on. The researchers simply help to run the project and offer advice on how to do a good scientific experiment.

- **Researcher-led**: At the other end of the scale, there are experiments that are led by researchers. In this case, the scientists decide what is tested and how, and to help with this, the farmers are usually asked to provide access to their land and information about their farm.

- **Co-designed**: In-between are experiments that are co-designed, with farmers and researchers (and sometimes others) working together to choose the questions, methods, where the experiments would be best placed and what the results will focus on (**Figure 4**).

What are the pros and cons?

Each of these options has its own pros and cons:

- **Farmer-led projects** often test new farming ideas that are practical and easy to use on real farms.

- **Researcher-led projects** often test practices backed by science, whilst also pushing the boundaries with new methods and tools.

- **Co-designed projects** can be time-intensive and therefore expensive if there is lots of discussion between everyone involved, but they allow for shared learning and can build strong and lasting partnerships and push science and farming practice both in new directions by combining two different knowledge bases.

Figure 4: Discussions between scientists and farmers to co-design on-farm research (photos by Alice Mauchline).

Making it work for farmers

For farmers, it is very important to have their voice heard in shaping farming research, and this can be a challenge for farmer-led or co-designed experiments. Because of this, it can be best to use different approaches at different times. The best option for a farmer may depend on:

- What the farmer wants to achieve
- How much time the farmer has
- What resources are available
- Their existing network of farmers and partners

What we found

In the SHOWCASE project, we ran a range of experiments, from researcher-led to farmer-led, and each gave farmers a different experience. But why hear it from us? Hear directly from the farmers below (**Figure 5**).

When we designed these projects together with farmers, we developed shared principles to get the best results and avoid problems. For example, it helps a lot to work with someone farmers already trust, like a local farming advisor or a farmer group. They can help build good relationships for research that lasts a long time. But it can be hard to find a fair and reliable advisor because these services are different in every area and country.

Another way to join in

Another way of getting involved in research on farms is through **citizen science**. Read the case study from Sweden (p. 81) to learn more.

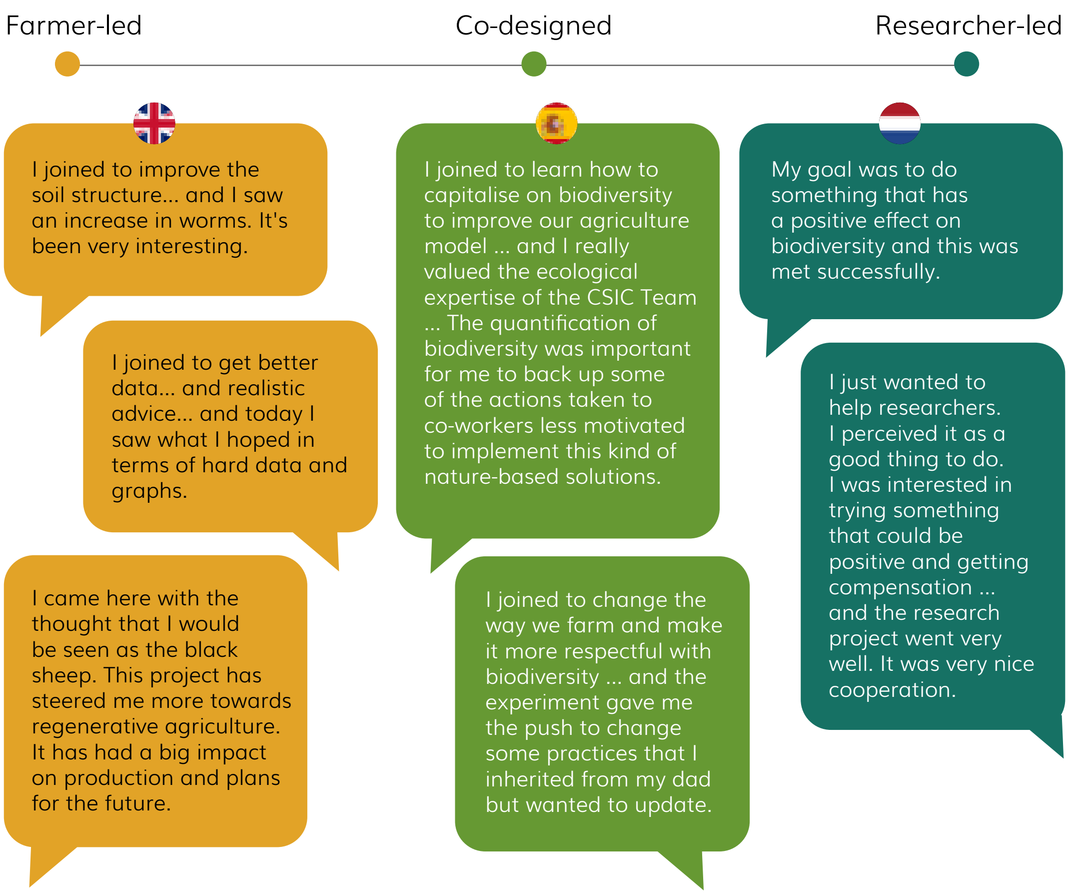
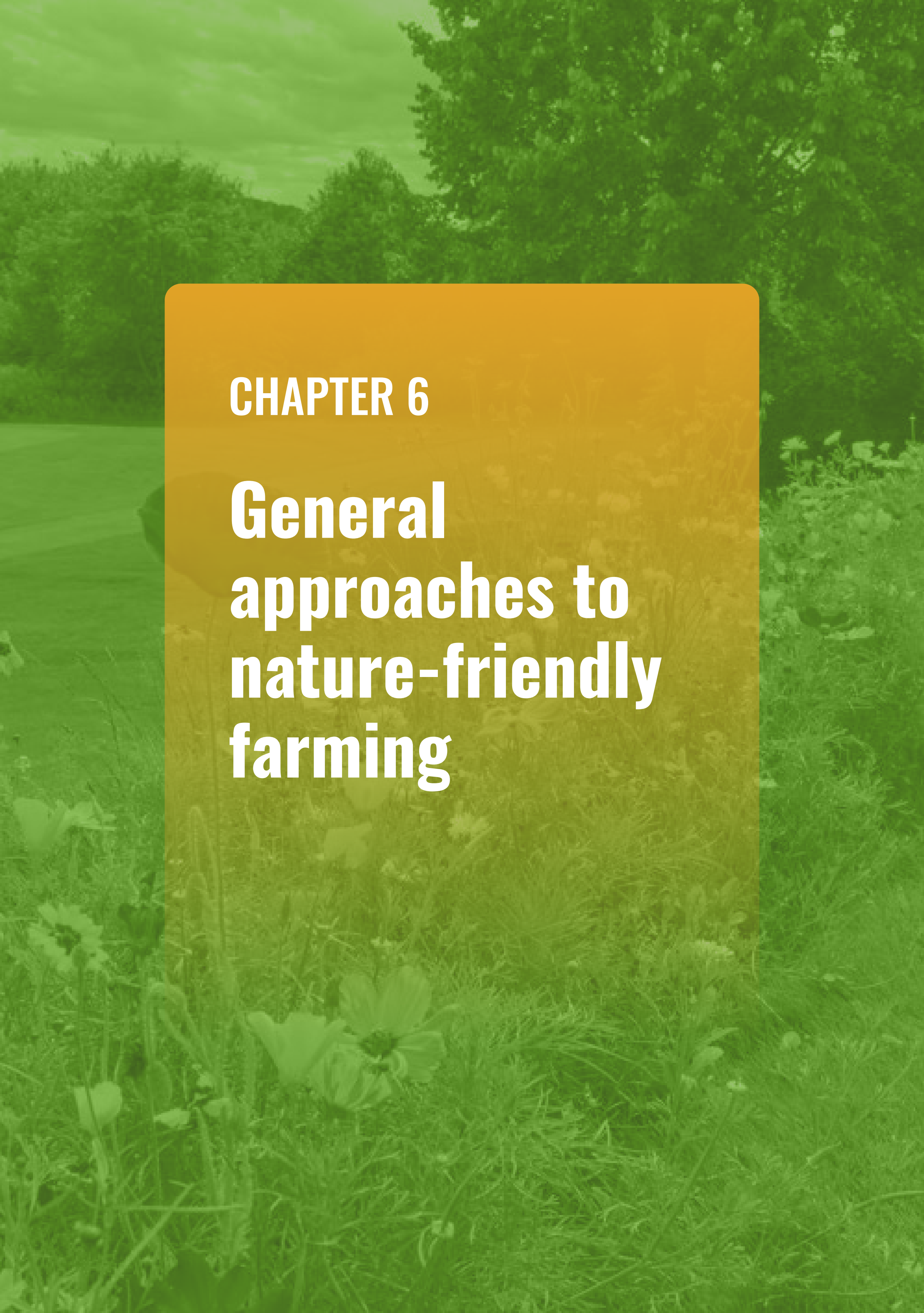


Figure 5: Quotes from European farmers involved in different types of farming research; researcher-led, farmer-led and co-designed by both.



CHAPTER 6

General approaches to nature-friendly farming

SHOWCASE demonstrates some general approaches to supporting biodiversity on farmland. Since every farm is different, these are not strict rules, but there are flexible options that can be adapted to different farms, landscapes and cultures.

We have listed them in a general order of benefits for biodiversity. The first brings the potentially greatest gains but often comes with the biggest trade-offs. The others still help, and when combined, they can be practical and could also make a real difference (**Figure 6**).

1. Set aside land for biodiversity

The most effective way to improve biodiversity on farms is to dedicate some land just for nature. This could mean:

- **Leaving or restoring a variety of natural habitats** like field strips alongside fields (e.g., Swiss and Hungarian EBAs) or between tree rows (e.g. Spanish and Portuguese EBAs), ponds, scrub, road verges, grasslands, woodlands or wetlands

- **Managing wild areas** with grazing (e.g., Estonian and Romanian EBAs), cutting, burning, wildflower sowing (e.g., Hungarian EBA) or removing invasive weeds

- **Restoring poor-quality farmland** for long-term use and resilience by converting it into a healthy functioning part of the landscape like permanent grassland, a wetland or a natural woodland

Even small patches help, especially when they are **connected**. Linked-up habitats (with hedgerows, grassy strips, or tree belts) make it easier for wildlife to move across the landscape.

2. Farm less intensively

The next best way to improve biodiversity on farms is to reduce the input intensity and soil disturbance. You might:

- Use less fertiliser and pesticide (e.g., French and Swiss EBAs)

- Try low or no-till systems (e.g., French EBA)

- Reduce management intensity (e.g., Dutch EBA)

- Add compost or manure to feed soil life

These practices protect pollinators, earthworms, and natural pest predators, and can also rebuild soil health over time.

3. Increase diversity

Farming more like nature means mixing things up. You might try:

- Intercropping or cover crops (e.g., UK EBA)
- Longer, more varied crop rotations
- Growing trees alongside crops or livestock (agroforestry)

Diverse systems are often more resilient to pests, disease, and extreme weather, and they can boost biodiversity above and below ground.

4. Support broader change

Nature-friendly farming is not just about individual farms.

- **Keep nearby natural areas intact**: Avoid breaking up forests, wetlands, or grasslands
- **Monitor what is working**: Track changes in soil, pests, or birds. For example, we developed the **InsectsCount** application to enable you to monitor flower-visiting insects yourself.
- **Celebrate local knowledge**: Farming with nature can protect traditions, support mental health, and connect communities.
- **Connect with others**: Exchange strategies, ideas, support and knowledge (Some SHOWCASE EBAs serve as hubs for sharing local and national knowledge (e.g., Romanian and Estonian EBAs), and some act as demonstration farms).

Help is available:

- Grants, national schemes, farmer-led groups, and local advisers can guide and support changes.
- Working together with neighbours, policymakers, and researchers builds trust and shared progress.

There is no one size fits all method for nature-friendly farming. But these general principles give a set of **flexible, prioritised ideas** that can be shaped to fit **different farms, regions, and needs**. You can:

- Start small, adapt as you go
- Mix approaches depending on your farm and goals
- Use national or local support to get going

Biodiversity-friendly farming works best for farmers when it is built together with farmers, supported by policies, rooted in local culture, and linked to good information and funding. **By combining these four strategies in a way that suits each farm**, farming can **support biodiversity** in a way that is practical and profitable.

