The FRAMEwork approach to farmer-based biodiversity and ecosystem services monitoring

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1 Background to the FRAMEwork project

1.1 FRAMEwork Project Executive Summary

Biodiversity is essential for agroecosystem resilience, sustainability, and long-term food security. Traditionally, management for short-term economic returns has taken priority over management for the environment. Current mechanisms for compensating and encouraging farmers to apply biodiversity sensitive management strategies are often inefficient, being applied at individual farm rather than landscape level, and tend to be generic solutions, imposed from the top down at an EU or national level. Monitoring is rarely carried out and there is therefore little scope for evaluating the success of strategies in achieving improvements to farmland biodiversity.

The FRAMEwork project has been designed and develop a novel alternative to this called the **FRAMEwork System for Biodiversity Sensitive Farming** to enable the transition of EU farming systems to a position where they can conserve biodiversity and benefit from the enhancement of ecosystem services, while mitigating agronomic or economic risks. The FRAMEwork System combines the following elements:

- **Advanced Farmer Clusters** – local farmer groups working as a collective to deliver landscape scale management, supported by a Cluster Facilitator with expertise in agriculture and the environment, and linked to a local Cluster Stakeholder Group to inform and promote policy and practice, organised into regional, national, and international networks.
- **Technical Resource** – technical specialists associated with the regional, national, international networks to provide technical information, methods, and tools to support agrobiodiversity monitoring, management and policy including the dedicated DSTs – FRAMEselect and FRAMEtest.
- **Scientific Innovation** – researchers associated with regional, national, international networks to provide knowledge on the ecology, sociology and economics that underpins the functioning of sustainable agricultural systems.
- **Citizen Observatory and Information Hub** – an open access platform to support FRAMEwork networks, sharing activities, information, data and resources between farmers, scientists, policy makers, and citizens.

The FRAMEwork project designs, builds, tests, and deploys a prototype of the FRAMEwork System for Biodiversity Sensitive Farming and works with 3 concepts important to the success and delivery of the project: (i) promoting collective landscape management; (ii) applying the approach across a diversity of European farming systems; and (iii) understanding and supporting the social and ecological change associated with a transition to biodiversity sensitive farming.

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1.2 Project Partners

No	Participant organisation name	Type	Country
1*	The James Hutton Institute (HUTTON)	Research Inst	UK
	Game and Wildlife Conservation Trust (GWCT)	Non-profit	UK
3	Groupe de Recherche en Agriculture Biologique (GRAB)	Non-profit	FR
4	Universitaet fuer Bodenkultur Wien (BOKU)	University	AT
5	Eesti Maaulikool (EMU)	University	EE
6	Hoehere Bundeslehr- und Forschungsanstalt fuer Landwirtschaft Raumberg-Gumpenstein (AREC)	Research Inst	AT
7	Fundacion Artemisan (ARTEMISAN)	Non-profit	ES
8	Scuola Superiore di Studi Universitari e di Perfezionamento Sant'anna (SSSA)	University	IT
9	The University of Hertfordshire Higher Education Corporation (UNI OF HERTS)	University	UK
10	Centro de Investigacion Ecologica Yaplicaciones Forestales Consorcio (CREAF)	University	ES
11	Institut National de la Recherche Agronomique (INRA)	Research Inst	FR
12	Internationales Institut fuer Angewandte Systemanalyse (IIASA)	Research Inst	AT
13	Universiteit van Amsterdam (UvA)	University	NL
14	Luxembourg Institute of Science and Technology (LIST)	Research Inst	LU
15	Universitaet Osnabrueck (UOS)	University	DE
16	Taskscape Associates Limited (TAL)	SME	UK
17	Ceska Zemedelska Univerzita v Praze (CULS)	University	CZ
18	Nordisk Fond for Miljo og Udvikling (NORDECO)	SME	DK

*Coordinating institution

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1.3 Purpose and structure of the report

The purpose of this report "*The FRAMEwork approach to farmer-based biodiversity and ecosystem services monitoring*" (D3.2) is to describe and synthesise insights from work taking place in the context of *WP3: Citizen Observatory and Information Hub*. The main objectives of WP3 are:

- to establish an in-situ citizen-based biodiversity observatory around 11 FRAMEwork Farmer Clusters as well as an online Information Hub (O3.1);
- to develop suitable approaches to engaging farmers in biodiversity observations using citizen science tools and methods (O3.2);
- implement engaging citizen monitoring and observations campaigns locally to raise public awareness of biodiversity (O3.3);
- connect with other biodiversity monitoring initiatives and networks to exchange knowledge and maximise joint impact (O3.4);
- as well as to ensure data interoperability of farmer and citizen generated data with other sources, such as the harmonised cluster monitoring data (WP2/WP5) and external data platforms, such as GBIF (O3.5).

The associated *Task 3.2 Citizen science monitoring with farmers: process, toolkits and training* encompassed the development of operational activity and engagement pathways for monitoring training and data collection working with famers in Farmer Clusters (FCs) as well as the wider farming community via existing monitoring or training programmes. This task is also directly linked with WP2, the establishment and management of FCs and facilitator training as well as WP6 investigating the effects of farmers' engagement in observation activities on their attitudes towards biodiversity-friendly farming.

The report is structured in the following way. Chapter 2 provides a brief overview of the context of citizen science and participatory approaches in the agri-food and agri-environmental research domain, where farmers and farmland communities have been engaged in monitoring and observation activities for a long time. Chapters 3 and 4 describe the process for and outcomes of jointly developing and implementing monitoring and observation activities with FC partners and farmers via an action-based approach considering the real-world context of the farmers, their interests and needs. Chapter 5 presents the emerging activity pathways for engaging farmers in biodiversity and ecosystem services (ES) observations and provides detailed use cases from the FRAMEwork FCs for each pathway. Chapter 6 summarises the capacity building and training approach, observation protocols and tools as well as other materials and resources used to support the implementation of farmer-based biodiversity and ES monitoring and observations locally. Chapter 7 provides a discussion and considerations for the uptake of the activity and engagement pathways as well as observation protocols and tools in other existing FCs and farming contexts with similar aims of enabling farmers and rural stakeholders to become more knowledgeable of local biodiversity and to better manage land to support it.

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2 Farmer-based citizen science and monitoring

The engagement of farmers, farming communities and other agri-food practitioners in agri-food research has a long history. Since the 1980s, farmer-centric and participatory approaches have been pursued to increase the local relevance and applicability of research as well as to empower farmers to monitor and gather evidence to inform and advance land management practices accordingly (van de Gevel et al., 2020). More recently, citizen science and related approaches, including ICT-enabled data collection and interpretation, which developed rapidly in the environmental sciences and ecology, have entered the domain of agri-food and agri-environmental research (Dehnen-Schmutz et al., 2016; Vásquez-Bermúdez et al., 2019). Common themes and topics of such citizen science initiatives include soil health, climate adaptation, pest and pathogen monitoring, invasive species, pollination and inputs and outputs, amongst others (Ebitu et al., 2021). For example, farmers, agricultural practitioners and farming communities have been involved in earthworm sampling in arable fields (Stroud, 2019), the study of seasonal availability of pollen sources for honey bees (Brodschneider et al., 2019), farmland biodiversity monitoring (Billaud et al., 2021; Ruck et al., 2024) or crop variety management for climate adaptation (van Etten et al., 2019). Current initiatives which employ citizen science and participatory monitoring and observation activities and deliberately engage farmers and farming communities include the "ÖPUL Naturschutzmonitoring mit LandwirtInnen" (nature conservation monitoring with farmers) in Austria, the "Observatoire Agricole de la Biodiversité" (agricultural observatory of biodiversity) in France, the "Boeren Insecten Monitoring Agrarische Gebieden" (insect monitoring with farmers in agricultural areas) in the Netherlands or the international "Farming with Nature" initiative of Earthwatch Europe, supporting farmers in assessing farmland soil health, freshwater resources and biodiversity. Such initiatives focus on specific monitoring activities, data collection, and targeted management advice as well as related funding schemes. For example, the biodiversity monitoring with farmers in Austria is directly linked to a results-based payment scheme, where farmers receive monetary incentives for monitoring biodiversity and implementing biodiversity improvement measures.

The above examples include the design and implementation of both top-down and bottom-up approaches as well as combined forms where certain aspects of the research process are prescribed, while others are co-developed or jointly evaluated with farmers. Top-down approaches include activities overseen by scientists and expert practitioners and they are directed largely by agricultural research or policy agendas. Bottom-up approaches enhance collaborative learning and knowledge production based on local farmer and farming communities' needs and interests to inform agricultural action and decision-making.

