

OUTLOOK FROM BIOMONITOR4CAP PROJECT

MONITORING TECHNOLOGIES IN FARMLAND BIODIVERSITY

BioMonitor4CAP materials for agricultural advisors

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Bio Monitor 4CAP

ADVANCED BIODIVERSITY MONITORING FOR RESULTS-BASED AND EFFECTIVE AGRICULTURAL POLICY AND TRANSFORMATION

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FARMLAND BIODIVERSITY MONITORING PROMOTES SUSTAINABLE FARMING

Biodiversity encompasses all living and non-living species of animals, plants and other organisms and their genes, as well as the diversity of habitats in which they live. Farmland biodiversity refers to all the biodiversity on the farm or within the farmland landscape.

Farmlands and biodiversity go hand-in-hand. Farmlands are important habitats for a wide range of species. In turn, diversity – both in production and in nature – also help make farms more resilient.

Biodiversity loss is a significant challenge with negative impacts on food production and human wellbeing. Farmers are key partners in biodiversity conservation, and the EU funded project BioMonitor4CAP spent three years investigating how biodiversity monitoring technologies can be adapted to monitor biodiversity at the farm level.

In this booklet, we present several of these technologies, as well as the results of social research with farmers and advisors about farmland biodiversity and its monitoring.

BIODIVERSITY MONITORING IN FARMLAND: WHY AND HOW?

Farmland biodiversity is the foundation of healthy, resilient agroecosystems that support essential processes like pollination, soil fertility, and natural pest control. When farmland biodiversity declines, these services erode and farms become more vulnerable to pests, disease, extreme weather, and soil degradation. Strengthening farmland biodiversity while maintaining crop yields is an investment in agricultural sustainability.

Biodiversity monitoring is the systematic, long-term observation and recording of changes in species, habitats, and ecosystem health. In agriculture, biodiversity monitoring is used to develop robust indicators about the ecosystem and changes that might be occuring. These help us understand how agricultural practices affect ecosystems and can improve policy for biodiversity-friendly farming. In practice, monitoring involves assessments of plants (e.g. agricultural weeds, wild plants) and animals (e.g. pests and beneficial insects) using a range of automated methods.

Traditional methods of biodiversity monitoring include manual field surveys, expert identification, and sample collection. The downsides of these methods are that they are often slow, costly, can only monitor a limited amount of biodiversity, and can be inconsistent across regions and seasons. Such monitoring often misses short-term activity peaks, rare species or subtle shifts in community composition.

Recent advances address these limits: automated sensors (camera traps, acoustic recorders, environmental sensors, environmental DNA) combined with AI-driven analysis and smart insect traps can provide continuous, non-invasive observation (Cord and Wätzold, 2026). These tools produce precise data that can inform farm management, national reporting and EU biodiversity assessments.

Agronomic benefits include helping farmers pinpoint when and where beneficial insects or pests are active. This knowledge supports integrated pest management and can help reduce pesticide use while maintaining yields.

Modern biomonitoring provides actionable indicators that link biodiversity to on-farm decisionmaking. It supports sustainable farming, improves soil and ecosystem health, enables transparent CAP payments, and contributes to Europe's biodiversity restoration goals.

Farmlands are important habitats for biodiversity, which can be monitored at the farm level using novel technologies. © T. Birge



Monitoring Technologies

A variety of technologies can be used to capture habitat complexity by remote sensing (drones), estimate bird and insect biodiversity via camera traps and acoustic devices, and monitor soil health with automated nematode counts or soil eDNA metabarcoding. Images clockwise from top left: © C. Scherber, © M. Clausen, © A. Kirse, © A. Kirse









WHAT'S IN THE SOIL? eDNA FOR IDENTIFYING SOIL ORGANISMS

Environmental DNA (eDNA) is the genetic material shed by all organisms, from microbes to vertebrates, into their surrounding environment. This DNA originates from materials like shed skin cells, mucus, waste products, and decaying organic matter.