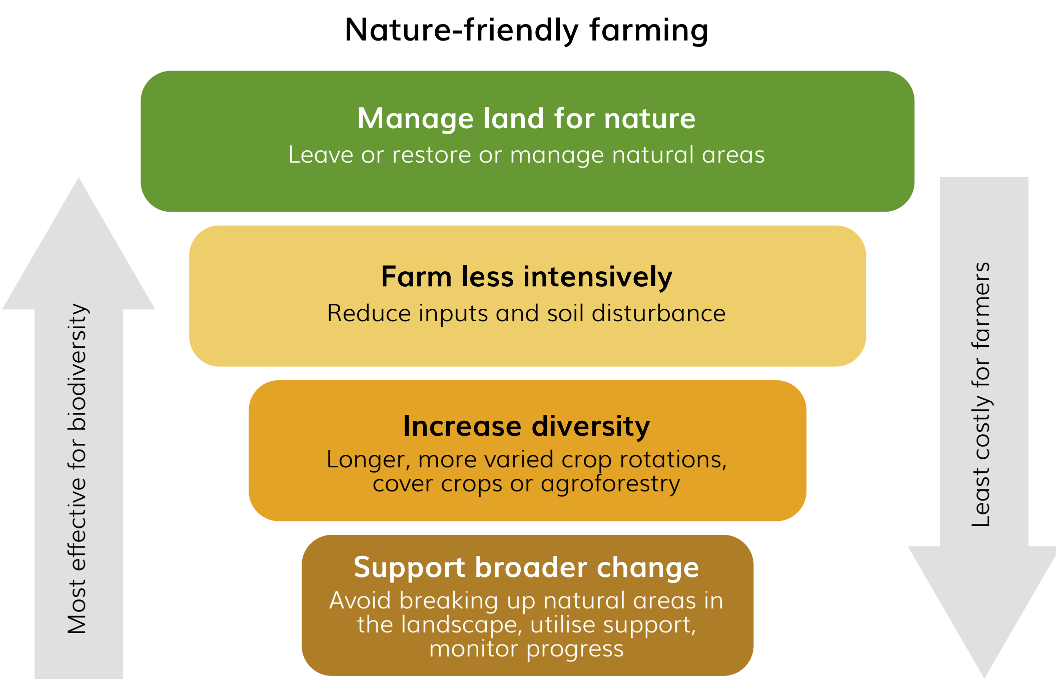
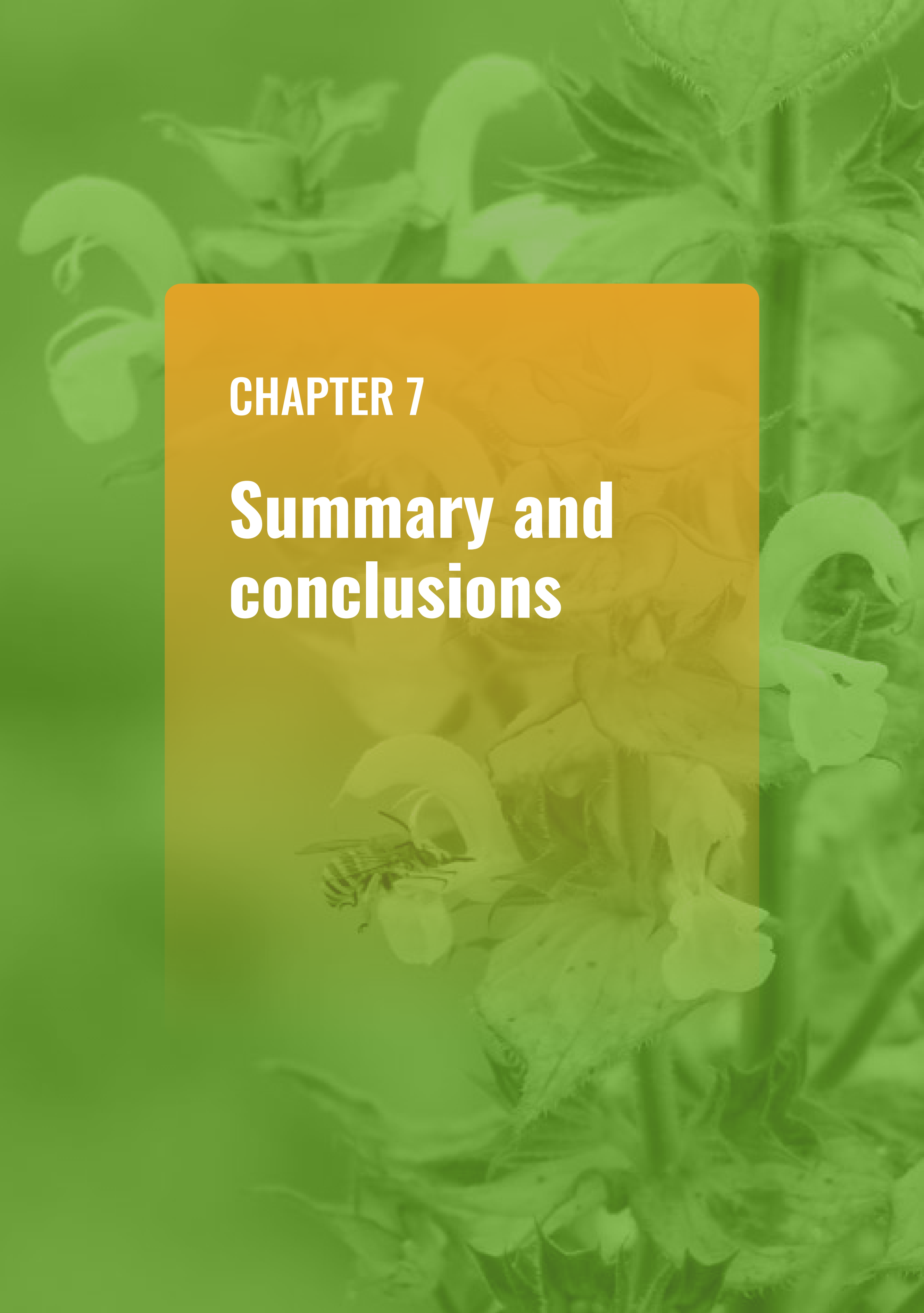


Figure 6: A pyramid showing four general strategies to support biodiversity on farms. The top of the pyramid represents actions with the highest impact on biodiversity which may also involve greater trade-offs in terms of productive land. Lower levels include strategies that are easier to adopt and less costly, but with smaller individual impacts. The four strategies are flexible and complementary and a mix of each can be chosen based on the goals, context and capacity of each farm. Combining multiple approaches often brings the greatest overall benefits for both biodiversity and long-term farm resilience.

CHAPTER 7

Summary and conclusions



Biodiversity on farms means the variety of all living things within a farm's ecosystem and the intricate ways they interact. This includes bees and birds, wild plants and healthy soil organisms, many of which are vital for strong and sustainable farming systems. The **SHOWCASE project is designed to support biodiversity-friendly farming that remains productive and profitable**.

Across 11 Experimental Biodiversity Areas in 10 countries, the SHOWCASE project worked with farmers to test different practices like planting flower strips, reducing pesticide use, and growing cover crops. These trials were carefully monitored to see how they affected biodiversity, and in some cases, crop yield and profit.

Nature-friendly farming helped boost biodiversity in all countries studied. In most cases, crop yields stayed the same unless there were big cuts to inputs like fertiliser or pesticides. **The effect of each trial on profits was usually, but not always, negative** and depended on the cost of the method used.

SHOWCASE found that important **motivations for farmers to take up biodiversity-friendly practices** included:

- Access to trusted advice
- Being part of a supportive food system
- Receiving payments that cover costs of biodiversity-friendly management
- Working with other farmers or experts

Some farmers were inspired by personal values, others by practical benefits like pest control, better soils, or market demand.

To be widely adopted, **nature-friendly farming must be both practical and feasible**, enhancing the benefits of biodiversity in supporting pollination, pest control and soil health, while also minimising costs in time, energy, yield and profit. Truly integrating these practices requires a clear understanding of the trade-offs and the real-world challenges farmers face. Overall, the SHOWCASE project has found that **with the right support, and in particular financial support, to farmers, farming with biodiversity can become the norm and benefit everyone**.

Glossary

Biodiversity – The variety of living things (plants, animals, and fungi). A good variety, or high biodiversity, improves soil health, crop pollination, and strong farm ecosystems.

Co-design – Working together (farmers, researchers, and other partners) to plan and test farming practices. Everyone brings their own knowledge, and decisions are made jointly to make sure the solutions are practical, useful, and tailored to the farm.

Control field – A field that is managed the same way as the trial field, but without the new practice being tested. This helps us see if the new practice is really making a difference or not.

Experimental Biodiversity Area (EBA) – A community of farmers, extension workers, researchers, NGOs, and citizens who work together to test and improve ideas for boosting biodiversity, strengthening farm productivity and making farming systems more nature-friendly. The SHOWCASE project has a network of 11 EBAs across 10 countries in Europe.

Intensive farming – Farming that uses high levels of inputs and technology to maximise yield per area of land. The goal is to increase production efficiently. The opposite of intensive farming is sometimes referred to as 'extensive farming'. For clarity of language, we refer to this as 'less intensive'.

Nature-friendly farming – A powerful approach which includes a range of methods to support biodiversity while still maintaining, or even enhancing, production by using science-based practices.

Resilience – A farm's ability to cope with challenges like extreme weather, pests, price changes or disease. A resilient farm can recover from setbacks, adapt to change and still produce food and income over time.

SHOWCASE project – Focuses on integrating biodiversity into everyday farming, helping farmers understand its practical value. It explores how payments, advice and regulations can support on-farm biodiversity, and tests ways to implement biodiversity-friendly farming.

Trial – A biodiversity-friendly practice tested on part of a farm to see how it affects nature, yield, or costs compared to usual farming.

Extra resources and further reading

showcase-project.eu

living-fields.eu

Contributors

Charlotte Howard[1], Ignasi Bartomeus[2], Vincent Bretagnolle[3], Nuria Chamorro[4], Amelia Hood[1], Maria Lee Kernecker[5], David Kleijn[6], Alice Mauchline[1], Lena Schaller[7], Simon Potts[1]

[1] University of Reading, United Kingdom

[2] Estación Biológica de Doñana, Spain

[3] Centre d'Études Biologiques de Chizé, Centre National pour la Recherche Scientifique (CNRS), France

[4] Scienseed, Spain

[5] Leibniz Centre for Agricultural Landscape Research, Germany

[6] Wageningen University & Research, Netherlands

[7] University of Natural Resources and Life Sciences, Vienna (Universität für Bodenkultur Wien), Austria

Acknowledgements

We are deeply grateful to everyone who contributed to this work. Thank you to the farmers, agronomists, NGO and policy representatives, and all others whose expertise and collaboration made this project a success.

Design and illustrations

Pensoft, Bulgaria

Case Studies

Case studies

Comparing agroecological and conventional farming practices in Switzerland

Felix Herzog, Matthias Albrecht,
Maura Ganz, Chiara Durrer &
Philippe Jeanneret

Summary

This case study examines the effects of agroecological practices compared to conventional farming in Swiss agricultural fields as part of the SHOWCASE project. We monitored biodiversity, crop yields, and agronomic inputs to understand the trade-offs between biodiversity enhancement and yield. Agroecological fields (wheat, barley and oilseed rape), employing wildflower strips, minimal pesticide use, and mechanical weeding, showed significantly higher biodiversity, particularly in spiders and bees. However, yields in these fields were generally lower than in conventional fields, which maintained higher outputs due to chemical inputs. While agroecological practices clearly benefit biodiversity, they present challenges in maintaining competitive crop yields, emphasising the need for targeted farmer support.

The challenge

Increased concern over the environmental impacts of conventional agricultural practices, such as biodiversity loss, pollution, and soil degradation, has led to growing interest in agroecological systems. These systems emphasise biodiversity conservation, reduced chemical inputs, and ecosystem services like pest control that support long-term productivity. However, the balance between biodiversity gains and maintaining crop yields remains uncertain.

The Swiss EBA

The SHOWCASE project aims to demonstrate nature-based solutions for sustainable agriculture across Europe by creating Experimental Biodiversity Areas (EBAs). These EBAs foster collaboration between farmers and researchers. In Switzerland, the EBAs are part of the **PestiRed project**, which seeks to reduce pesticide use by at least 75% while maintaining crop productivity (<10% yield losses) through agroecological interventions such as wildflower strips, under-sowing (where a second crop, often a cover crop like clover or grass, is sown into an existing main crop), and mechanical weeding.

Our approach

Agroecology integrates ecological principles into agricultural practices to promote biodiversity and ecosystem services, such as natural pest regulation, while reducing synthetic chemical inputs. In Switzerland, agroecological management has focused on fostering habitat diversity and utilising biological and mechanical control methods to ensure crop yield.

In this study, agroecological fields (Figure 1) implemented several key interventions:

- **Reduced pesticide use**: No pesticides (fungicides, herbicides, or insecticides) were applied in agroecological fields. Instead, farmers relied on mechanical weeding and soil management to control weeds and pests.

- **Wildflower strips**: Introduced at field margins, these strips promoted plant and arthropod biodiversity, providing habitat for beneficial species like spiders and bees.

- **Mechanical interventions**: Agroecological fields frequently used mechanical methods, including adapted crop varieties and under-sowing techniques, to manage weeds and maintain soil health.

Figure 1: An example of a field under agroecological management with a wildflower strip, in the Swiss EBA. Photo by Vincent Sonnenwyl.

By contrast, conventional fields used chemical inputs, including pesticides and nitrogen fertilizers, to maintain productivity. A simple analysis showed that conventional fields were characterised by higher pesticide applications, while agroecological fields tended to have more frequent mechanical interventions.

Standardised data collection focused on biodiversity and agronomic parameters in 22 paired fields across Switzerland. Assessments included spider and wild bee monitoring, vegetation surveys, and yield measurements. Predators and pests were sampled using pitfall traps, sweep netting, and vacuum suctioning to evaluate species abundance and diversity.

A co-design approach between farmers and scientists was followed to design and implement the agroecological interventions and monitor their impacts. This involved regular workshops and interviews with farmers.

What we found

BIODIVERSITY BENEFITS

Agroecological fields demonstrated significantly higher biodiversity, particularly in plant species richness and invertebrate populations, compared to conventional fields (Figure 2). Wildflower strips in agroecological fields greatly enhanced vegetation diversity, providing favourable conditions for beneficial arthropods such as spiders and bees. However, these biodiversity gains varied depending on crop type and management practices.

Agroecological management significantly increased plant species richness. Plant species richness was consistently higher at field margins, in both agroecological fields with wildflower strips and conventional fields with ruderal vegetation.

Bee populations were sparse in cereal and oilseed rape fields and were almost entirely dominated by honeybees (*Apis mellifera*). However, graphical analysis showed that wildflower strips in agroecological fields provided essential habitats for wild bees, highlighting their effectiveness in supporting pollinator communities.

There was no significant effect of agroecological management on spider abundance or species richness. However, spiders were more abundant and diverse in wildflower margins, including wildflower strips in agroecological fields and ruderal vegetation in conventional fields. This indicates that field margins play a crucial role in supporting spider diversity.