Additionally, the varied practices of citizen science and participatory research can take different forms and roles depending on the context of their implementation. Participants' varying levels of engagement in the stages of the research process has inspired different models of citizen science participation, such as consulting, contributory, collaborative, co-created or collegial (Shirk et al., 2012). Apart from focusing on traditional steps of the research process, citizen science practices also deliberately include aspects of awareness raising, learning, capacity building and communication activities (Haklay et al., 2021). Awareness raising and capacity building are essential building blocks to enable deeper engagement in the stages of the research process. It is, however, not required to gain all relevant skills prior to any engagement with citizen science. Citizen science practices themselves offer valuable learning-by-doing and up-skilling opportunities as part of the process.

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3 Action-based approach, underlying concepts and models

The FRAMEwork project took a bottom-up and action-based research approach to developing biodiversity and ES observation and monitoring activities with farmers in FCs. This approach was chosen as it allows to cater directly to the real-world context of the farmers, as well as their interests and needs in terms of biodiversity and ES.

Action-based research is a method commonly used for improving local practice through an iterative process (Figure 1w) and by directly working with those affected by or concerned with an issue or ambition. It can also be used to develop suitable and practice-oriented approaches and actions for a specific context and community. Several key characteristics of action research (Koshy, 2010) proved to be both highly relevant and challenging for the development of the FRAMEwork approach. Action-based research is collaborative and driven by a shared purpose. It is situated and context specific and dependent on input, reflections and interpretations by those involved and hence, highly uncertain in its outcome. Knowledge creation and development is directly related to action on-site. It involves iterative problem solving to improve practices. Developed solutions will not be final or absolute and remain open to ongoing adaptation.

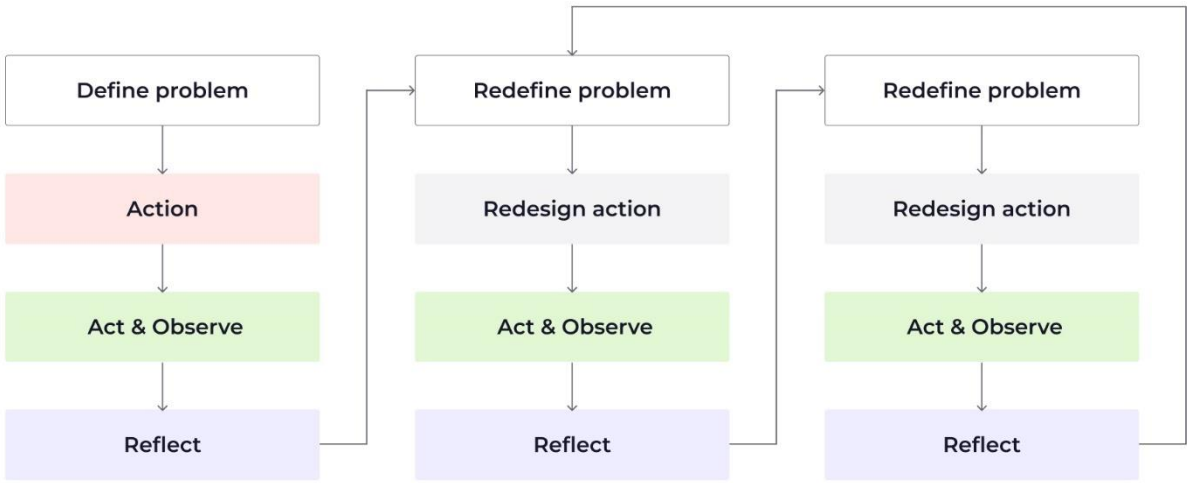

Figure 1. Research and learning cycle for adaptive and collaborative development of actions and solutions (adapted from Cornish et al., 2023).

Furthermore, building relationships and trust amongst those involved is an essential enabling condition for action-based research to succeed and to bring about implementable solutions and change as envisioned. To set and manage realistic expectations, it is also critical to establish mutually accepted working practices and a common understanding of the purpose of collaboration and the challenge to be tackled together (Cornish et al., 2023). This aspect includes recognition of time, resources, skills and knowledge available, as well as the likelihood of them being unequally distributed across those collaborating.

In addition to taking an action-based, iterative research and learning approach, our thinking was also informed by a model of local stakeholder engagement at the science-society interface (Danielsen et al., 2022) and the concept of value creation stories (Wenger-Trayner et al., 2011). The model of local stakeholder engagement, on the one hand, outlines different modes of interaction between scientists/researchers and local communities. These proposed modes of interaction include, for

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example, activities where communities/citizens primarily collect data for science, consultations with/without follow-up or feedback of results as well as closer engagement between scientists and communities. The models were useful to identify and distinguish new emerging patterns of collaboration between farmers and facilitators/facilitating teams in the process of jointly developing observation and monitoring activities. The framework for value creation in communities, on the other hand, describes how groups and communities can develop a common purpose and aspirations and achieve value-added outcomes via shared activities mediated by strings of storylines and developing narratives. The framework was useful to identify the potential contribution of different observation and monitoring activities and associated narrative forms to strengthen FCs as local learning communities with a shared interest and purpose to improve farming practices for the benefit of biodiversity.

Taking an action-based approach imparts inductive qualities to the process, whereas using guiding models and conceptual frameworks offers deductive qualities. The emerging patterns and insights arise by combining these inductive and deductive aspects and they inform the iterative formulation of more generic activity and engagement pathways as outlined in Chapter 5. The following chapter describes how the action-based process was implemented in the 11 FCs of the FRAMEwork project.

4 Implementation in and with FRAMEwork Farmer Clusters

4.1 The 11 FRAMEwork Farmer Clusters

Eleven FCs across Europe are part of the FRAMEwork project. FCs are regional communities and groups of farmers who share knowledge and support to conserve and enhance the biodiversity and ecological health of their farming landscapes. FCs are supported by a FC facilitator or facilitating team with group moderation, relevant expert knowledge and support networks for the realisation of FC activities. The 11 FRAMEwork FCs have either been established from scratch or, where a FC already existed pre-project, received additional support and guidance as part of the project. The FCs (Figure 2) are situated across different climatic regions and countries of Europe, including Spain, France, Italy, Luxembourg, the Netherlands, the UK, the Czech Republic, Austria and Estonia. They cover different farming systems (e.g., arable, fruit production, grasslands and livestock) and approaches (e.g., conventional, certified organic). The associated landscapes contain a variety of additional landscape elements, such as flower areas and strips, hedges and other woody elements, shrubland, grassy strips, reed or sedge beds, wetlands, open water etc. The size of the FCs (or the total size of associated agricultural land) differs greatly and ranges from 50 ha (Val Graziosa FC in Italy) to 10,000 ha (Cranbourne Chase FC in the UK), so does the number of participating farms (from 5 in the Buchan FC to 22 in the Cranbourne Chase FC, both UK). Additional information and individual FC locations and profiles as well as videos and stories from the FCs can be found on the Recodo online platform.

The development and implementation of biodiversity and ES observation and monitoring activities with farmers based on citizen science methods was complemented by citizen science activities for the wider public and local volunteer communities around the FCs. At times, the activities overlapped, engaging both farmers and citizens at the same time. Furthermore, the situated citizen science activities took place in parallel to a harmonised biodiversity monitoring approach performed by professionally trained personnel, which applied a top-down, over-arching monitoring design across all 11 FCs of the FRAMEwork project.

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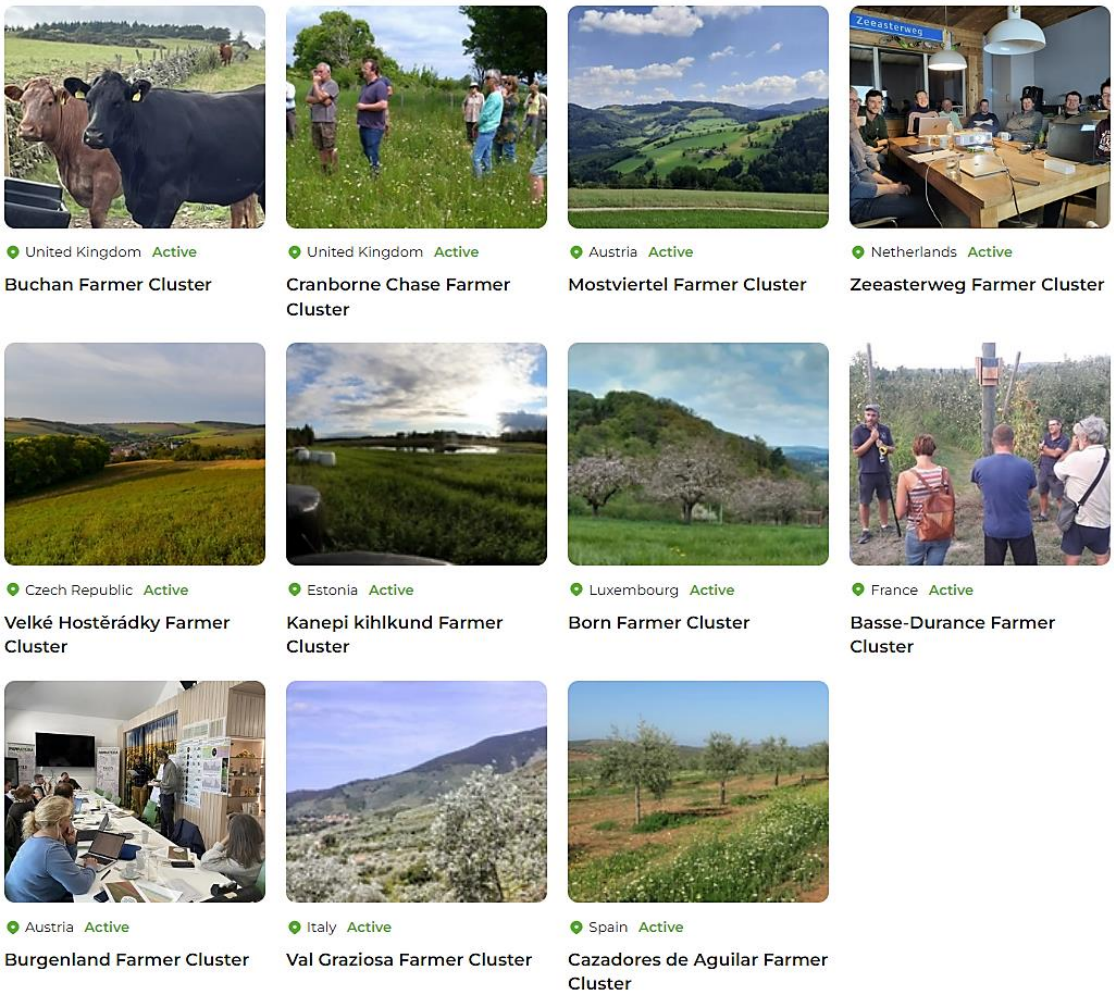