The benefit of eDNA is that the presence of organisms in a specific habitat can be confirmed by extracting and analysing eDNA from a soil or water sample. This method is non-invasive and reduces the need for specialised taxonomic experts to conduct identification and saves time in the field compared to traditional field methods.

The eDNA isolated from the samples provide a genetic snapshot of the biodiversity in the ecosystem. The information gained can be applied to farming and biodiversity conservation in multiple ways:

- **Comprehensive biodiversity**: Identify a vast array of species in a farm's soil, water, or even air samples. This establishes a true baseline of ecosystem health.
- **Key functional groups**: Understand the roles different organisms play in nutrient cycling, soil structure, and overall farm ecosystem health.
- **Pest and beneficial organism detection:** offers an early warning system for specific plant pathogens, nematodes, or insect pests. Conversely, it can confirm the presence and abundance of key natural enemies (predators, parasitoids) and pollinators, supporting integrated pest management (IPM).
- **Soil functioning profiles:** Gain insights into how your soil is truly performing by analyzing the functional traits of detected fungi, bacteria, and invertebrates.

eDNA collection in the field is fast, can be standardised and is easy to reproduce. The sampler follows a simple protocol to collect the sample and send it to a lab. Sampling is often carried out by non-specialist personnel. For farmers, it can be can be integrated into routine fieldwork.

What is the status of eDNA technology?

eDNA metabarcoding, a technique used to identify organisms by their molecular fingerprint, facilitates the simultaneous identification of multiple species of key microbial and invertebrate communities. Sampling kits enable the collection of contamination-free eDNA samples for analysis. Several laboratories have the capability to assess fungi, bacteria and soil invertebrate communities from such samples. Some commercial laboratories specialised on metabarcoding also provide analysis for insect bulk samples collected via traditional trapping (such as pitfall or pan traps).

Future applications of eDNA metabarcoding for farming may include providing information for improving farming or providing evidence for different types of payment schemes and certifications including:



- **Optimised soil functioning:** By linking the genetic profile to agricultural practice, eDNA metabarcoding may help advisors optimise good farming practices such as cover cropping and minimum tillage to enhance beneficial microbes and invertebrates.
- **Precision pest and pathogen management:** eDNA metabarcoding may provide timely, species-specific detection of pests and disease indicators of, for example, specific fungal pathogens or root-feeding nematodes. This information can be used to better target interventions and reduce the need for pre-emptive and broad spectrum treatments..
- **Evidence-based certification:** eDNA metabarcoding is becoming more robust, and future applications may include providing an evidence base for a farm's biodiversity impact for sustainability schemes, carbon accounting, or natural capital reporting.

eDNA information

Environmental DNA, or eDNA can be collected from soils to provide information about the presence of specific fungi, bacteria, nematodes and other invertebrates of interest, and from the crop to determine presence or absence of insects and spiders. © C. Scherber







HEAR THAT? ACOUSTIC MONITORING OF BIRDS, BATS AND INSECTS

Acoustic monitoring uses automated recording devices to capture sounds produced by animals such as birds, insects, and bats. These acoustic recorders collect audio without disturbing wildlife. They can operate continuously or at scheduled intervals.

The benefits of acoustic monitoring are that it provides a non-invasive, standardised, scalable, and time-efficient way to document the presence, behaviour, and activity patterns of sound-emitting target species. When suitable automated or expert manual identification is available, acoustic monitoring can be a more efficient method than traditional survey methods that rely on visual detection or trapping (Hoefer et al., 2023).

Some modern recorders can be set to run for weeks or months. Large volumes of audio can be stored for later analysis either manually or with AI-based species recognition tools such as BirdNet or the BTO Acoustic Pipeline. Acoustic monitoring is particularly valuable for taxa like nocturnal insects, small mammals or echolocating bats, which are difficult to observe visually (Ashton-Butt et al., 2025). Applications include:

- **Comprehensive biodiversity assessments:** Acoustic devices can detect any species that actively produces sound, including those inaudible to human ears. Recent efforts are even being made to identify insects by the sound of their wingbeats, but this is still hampered by incomplete reference databases and inconsistencies under different weather conditions. Overall, acoustic monitoring enables comprehensive assessments of species richness, community composition, and seasonal dynamics across habitats.