YIELD TRADE-OFFS

Conventional fields consistently produced higher yields across all crops studied, with yields being 17.9% higher in oilseed rape, 8.1% in wheat and 10.6% higher in barley (Figure 3). Protein content was 8.8% higher in conventional fields, particularly affecting wheat quality. The yield gap was primarily driven by pesticide application in conventional fields, while mechanical interventions in agroecological fields contributed to reduced yields.

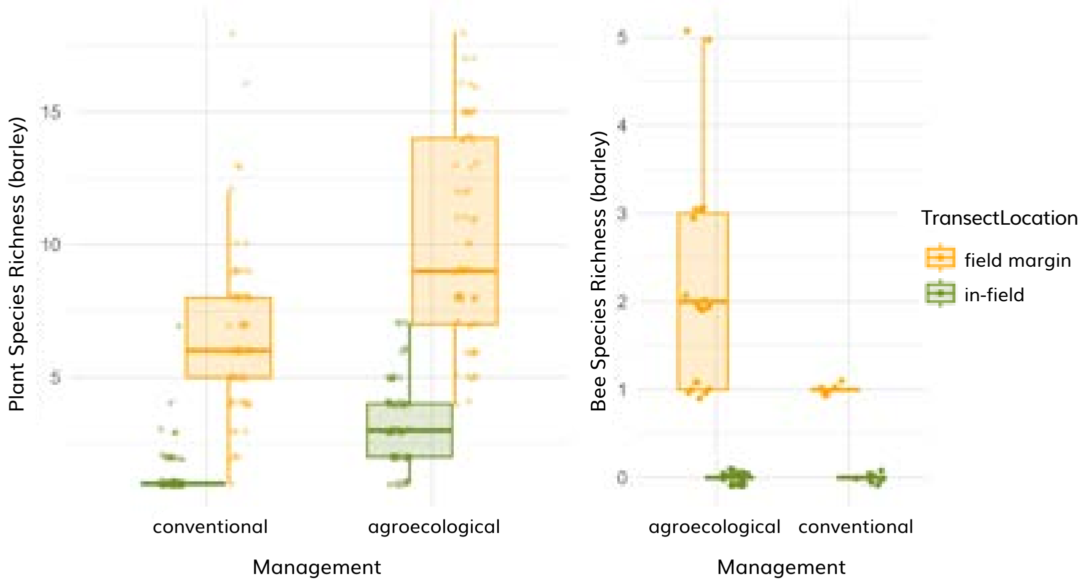


Figure 2: Plant (left) and bee (right) species richness in barley fields (green) and wildflower margins (yellow, flower strips vs control strips at margins of conventional fields). Points represent sampling (the number of species per plot, sampling occasion, and farm).

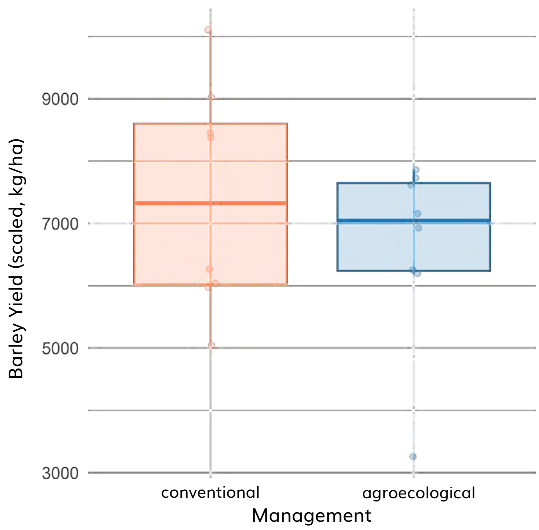


Figure 3: Barley yield (kg/ha) as reported by the farmers. Red points represent yield in conventional, and blue in agroecological fields.

CO-DESIGN

Interviews with three farmers indicated that the co-design process with scientists was perceived positively. The farmers emphasised that such collaborations should be more frequent and intensive. The wildflower strip intervention was unanimously seen as beneficial for biodiversity, though its impact on crop yield was not favourable. The under-sowing intervention was considered advantageous for biodiversity, but its effect on yield was mixed, with varying outcomes across different contexts.

What are the implications

BIODIVERSITY AND ECOSYSTEM SERVICES

Agroecological practices can offer significant biodiversity benefits, particularly for spiders and wild bees. However, these biodiversity gains do not always translate into reduced pest pressure or higher yields. Farmers may need additional support, such as financial incentives or technical assistance, to optimise pest control benefits from biodiversity.

YIELD CONCERNS

The yield gap between conventional and agroecological systems remains a challenge. Farmers transitioning to agroecological methods will need to balance trade-offs between reducing chemical inputs and maintaining crop yield. Agri-environment schemes could help bridge this gap by offering financial compensation or technical assistance to minimise yield loss while promoting biodiversity.

POLICY IMPLICATIONS

Policymakers should promote agroecological practices as part of a broader strategy for sustainable agriculture. Policies must be flexible to account for local conditions and should support farmers with tools to monitor biodiversity and manage pests effectively. Tailored policies will help optimise both biodiversity and yield outcomes.

Grazing is good for ground-dwelling beetles, but not for other soil arthropods in Estonian coastal agroecosystem

Aki Kadulin, Mylene Martinez & Indrek Melts

Summary

The Estonian Experimental Biodiversity Area (EBA) included coastal grasslands created through traditional agricultural activity. However, due to changing socio-economic conditions, the management of many of these habitats has been abandoned. In the Estonian EBA we studied the effects of grazing and abandonment on the soil-dwelling arthropods (invertebrates with cuticles and segmented bodies) in these grasslands. We found some previously unrecorded species of macro- and micro-arthropods in grazed areas, and showed that in general, grazing enhanced arthropod abundance. However, coastal wooded and abandoned habitats supported more specialist species, and other types of soil-dwelling arthropods. We conclude that both abandoned and wooded habitats should be preserved to support arthropod and wider biodiversity in the Estonian coastal landscapes.

The challenge

The area of semi-natural grasslands has decreased considerably in Estonia over the last century, primarily due to land use change. Farming in this area is mainly characterised by crop and livestock production, and secondary coastal grasslands depend on ongoing management practices such as mowing and grazing. Ongoing farming activity is crucial for maintaining biodiversity as well as providing a wide variety of ecosystem services. The persistence of these secondary coastal grasslands relies in part on financial support for farmers from the Estonian agri-environmental programme through the Common Agricultural Policy (CAP). Under this, farmers are expected to; clear the land of trees and shrubs, graze at low pressure, mow late, and attend training courses. Most management is achieved by grazing, especially in areas like coastal secondary grasslands, as it is known to improve plant, bird and amphibian biodiversity. However, knowledge is lacking about the best management practices in these grasslands for other important aspects of biodiversity, such as soil-associated arthropods.

The Estonian EBA

The Estonian Experimental Biodiversity Area (EBA) is located on mainland Estonia's western and southwestern coast next to the Baltic Sea in the Pärnu and Lääne counties, covering about 300 km of the Estonian coastline.

The vegetation is characterised by sand beach ridges, dunes and wetlands, vast areas of coastal and floodplain grasslands, and reedbeds. The place is also rich in other semi-natural habitats with high biodiversity, such as pine, dry boreal, and mixed spruce and deciduous forests. Many of these high-nature value areas are protected and their management should follow specific regulations and restrictions.

Our approach

The farmers participating in the Estonian EBA were selected based on their cooperation with the Estonian Environmental Board, a government institution responsible for managing semi-natural habitats in the protected areas and areas of NATURA 2000 network. We compared sites under a grazing management intervention with ungrazed control sites in abandoned coastal habitats covered by reed, shrubs and/or trees. Ten farmers were involved in the co-design of the intervention through general discussions, and in 2021, field level experiments were implemented in 10 intervention fields and compared with 10 control fields. Different biodiversity parameters (e.g., plants, soil-associated arthropods) were surveyed to determine the impacts of grazing and abandonment in two different landscape regions (Figure 1).

Figure 1: An example of a grazed coastal secondary grassland with the highest ground beetle diversity (above) and grazed coastal secondary grasslands with the highest spider diversity (below). Photos by Indrek Melts.

What we found

In 2021, 56 species of ground beetles (more than 15% of the entire Estonian ground beetle fauna) and 63 species of spiders (more than 10% of Estonian spiders) were collected and identified using the pitfall trap method. Soil samples were also taken and using Tullgren-Berlese funnels we extracted soil-associated arthropods. Among these studied arthropods were many new records for Estonian coastal agroecosystems, including species of spiders, ground beetles, and soil micro-arthropods (Sammet et al. 2023)[1] for example, the spider *Talavera thorelli*, and the ground beetle *Diachromus germanus* (Figure 2). Many of the new records were found in abandoned and wooded areas. Most of the microarthropods are widespread species, but there are significant knowledge gaps regarding microarthropods (Sammet et al. 2023)[1]. The presence of some new species (e.g., *Agroeca dentigera*, *Rugathodes instabilis)* in Estonian coastal habitats may indicate range shifts due to climate change.

Figure 2: Dorsal view of *Diachromus germanus* collected from the area of cut trees in the grazed coastal secondary grassland (Sammet et al. 2023)[2]. Photo by Olavi Kurina.

Grazing benefited ground beetles and spiders in the grasslands, as indicated by higher species richness for both taxa (Figure 3, above). However, abandoned and wooded habitats supported unique assemblages of ground beetles and spiders that also provide important ecosystem services (nutrient cycling). Additionally, abandoned and wooded habitats preserved other soil-associated arthropods (Figure 3, below).

Open and grazed grasslands were inhabited by more generalist ground beetle and spider species (i.e., those with a broad habitat and diet range), with smaller body sizes and greater flight tendencies. Open habitats were inhabited by highly diverse above-ground arthropod communities. In contrast, abandoned and wooded coastal habitats were important habitats sheltering more specialist species of ground beetles and spiders. Abandoned and wooded habitats in coastal areas may also offer stable environmental conditions essential for the conservation of less mobile soil-associated organisms.

[1] Sammet et al. 2023: https://checklist.pensoft.net/article/111005/

[2] Sammet, K., Martinez, M.R., Tali, K. and Melts, I., 2023. New records of arthropods from the priority Natura 2000 habitats in Estonian coastal areas. Check List, 19(6), pp.1029-1048.

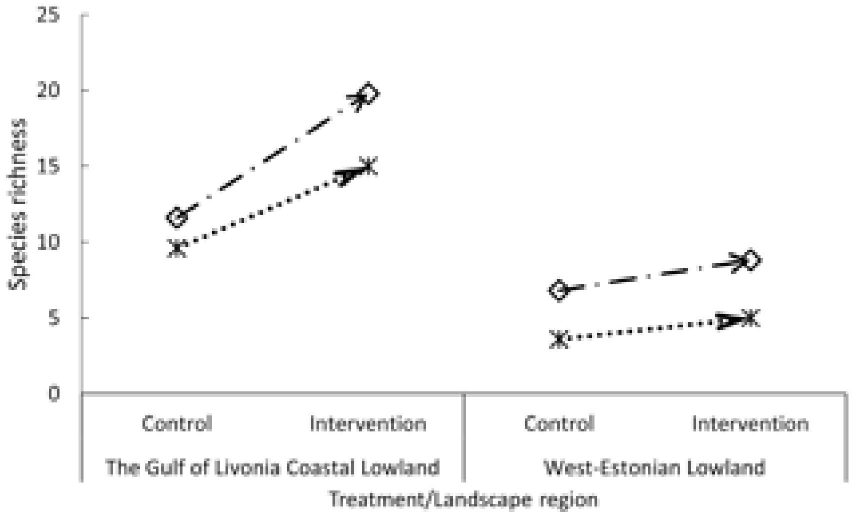


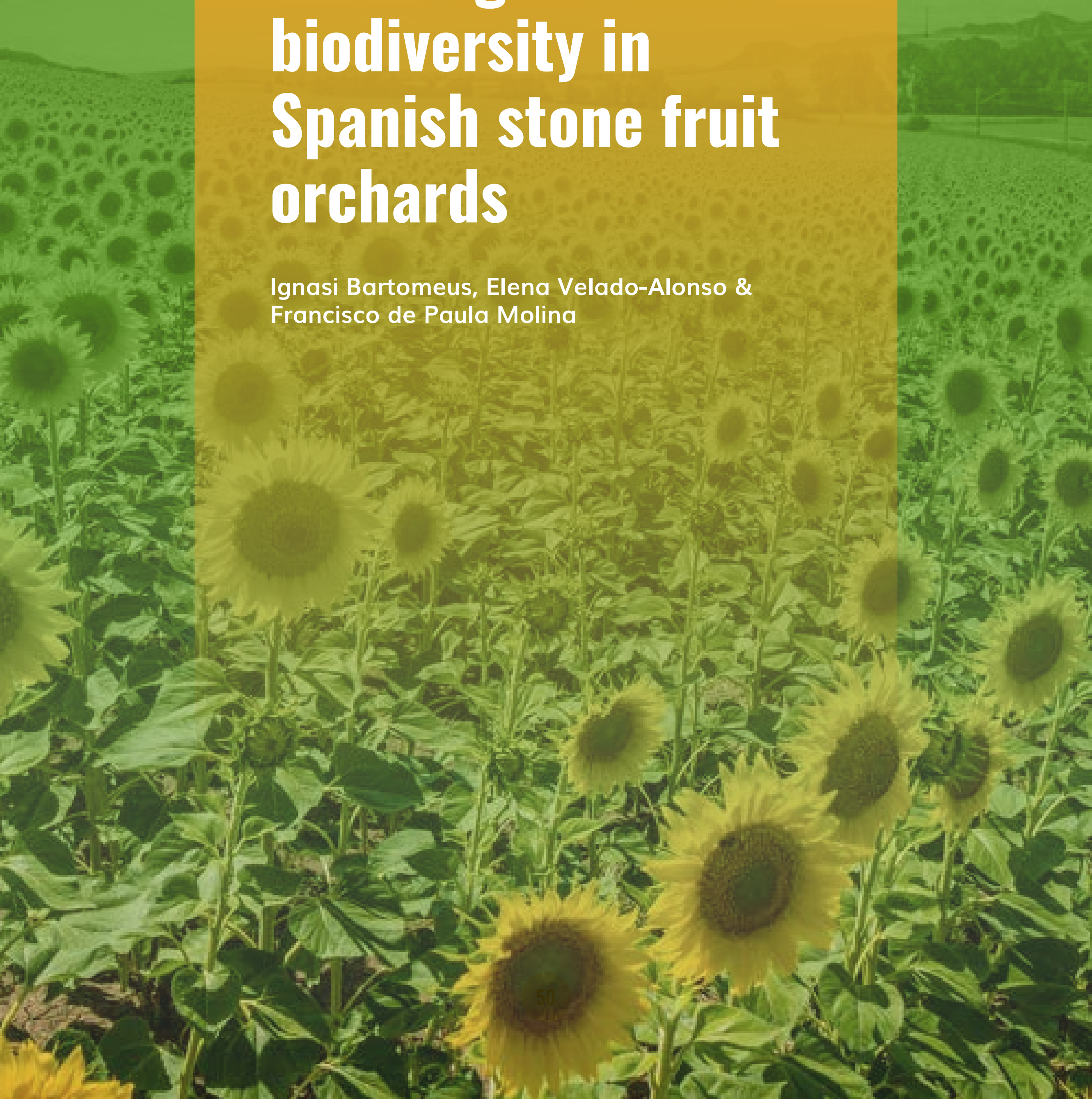
Figure 3: Species richness of ground beetles (long dash-dot) and spiders (round dot line) in grazed (intervention) and control sites (above) and the average abundance of soil arthropods (*Diplopoda* – saltire and *Isopoda* – cross) (below) in grazed (intervention) and control sites in the Estonian coastal habitats in 2021. Two regions within the EBA are shown: the Gulf of Livonia and West Estonian lowland.