Figure 2. Overview of the 11 FRAMEwork FCs across nine European countries.

4.2 Starting conditions and expectation management

For the five-year project, the 11 FC facilitating project partners had, on average, 4 person months to co-develop and deliver farmer-based observation and monitoring activities in their FCs. These activities were developed and implemented with and by so-called FC facilitators or facilitating teams. Amongst the facilitating organisations, only some employed facilitators with experience and background knowledge in citizen science or participatory approaches. Associated capacity building and support efforts were needed to enable implementation of activities on the ground (see Chapter 6). Hence, overall, local partners faced limitations in terms of available capacity and resources.

Where farmer groups had not yet existed prior to the start of the project, the initial establishment of FCs (as part of FRAMEwork WP2 – Advanced Farmer Clusters) was started in late 2020 and at the beginning of 2021. At this time, Europe was still largely paralysed, and communities and families highly affected by the impacts of the COVID-19 pandemic. The conditions were challenging if not detrimental to the aim of setting up trusted, collaborative and place-based groups where farmers were meant to share knowledge and work together to jointly enhance farmland biodiversity. Local FC partners erred on the side of caution when setting fixed requirements and managing expectations around farmers'

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overall engagement. Not to alienate farmers during a time of crisis, the focus was set on securing farmers' agreement to allow access to their farmland for biodiversity monitoring performed by trained experts as well as participating in joint meetings to discuss monitoring results and adaptation of farming practices and measures (related to WP2). Committing to actively participate in observation and monitoring activities themselves, was not a pre-condition to becoming part of a FC or the FRAMEwork project. Furthermore, it is a central principle of the FC approach that the farmers have autonomy in deciding upon FC objectives and activities. Consequently, farmer-based observation and monitoring activities were treated optionally and to be implemented depending on farmers' interests and motivations during the five-year project.

4.3 Iterative process

Hence, the iterative action-based process to developing observation activities with farmers (under WP3) was embedded within the larger journey of the FRAMEwork project to establish and manage 11 FCs across Europe (under WP2). Activities in the FCs were focused on conducting the harmonised biodiversity monitoring across FCs as well as the co-development of biodiversity friendly farming practices and implementation of management measures (e.g., hedgerow plantings, flower strips, adapted ground cover and grassland management, habitat creation via nesting boxes etc.). The efforts to engage farmers in observation and monitoring activities varied across FCs but received overall less attention.

Planning started while the FCs were still in their early stages of formation and local FC partners were only beginning to get to know the farmer groups and started building relationships. Between 2021 and 2022, monthly recurring ideation and planning meetings were held between local FC partners and WP3 lead partner IIASA to understand the respective context, identify potential challenges and opportunities to engaging farmers in observation activities. Over time and after on-site discussions had started with farmers in the FCs the aim of meetings shifted and they were held to reflect, redefine and redesign actions (Figure 3).

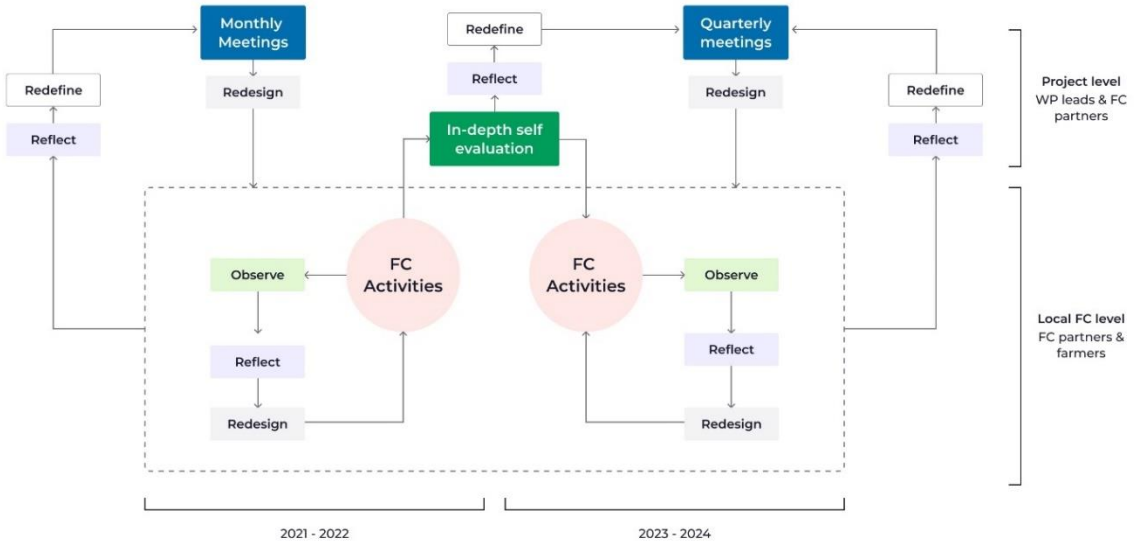

Figure 3. Stylised overview of iterative, action-based process

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In early 2023, stock was taken by all FC partners with a comprehensive self-evaluation survey provided by IIASA (see Appendix 1). This survey aimed to enable deeper reflections and discussions about process development and whether the existing course of action would be pursued further or more considerable changes in strategy would be needed to co-define and enable the engagement of farmers in observation activities. After the self-evaluation survey, iterative development was supported by quarterly reflection and planning meetings, now also joined by WP2 lead partner GWCT in parallel to implementation of activities in the FCs by local partners.

4.4 Aims of farmer-based biodiversity and ecosystem services monitoring

Farmer engagement in biodiversity and ES observation activities in the FCs was subject to the overall starting conditions, interests, needs and available resources in the FCs. Aligning with the different functions that citizen science practices offer, the primary goal was set to raise awareness about observation and monitoring opportunities and their added-value to FC farmers. This included capacity building and up-skilling to enable farmers to engage in monitoring activities and to take those forward by themselves. Efforts were taken to collect observations and data and use them to inform discussions and to reflect on local biodiversity and the effects of farming practices. Less emphasis was placed on ensuring the collection of scientifically robust data. Nevertheless, farmers also collected and shared high-quality biodiversity data for scientific purposes, e.g., via the iNaturalist platform and subsequently GBIF.

4.5 Overview of activities

Despite limited resources and challenges outlined above, FC partners devised and implemented a considerable number of local activities. About 70 events and activities were organised between autumn 2021 and 2024 across the 11 FCs, with more than 1,000 attendances of farmers and other local participants. Table 1 provides an overview of these activities, including one-off training and demo events, recurring observation and monitoring activities as well as longer-term observation projects.

Table 1. List of farmer-focused events and activities in the FCs (2021-2024). Numbers in brackets indicate the number of participants (farmers and other local stakeholders), excluding FC facilitators, researchers and experts.