- **Pest and beneficial species detection:** Acoustic signals can reveal the presence of agricultural pests such as cicadas, crickets, certain beetles as well as beneficial species such as predatory bats. Identification supports more targeted management strategies including integrated pest and pollinator management (IPPM).

- **Activity patterns and behaviour:** Continuous or periodic recording allows researchers to detect animal activity and patterns. These patterns include their rhythms during the day, migration, mating calls, and seasonal shifts in activity. The information can be used to improve recommendations for time-sensitive interventions on the farmland.

Acoustic monitoring devices are unobtrusive in the landscape. © A. Kirse



What is the status of acoustic monitoring technology?

Acoustic devices for monitoring birds and bats are already available commercially (e.g. SongMeter and AudioMoth). Identification is dependent on acoustic databases and/ or expert verification used to identify the animals by sound. While libraries of bird and bat calls are already mature, databases of insect sounds are still incomplete. AI-based species recognition is improving quickly, but accuracy varies across taxa and habitats.

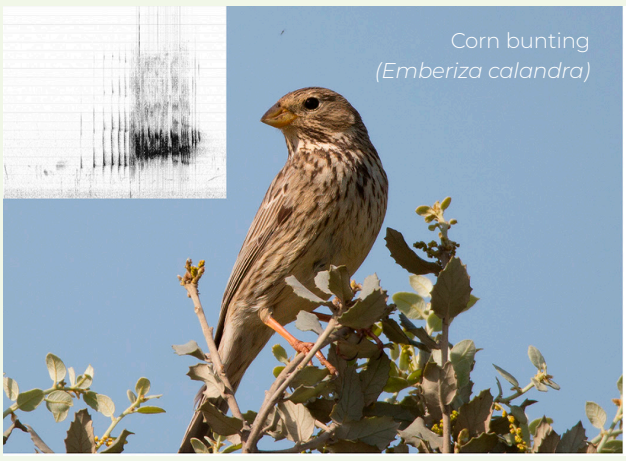
Overall, the technology is highly promising and increasingly operational. Harmonised protocols, validated identification pipelines, clear baselines, and cost-efficient data storage and hardware are still needed for large-scale implementation.

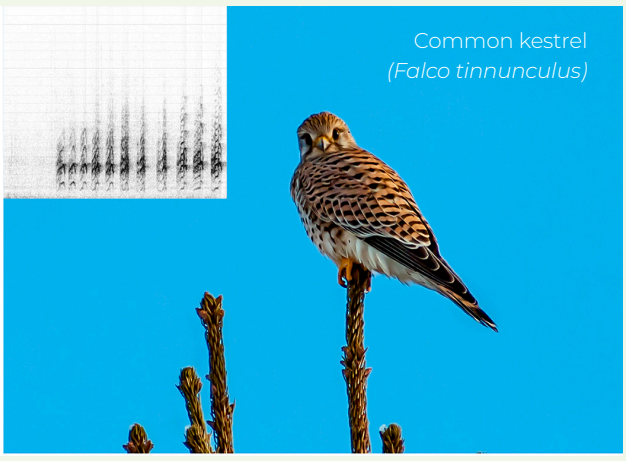
Moderate but regular maintenance ensures consistent data quality from acoustic devices. Power sources need to be checked and memory cards replaced or the data downloaded at regular intervals. Periodic cleaning of microphones and their protective housings and replacement of the microphone foam improves pick-up and reduces background noise. Firmware and software updates help maintain compatibility with analysis tools. These routine steps enable acoustic monitoring systems to operate reliably over long periods with minimal field effort.

Future applications of acoustic monitoring are likely as the hardware and machine-learning models advance and become more powerful and reliable. Potential applications include:

- **Large-scale acoustic networks:** These may operate across entire landscapes to continuously track target species and overall ecosystem health. Increasingly precise sound analysis will enable fine-scale behavioural studies about breeding success, predator-prey interactions and species responses to environmental stressors.
- **Long-term acoustic datatsets:** These may be used in the development of policy-relevant biodiversity indicators. Acoustic monitoring has the potential to become a cornerstone of non-invasive, high-resolution biodiversity assessment across Europe.
- **Agronomic applications:** These may include real-time species identification and automated alerts for rare, invasive or pest species. Such alerts may become standard. In the future, the devices will be able to wirelessly send processed data directly to the user.