What are the implications

It is crucial to prioritise wooded and abandoned habitats in coastal agroecosystems for specialist species of arthropods due to their vulnerability to disturbance. The main challenge is the pressure for more intensive management and the reduction of natural landscape elements. Trees, shrubs, and other landscape elements that are not actively managed, contribute to landscape diversity, but are currently excluded from areas eligible for subsidies. However, this practice is starting to change. At the same time, sustainable management practices, including fallow periods or rotational management, could also contribute to the maintenance of diverse landscapes and overall biodiversity in Estonian coastal agroecosystems.

Boosting insect biodiversity in Spanish stone fruit orchards

Ignasi Bartomeus, Elena Velado-Alonso & Francisco de Paula Molina



Summary

We worked with stone fruit farmers in a high-intensity agricultural area to find ways to improve biodiversity without reducing crop yields. We tested the use of sowing flower cover between the trees. The flower cover helped increase the number of plants, pollinators, spiders and other beneficial insect like predators and parasitoid wasps (wasps which can sometimes kill pests by laying eggs in, or on the pest as a 'host' for the young to feed on). The farmers did not lose fruit production. In fact, many of them liked the sown cover so much that they kept them after our experiment was over.

The challenge

Stone fruit orchards often have bare soil in the non-productive areas between the tree rows. Farmers have concerns that these strips between trees may encourage weeds and insect pests, so they use herbicides to remove weeds and insecticides to reduce pests on the trees. However, there is no clear evidence that weed-free alleys reduce pests or yield, but do we know they are contributing to a major environmental and economic problem in the region, due to the erosion and degradation of fertile soils. In fact, weed-free alleys can also harm biodiversity, including beneficial insects such as specialist parasitoid wasps (e.g., *Braconidae*) that can help to control crop pests, and bees that pollinate the fruit trees. We worked with farmers to experimentally explore a way to keep the soil covered without sacrificing crop yields.

The Spanish EBA

We created Experimental Biodiversity Areas (EBAs) on 16 stone fruit farms. The study area was the Vega del Guadalquivir region, a fertile and flat river valley northeast of Sevilla (Southern Spain), mostly devoted to intensive agriculture with significant surface cover by woody crops like citrus, olive groves and stone fruit orchards. Together with stone fruit farmers and other agriculture-related stakeholders, we initiated the Guadalquivida[1] community (Figure 1), with the aim of testing local solutions to local challenges, sharing a core approach with other initiatives through Europe. The Guadalquivida community goals were; (1) bringing intensive farming and biodiversity conservation together, (2) sharing knowledge between stakeholders, (3) seeking common solutions together, and (4) joining the sector in needs and opportunities.

[1] Guadalquivida https://www.beeproject.science/eba.html

Figure 1: Guadalvida farming community logo showing the ecological contrast between alleys at the experimental farm "La Mejora" in Alcolea del Rio, Seville province (South Spain). Tree alleys with flower strips benefited insects without competing with the crop (intervention) in comparison with the weed-free alleys showing mostly bare soil (Control). Photos by Elena Velado-Alonso. In the central picture, we observe the feeding behaviour of a crab spider (Thomisidae) on a managed honey bee (Apis mellifera), an example of the rich set of interactions between wild plants, the spiders using them as habitat, and pollinators. Photo by Estefania Tobajas and logo developed by Scienseed.

Our approach

We conducted an in-person diagnosis workshop to identify needs and opportunities. This workshop consisted of 3 joint activities; (1) an ice-breaking discussion on biodiversity perception, (2) farm mapping study to understand 'business–as–usual' management in the farms, and (3) a using a problem tree to identify potential solutions and opportunities linked to biodiversity.

As a result of the diagnosis workshop farmers and agricultural technicians were interested in improving the knowledge of biodiversity status within farms and co-designing interventions aligned with existing and future Common Agriculture Plans. Scientists developed an intervention dossier based on scientific evidence to discuss potential measures oriented to flower strips and hedges. After two rounds of in-person visits to each farm and discussions with farmers, agricultural technicians and other company workers, wildflower strips were selected as experimental intervention. The goals of the strips were to foster farm stability by favouring fauna beneficial to production, improving soil characteristics, and breaking pest cycles, while not negatively affecting yield.

We used a seed mix of five species: two clovers (*Trifolium pratense* and *Trifolium repens*), mustard green (*Brassica juncea*), rye (*Secale cereale*), and hairy vetch (*Vicia villosa*). As part of the co-design, farmers chose the area of implementation and common management practices were adapted to daily operations within the farms. In each farm, we planted flower strips on 1 ha of land (our experimental treatment) and left 1 ha bare (our control) (Figure 2). We monitored how the strips affected biodiversity of plants, pollinators and spiders, as well as crop yields. Monitoring was carried out in 16 stone fruit orchards of which eight were peach (*Prunus persica*), three nectarine (*Prunus persica nucipersica*), four plum (*Prunus domestica*) and one almond (*Prunus dulcis*) orchards.

Figure 2: Representative examples of farms without flower strips, control treatment (above) and with strips, experimental treatment (below), Early spring with flowering orchards (left), and drier summer conditions (right). Photos by Francisco de Paula Molina.

What we found

Our experiment showed that flower strips can significantly improve biodiversity without harming stone fruit yields. We found more plants, pollinators and spiders in the areas with strips. This is important because these creatures can help to control pests on the fruit crop and improve soil health.

In particular, we found 99 different plant species, 91 species of pollinators and 56 species of spiders, showing the rich biodiversity that orchards can host. Relative to the control, flower strips led to an estimated 10-fold increase in pollinator abundance. Pollinator species richness in green covers by three-fold compared to the control. Relative to the control, flower strips led to an estimated 100-fold increase in flower abundance and Flower species richness in flower strips was twice as high. Spider abundance in flower strip alleys was on average 1.5-fold higher compared to control alleys and spider species richness was two-fold higher in flower strip compared to control alleys (Figure 3).

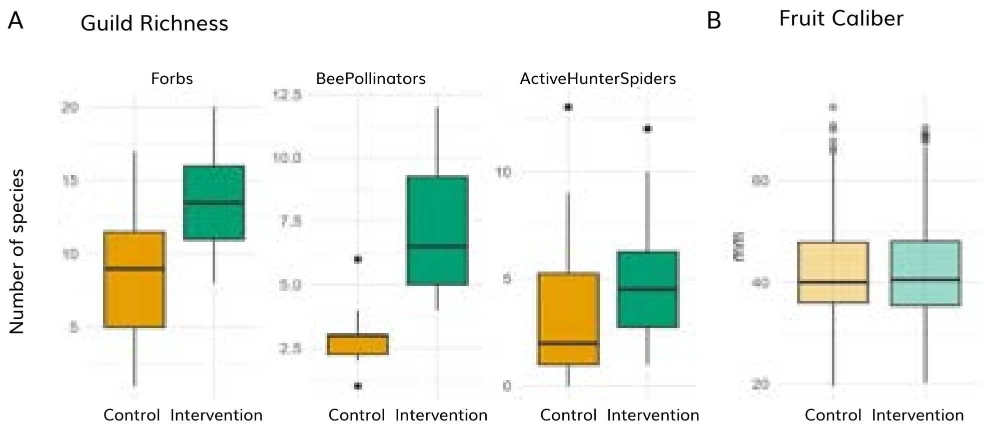


Figure 3: The number of species of relevant functional groups for the provision of ecosystem services in the farms (left) fruit calibre (diameter of the fruit, a typical measure of fruit quality) as a proxy of fruit yield (right) between control (bare soil) and intervention (sown flower strips) plots.

What are the implications

Our findings demonstrated that it is possible to increase biodiversity in intensive agricultural systems without compromising productivity. This is good news for farmers who want to protect the environment while also running profitable businesses. Additionally, using flower strips can help reduce the need for herbicides, saving farmers money and protecting the environment.

A participating farmer said "I was sceptical at first, but I'm really impressed with the results. The flower strips worked well in my orchard. I've not seen more pests, and my trees are healthy. Plus, I've saved money on herbicides."

This case study shows that flower strips can be a valuable tool for improving biodiversity in stone fruit orchards. By working together, farmers, scientists and policymakers can create more sustainable and resilient agricultural systems that benefit both people and the planet.

Agroecological experiments with farmers to reduce the intensity of farming practices had no effect on yields, but positive effects on biodiversity and gross margins

Vincent Bretagnolle, Jerome Faure & Sabrina Gaba

Summary

A series of experiments were carried out 2022-2023 with 19 farmers and 58 cereal fields, some of which were conventional and some of which were organic. Experiments targeted: (i) the reduction of pesticides and/or synthetic nitrogen by 30-50% for conventional farmers, and (ii) mechanical weeding and soil work, typically by avoiding deep ploughing, for organic farmers. Biodiversity (arable flowers, spiders, carabid beetles, and bees), crop yields, farming practices, and gross margins were all assessed, and analysed to test whether a win-win situation between biodiversity and yield and/or gross margin could be achieved. We found that overall, yields were not significantly penalised by reductions of inputs (magnitude of effect was around 5% decrease), but this depended on the year of experiment and the intensity of the farming practices. Consequently, overall gross margins were either stable or significantly increased, depending on year and in particular, the balance between crop prices and inputs prices (that varied largely between 2022 and 2023).

The challenge

(1) Conventional farming: Pesticide use has helped support food security, but its use also threatens human and ecosystem health, and the functioning of ecosystems, to the extent that alternative methods of pest control have become important political and societal goals. Understanding whether reducing the use of pesticides, without compromising food production and quality, increases farmers' workload and favours pests and weeds outbreaks, remains a key challenge. We conducted two sets of experiments to address this. We conducted input-reduction experiments in 31 conventional farmers' wheat fields and assessed the consequences in terms of yield and gross margin. One of the main goals of our Experimental Biodiversity Area (EBA) was to evaluate the impacts of a substantial pesticide reduction (typically 30-50%), alongside a similar reduction in nitrogen (fertiliser), on biodiversity at the field level, yields, and subsequently, the gross margins.

(2) Organic farming: Soil quality is very important in agricultural productivity and sustainability, and depends largely on decomposers that recycle nutrients. Biodiversity also affects soil structure and quality. In particular, earthworms have an important role in transferring and accumulating organic matter throughout the soil profile. Organic farmers use ploughing to prepare fields before sowing, and they also use mechanical weeding to control weed populations. These two farming practices are known to reduce soil biodiversity. and so organic farmers were encouraged to reduce their soil work, and in wheat crops. Thus, in a second set of fields we explored a reduction of soil work (mechanical weeding, reduced tillage) in winter cereal fields in 27 organically farmed fields.

The French EBA

The French EBA is located within the Nouvelle Aquitaine Region, Centre West of France. The site covers around 450 km^2 with more than 13,000 agricultural fields belonging to almost 450 farms. It is a research platform that belongs to the French Long Term Ecological Research network[1] (part of the European LTER[2]). More than 90% of the area is farmed, shared equally between mixed and pure arable farming, and mixed farms have decreased from 80% in the last 25 years. Of the 450 farms, over 70 are organically farmed, and more than 100 have contracted agri-environmental measures, half of the study area is a Natura 2000[3] site. A typical landscape within the EBA can be seen in Figure 1.

Figure 1: A typical spring landscape in the core of the Natura 2000 site. Photo by Zone Atelier Plaine and Val de Sevre.

[1] French Long Term Ecological Research network, https://deims.org/networks/d8d9206f-b1bd-4f90-84b7-8c662d4235a2
[2] European LTER https://elter-ri.eu/
[3] Natura 2000 https://www.eea.europa.eu/themes/biodiversity/natura-2000/the-natura-2000-protected-areas-network

Our approach

We tested interventions aimed at reducing the intensity of management of crop production in winter wheat, which was achieved through combination of; (1) Conventional farming (reducing nitrogen and pesticide use), and (2) Organic farming (reducing tillage from several times per year to no tillage, while at the same time reducing mechanical weeding to once or twice per year).