Farmer Cluster	Citizen science observation and monitoring activities with farmers
Basse-Durance (France)	• Predation assessment with predation cards close/far from flower strips - farmer training and involvement, March-May 2023 and 2024 (4) • Bat boxes monitoring in orchards, farmers monitor box occupation (summertime and after harvests), 2023-2024 (3) • Bird nests observation (wintertime), 2023-2024 (3) • November 2021: Workshop with Agrinichoirs, agreement of box instalments and monitoring of bird and bat occupations. December 2021 and January 2022 – setting up box locations with the farmers. Box occupation monitoring done by Agrinichoirs in 2022 and 2023.
Born (Luxembourg)	• Wildlife camera traps in orchards and monitoring with farmers, since Sept 2022 (6) • Public BioBlitz as part of CNC 2022-2024 (>600 participants, 3-6 FC farmers/year)
Buchan (UK)	• Aden Country Park and Buchan Farmer Cluster BioBlitz, May 2023 (3 farmers + uncounted participants) • Wild edible plants identification walk and talk, March 2022 (9) • Earthworm sampling workshop, Oct 2021 (2)

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Farmer Cluster	Citizen science observation and monitoring activities with farmers
Burgenland (Austria)	• Co-development of monitoring of key species, since May 2023 (10) • Wild bee exhibition for farmers during Farmer Cluster event at Aubauernhof - May 2023 (100) • Soil structure and aggregate stability of different soils, Nov 2022 (5) • Ground dweller workshop and Mini-BioBlitz for farmers at Farm in Groß-Enzersdorf, May 2022 (20) • Earthworm sampling training for farmers and sampling on farms, April 2022 (6)
Cazadores de Aguilar (Spain)	• Soil, production and cover vegetation, March 2024 (48)
Cranborne Chase (UK)	• Farmland bird winter feeding and monitoring, Dec 2022-April 2023, 2025/25 (6) • Pollinator Identification, 2023-2024 (22) • Big farmland bird count and farmland bird ID training, Feb, 2022-2024 (30) • Introduction to arable plants, 2022 (5) • Soil assessment training and earthworm surveys, March 2022 (15)
Kanepi kihlkund (Estonia)	• Pitfall trapping protocol for ground dweller observations, June 2024 (6) • Bumblebee identification - using identification chart and on field training for farmers - July 2023 (7) • Wildlife photography training for farmers - July 2022 (7) • Hedgehog monitoring - introduction to protocol and materials for farmers - July 2022 (7)
Mostviertel (Austria)	• iNaturalist project and training for farmers, since May 2022, ongoing (14) • Biodiversity farm portraits co-created with farmers, since April 2024 (associated with activity above) (8) • Grassland monitoring on newly sown meadows, September 2024 (9) • Mostviertel Farmer Cluster meets Salzburger Flachgau, October 2023 (35) • BioBlitz with farmers during Farmer Cluster event at Aubauernhof - May 2023 (15)
Val Graziosa (Italy)	• Olive fruit fly monitoring with farmers, May to Sept 2023, repeated in 2024 (9) • Soil biological fertility assessment through QBS method, 2021-2024 (2) • Ground cover diversification and management in olive groves, 2023-2024 (7) • Local public BioBlitz, May 2024 (45) • Wild edibles walk and training, April 2024 (18) • City Nature Challenge in the Monti Pisani region, May 2023 (>100)
Vélke Hostěrádky (Czech Rep)	• Birds of prey for natural pest control, 2021-2024 (50) • BioBlitz – biodiversity path opening, April/May 2024 (250) • Co-development of biodiversity path, Dec 2022-2023 (9) • Earthworm sampling training and demo for farmers, Oct 2022 (25)
Zeeasterweg (The Netherlands)	• Farmer-based monitoring in collaboration with Earthwatch Europe, since March 2024 (9) • Introduction to BIMAG moth monitoring, July 2024 (12) • Monitoring with insect pan traps at Flevoland Bloeit, June 2023 (40) • National Bee counting day and wild bee identification, May 2022 (40)

Some of the activities are described in more detail as use cases in Chapter 5. The full collection of activities outlined in Table 1 are described in the form of "Farmer Cluster Activity Briefs" (Appendix 2), published on Zenodo. Additional short stories and news about the activities published by FC partners can be accessed on the Recodo online platform: Farmer Cluster Stories.

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5 Emerging activity and engagement pathways

From the iterative and reflexive planning and implementation of activities, embedded in the broader set of FC-related (inter-)actions, four generic activity pathways emerged to engage farmers and local communities in context-specific learning about and conducting biodiversity and ES observations using citizen science methods and approaches (Figure 4). The pathways are presented in a harmonised format, lending from the adapted models and concepts of stakeholder interactions and value creation storytelling.

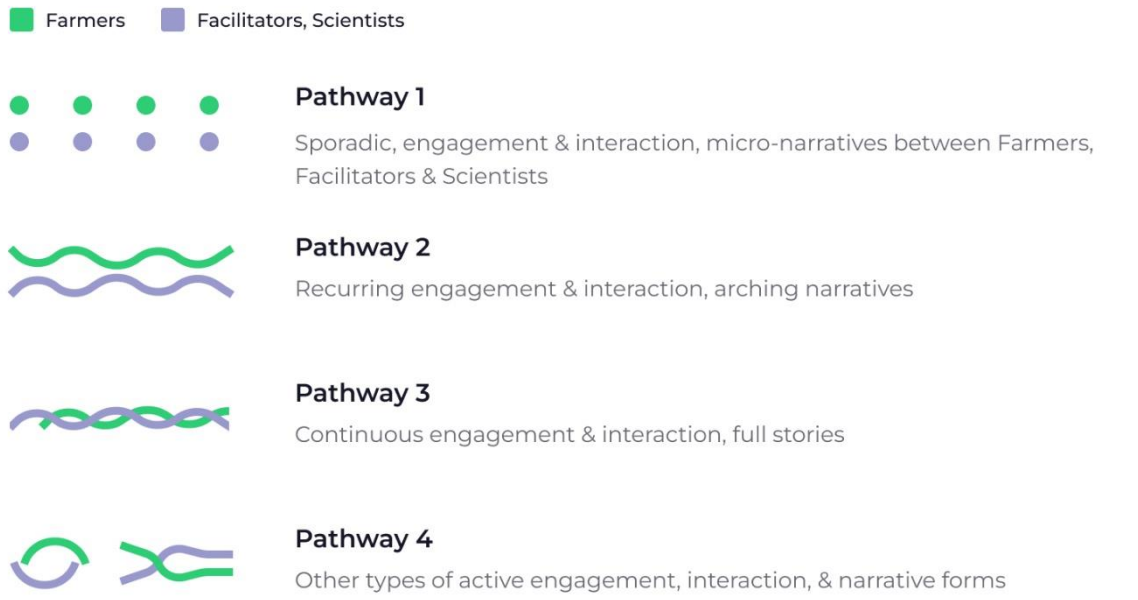

Figure 4. Engagement and activity pathways, (adapted from Danielsen et al., 2022).

Stemming from an action-based research process, the pathways entail both descriptive and prescriptive qualities. On the one hand, they are a descriptive aid based on the type of activities that have taken place in respective FCs from 2021 to 2024. On the other hand, they also represent a guiding framework to develop new activities that can engage farmers in biodiversity and ES observations. Each pathway is comprised of a set of specific aspects and considerations. These include the focus of the pathway, i.e., what it concentrates on or revolves around, its character, i.e., they type or nature of the activity, the main aim of the activity, certain must-haves to qualify for the pathway, a range of possible activity formats through which the pathway unfolds, data collection considerations as well as indications on activity occurrence over time. The pathways specifically focus on the activities with and for farmers to engage them in biodiversity and ES observations. In many FCs, these activities were embedded within a larger context of actions implemented in and with FCs. Hence, as outlined, the pathways are not all-encompassing and do not consider a full representation of relevant inter-actions that have happened in the FCs. The pathways are described in more detail in the following sections using one or two use cases from the FRAMEwork FCs respectively[1].

[1] Use case descriptions have been summarised from Farmer Cluster Activity Briefs (see Appendix 2) with AI support.

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5.1 Pathway 1: Sporadic engagement and interaction, micro-narratives

Pathway 1

Sporadic, engagement & interaction, micro-narratives between Farmers, Facilitators & Scientists

This first pathway describes engagement activities that are contained, and form, if organised in series, a rather loose string of interactions and potential for building shared focus on topics, aims and narratives in the FC. The relationship and collaboration between farmers and experts external to the FC are largely time-bound to the duration of the activity itself.

Focus: A specific topic, practice or activity related to biodiversity and ES observations and monitoring, which is locally relevant to farmers, or which is meant to increase farmer's awareness and skills. Topics are related to biodiversity and ES in farmland, including observations and monitoring.

Character: Stand-alone activities, not necessarily connected to other activities.

Aim: Awareness raising and capacity building.

Must have: Hand's on activities that demonstrate biodiversity observation and monitoring methods, biodiversity identification and introduce tools and protocols that the farmers can use themselves.

Formats: Workshops, specific training activities, active participation in existing events, organized by third parties, field walks, BioBlitz, expert talks, hands-on activities, moderated discussions, presentations, poster sessions, exhibitions, demos etc.

Data collection: Is desirable, digital or hybrid data collection tools are preferred, paper-based data collection is acceptable, if more suitable to context and participants.

Occurrence: Min. 2 events per year.