In Austria, BioMonitor4CAP acoustic devices captured 63 bird species, whereas only 20 species were identified through traditional bird counts. Nine of the bird species were of special conservation interest in the Austrian farmland bird index. The traditional methods identified only two species in the Austrian farmland bird index. © C. Scherber





SAY CHEESE! CAMERA TRAPS FOR IDENTIFYING INSECTS

Camera traps are designed to automatically capture high-resolution pictures or short video sequences of animals as they move through a defined field of view. Camera traps include more familiar wildlife cameras and cameras calibrated for insect monitoring.

In insect monitoring, the cameras are adjusted for the small size of the insects, which can be enticed toward the camera with an appealing substance such as a scent or with a coloured surface that mimics a flower.

The benefits of automated motion-triggered or time-lapse cameras are that they provide a non-invasive, non-lethal method to document activity and can provide standardised, scalable, and timely data about insect communities or other wildlife.

Camera settings can be adjusted for a continuous visual record of species presence and behaviour. With the right analysis, this can provide a good overview of species abundance. Applications include:

- **Comprehensive biodiversity assessments:** Camera traps can be used to monitor a wide range of animal groups, including insects, mammals and birds. The data can be used to understand the richness and abundance of species, patterns of their behaviour, and establish realistic baselines about farmland biodiversity. This knowledge can be applied to better understand crop pollination, pest suppression and nutrient cycling.

- **Detection of pest and beneficial organisms:** Camera traps can provide early detection of pest species as well as pollinators and predatory species that feed on pests. Such identification supports more targeted management strategies including integrated pest and pollinator management (IPPM).

- **Activity patterns and behaviour:** Continuous monitoring allows researchers to better understand the daily rhythms of the target species, their seasonal dynamics, and interactions within and across species. In insect monitoring, this information supports fine-tuning of interventions including when they are needed and what time of the day would be most effective for pest control.

DIOPSIS insect camera is an automated solar powered camera trap that uses a large yellow screen to attract insects. © C. Scherber



What is the status of camera trap technology?

Commercial wildlife camera traps are already widely available and robust, but camera traps suitable for insect monitoring are currently in a transitional phase between research prototypes and broader practical deployment. Features of insect-optimised systems include macro-capable optics, high resolution images, sufficient power supply, and automated image analysis.

AI-supported identification is being developed by several research groups and companies. These tools are not yet fully standardised or validated across habitats and taxa. Reference databases are still incomplete. Image-based identification also has its limits – some species can only be definitively identified through close examination, e.g. dissection. Overall, the technology is promising, but widespread use in large-scale monitoring programmes will require further refinement, benchmarking, and cost reduction.

Moderate but regular maintenance ensures consistent data quality from camera traps. Batteries or solar-powered systems need to be checked and memory cards replaced or the data downloaded at regular intervals. The lenses and their protective housing should be checked and cleaned periodically. Software updates and occasional recalibration of image-recognition algorithms help maintain data quality. With these basic steps, camera traps can operate reliably for extended periods with minimal human intervention.

Future applications of camera traps are expected to expand significantly as the hardware and AI-based species recognition are improved. Automated identification of insects to genus and species level will enable real-time biodiversity monitoring and early-warning systems for invasive species. Integration with sensors collecting other types of environmental data could provide a holistic view of ecosystem dynamics. Additionally, interactions can be monitored for better understanding of dependencies including foodwebs.

In farmland, camera traps may be used to support precision farming by monitoring insect activity in relation to crop production to reduce the use of pesticides. Camera-based monitoring could become a cornerstone of scalable, non-invasive farmland biodiversity assessment across Europe.