Contacts were set up with farmers, many of which engaged in previous projects, and the intervention was co-designed with these farmers to decide on the area and location of experimental plots, and how a reduction in intensity of management could be achieved. Experimental plots (Figure 2) were then compared with a control (business as usual practices); (1) conventional farmers chose the width, position, and level/magnitude of pesticide and nitrate reduction to be applied in part of or all the field, and (2) organic farmers decided on the intensity, and type of soil operations they wanted to reduce (i.e., either ploughing, mechanical weeding or both).

This approach resulted in a complex design to accommodate the variety of farmer preferences. In total, 27 farmers participated each year (for a total of 19 across the two years). Some farmers experimented at the whole field scale, resulting in between field experiments. Other farmers decided to split their field into an experimental and a control part, a design generally preferred by researchers as it has the strongest statistical power due to other factors being constant (except for the experimental intervention) between the two samples. The experimental plots were highly variable in size, ranging from a strip about 6m wide (along the length of the field) up to about 2ha field area. An example of an intervention plot is illustrated in Figure 2.

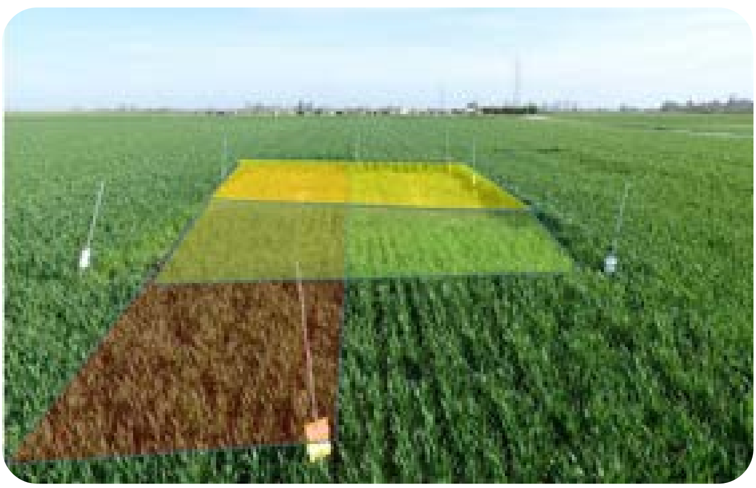


Figure 2: Plots in a two-factorial design within a wheat field. All plots on the left received reduced nitrogen (red), plots on the right received reduced herbicide (green). Note that in this case, the upper plots were left unsown (yellow) to estimate weed diversity and abundance from the seed bank. Photo by Zone Atelier Plaine and Val de Sevre.

What we found

We detected no significant (i.e., statistically supported) differences in wheat yield between experimental and control plots in either the conventional farms (first experiment, average decrease of yield 4%) or organic farms (second experiment, average decrease of yield 8%). Reducing pesticide (experiment 1) had no effect on yield, while nitrogen reduction had a marginal effect of 5.8% (Figure 3). Overall, the reduced costs of using less pesticide and nitrogen in conventional farms, more than offset any minimal reduction in yield, resulting in conventional farmers improving their gross margins by an average of €95/ha. In organic farms, there was no effect on the gross margin.

Considering both years and both conventional and organic farming systems together, we found a moderate positive effect on arable weed diversity and abundance, a positive effect on bee diversity (more pronounced in organic fields), and a very strong positive effect on both spider abundance and diversity in experimental versus control plots.

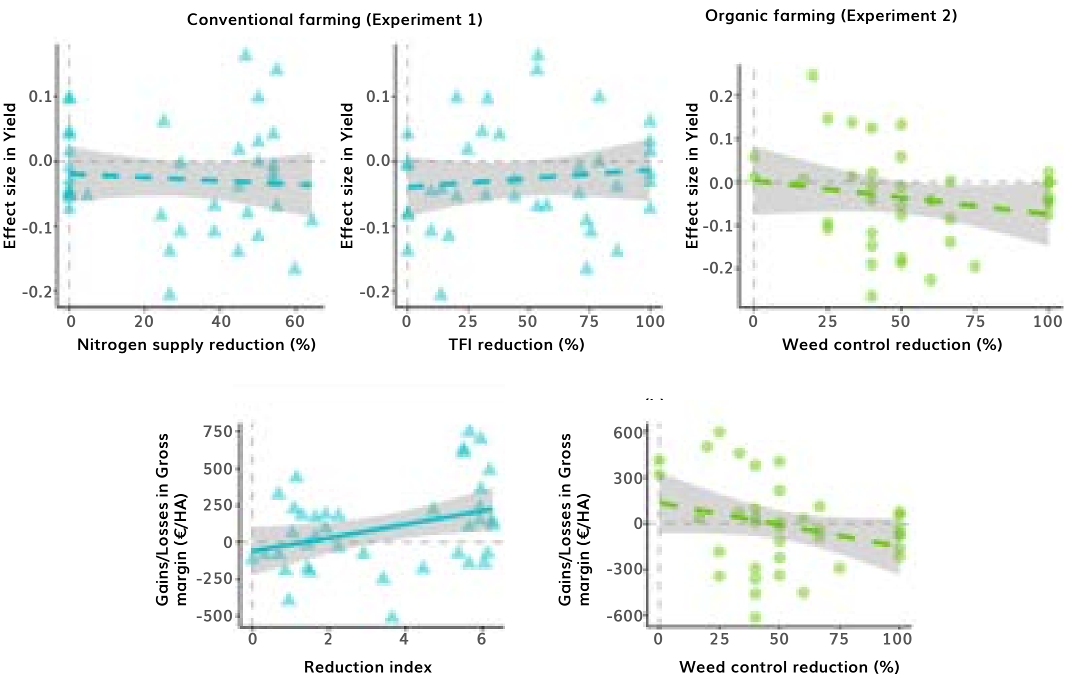


Figure 3: Cereal yields according to type of reduction, nitrogen (left), pesticide (middle), mechanical weeding (right) (above) and gross margin according to experimental reduction (below) for organic (green circles) and conventional (blue triangles) farms. Significant trends are shown with continuous lines, non-significant effects are in dashed lines.

What are the implications

Farmers were very positive about the findings but still face huge increases in the cost of inputs due to uncertainty in global geopolitics and markets. They were therefore looking for solutions to reduce the input costs, while maintaining yield, without a significant increase in their workload. The EBA farmers already had some ideas of the interventions they wanted to explore and saw the SHOWCASE project as an opportunity to test these rigorously by working with researchers to design an experiment to monitor biodiversity and yield. Working together, farmers and researchers were able to design experiments and test outcomes showing that there are some win-wins for production and biodiversity across a range of farming systems. Further, in 2024, some farmers set up experiments on their own based on the SHOWCASE approach and methods. They focused on experimenting with other factors (e.g., crop mixture). Others reported that they were willing to modify their practices to be more robust to climate and geopolitical crises.

Wildflowers at work: How ecological interventions boost yields and biodiversity on farms in Hungary

Gyula Szabó, Flóra Vajna & András Báldi

Summary

Farmland biodiversity is rapidly declining, including pollinators such as wild bees, and pest control providers, such as spiders and birds. The goal of our EBA was to restore populations of these ecosystem service providers. We teamed up with 10 Hungarian farmers, to assess the effectiveness of pollinator-friendly agricultural practices, using two experiments: (1) we overseeded fallows with locally native wildflowers, and (2) established 0.5 ha wildflower fields and strips next to crops. Both experiments had positive results, with the abundance of pollinators, including wild bees, hoverflies and butterflies, increasing with the experimental treatments compared to control areas. The overseeded fallows yielded more hay, and soil quality improved, while the yield of crops did not change next to the wildflower fields. The wildflower fields were especially important in late summer, when homogeneous arable landscapes do not provide any other flower resources for pollinators. We found that these wildflower patches also provided wider biodiversity benefits, for example by attracting farmlands birds and game species (e.g., hares and deer) which use them as feeding and resting sites.

The challenge

Biodiversity is declining all around the world. One of the main causes is the intensification of agriculture; forests get cut down and grasslands get ploughed to make space for more crops. This results in habitat loss for both native plants and animals. However, we need wild species in farmlands as they provide farmers and wider society with a range of ecosystem services. Wild bees, hoverflies and butterflies pollinate some crops, while spiders and birds can predate crop pests. We need native plants in agricultural landscapes to provide pollinators with food and shelter all year around, since crops, such as oilseeds, only bloom for a short period of time. Native habitats can also provide nesting, shelter and forage resources for farmland birds and mammals.

The Hungarian EBA

We collaborated with 10 farmers, one of whom had previously worked with a national park as a conservation biologist. This farmer liked to practice biodiversity-friendly farming, and we implemented two experiments. In the first, we overseeded fallows with native wildflowers on the land of 9 farmers. On these plots, the soil is sandy and crop production ended 10-15 years ago, and farmers now use these fields for grazing and hay meadows. In the second experiment, we established 0.5 ha wildflower fields (Figure 1) on the edge of large crop fields (mostly wheat, barley, corn and sunflower), belonging to one farmer. We then monitored biodiversity in these two experiments.

Figure 1: A wildflower field in May (above, Photo by Gyula Szabó) and a control sunflower field, without flowers, with a pan trap used for monitoring pollinators (below, photo by András Báldi)

Our approach

(1) OVERSEEDING EXPERIMENT

In the fallow overseeding experiments we sowed 11 native wildflower species once in 2019 on 9 plots of 0.5 ha meadows. Of the 11 plant species, 7 were legumes, which help accumulate nitrogen and organic material in the soil. To offer the widest range of resources for biodiversity, we chose plant species with a variety of sizes and structures above- and below-ground, and a range of flower sizes and colours. For each sown plot, we chose an untreated control plot of the same size, to compare with our intervention. The fallows were mowed once a year. We monitored the soil, plants and pollinators on all overseeded and untreated plots (Figure 2).

(2) WILDFLOWER FIELD EXPERIMENT

We established 8 experimental fields with sown strips along the edges of crops, with an untreated control site for each experimental field. A wildflower field was a single 0.5 ha field, sown with native wild follower species, and had small flower strips along 3 edges. We chose 32 locally native plant species for sowing, which covered a variety of architectures, flower colours and sizes, and we also included some locally rare plants. We monitored pollinators and birds in the fields and strips (Figure 2). Four of the experimental wildflower fields were in a homogeneous agricultural landscape (>95% of the surrounding area was crops) and 4 were in a heterogeneous landscape (~50% of the surrounding area was semi-natural grassland and wetland).

Figure 2: A bumblebee (*Bombus agricellus)* feeding on a flower in a wildflower strip (above) and a male European stonechat (*Saxicola rubicola)* in a wildflower field. Photos by Gyula Szabó.

What we found

(1) OVERSEEDING EXPERIMENT

We found that hay mass significantly increased on the overseeded plots, providing more food for cattle and sheep. The number of wildflowers increased, and increases in pollinators followed. In the third year after the overseeding, wild bee and butterfly abundance increased as well, and remained high in the following years. The number of wild bees were especially high in the summer, when the crops were harvested, and the farmed landscape was mostly covered by bare soil. The overseeded plots provided refuges for wild bees. At the same time, the soil quality also improved, due to the increased number of legumes.

(2) WILDFLOWER FIELD EXPERIMENT

Both the wildflower strips and fields had a positive effect on pollinators. Wild bee abundance increased around wildflower strips and fields in the homogenous agricultural landscape. In the heterogeneous landscape, this effect was much weaker. When there are plenty of semi-natural habitats in the landscape pollinators rely less on sown wildflower patches. We also found that wildflower patches attracted farmland birds. The birds preferred the single, bigger field opposed to smaller strips. An additional benefit of our pollinator friendly treatment was realised by local hunters as game often used the wildflower strips and fields as resting and feeding places.

What are the implications

Taken together, our experiments reveal benefits not only for pollinators, but also for birds and game. From the farmers' perspective, both experiments were successful, and all the farmers reported that they had seen their soil quality improve, and they had more hay from their meadows. In addition, hunters reported that game used the wildflower strips for both feeding and resting, and farmland birds also benefited from these habitats. As biodiversity improved, the yield either did not change (wildflower strips) or improved (overseeding), demonstrating that biodiversity and production can go hand in hand.

Could farming for biodiversity in grasslands pay for itself?

J.P. Reinier de Vries, José G. van Paassen & David Kleijn

Summary

Reduction in management intensity of grassland management is one of the most widely implemented agri-environmental measures to restore farmland biodiversity. Higher biodiversity can support ecosystem services that are beneficial to farmers, such as higher grassland productivity. Schemes to reduce management intensity that successfully increase biodiversity may therefore be more cost-effective to farmers than schemes that do not. In the Geuldal area, in the Netherlands, we investigated to what extent biodiversity can compensate for yield losses associated with less intensive management. We examined biodiversity, various ecosystem services, yield and farmer income in 41 grasslands with a range of management intensities, from zero to heavy fertilisation. Farming less intensively effectively enhanced biodiversity and most of the measured ecosystem services, which produced significant benefits to society. However, only cover of legumes, such as clover, contributed to yield. Farming less intensively resulted in a loss of income for farmers that was not compensated by enhanced provision of ecosystem services. This highlights the importance of financial incentives to stimulate farming for biodiversity.

The challenge

Biodiversity on farmland is important as farmland covers a substantial part of the land. However, agricultural intensification with the aim to maximise production has been an important driver of farmland biodiversity decline over the last century. A main cause of this decline is the loss of extensively managed grasslands across Europe. To counteract this trend, agri-environment schemes have been introduced aiming to compensate farmers financially for farming less intensively. At the same time, scientific evidence suggests that improving biodiversity on farmland can be beneficial for farmers as well. For example, having a higher number of grassland plant species could maintain yield but with a lower level of fertiliser input. We used the Dutch EBA to find out whether farming less intensively for biodiversity could (partially) pay for itself.