5.1.1 Use case: Cranbourne Chase – Observing and identifying biodiversity

The following activities were designed to raise awareness and improve skills among farmers and volunteers in biodiversity monitoring and sustainable farming practices. The activities were part of a series of events and a packed calendar of the Cranbourne Chase FC, but in themselves, rather loosely related. They focused on arable plant conservation, soil health, bird identification, and pollinator monitoring (Figure 5).

Arable Plants – The goal of this activity was to raise awareness about rare and often overlooked arable plant species that are essential to local biodiversity. Led by local expert, the session included a presentation on rare arable plants, supported by the cluster facilitator, and featured a few plant specimens for the participants to observe. Afterward, a guided walk took place to a plot identified as being of National Importance during a 2022 survey. Despite heavy rain, participants engaged in this hands-on learning experience. Four volunteers and one farmer participated in this 2.5-hour event. While no data was collected by participants during the training, ongoing surveys of arable plants in the FC are conducted by experts. The future plans involve continuing to cultivate and monitor these plots as long as funding is available, ensuring the preservation of these vital plant species.

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Figure 5. Wild arable plants and bird feeders in Cranbourne Chase FC.

Earthworm Surveys – This activity aimed to train farmers on a simple method to assess soil health by measuring biological activity in the soil, particularly through the identification and counting of earthworms. An expert from GWCT led the session, teaching farmers how to dig soil pits, collect and count earthworms, and assess their age to determine soil health. Five farmers and ten volunteers participated in the 1.5-hour session. The training was designed for farmers to apply the method independently on their farms, allowing them to monitor soil health over time. Although no formal data was collected during the session, one farm estate carried out comprehensive earthworm surveys on its fields and shared results with the facilitator.

Farmland Bird ID Training – This activity aimed to build farmers' skills and confidence in identifying farmland birds and encourage their participation in the GWCT Big Farmland Bird Count, which takes place annually in February. An early morning farm walk was organised to teach participants how to identify birds through sight and sound. In 2022, the event was exclusive to cluster farmers, with six participants. In 2023 and 2024, the event was opened up to citizen science volunteers, with participation growing to 20 in 2024. Each training session lasted two hours, after which farmers were asked to conduct two 30-minute bird counts on their own farms. The data collected during these counts was submitted directly to GWCT, with farmers sharing additional data with the facilitator in 2024. The plan is to encourage farmers and volunteers to continue participating in the annual bird count in future years, though further training will only be provided upon request.

Pollinator Identification – This activity aimed to train both farmers and volunteers in identifying key pollinators, including butterflies, bees, and hoverflies, and introduce them to the Flower-Insect Timed (FIT) count protocol, part of the UK Pollinator Monitoring Scheme. Led by an entomologist with the support of the cluster facilitator, the session began with a presentation on pollinator identification, followed by guided walks through wildflower meadows at Chettle House (2023) and Canada Farm (2024). Seventeen volunteers participated in 2023, while two volunteers and three farmers attended the 2024 session. Participants conducted FIT counts during the walk, and these were submitted to the Pollinator Monitoring Scheme (POMS). A refresher event was held in July 2024 to encourage more surveys, and a new green lane survey methodology incorporating FIT counts was introduced to the group for use over the summer. The methodology was shared with all volunteers to encourage further pollinator monitoring.

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5.2 Pathway 2: Recurring engagement and interaction, arching narratives

Pathway 2

Recurring engagement & interaction, arching narratives

The second pathway describes activities that are interconnected and form, organised in series, a recurring engagement with a consistent topic and related activities. The potential to strengthen a shared focus on topics, aims and narratives in the FC is enhanced. The relationships and collaboration between farmers, FC facilitators, and external experts are woven together by a common thematic thread, reinforced through cross-referenced activities and shared practices.

Focus: A specific topic, practice or activity related to biodiversity and ES observations and monitoring, which is locally relevant to farmers, or which is meant to increase farmer's awareness and skills, determined based on farmer interests and collaborative selection in the cluster.

Character: A series of events/meetings, which follow a red thread and are connected by an overarching narrative or topic. The narrative can, for example, be general and cover a wide topical area or develop from a general entry point to very specific details and knowledge about one topic or subject. Topics must be related to biodiversity and ES in farmland, including observations and monitoring.

Aim: Learning and capacity building, knowledge sharing, new insights, input to farm-level or cluster-level decision making.

Must have: Hand's on activities that demo biodiversity observation and monitoring activities, biodiversity identification and tools and protocols that the farmers can use on their own.

Formats: Workshops, specific training activities, active participation in existing events organized by third parties, recurring contribution to existing, national monitoring initiatives (setting up and facilitating collaboration with initiative), field walks, BioBlitz, expert talks, hands-on activities, moderated discussions, presentations, poster sessions, exhibitions, demos etc.

Data collection: Is desirable, digital or hybrid data collection tools are preferred.

Occurrence: Min. 2 events per year

5.2.1 Use case: Mostviertel – Observing and managing grassland diversity

The overarching goal of several recurring activities was to engage farmers in biodiversity monitoring and conservation efforts on their grasslands (Figure 6), with a particular focus on the use of citizen science tools like iNaturalist. By encouraging farmers to observe and document biodiversity, these activities aimed to enhance awareness and demonstrate the ecological benefits of sustainable grassland farming practices. Collectively, these activities emphasised farmer engagement in biodiversity monitoring and conservation of grasslands, using iNaturalist as a key tool.

iNaturalist Project and Training for Farmers: The iNaturalist project was initiated to encourage farmers to document biodiversity on their farms using the iNaturalist app. In May 2022, a training session was held for FC participants, where they were taught how to download and use the app, take appropriate photos, and understand the importance of additional biodiversity data. After the training,

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farmers engaged in hands-on monitoring in the surrounding meadows. The project is ongoing, with farmers continuously contributing data to the “Artenvielfalt im Mostviertler Grünland” iNaturalist project. By September 2024, 558 observations of 308 different species had been uploaded by the cluster members, making it a valuable resource for biodiversity data. This initiative not only sensitizes farmers to the biodiversity on their land but also provides them with a simple tool to continue monitoring independently. The project will be revisited at the annual FC meeting, ensuring ongoing farmer engagement.

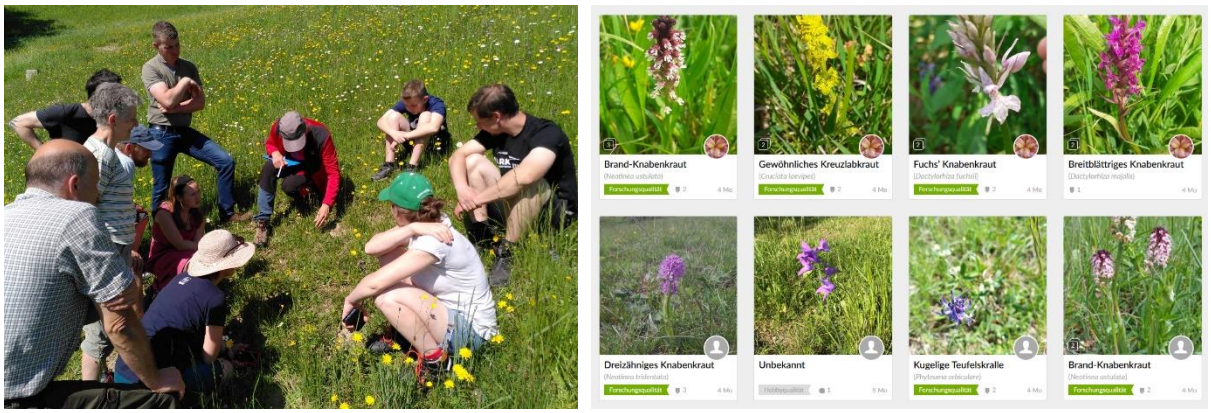

Figure 6. Biodiversity monitoring demo and observations from the FC on iNaturalist.

BioBlitz with Farmers during FC Event: The BioBlitz event, held on May 26, 2023, aimed to raise awareness of biodiversity among farmers and the local community. An informational stand was set up at the Aubauernhof farm, and participants were invited to join a guided walk across different farm habitats. During the walk, insects were caught and identified using nets and magnifying glasses, while plants and animals were recorded using the iNaturalist app. The BioBlitz demonstrated the ease of observing biodiversity and encouraged participants to continue using iNaturalist to document species on their land. The event, which lasted 1.5 hours, was part of a broader initiative to integrate farmers and local citizens into biodiversity monitoring, with future plans to host more BioBlitz events, excursions, and citizen science activities.

Grassland Monitoring on Newly Sown Meadows: This activity focused on evaluating the success of biodiversity-enhancing measures, particularly newly sown species-rich meadows. During a FC meeting in September 2024, farmers visited a farm with new smooth oatgrass meadows sown in late summer 2021. Farmers learned about managing species-rich meadows and the insects that visit these diverse habitats. Experts provided insights into wild bees' roles as pollinators and bird conservation efforts. Although no formal data collection took place during this meeting, the farmers exchanged knowledge about best practices for enhancing biodiversity. The success of these measures will be reflected upon in future meetings, promoting ongoing biodiversity monitoring and management.