There are many types of camera traps, including small cameras that can be attached to trees, fences or temporary posts that can be removed during field work. © A. Kirse





IS THERE AN APP FOR THAT? SMART APPS FOR SPECIES IDENTIFICATION

Apps and digital identification tools use smartphones or tablets to identify species based on user-provided observations such as photos or sound recordings. Apps can be used to identify plants and animals – including birds, insects and spiders – in the field.

Identification apps rely on machine-learning models that are trained on large reference databases. Many platforms also use crowdsourced expertise for verification of species identities. Identification apps include Merlin, Pl@ntNet, iNaturalist, and ObsIdentify.

The benefits of digital identification apps is that they enable non-invasive, standardised, and scalable data collection by a wide range of users, including farmers, land managers, and citizen scientists. Applications include:

- **Species identification for non-experts:** Smartphone apps make it easy for people to record and identify plants and animals. The apps support initial identification of birds, insects, and plants.
- **Biodiversity monitoring and citizen science:** Expert-verified sightings submitted by large numbers of users can be aggregated to assess species distributions, seasonal dynamics, and changes over time. This expands the coverage compared to traditional field research by scientific experts.
- **Early detection of invasive or rare species:** Digital identification tools can support early reporting of invasive species, pests, and observations of rare and protected species.

What is the status of species identification app technology?

Species identification apps are already widely available and actively used. Their accuracy varies depending on species group, regional reference data, and image or sound quality. Identification for birds and plants is generally high, but insect identification is still challenging in some cases, especially for morphologically similar or rare species.

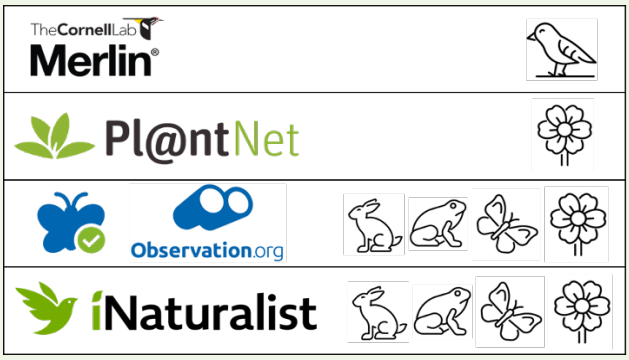
Overall, these tools are operational and mature for many applications, but their use in formal monitoring schemes requires quality control, validation, and clear guidance on uncertainty.

Additionally, formal monitoring requires standardisation about where and when recordings are made, as well as how many recordings are collected. It should also be taken into account that this approach does not provide data on species abundances.

Maintenance requirements are low and mainly involve regular software updates and user guidance to ensure consistent data quality. No dedicated field equipment is required beyond standard mobile devices.

Future applications for apps are expected to expand as reference databases and improved AI models become more reliable in identification across taxa and regions. In the future, they may support near real-time biodiversity reporting and automated alerts for invasive species. The integration of digital apps into national and European monitoring frameworks further highlights the increasing importance of citizen science. Combined with expert validation, app-based observations show the potential for development of policy-relevant biodiversity indicators.





Some apps, like Merlin and PlantNet, focus on birds and plants, respectively. Others provide identification for a wide range of taxa. Image on the left © A. Kirse

Precision-farming plant identification systems identify plants in the field

Precision-farming plant identification systems identify crops and weeds directly in agricultural fields. These systems may be integrated into farm machinery (e.g. band spray hoes) or may be attached to drones or tractors. They often combine high-resolution RGB imaging with multispectral sensors and AI-based classification.

The benefit of these systems is that they are designed for operational use in agriculture and support automated or semi-automated management decisions. They can be used for:

- **Optimised farm management including crop and weed differentiation:** Precision-farming systems enable reliable differentiation between crops and weeds, which supports targeted mechanical or chemical weed control. By linking plant identification with spatial data, these systems support site-specific management for more targeted input use and lower environmental impacts.
- **Monitoring of plant communities in agricultural landscapes:** These tools can provide information on non-crop vegetation as part of assessments of plant diversity and habitat quality in farmland.

What is the status of precision-farming plant identification technology?