The Dutch EBA

The Dutch EBA is situated in the Geuldal area (South-East Netherlands, covering approximately 70km^2). This is a varied landscape with undulating hills, consisting of plateaus with fertile agricultural soils (loess), river gulleys, dry valleys, and chalk-rich sediment surfacing on the slopes. Land use in this area includes intensive conventional arable and dairy farming, organic mixed farming and a significant area of nature reserves (Figure 1). In this area, an initiative, De boshommel terug in het Geuldal[1], has started in

[1] https://boshommellandschap-geuldal.nl/

which farmers, nature conservation organisations, municipalities, the waterboard, the province and scientists work together to improve the whole landscape for biodiversity. Furthermore, farmers are united in a collective that promotes nature-inclusive farming through agri-environmental schemes. However, the majority of the EBA is farmed intensively, which drives further decline of its rich natural heritage.

Figure 1: Typical landscape of the Geuldal, showing localised chalk grasslands on steeper slopes (front) and intensively managed arable fields and agricultural grasslands managed for dairy cattle on the loess plateaus (back). Photo by Reinier de Vries.

Our approach

We studied the biodiversity, multiple ecosystem services (e.g., soil health, soil carbon, pollinators) and grassland productivity of 41 grasslands. The sites formed a gradient ranging from semi-natural grasslands with a low management intensity, through to high-intensity production grasslands. Through farmer interviews we collected information on fertiliser inputs, management costs and yield to estimate farmer income from these grasslands.

What we found

The results showed that reduction in management intensity increased the number of plant, bee and earthworm species in grasslands, reduced leaching of phosphate and nitrate to groundwater and resulted in higher soil carbon (Figure 2). The species richness of the vegetation increased strongly, especially from medium to low productivity levels.

This indicates that low productivity grasslands dominated by forbs are crucially important for biodiversity.

However, after accounting for the effect of fertiliser, higher biodiversity did not result in higher productivity, although higher legume cover (mainly clovers) had a positive effect on grass production **(Figure 3**). Farmer income was primarily related to farming intensity, with income benefits of increasing intensity levelling off at high fertilisation levels.

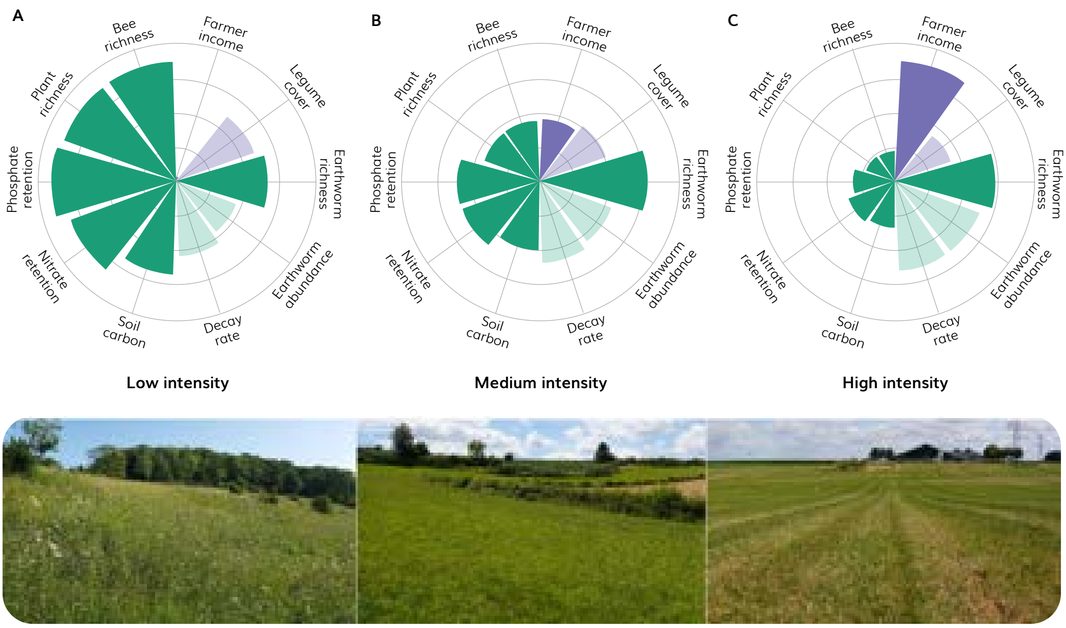


Figure 2: Farmer benefits (purple) and public goods (green) vary for low (left), medium (middle) and high (right) intensity grassland management represented by farmer income (i.e., gross margin levels of 50, 700 and 1,350 €/ha/year). Ecosystem services for which we did not find evidence to change with gross margin are shown in faded colours. From low to high intensity, increases in gross margin relate to decreases in biodiversity (plant and bee richness), nutrient retention and soil carbon sequestration, while soil functions are not affected. Photos by Reinier de Vries.

Figure 3: In this meadow, organic dairy production combines reduced fertilization with nutrient fixation by legumes (white clover and lucerne). Production remains fairly high, and both biodiversity and nutrient retention have improved, though not as much as they would under more extensive management. Photo by Reinier de Vries.

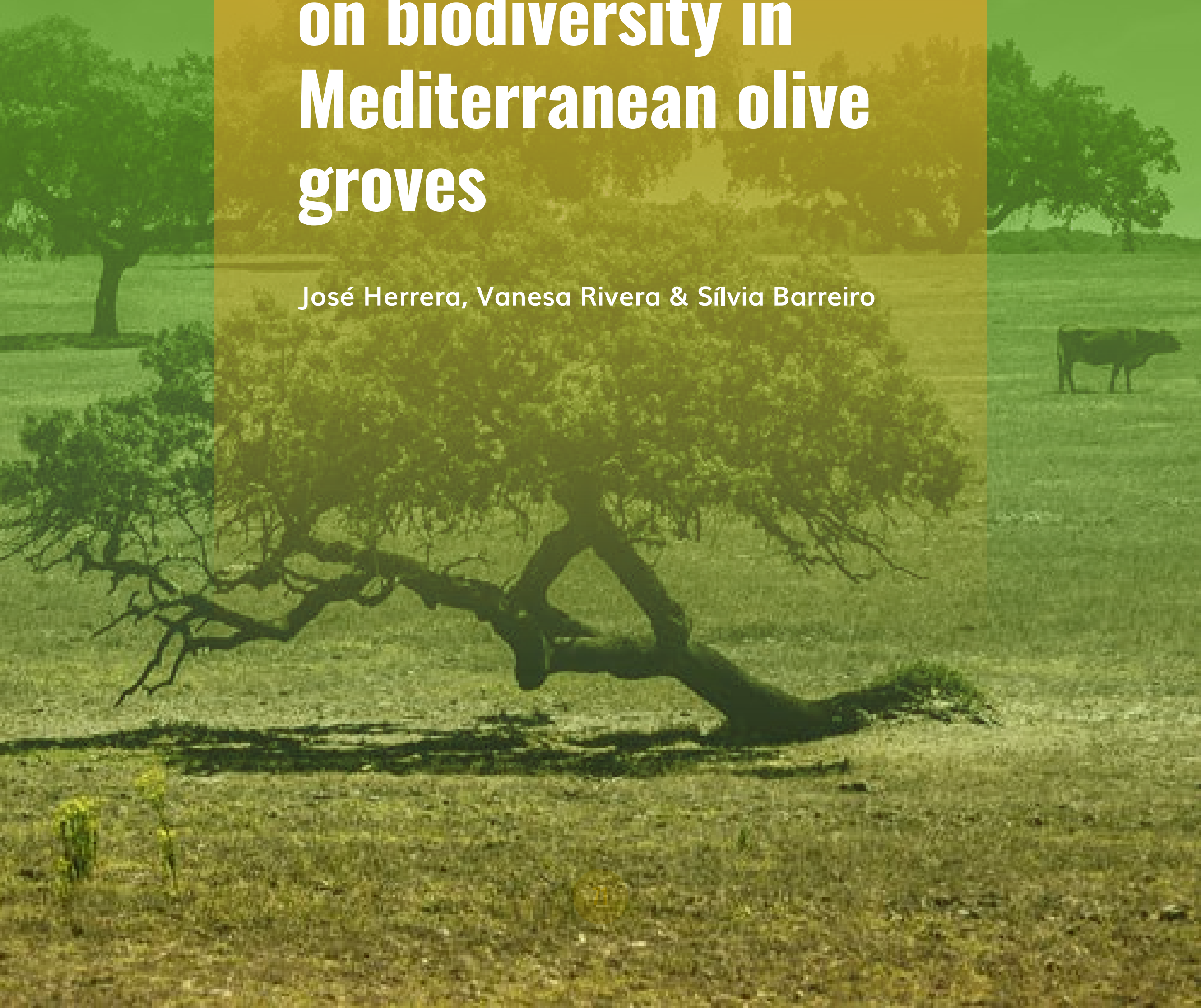
What are the implications

In agricultural grasslands in the Netherlands, farming less intensively restored the ecological functioning. This improves multiple societal benefits in parallel, but results in a decrease in farmer income. In other words, enhancing biodiversity on farmland does not pay for itself but requires that farmers are financially rewarded for the delivery of these public goods. For example, price premiums, public payment schemes or taxation of negative impacts can make it rewarding for farmers to farm for biodiversity. These rewards should be in line with both the benefits and the long-term income stability that intensive livestock keeping can provide. This could motivate more farmers to play an important role in restoring biodiversity and public goods in agricultural landscapes.

The paper based on this study can be found here: **Loss of income constrains the restoration of multiple biodiversity-based ecosystem services in agricultural grasslands**.

Lessening the impact of crop production intensification on biodiversity in Mediterranean olive groves

José Herrera, Vanesa Rivera & Sílvia Barreiro



Summary

Over the last 30 years, olive farming has experienced a rapid and large-scale intensification process across its Mediterranean historical range, with significant negative impacts on biodiversity. In the Portuguese EBA 'EBAlentejo', we investigated the effect of inter-row vegetation cover in a range of experimental sites on three biodiversity groups: bees, spiders and wild plants. Each site included two distinct areas, an intervention area in which inter-row herbaceous vegetation was sown, and a control area where no herbaceous vegetation was sown in the inter-row. We found that inter-row vegetation (a kind of wildflower strip) cover significantly impacted all three biodiversity groups. Specifically, the increased diversity and biomass of plants in the experimental treatment led to a higher richness and abundance of bees, spiders and plants. Our findings therefore suggest that managing inter-row vegetation cover can be crucial for helping biodiversity conservation in olive farms, including intensively managed farms.

The challenge

The production of olive (*Olea europaea*) represents a significant proportion of the agricultural sector in Europe, particularly in countries around the Mediterranean Sea. Over the last 30 years, olive farming has undergone a rapid and widespread intensification process, which is characterised by distinct changes in grove structure (e.g., higher densities of smaller and younger trees) and associated management activities (e.g., use of irrigation, and greater mechanization and agrochemical inputs). Together, these changes are reshaping Mediterranean farmland landscapes with associated negative impacts on biodiversity. A well-established literature demonstrates that agricultural intensification affects virtually all taxonomic groups, including both plants and animals. Therefore, improved management of olive groves is widely recognized to be essential for successful biodiversity conservation in Mediterranean Europe.

The Portuguese EBA

The 'EBAlentejo' is located in the region of Alentejo, southern Portugal, which is one of the most important olive growing regions in Europe. The regional climate is Mediterranean, which is characterized by mild and rainy winters and by warm and dry summers with temperatures commonly reaching 40 °C. Within the landscape there are biodiversity-rich natural and semi-natural patches mostly composed of Portuguese 'montado', evergreen forests of cork (*Quercus suber*) and holm oaks (*Quercus rotundifolia*), leading to the region being considered a High Nature Value Farming System (low-input farming with rich habitats for wildlife) (Figure 1).

Figure 1: A recently planted shrub-like olive farm in a 'montado' landscape showing a range of isolated native remnant trees in the region of Alentejo (Portugal). Photo by José Herrera.

To engage olive farmers into our experimental design, we created an Experimental Biodiversity Area (EBA), called EBAlentejo, with the aim to increase the cohesion among olive farmers across the study region (Figure 2). We ran group meetings with olive farmers interested in taking part in EBAlentejo to create an experimental approach co-designed between olive farmers and SHOWCASE researchers. Through this dialogue, we successfully designed a seed mixture which aimed to increase the availability of food and shelter resources for beneficial groups like bees and spiders, while at the same time not increasing the number of olive pests such as the olive fruit fly a (*Bactrocera oleae*) and olive fruit moth (*Prays oleae*).

Figure 2: Logo of the EBAlentejo Experimental Biodiversity Area in the region of Alentejo, Portugal.

Our approach

The EBAlentejo was used to investigate the effect of inter-row vegetation cover (intervention) on three target biodiversity groups: bees, spiders and wild plants. We sowed inter-row herbaceous vegetation in 10 experimental sites in 2022, and 12 in 2023. We used a paired design, so that each experimental site included two distinct areas: an area in which inter-row herbaceous vegetation was sown (intervention), and a control area where no herbaceous vegetation was sown in the inter-row (Figure 3). Both intervention and control areas covered four inter-rows 50 m long and 1.5 m wide in size. The sown vegetation aimed to increase vegetation and floral resource abundance between olive tree lines and consisted of a mixture of coriander (*Coriandrium sativum*), rapeseed (*Brassica napus*), sainfoiun (*Orobrychus vicifolia*), clovers (*Trifolium suaveone* and *T. presupinatum*), vetches (*Vicia sativa* and *V. villosa*), and lupins (*Lupinus luteus*). It was sown at a density of approximately 15 kg of mixture per hectare.