Biodiversity Farm Portraits Co-created with Farmers: This ongoing project, running from 2022 to 2024, involves farmers documenting biodiversity on their farms to create “biodiversity farm portraits.” Farmers were trained to use iNaturalist and encouraged to upload their observations to the platform. The facilitator will compile the collected data and photographs into a booklet, highlighting the farmers’ contributions to biodiversity conservation. These portraits aim to educate consumers about the ecological benefits of organic farming and showcase the farmers’ efforts in promoting species

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richness. Once completed, the booklet will serve as a resource for farmers, BIO Austria, and the wider public, demonstrating that biodiversity promotion is achievable on organic farms.

5.2.2 Use case: Basse-Durance – Pest and predator monitoring in fruit orchards

The pest and predator monitoring activities in the Basse-Durance fruit orchards aimed to promote natural pest control by encouraging the presence of beneficial species like bats, birds, and insects. Through the installation and observation of bat boxes, bird nests, and the use of flower strips, these individual activities involved farmers in monitoring wildlife that helps reduce pest populations, such as moths and other harmful insects. By engaging farmers directly and providing them with the necessary tools and training, these activities sought to foster sustainable, biodiversity-friendly pest management practices that can be maintained over time.

Bat Boxes and Bird Nests Installation: The goal of this activity was to install bat boxes and bird nests in orchards to observe their long-term occupation and potential effects on controlling apple pests, especially moths. Agrinichoirs, a subcontractor, met with farmers to select appropriate plots for installation. The installation itself took two days and was carried out solely by Agrinichoirs, without direct farmer involvement. Data on box occupation was collected in 2022 and 2023, shared with INRAE, but no formal protocols, apps, or tools were used. The results will be incorporated into future monitoring activities.

Bat Box Observation (Summertime): This activity focuses on monitoring the bat boxes to measure their occupation over time and assess their effectiveness in reducing fruit damage. Farmers were provided with maps and endoscopic cameras to observe the boxes during the day (Figure 7). Several farmers participated in this observation process during summer and fall 2023. A public event, in October 2023, introduced the importance of bats for agriculture to students and the general public. While some farmers collected data, it has not yet been returned to GRAB. This training enables farmers to continue bat box observations independently.

Figure 7. Bat box monitoring.

Bird Nests Observation (Wintertime): This wintertime activity aims to monitor bird (blue tit) nests to assess their occupation and role in reducing fruit damage. Farmers were given maps and protocols to

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help them observe and clean nests to ensure the nests remain operational for the following season. Data collection occurred during winter 2023/2024, but only a few farmers have reported their observations to GRAB. The activity takes about half a day per farm, and farmers have been trained to continue monitoring independently beyond the project timeline.

Measuring Flower Strip Effects in Orchards: This activity aimed to demonstrate the benefits of flower strips for attracting beneficial insects and promoting natural pest control. Flower strips were sown during the fall/winter of 2022/2023 and 2023/2024, and predation cards with codling moth eggs were used to measure insect movement and predation rates in orchards. Farmers were involved in observing the predation cards to gauge the effectiveness of flower strips. The first results from March 2023 showed some positive effects, though complicated weather conditions limited participation in 2024. Data collected by GRAB was analysed using Excel, but no future plans for the activity are in place.

5.3 Pathway 3: Continuous engagement and interaction, full stories

Pathway 3

Continuous engagement & interaction, full stories

The third pathway describes activities that together form a consistent action over time with a clear shared focus and purpose. The relationship and collaboration between farmers, FC facilitators and experts external to the FC are built through the activity and essential for the activity to sustain and succeed over time.

Focus: An observation project is set up with/for farmers and farmers collaborate in data collection, related to biodiversity and ES observations and monitoring, which is locally relevant to farmers, or which is meant to increase farmer's awareness and skills, determined based on farmer interests and/or collaborative development in the cluster.

Character: Longer-term activity, with several and continuous points of interaction and collaboration between FC org/researchers and the cluster farmers, individual activities are all connected and part of a greater whole.

Aim: Learning and capacity building, data collection, evidenced insights, feedback to decision making and adjusted management.

Formats: Contextualised to fit the nature of the campaign e.g., workshops, specific training activities, active participation in existing events organized by third parties, field walks, thematic BioBlitz, individual data collection, expert talks, hands-on activities, moderated discussions, presentations, poster sessions, exhibitions, demos, results workshops etc.

Data collection: Is a must, data should be digitally collected and accessible, use of robust and tested protocols.

Occurrence: 2-4 f2f meetings/activities per year plus continuous support via selected cluster communication channels.

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5.3.1 Use case: Burgenland – Co-development of monitoring of key species

The co-development of biodiversity monitoring for key species in Austria is part of an effort to raise awareness among farmers and actively engage them in biodiversity conservation on their lands. The activity is aligned with the Austrian Agri-environmental Program's (ÖPUL) farmer-based biodiversity monitoring and aims to complement their efforts through additional species observation by farmers. The goals include biodiversity awareness training, the identification of key species, and recurring engagement of farmers in monitoring. The main objectives of this project are to provide biodiversity awareness training for farmers involved in the Austrian ÖPUL program and those participating in ÖKL (Austrian Board of Trustees for Agricultural Engineering and Rural Development) events, to collaboratively identify key species of interest to be monitored by farmers, expanding on the ÖPUL biodiversity monitoring, and to engage farmers in active and continuous observation of biodiversity on their farmland.

The co-development began in May 2023 with a joint online meeting (Figure 8), where farmers and experts identified species that would be monitored from 2023 to 2025. Farmers were provided with information about the selected species, particularly those with specific ecological roles on agricultural land. During this meeting, it was decided collectively that the Queen of Spain fritillary butterfly (*Issoria lathonia,* Kleiner Perlmutterfalter) would be monitored due to its importance as an indicator of biodiversity and extensive management practices in agriculture. Additionally, the plant *Stachys arvensis* (Ackerziest), which had once disappeared from arable land but has reappeared in recent years, was chosen for monitoring at the request of farmers. Following this initial meeting, materials were prepared to assist farmers in monitoring, including species identification information and specific methods adapted from existing monitoring programs. On July 6th 2023, an on-site workshop was held as part of an ÖKL event on biodiversity monitoring. After the official ÖKL part, cluster farmers and interested participants from the event were trained on the biology, significance, and monitoring methods for the selected species.

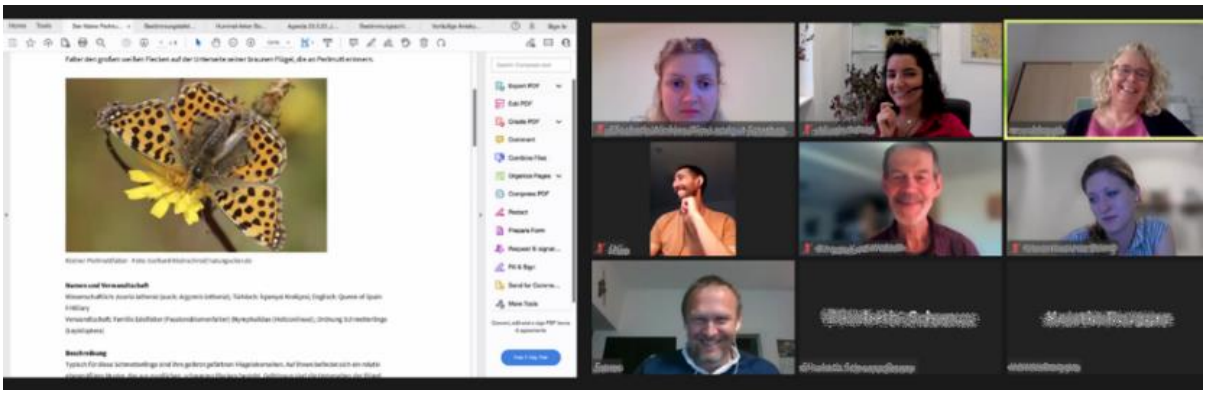

Figure 8. Co-development session and selection of key species.

Farmers were provided with materials, including a folder containing species identification keys, monitoring protocols, and data collection sheets (Figure 8). The methods for observing the butterfly and plant species were explained, and the timeframe and locations for monitoring were discussed. The goal was for farmers to regularly observe and document the presence of the selected species on their farms over a multi-year period. The project involves cluster farmers as well as other farmers

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participating in the ÖPUL monitoring program. The activity began in May 2023 with an online meeting, followed by a 1.5-hour workshop in July. Monitoring is ongoing and will continue until 2025.