Precision-farming plant identification systems are already operational for specific applications such as weed detection and used in commercial farming. However, performance varies across crop types, growth stages, and environmental conditions. Identification of non-crop and rare plant species remains limited. Widespread use in biodiversity monitoring is generally not planned for and will require further development, benchmarking, and integration with ecological assessment frameworks. System maintenance includes regular calibration of sensors, cleaning of optical components, battery or power -supply management, and software updates.

With routine maintenance, these systems can operate reliably over long periods with limited manual intervention.

Future applications are expected to combine plant identification with real-time decision support, autonomous machinery, and farm management platforms. In the long term, precision-farming technologies could contribute to large-scale monitoring of plant diversity in agricultural landscapes and support biodiversity-friendly farming practices. Additional developments are focused around insect pest and plant pathogen identification.

Identification apps are a low-cost tool that can be used for casual identification, as monitoring tools, and to inform farming practices. Machinery-mounted plant identification systems are used for precision agriculture. © C. Scherber



WHY MONITOR BIODIVERSITY? A FARM MANAGEMENT PERSPECTIVE

Farmers already use a variety of tools and professional knowledge to understand what is happening on their farm and in their production. Modern biodiversity monitoring tools add to the toolbox by enabling systematic monitoring and data collection to provide more and higher quality information about the farm and landscape level biodiversity

The benefit of tools and techniques like eDNA soil samples, camera and audio traps, remote sensing and identification apps for farmers are that they can help to provide a "health check" that tracks changes in fields, soils and habitats over time.

- **Risk reduction:** Early detection of pollinator decline, emerging pests, soil issues or drought enables preventive responses and reduces income shocks.

- **Targeting of inputs:** Timely and spatially precise information facilitates evidence-based production strategies such as integrated pest and pollinator management (IPPM). Targeted input use optimises nutrient availability, crop protection and livestock health and can reduce the environmental impact of farming while saving money.

- **Compliance and access:** Credible monitoring can underpin result-based agri-environmental schemes, nature credits, and other emerging market or certification requirements.

- **Climate adaptation and farm design:** Knowledge of baselines and trends help farmers adapt to a changing climate. Biodiversity monitoring can provide knowledge about pests and diseases and support farmers in choosing crop varieties most suitable to their conditions. Knowledge of the farm's biodiversity can help farmers in (re)designing their farms to improve their farm design in areas such as drought resilience and promoting insect pollination of crops.

There are many ways to implement biodiversity monitoring on the farm, and the monitoring can provide benefits to the farm. A clear goal and good planning will facilitate a smooth monitoring process that produces useful results.

Using a time-lapse camera trap to capture flower-visiting insects. © C. Scherber



Preconditions for sustained uptake

BioMonitor4CAP project identified three essential conditions for farmers to conduct biodiversity monitoring. If any condition is absent, monitoring often remains an unimplemented idea:

- **"Can we actually do it?"** Capacity includes basic skills, sufficient labour resources, simple equipment routines (battery/storage checks), and confidence to act on results.
- **"Is the system workable?"** Opportunity includes the presence of clear procedures, predictable payments and controls when the monitoring is part of a scheme, sufficient and accessible advice and training, practical tools, and manageable bureaucracy.
- **"Is it worth it?"** Motivation includes the perceived benefits to the farm, including risk reduction, input savings, payment or market prospects, and proportional effort versus payoff. Farmers may also be motivated to participate in monitoring through their personal interests in biodiversity, technologies or developing the farm.

Advisory services can assist farmers in becoming aware of tools and services for monitoring biodiversity and how these may be used on the farm. In the absence of biodiversity monitoring programmes, farmers and farm advisors can consider how biodiversity monitoring might be used in meeting the farms' goals. Key considerations include what biodiversity to monitor, why to monitor, and how. The cost of the monitoring, equipment and analysis are important considerations.