Figure 3: Example of a control area in which no sowing was carried out (unsown, business as usual) (left) and an intervention area showing sown herbaceous vegetation cover (sown) (right). Photos by José Herrera.

What we found

That sown inter-row vegetation cover significantly positively impacted all three biodiversity groups. Specifically, there was higher diversity and biomass of plants in the experimental treatment and higher richness and abundance of bees, spiders and plants in both study years (Figure 4). In addition, our intervention had no impacts (positive or negative) on olive pest infestation levels by either *B. oleae* or *P. olae*.

What are the Implications

Our findings suggest that implementing inter-row vegetation cover can be an important tool for helping biodiversity conservation in olive farms, including intensively managed ones. Indeed, all farmers who participated in the project and integrated into EBAlentejo, see this increase in biodiversity as an incentive to conserve and promote inter-row vegetation cover within their farms. However, it is not only the biodiversity increase, but also the absence of any impact of the intervention on olive pests, which resulted in positive views towards managing inter-row vegetation cover.

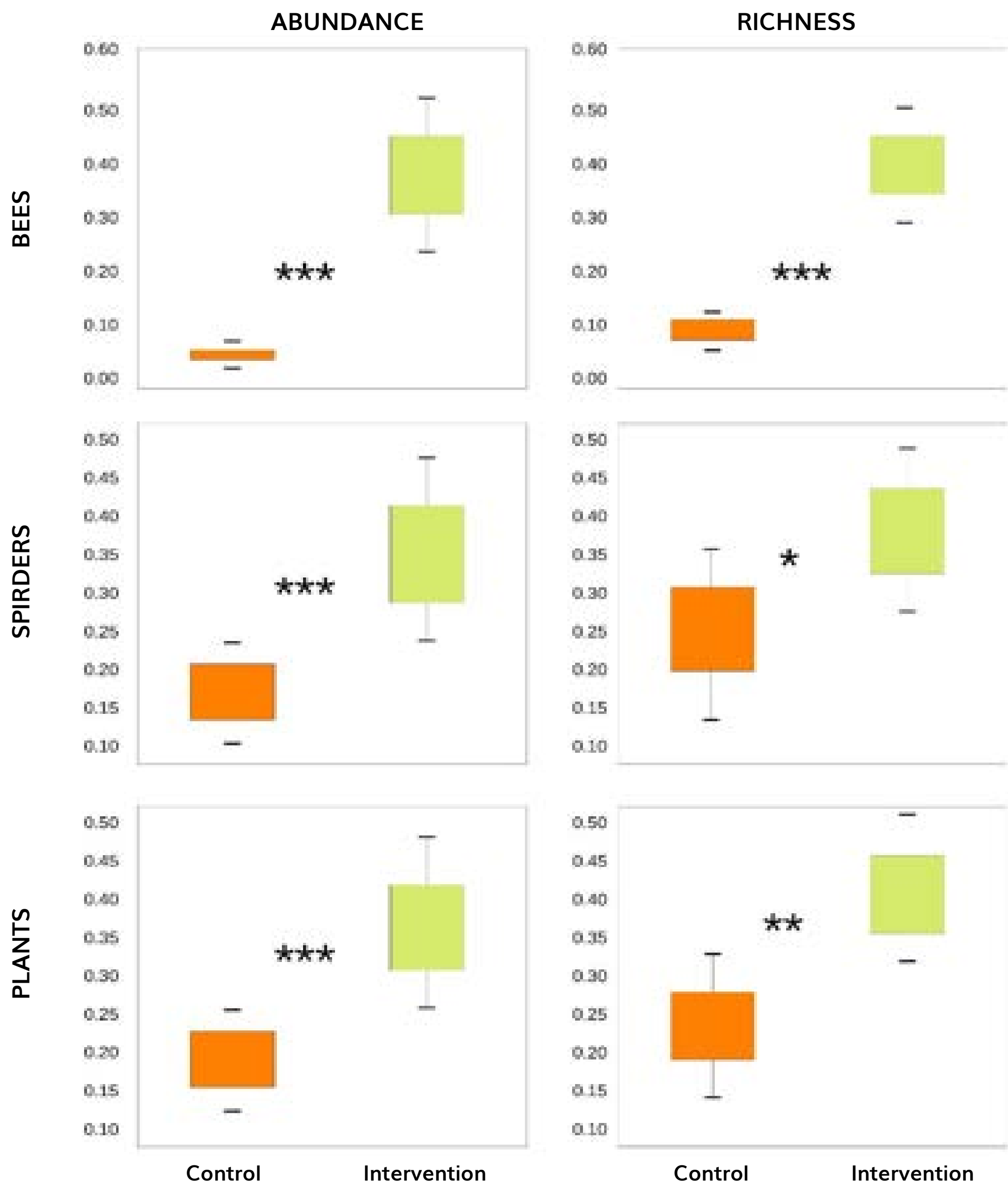


Figure 4: Species abundance and richness of bees, spiders and plants between olive grove intervention areas with sown herbaceous plant cover (intervention). and unsown areas in which no sowing was carried out (control). Statistical significance is shown as *** ($p < 0.001$), ** ($p < 0.01$) and * ($p < 0.05$).

In addition, the olive farmers showed a strong interest in understanding the potential impacts of the interventions on insectivorous vertebrate species, including birds and bats. This interest reflects the increasing recognition that birds and bats can provide effective biocontrol services in Mediterranean olive farms.

At least 10% cover of shrubs is needed to maintain butterfly biodiversity in Romanian grasslands

Prof. Dr. Laszlo Rakosy, Bodea Flaviu, Cristina Costache & Răzvan Popa

Summary

The natural-cultural landscape of Transylvania hosts European hotspots of plant and insect biodiversity. The species-rich meadows are the result of millennia of traditional land use in harmony with nature. To support biodiversity in these grasslands, a key land management practice is the removal of shrubs for which farmers receive financial compensation from the Romanian government. In 2022 and 2023 the Romanian EBA (Experimental Biodiversity Area) monitored the butterfly biodiversity in both recently cleared patches and uncleared patches of grassland. The results showed that biodiversity increased after the shrubs were removed. Moreover, biodiversity continues to increase in the following years if the grasslands are continually managed.

The challenge

During the last 25 years, traditional non-intensive land use activities have often been replaced by large scale intensive agriculture or land abandonment. In abandoned areas, where management is lacking, shrub density increases, grasslands become unusable for grazing or mowing. To help reduce the negative effect of land use abandonment and expansion of shrubs in grasslands, APIA[1] (the Romanian government payment agency) has offered compensatory payments to farmers to clear the shrubs. From 2007 to 2014, Romania implemented a National Rural Development Programme, and as a result, some farmers removed shrubs or trees from their grasslands to receive Common Agricultural Policy (CAP) payments. Unfortunately, many farmers removed all landscape features from their grasslands, probably due to misunderstandings or lack of proper information, leading to significant negative impacts on biodiversity, soil erosion, and water regulation.

The Romanian EBA

The Romanian EBA aimed to evaluate the impacts of agri-environmental measures aiming to mechanically or manually clear areas of high shrub density on butterfly biodiversity. The EBA is located in Transylvania, in the Natura 2000 site East Cluj Hills, which includes the "Land of the blue butterflies", an area after which the locals brand their local products and services. This originates from the presence of four species of the large blue butterfly (*Phengaris* ssp., Figure 1), which are protected under special conservation measures. The area incorporates 23 hillside villages, characterised by clay-sand or calcareous soils, on which biodiversity-rich natural and semi-natural grasslands are found which are supported by traditional, low-intensity agricultural practices.

[1] APIA https://apia.org.ro/

Our approach

We implemented standardised butterfly monitoring methodologies in 15 locations where shrubs have been removed by management one year prior (Figure 2), and 15 locations where the shrubs were not cut and cover was at least 25-30% (Figure 3).

Figure 1: Scarce large blue butterfly (*Phengaris teleius*). Photo by Prof. Dr. Laszlo Rakosy.

Figure 2: A recently cut area of grassland where the six to seven year-old shrub was mechanically removed. Photo by Prof. Dr. Laszlo Rakosy.

Figure 3: Comparison between an area with recently cut shrubs and the surrounding areas with high coverage of seven to eight year-old shrubs. Photo by Prof. Dr. Laszlo Rakosy.

What we found

Our findings show that for the areas where shrubs were cut butterfly diversity increased from 2022 to 2023 (Figure 4). In comparison, in the control plots where the shrubs were not cut, butterfly diversity was very similar in both 2022 and 2023.

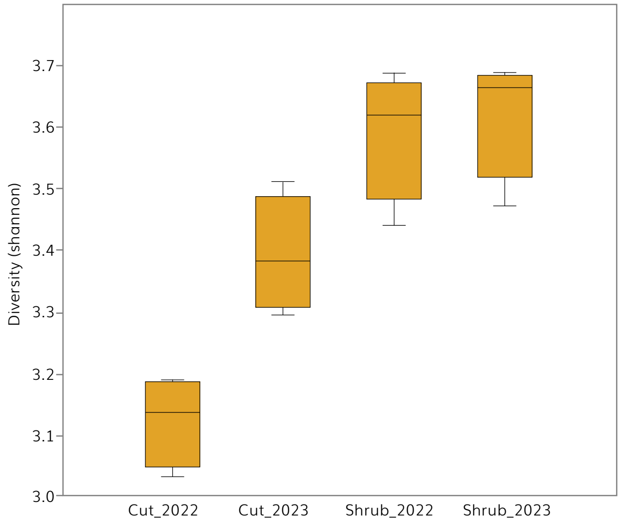


Figure 4: The diversity of butterfly species (calculated with the Shannon Index) for each intervention; shrubs cut in 2022, cut in 2023, and uncut controls for each year.

Butterfly diversity was relatively high in the control plots because there were paths and patches of grassland between the dense shrubs. This creates diverse microhabitats suitable for many butterfly species. However, if unmanaged, in a few years these shrubs will become very dense and homogenous, and the microhabitats will be lost, which will be detrimental to local butterfly biodiversity. As these shrubby areas cannot be used for agriculture or livestock, there is an important opportunity to maintain biodiversity through shrub removal using other practices such as cutting.

What are the implications

Based on our findings and the experience of local farmers, we co-designed recommendations for shrub removal. Mechanical clearing of shrubs through mulching (Figure 5) is preferable to manual clearing, as the cleared area can be used for grazing, or mowing for hay production from the second year after clearing. Manual clearing is recommended to reduce shrub encroachment on meadows where cover is 15-30%. In such cases, manual removal restores the open spaces between the shrubs that are necessary for the development of a variety of plant and animal species, especially insects and birds. The complete removal of shrubs has a negative impact on biodiversity. Therefore, maintaining structures in which shrubs occupy 5-15% of the grassland, and are relatively evenly distributed, or with small, compact areas of shrubs, is the optimal alternative for biodiversity and farmers (Figure 6).

Figure 5: Example of the heavy machinery used to clear the shrubs. Photo by Prof. Dr. Laszlo Rakosy.

The experience from Romanian EBA, in conjunction with the Romanian Society of Lepidopterology[2], was the basis in 2022 to propose to the Romanian Ministry of Agriculture, two agri-environmental packages aimed at the conservation of butterflies through the retention of 15-20% shrub cover in grasslands. At this time, these have been accepted by the Ministry, but have not yet been implemented within the National Strategic Programme. Keeping 15-20% of shrubs per hectare makes farmers eligible for financial support for shrub removal, without which it would be difficult for them to implement the practice to benefit biodiversity.

Figure 6: Example of semi-natural permanent grassland with optimal vegetation structure. Photo by Prof. Dr. Laszlo Rakosy.

[2] Romanian Society of Lepidopterology https://www.lepidoptera.ro/english.htm

SWEDEN

Volunteer for farmland biodiversity – gain support, learn and make a difference

Elin Lundquist, René var der Wal & Erik Öckinger

Summary

Over centuries, landscapes have evolved under the pressure of human land use. While change is an inevitable part of our existence, each transformation brings the challenge of balancing agricultural productivity with biodiversity conservation. As species continue to decline across farmlands, the urgency to protect biodiversity, essential for both agricultural resilience and overall ecological health, intensifies. Through SHOWCASE, we have searched for interventions where farmers, who face many commitments and challenges around growing food, can be assisted in addressing biodiversity interests and concerns. These interventions are diverse in approach and how farmers connect to them, but typically they are concerned with monitoring or conservation action. Here, we present some examples, illustrating three forms of farmer involvement.

- In the first, **farmers take a back-seat** position and let other volunteers implement monitoring or conservation work. This means that biodiversity-supporting activity can take place on or around farmers' land without their direct involvement, but where farmers may receive feedback from the volunteers. Sometimes, this type of volunteer activity on farmland leads to further steps, at which point farmers might become actively engaged.

- In the second category, farmers can increase their level of involvement by **asking volunteers,** or respective biodiversity recording organisations, for help in increasing monitoring or conservation.

- The third level is where **farmers themselves volunteer** for biodiversity through monitoring species on their farm.

Farmers in the back seat

The initiatives covered here aim to directly protect wild farmland species, evaluate the success of conservation efforts or gain a deeper understanding of the distribution and abundance of biodiversity in farmland. Volunteers are often actively working to promote and protect biodiversity, focusing on mobile farmland species that have declined or disappeared. One volunteer initiative is dedicated to monitoring the Montagu's harrier, a relatively rare bird of prey in southern Sweden (Figure 1). Volunteer birdwatchers work with local authorities to locate and protect these nests and inform farmers who have a nest on their land before fields are mowed, ensuring the birds' safety without disrupting farming activities too much. This collaboration exemplifies how conservation and agriculture can coexist with careful coordination.