Farmers were provided with tools to aid in species identification and observation, including information on identifying the Queen of Spain fritillary butterfly and the *Stachys arvensis*, which are both important for the Seewinkel region and sensitive to biodiversity loss as well as an observation protocol and data collection sheet to document their findings (Figure 9). Data collection began in 2023 and will continue through 2025. Farmers record their observations on paper, and the data will be compiled and reviewed collectively during group discussions. Farmers collect data on paper and will later share and discuss their observations in joint meetings.

Figure 9. Butterfly observation demo in the field and identification key.

The project is carried out in collaboration with ÖKL, which has integrated biodiversity monitoring into its training programs for farmers participating in the ÖPUL program. The monitoring activity is ongoing, and data will be gathered over the three-year period, from 2023 to 2025. There are plans to assess the data and discuss results with participating farmers at the end of the monitoring period. As of September 2024, the monitoring is continuing, and future plans include analysing the data and engaging in discussions with farmers to evaluate biodiversity trends on their lands.

5.3.2 Use case: Born – Wildlife camera trapping

The wildlife camera trap project in orchards was initiated to involve farmers in biodiversity monitoring and highlight the presence of nocturnal animals in these agricultural settings. This effort complements other citizen science initiatives and scientific biodiversity assessments. The project began in October 2022, and its ultimate goal is to collect, sort, and analyse biodiversity data with the collaboration of farmers and local citizens, providing insights into the wildlife present in orchards.

The project kicked off by introducing the idea to farmers in October 2022, emphasizing its benefits in promoting their orchards and expanding scientific knowledge. The first phase, now complete, involved installing camera traps on participating farms. A small training session was conducted to teach farmers how to install the cameras, maintain batteries, and manage the data collected from the SD cards. Six volunteer farmers installed 11 camera traps on their properties, capturing over 54,000 images between October 2022 and December 2023 (Figure 10). While some farmers were more involved in the camera maintenance, the supervision of a researcher from the Luxembourg Institute of Science

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and Technology (LIST) was necessary to ensure data was consistently collected and backed up. The second phase, which began in January 2024 and is still ongoing, focuses on sorting the vast collection of images. Farmers were trained to use the Picture Pile application, developed by the NODES group at the International Institute for Applied Systems Analysis in Austria. Picture Pile allows users to help classify the images by separating wildlife sightings from false triggers, such as photos of livestock, vehicles, or hikers. This app is a key tool in the data pre-analysis process. Initially, the image sorting was tested by farmers, but it is now open to citizen participation as well. The third and final phase, yet to commence, will involve a deeper analysis of the biodiversity data collected. The aim is to use the results for publication and to communicate findings with the FC. As of September 2024, the full analysis has not yet started.

Six farmers have been actively engaged in this project, with 11 camera traps deployed across different orchard sites. The first phase of data collection ran from October 2022 to December 2023, while the second phase of sorting and pre-analysis started in January 2024 and is still in progress. Farmers were trained both on-site and through presentations. The primary tool for sorting the images is the Picture Pile app, which allows widespread participation in the data classification process. The scientific analysis will be carried out using Agouti software, a specialized tool for handling and analysing wildlife data. Over 54,000 images have been collected, with 5,000 already uploaded into Picture Pile for sorting. The remainder of the dataset is stored on a LIST server and will be fully analysed using Agouti.

Figure 10. Setting up camera traps in orchards and captured wildlife.

The project aims to further evaluate the usefulness of Picture Pile and upload all images into Agouti for detailed species determination. The results will be shared with the FC, and there is potential for a scientific publication based on the data collected. The ultimate goal is to assess and communicate the biodiversity captured by the camera traps, thus contributing valuable data to both local biodiversity monitoring efforts and broader scientific research. Key partners in this initiative include the Ramborn Cider Company and the Luxembourg Institute of Science and Technology (LIST).

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5.3.3 Use case: Val Graziosa – Olive fruit fly monitoring

The Olive Fruit Fly Monitoring activity, conducted from May to September 2023, was designed to equip olive growers with the knowledge and tools needed to effectively monitor and manage the olive fruit fly (*Bactrocera oleae*), a key pest that can cause significant damage to olive crops. The overarching goal of the initiative was to train farmers to take ownership of pest management in their groves and improve their understanding of the olive fly's impact, ensuring more proactive and informed decision-making for pest control.

The training was delivered through three key sessions held in April, June, and July 2023. During these sessions, participants engaged in practical, field-based learning activities. Farmers were taken on field walks to observe the olive fruit fly population firsthand by inspecting pheromone traps. These traps are essential for capturing flies and monitoring their presence, providing an early warning system for potential infestations. Additionally, farmers were trained to identify "stings" on olives, a visual indication of olive fly infestation, and assess the level of damage. The training also focused on the importance of collecting accurate data to monitor pest trends, which could then be used to predict future outbreaks.

One of the most valuable aspects of the training was the introduction of the Poderi app, a digital tool that allows farmers to record their observations directly from the field (Figure 11). By inputting data into the app, farmers could track the pest population development in real-time and receive insights into infestation levels. This data-driven approach allowed farmers to make timely decisions about implementing control measures, such as mass trapping or applying organic treatments, to prevent further damage. For those unable to attend the scheduled training sessions, personalized visits were arranged, ensuring comprehensive training coverage for all participants.

Figure 11. Poderi data collection app and infestation inspections in the field.

A total of 18 individuals participated in the training, including four farmers from the cluster, five from the wider area, as well as one advisor, four researchers, three experts, and a facilitator. The collaboration between researchers and farmers was crucial, allowing the latest scientific knowledge and techniques to be shared and applied in real-world settings. Farmers were encouraged to take part

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in the monitoring process actively, and many continued to use the techniques and tools learned during the training long after the sessions ended.

In terms of data collection, farmers contributed significantly by uploading their observations on olive fruit fly population development to the Poderi app. This data provided valuable insights not only for individual farms but also for the broader farming community, helping to predict pest trends and inform pest management strategies on a larger scale. The data is shared among all participants, fostering a sense of community-based monitoring and collective pest management. The initiative was supported by the IPMWORKS project and the PATH2DEA project, both of which focus on integrating innovative pest management practices in agriculture. These collaborations brought additional expertise, ensuring a well-rounded approach to olive fruit fly control.

Looking ahead, some of the farmers involved in the training have chosen to continue monitoring and mass-trapping activities into the 2024 growing season, demonstrating the long-term sustainability of the training. This continuity ensures that the lessons learned during the 2023 sessions will have a lasting impact on olive farming practices, helping to protect crops from damage and promoting environmentally friendly pest control techniques. The success of this activity highlights the importance of empowering farmers with knowledge and tools to manage their own pest control, leading to healthier crops and more resilient agricultural practices.

5.4 Pathway 4: Other types of active engagement, interaction and narrative forms

Pathway 4

Other types of active engagement, interaction, & narrative forms

The fourth pathway describes other continuous and discontinuous forms of engagement with varying degrees of collaboration and levels of shared purpose between farmers, FC facilitators, experts external to the FC and the wider communities around FCs, including the general public and citizens.

Focus: A specific topic, practice or activity related to biodiversity and ES observations and monitoring, which is locally relevant to farmers, or which is meant to increase farmer's awareness and skills.

Character: Does not fall into one of the above categories but provides other opportunities for farmers to engage in activities related to biodiversity observations and monitoring.

Aim: Awareness raising and capacity building, farmer engagement.

Data collection: Is desirable, digital or hybrid data collection tools are preferred.

5.4.1 Use case: Velké Hostěrádky – Biodiversity Path

In the Czech Republic, a public Biodiversity Path (Ekofarma PROBIO et al., 2024) was co-developed with FC farmers and local stakeholders to promote biodiversity awareness and educate visitors about the local ecosystem and the role that farmers play in preserving and enhancing biodiversity. These activities involved collaborative efforts between farmers, local stakeholders, and institutions, leading to the establishment of an educational biodiversity path and a public event to promote its opening.

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Farmers and other stakeholders, including local landowners and municipal officials, contributed to the design and content of information boards placed along the path (Figure 12). These boards highlight the region's unique fauna and flora, explaining how farming practices contribute to sustaining the landscape's ecological health. The development process began in December 2022, with initial meetings to gather input from farmers, landowners, and local officials about what information should be included on the educational boards. Over the course of a year, these stakeholders remained engaged, providing content, photos, and insights. Farmers also played a key role in tree planting along the path, ensuring that the biodiversity path would enhance both the natural environment and the visitor experience.

Figure 12. Collaborative development of biodiversity path.

The biodiversity path is connected to an ongoing biodiversity monitoring effort using the iNaturalist app. Visitors can contribute to biodiversity data collection by using the app to record species they observe during their walks. This data is stored in the iNaturalist project, ensuring that the biodiversity path not only serves an educational purpose but also contributes to citizen science.