Suggestions for getting started with biodiversity monitoring

- **Start with a clear goal for the monitoring.** Choose a priority that matters now, for example: soil performance, pest pressure, drought risk, pollination/beneficial insects, or keeping margins and habitats in good condition. A clear goal prevents monitoring becoming "extra work with no return".
- **Choose a realistic level of monitoring.** Start small and build up. App-based monitoring using photos is low-cost and simple. Automated seasonal devices are easy to install but may be costly and require regular maintenance and data management. Find out what kind of services are available for soil eDNA samples in your area, how much they cost and whether there is support for interpreting the agronomic relevance of the results.
- **Establish the division of labour for the monitoring.** Monitoring works best when someone carries responsibility for the monitoring. Responsibilities include who takes samples and conducts maintenance on the devices, who maintains data and the records of the observations, and who will interpret the results. Special training or the aid of a trained expert may be required for interpretation of technical results such as from eDNA.
- **Plan for the "hidden workload".** It is important to account for the operational workload. Workload varies according to the technology. For automated devices, batteries or other power sources must be maintained and data uploaded so that devices do not run out of memory and stop recording. Field-mounted devices must be placed securely and be kept clean and free of any obstructions. Seasonal access and device location in consideration of the field work are important considerations. Devices may need to be secured against theft or easily removable depending on context.

FARMER AND ADVISOR VIEWS ON BIODIVERSITY AND MONITORING

Farmers and advisors are central to farmland biodiversity monitoring. We conducted 30 focus groups with farmers and advisors in in Austria, Bulgaria, Finland, Germany, Poland, and Portugal to ascertain their views related to farmland biodiversity. We were specifically interested in their impressions and experiences with farmland biodiversity monitoring.

Each country held five focus groups across different production sectors: arable field, horticulture, dairy, agroforestry, mixed farming, farming in protected areas, and high nature value grazing. The researchers selected farmers and advisors with prior experience in biodiversity measures to participate. Both conventional and organic farms as well as farms of different sizes were included. A total of 112 farmers and agricultural advisors participated.

Focus groups started with a discussion about what the farmers and advisors consider good farming. Participants indicated that a good farmer produces high-quality foods, promotes biodiversity and nature conservation, runs an economically viable farm using best practices and takes care of their own well-being. A good farmer also improves soil health and ensures that the land is passed on to the next generation in better condition. They noted that farmers will have differing definitions of what constitutes a good farmer:

This depends on what we understand as 'good'. For some, if this brings enough income in the long term – that would be enough. For others – this might include also other factors, like biodiversity conservation. My understanding is that these two components are tied together and the good practice must actually consider biodiversity conservation.
– Farmer, 'field crops' focus group, Bulgaria

Participants broadly recognised biodiversity as important to agriculture. They discussed benefits provided by biodiversity, including the role of wild pollinators in crop production and predatory insects in pest protection. Some farmers also described a stewardship relationship toward managing farmland biodiversity:

...when you go into the meadow and everything jumps away from you, there's a huge swarm of insects in front of you. I only found out over time that this is not normal, that it's not like that anywhere else. And that's why we found our joy. And that's how you start to take an interest in it and manage it.
– Farmer, 'grazing' focus group, Austria

Some participants also considered that farmers are 'at war' with biodiversity and asserted that there is little awareness of biodiversity. Participants identified challenges in the agricultural subsidy system as part of the problem when it comes to farmland biodiversity. They viewed poorly planned policy, including some agri-environmental programmes, as hindering farmland biodiversity conservation.

Experiences and views on farmland biodiversity monitoring

The interviewed farmers and advisors had only limited experience with farmland biodiversity monitoring overall and no experience with biodiversity monitoring using the automated devices in BioMonitor4CAP. They explained that they engage in informal biodiversity monitoring such as observation of large predators like jackals in Bulgaria and wolves in Finland as well as self-monitoring of crop pests. In some countries, the farmers already use mobile phone cameras to document biodiversity, the landscape or their farming practices for authorities as part of various payment or certification schemes. Participants identified uses for some of the monitoring technologies:

Phone-based approaches were identified as accessible due to the ubiquity and familiarity of mobile phones:

Mobile phone camera-related innovations [are familiar], so they could also be useful [for monitoring]
–Advisor, 'field crops' focus group, Finland