Researchers also reached out to farmers, both within and outside of the Swedish EBA, asking whether they had an interest in monitoring pollinators on their land. Some farmers had the option to receive feedback from naturalist volunteers who had conducted monitoring, instead of the farmers monitoring pollinators themselves. These farmers appreciated the knowledge of volunteers and supported their efforts while feeling they had neither time nor knowledge to monitor themselves. This helped to facilitate social bonds between groups who would normally otherwise be separated.

Ask volunteers for help

Another example of volunteers working to increase farmland biodiversity is the effort to reintroduce the white stork (*Ciconia ciconia*), a species once lost from Sweden due to changes in land use (Figure 2). The Swedish Stork Project (Storkprojektet)[1], a collaboration between two NGOs (Naturskyddsföreningen Skåne and Skånes Ornitologiska förening), has two main goals; bringing back the white stork to farmland, and raising the issue of restoring the wetlands that are vital to its habitat. Volunteers play a key role in this initiative by caring for and feeding young storks, making the agricultural landscape more resilient, preparing them for life in the wild and encouraging the return of a species tied to restored landscapes that could benefit other species. Although farmers are not directly involved in the project, it helps landowners by offering guidance on building nesting platforms and advice on wetland restoration efforts.

In the Netherlands, volunteers help farmers by searching for nests of meadow birds, a nod to the former tradition of finding the first lapwing egg of the season. Volunteers across the country go onto farmland each year, marking out nests of lapwing (*Vanellus vanellus*), black-tailed godwit (*Limosa limosa*) and oystercatcher (*Haematopus ostralegus*), such that farmers and contractors can mow around them (Figure 3). Small agriculture-oriented local communities are forming around farmland to give meadow birds a fighting chance. Their activities tie into agri-environmental schemes, meaning farmers can get financial compensation. These activities do not just happen: there are coordinating organisations that tap into existing structures, both on the side of farmers and bird conservationists. As a result, many volunteers find themselves on farmland and highlight the value of meadow birds, which many farmers share or pick up on, and ultimately use in their work. We recognise that not every country in Europe can build on the same strong cultural interest in meadow birds, but they could search for biodiversity that resonates within the respective farming culture and build on existing structures.

[1] Storkprojektet https://storkprojektet.com/

Figure 1: By monitoring the Montagu's harrier population in spring, the organisation, Projekt Ängshök, can identify and protect their nesting sites. Photos by Anders Åberg.

Figure 2: The Swedish Stork Project works to reintroduce the white stork in Sweden, relying on dedicated volunteers. Photo by Per-Erik Larsson.

Figure 3: Volunteers from Boerenlandvogels[2] conducting a survey of meadow birds. Photo by Berry Lucas.

2 Boerenlandvogels https://www.boerenlandvogelsnederland.nl/

Farmers as citizen scientists

The third level of involvement is where farmers take on the role of a biodiversity volunteer themselves and become citizen scientists. This is exemplified in a moth monitoring project, also in the Netherlands, where farmers set up and manage insect traps on their land to support data collection. The farmers photograph the moths, which are then identified at one of the organisations leading the project, De Vlinderstichting[3]. We found that a farmers' motivation was not only to provide valuable information about farmland ecosystems, but also to counter misconceptions about the impact of farming on biodiversity. Through this hands-on work, farmers, driven by a concern for nature, can deepen their understanding of their land's ecosystem.

Similarly to the moth monitoring project, farmers monitored pollinators on their land as part of the SHOWCASE project in the EBAs in Sweden, Spain, and the UK, but here identifying the insects themselves. These farmers were motivated by a desire to learn more about their land, assess the impact of their efforts on nature and biodiversity, and contribute to scientific research. For many, this monitoring provided a unique opportunity to discover the variety of butterflies and other insects on their land while contributing to scientific data. Although some participants initially found it challenging to find time for these observations, others found creative ways to integrate it into their routines, such as during brief breaks in work. One participant noted that taking a moment to focus on butterflies even offered a relaxing pause from the day's tasks, underscoring how biodiversity monitoring can enhance both environmental awareness and personal well-being.

From across all these examples, we saw that involvement supported conservation by providing data, encouraging responsibility for nature, and strengthening community bonds, which fostered a shared commitment to preserving our environment for future generations.

[3] De Vlinderstichting https://www.vlinderstichting.nl/

UNITED KINGDOM

Winter cover crops promote soil health in UK arable systems

Amelia Hood, Alice Mauchline, Tom Sizmur & Simon Potts

Partners: Megan Whatty, Ian Gould, Duncan Westbury, Andy Bason, Will Batt, Jim Bryce, Jon Capes, Nick Down, Jake Freestone, David Lemon, Andrew Mahon, Jeremy Padfield, Robert Price, Mark Tufnell

Summary

Cover crops are planted to cover and protect the soil when it is not being used by other crops. They can provide a range of environmental and production benefits, but their impact depends on which species are planted. Here, we compared three winter cover crop mixes and a control where no cover crops were planted. We found significant benefits to biodiversity as a result of cover cropping, with 26% more spiders and 53% more earthworms in the cover cropped plots over winter. Earthworm abundance and biomass (weight/area) also increased in the subsequent spring crop by 66% and 60% respectively. Earthworms promote soil health and spiders are important for pest control, both of which can increase crop yield and farm profits. These results are hugely promising as this study was conducted over one year, and the benefits of cover cropping will likely increase if practiced over several years. These results strongly support the environmental benefits of winter cover cropping in the UK. We also showed the value of including farmers when setting research questions and designing experiments, as our research question was co-designed with 16 farmers. This made our results directly relevant to our farming community, and several participants changed their practices as a result of our findings.

Challenge

Cover cropping dates back at least 2000 years, with records from Ancient Greece and Rome describing legumes being ploughed into the soil to improve fertility.

Research has shown that winter cover cropping can provide many benefits in arable systems, including promoting beneficial biodiversity (e.g., pollinators, natural enemies, soil invertebrates), suppressing weeds, and improving soil health (e.g., reducing compaction and erosion and increasing organic matter and nutrient availability).

These benefits can also increase crop yield in the subsequent crops, but not always. The impact of cover crops on production depends on the site and management context. For example, some studies only show benefits with legume cover crop mixes, or when the soil is not disturbed by ploughing. These mixed results can make it hard to know which species to plant and how to manage them.

UK EBA

Our research question was co-designed by 16 arable farmers, researchers and our industry partners. Our aim was to test a farming intervention that could promote production and biodiversity at the same time, and after eight months of meetings and discussions we decided to run a cover crop trial. In particular, we aimed to test the environmental and production impacts of different cover crop mixes, and the impact of cover crop frost tolerance specifically. In the UK, cover crops are most commonly removed by spraying herbicide, and we wanted to test the impacts of mixes that may need less herbicide if they have partially died off in the frost and therefore have reduced plant biomass. This could have environmental and financial benefits due to reduced application rates. We hypothesised that frost sensitive mixes might also improve soil health by adding nutrients when decomposing above and belowground throughout the winter.

Our approach

This trial was conducted on eleven farms across Southern England from 2021-2023. We collected data at four times, using a robust experimental design that includes pre-treatment and post-treatment measurements.

We tested four cover crop treatments (Figure 1):

1. **Frost sensitive**: A four-species mix of frost-sensitive cover crops including early English vetch, bersem clover, black oats, and buckwheat.

2. **Frost hardy**: A four-species mix of frost-hardy cover crops including winter vetch, crimson clover, protector rye, and linseed.

3. **Mix**: An eight-species mix using a reduced application rate of each of the species above.

4. **Control**: No cover crops were planted.

We assessed the impact of these mixes on biodiversity (including plants, spiders, beetles and earthworms), soil health (including decomposition, structure and organic matter), and production (including cereal yield and thousand grain weight, and cover crop biomass and nitrogen content) (Figure 1).

What we found

Cover crops vs control. We found a significant impact of the cover crop treatments on plants, spiders, earthworms and decomposition:

- Bare ground cover was double in the control plots compared to the cover crop plots (Figure 2).

- There were 26% more spiders in the cover crop plots compared to the controls when the cover crops were in.

- Earthworm abundance (counts) and biomass (weight per area) were 53% and 57% higher when the cover crops were in, and 66% and 60% higher in the subsequent spring crop respectively (Figure 2).

- Microbial decomposition (measured by burying and weighing tea bags) was 42% faster in the cover crop plots during cover cropping.

Figure 1: Winter hardy mix in the foreground, winter sensitive mix behind, and the control in the background (left), farmers and researchers discussing the cover crop mixes (upper middle), mixed treatment on the left and control on the right (lower middle), and collecting and hand sorting earthworms in the field using a soil monolith (right). Photos by Amelia Hood.

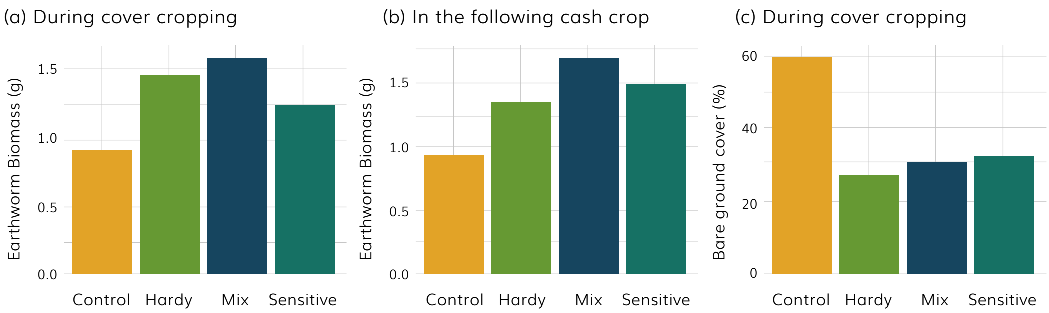


Figure 2: Three plots showing the average (a) earthworm biomass per sample during cover cropping (Jan-Feb 2023), (b) earthworm biomass per sample in the cash crop (spring barley, wheat, oats) that followed the cover crop (March-April 2023) and (c) percentage bare ground cover during cover cropping (Oct-Nov 2022).

Whilst there was no significant impact on the other indicators (beetles, soil structure, organic matter, and production), this does not mean that cover cropping would not benefit these indicators over a longer period of time. In fact, several studies have shown that the benefits of cover cropping increase after multiple years of use. Given the strength of the benefits that we found here, including benefits in the subsequent crop, our results suggest promising potential for wider, longer-term benefits.

Differences between the mixes. The winter sensitive mix died off through the winter, which increased bare ground cover compared to the winter hardy and mix treatments (Figure 2). The hardy and mix treatments also had 44% more dry plant biomass and 15% more nitrogen in the cover crops per area.

In terms of their impact on biodiversity and soil health, the differences between the treatments were smaller, with fewer spiders and slower decomposition rates in the winter sensitive mix compared to the other two mixes. Overall, these results are promising for using winter sensitive mixes to reduce herbicide rates for cover crop removal whilst maintaining the ecological benefits of cover cropping.

What are the implications

Our findings show that cover crops can effectively provide multiple environmental benefits after one season, and these benefits will likely increase if practiced over several years. The increase in spider abundance will likely provide benefits to production over the longer term as spiders are important natural enemies (e.g., controlling aphids). Furthermore, increasing plant cover and encouraging earthworms can improve soil health via better soil structure, greater nutrient availability, increased organic matter, and reduced erosion. This is important for crop yield, but also for creating soils that are resilient to climate change (e.g., improved water infiltration during heavy downpours). These results strongly support the benefits of winter cover cropping.

We also showed the value of including farmers when setting research questions and designing experiments. Our research question was directly relevant to our farming community, and several participants changed their practices as a result of our findings.

Acknowledgements

We are deeply grateful to everyone who contributed to this work. Thank you to the farmers, agronomists, NGO and policy representatives, and all others whose expertise and collaboration made this project a success.

Contributors

SWITZERLAND

Felix Herzog[1], Matthias Albrecht[1], Maura Ganz[2], Chiara Durrer[1] & Philippe Jeanneret[1]

[1] Agroscope, Switzerland

[2] Department of Environmental Systems Science

We are grateful to Mirjam Luethi from the IP-Suisse farmer association for her support in the Swiss EBA.

ESTONIA

Aki Kadulin, Mylene Martinez, Kaarel Sammet & Indrek Melts

Estonian University of Life Sciences, Estonia

SPAIN

Ignasi Bartomeus, Elena Velado-Alonso & Francisco de Paula Molina

Estación Biológica de Doñana, Spain

FRANCE

Vincent Bretagnolle[1], Jerome Faure[1] & Sabrina Gaba[2]

1 Centre d'Études Biologiques de Chizé, French National Centre for Scientific Research, France

2 National Research Institute for Agriculture, Food and Environment, France

HUNGARY

Gyula Szabó, Flóra Vajna & András Báldi

HUN-REN Centre for Ecological Research, Hungary

We are grateful to the landowner (Állampusztai Mezőgazdasági Kft.) and the Kiskunság National Park Directorate for supporting the work in the Hungarian EBAs.

NETHERLANDS

J.P. Reinier de Vries, José G. van Paassen & David Kleijn

Wageningen University & Research, Netherlands

PORTUGAL

José M. Herrera, Vanesa Rivera & Sílvia Barreiro

Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento, Portugal

ROMANIA

Prof. Dr. Laszlo Rakosy, Flaviu Bodea, Cristina Costache & Răzvan Popa

Universitatea Babeș Bolyai, Romania

SWEDEN

Elin Lundquist, René van der Wal & Erik Öckinger

Swedish University of Agricultural Sciences, Sweden

UNITED KINGDOM

Amelia Hood, Alice Mauchline, Tom Sizmur & Simon Potts

University of Reading, United Kingdom

Partners: Megan Whatty, Ian Gould, Duncan Westbury, Philip Arkell, Andy Bason, Will Batt, Jim Bryce, Jon Capes, Nick Down, Jake Freestone, David Lemon, Andrew Mahon, Jeremy Padfield, Robert Price, Mark Tufnell