Soil eDNA sampling where farmers or others collect a soil sample and send it to a lab for analysis generated interest:

I am not yet familiar with soil sampling with eDNA determination, and we have never done this before. That would be very interesting and also something I would want to implement at and on the farm.
– Farmer, 'field crops' focus group, Germany

Remote sensing appealed to some farmers managing large areas:

The most useful methods, in my work, are the remote sensing methods, using drones or satellites to cover extensive areas of hundreds or sometimes thousands of hectares.
– Advisor, 'agroforestry' focus group, Portugal

The main challenges farmers identified to carrying out potential biodiversity monitoring included lack of time, the need for training, and interpretation of the scientific results for their relevance to the farm. Other concerns included cost of the equipment, securing it from theft or damage and privacy issues related to the data collection – e.g. audio recording devices. The farmers were understandably reluctant to take on additional work without a monetary incentive or clear benefit.

In the future, the EU may include farmland biodiversity monitoring as part of EU-wide biodiversity monitoring or as a means to prove results for results-based agri-environment payments. The farmer-advisor focus groups show that farmers may be willing to try out farmland monitoring technologies on their farms, but cultural acceptance amongst farmers depends on addressing farmer concerns and the practical issues of biodiversity monitoring.

Views on Monitoring

Focus group participants were provided with descriptions of the technologies and tasks that farmers might be asked to carry out. They did not oppose on-farm biodiversity monitoring, but they did express concerns ranging from privacy issues to who is going to pay for it and whether the data will be useful for them in their farming.



Soil sampling package / eDNA barcoding
- Collect soil samples at pre-defined spots on the farm
- Submit soil samples via pre-paid envelope



Optical / Camera
- Collect memory cards
- Upload videos to server
- Charge batteries



Acoustic / Audiomoth
- Collect memory cards
- Upload videos to server
- Charge batteries



Remote sensing / Periodic sensing with optical, radar and quadcopter-based tools
- Wireless internet connection
- Technical know-how/service
- Battery charging



Traditional methods
- Bird counts
- Transect walks
- Traps



Other methods, ideas?
- Innovative biodiversity monitoring methods

WHAT IS THE OUTLOOK FOR FARMLAND BIODIVERSITY MONITORING?

Technological advances to collect data on biodiversity are developing rapidly and have new applications for farming and biodiversity conservation in farmlands. The EU is funding projects such as BioMonitor4CAP to understand how to leverage the technologies to systematically monitor biodiversity and strengthen the resilience of European agriculture.

Several EU developments suggest that farmland biodiversity monitoring is likely to become more prominent in the future. The legislative environment for biodiversity conservation has been strengthened with the EU Nature Restoration Regulation (Regulation (EU) 2024/1991). This EU-wide law is a key element of the EU Biodiversity Strategy and obligates Member States to increase biodiversity. Obligations require verification, and the EU is also exploring the development of biodiversity monitoring across Europe with grid-like monitoring coverage. Such monitoring would ideally include all habitat types, including farmland. Further, the forthcoming Common Agricultural Policy is likely to have an increased emphasis on documented environmental results to receive agri-environmental payments.

Public participation is a feature of EU environmental law and policy, and increasing attention is being given to involving farmers as 'citizen scientists' (Alblas and van Zeben, 2023). The involvement of farmers in biodiversity monitoring can increase knowledge about biodiversity in farmlands and also help to make conservation work by farmers more visible.

Advisors and farmers should stay abreast of the rapidly developing field of biodiversity monitoring for the opportunities the technologies may provide for farmers, but also for how the growing availability of eDNA barcoding, audio and image capture, remote sensing and other technologies may influence agricultural policy, the development of machinery and practices, and more.

Agricultural advisors have an important role in providing their clients with information on what biodiversity can tell farmers about the health of their farms and what types of services are available for biodiversity monitoring. Early familiarity will also prepare farmers to benefit from voluntary monitoring programmes in the future.

Farms are integral to protecting biodiversity. Farmland biodiversity supports sustainable, resilient farms. © T. Birge



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