To celebrate the opening of the biodiversity path, a BioBlitz event was held on May 18th 2024, at Ekofarma PROBIO, a local organic farm (Figure 13). The event brought together approximately 250 participants, including farmers from the cluster and other regional farmers, local citizens, and supporters of the social farm Jasan. The purpose of the event was to engage the public in biodiversity monitoring and to raise awareness about the ecological contributions of local farmers. At the beginning of the walk, participants were introduced to the iNaturalist app and the specific project associated with the biodiversity path. Instructions on how to install and use the app were provided, enabling visitors to actively contribute to biodiversity data collection as they explored the path. Throughout the event, participants documented plants, insects, and other wildlife along the route, contributing valuable data to the publicly accessible iNaturalist project.

The BioBlitz event highlighted the connection between sustainable farming and biodiversity conservation, allowing participants to see firsthand how the practices of local farmers positively impact the environment. The event was supported by a variety of partners, including Czech organics, Friends of the Earth Czech Republic, local ornithologists, and the municipality of Velke Hosteradky. The biodiversity path is a permanent installation and will continue to be promoted through media outlets such as Mapy.cz, a popular Czech map portal. There are also plans to potentially host the

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BioBlitz event annually, potentially coinciding with global citizen science initiatives like the City Nature Challenge. The ongoing use of the iNaturalist app will allow for continued data collection, further integrating public engagement with long-term biodiversity monitoring.

Figure 13. Biodiversity path opening and BioBlitz with the public.

Through these initiatives, farmers, local stakeholders, and visitors are empowered to actively contribute to the preservation and understanding of biodiversity in the region, fostering greater appreciation and responsibility for the local environment.

5.5 Pathway combinations and transitions

The different pathways are non-exclusive and should always be considered as either explanatory or initially formative frames for what are highly dynamical processes. Activities to engage farmers in biodiversity and ES observation and monitoring can start off under one pathway and then, over time transition into other pathway types. For example, one-off, or sporadic activities under Pathway 1 can become recurring if, for example, repeated yearly, or if a more comprehensive topical thread is developed and active engagement is enabled to link these one-off activities. Likewise, what has started as a highly integrated pathway (Pathway 3) can, over time relax into less intense forms of collaborations or less regular activities. Different pathways can also run in parallel, with different attendance of FC members across pathways.

6 Capacity building, materials and tools

To enable FC facilitators and facilitating teams and farmers alike to engage in and conduct biodiversity and ES observation and monitoring activities on-site, a range of supporting capacity building, knowledge exchange and materials were set up and collated.

6.1 Training approach

A training approach that could best support the specific farmer-based and bottom-up activities also had to be demand and context driven. Hence, we tied training and capacity building in with the overall implementation process and engagement pathways as described in the previous chapters. Training and capacity building events were held for and with two groups – the FC facilitators and facilitating teams, as well as the FC farmers.

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6.1.1 For facilitators: Train-the-trainer and peer-to-peer exchange

As outlined in Chapter 4, FC facilitating organisations faced several challenges to best support farmer-based biodiversity and ES monitoring, including time and skill constraints. Across the 11 FCs, facilitators' expertise varied greatly, ranging from functional biodiversity, biodiversity conservation, soil health and landscape ecology to sustainable agriculture, farming practice and farm advisory, amongst others. While there was great diversity in relevant content-expertise, few designated facilitators had experience in citizen science or participatory monitoring methods. As facilitators were also functioning as trainers in the FCs – providing training and advisory support to the FC farmers – a dual approach was chosen combining train-the-trainer (TTT) aspects with peer-to-peer (PTP) knowledge exchange for up-skilling the facilitator group. This allowed us to capitalise on and maximise the shared knowledge and expertise and skills held within the consortium.

In the **TTT approach,** one or more organisations hold primary content-area expertise (e.g., project partners IIASA and NORDECO about citizen science and participatory methods) and provide guidance, instructional material, tools and support to trainers (FC facilitators) with ties to a target community and the aim to increase skills and knowledge within the community (FC farmers). While initially relying on primary expertise, activities would, over time, be sustained and implemented by trainers (facilitators) in the communities (FCs). At the same time, knowledge would be distributed and skills built across the group (Orfaly et al., 2005). Hence, a TTT approach also serves to increase social capital more broadly, where learning together serves both the acquisition of knowledge and skills, but also the building of community relationships (Balatti and Falk, 2002).

The TTT activities in regard to citizen science activities included starter modules, such as group-based online and on-site face-to-face training. The topics covered in these modules were Citizen Science tools (with a focus on iNaturalist), Citizen Science formats (e.g., BioBlitz) as well as farmer engagement and co-creation of observation activities. These starter activities were then followed by more targeted training, advice and support. These targeted trainings ranged from demos for earthworm sampling in the field to how to set up a citizen science campaign using the crowd-sourcing application Picture Pile.

In addition to this demand-driven TTT approach, a more overarching online training course was developed for FC facilitators by FRAMEwork WP2 partners, the Landscape Leaders: Farmer Cluster Training Programme.

The **PTP approach** builds on the exchange of knowledge within a group of people who, e.g., share a common practice but may diverge in content-expertise. Such a group can be considered a learning "Community of Practice" (Hara, 2009). FC facilitators have the shared aim to manage a FC and, amongst others, engage farmers in biodiversity and ES observations and support them on their journey towards biodiversity-friendly farming. PTP discussions enable FC facilitators to share experiences about their journey more broadly, to exchange approaches on how to address specific topics and to learn from one another. Facilitator PTP exchanges in FRAMEwork ranged from discussions between FCs Basse-Durance (France), Val Graziosa (Italy) and Cazadores de Aguilar (Spain) regarding predator management (promoting and monitoring bat populations) and olive fruit fly monitoring to exchange between all FC facilitators regarding how to address challenges of farmer engagement (Figure 14).

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Figure 14. FC facilitators addressing the challenges of farmer engagement together.

6.1.2 For farmers: On-site and multi-modal

Experiences working with FC groups suggested that FC farmers were overall most engaged in on-site and in-person trainings that offered a combination of theoretical and evidence-based input as well as hands-on demos in the field. This anecdotal insight from the FCs aligns with research on farmer learning styles and preferences for knowledge and skill acquisition. Fostering the combination of implicit (tacit, practice-based) and explicit (conceptual and theoretical, information-based) modes of learning promises most successful and appears to cater to farmers' learning preferences (Kilpatrick and Rosenblatt, 1998; Sutherland and Marchand, 2021; Trede and Miller, 2000). Based on these recommendations from within the FCs as well as the literature, the focus was directed towards the development and design of on-site capacity building rather than digitally mediated training. Where relevant and suitable, accompanying online resources, such as websites, videos and interactive tools were provided to farmers to be able to deepen their knowledge on an individual basis.

Training activities for a FC, overall, followed these generic steps:

- Step 1: Defining the purpose and goal of training aligned with farmer interests, needs and contextual relevance.
- Step 2: Outlining and defining of training activities, including:
    - Invitation of experts within project consortium and/or collaboration with relevant local/national organisations
    - Theoretical and evidence-based input
    - Practical demos and hands-on exercises
    - Peer-to-peer knowledge exchange opportunity
    - Selection of relevant materials and protocols
    - Recommendations for farmers
- Step 3: Implementing training activities in FCs
- Step 4: Reflecting and considering follow-up activities

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While these steps serve as a general guiding frame, each FC devised its own individual training paths – aligned with the aims and needs of the FC farmers as well as limitations faced (e.g., time availability of farmers). The following examples illustrate the range of topics covered in the farmer-based training sessions in the FCs and how they were .

Cazadores de Aguilar – Groundcover and soil health

On March 12th 2024, a workshop on soil and cover vegetation was held in Aguilar de la Frontera to train farmers on simple methods to observe ES. The primary focus was to demonstrate how soil infiltration capacity can be measured using a double ring infiltrometer, comparing areas with and without cover crops. The demonstration clearly showed that water infiltration is significantly higher in plots with cover crops, highlighting the negative impact of ground cover removal on infiltration rates and subsequently, soil erosion and water availability for olive trees.

The training was attended by 30 farmers and 18 additional participants, beginning with a brief morning field demonstration for 10 people, where the double ring infiltrometer was used in two plots, one with and one without ground cover. This was followed by a three-hour meeting, where participants were further trained on data collection techniques and methodologies. The double ring infiltrometer test measures how fast water infiltrates into the soil.

By placing a litre of water in both the inner and outer rings, participants could observe the rate at which the soil absorbs the water, providing insights into soil health and its capacity to retain water (Figure 15). The workshop was supported by various stakeholders, including Gonzalo Varas (Facilitator-FA), local council members, researchers from IFAPA, representatives from SEO/BirdLife, FAC, and the Hunters' Association. The collaboration between these organizations helped highlight the importance of sustainable land management practices. This training emphasised the importance of integrating cover crops to recover and maintain soil health.

Figure 15. Demo of water infiltration test in the field.

Zeeasterweg – Moth monitoring

The BIMAG Moth Monitoring training on July 18th 2024, introduced the ongoing Farmer Insect Monitoring Agricultural Area (BIMAG) initiative. The aim of this initiative is to engage farmers in monitoring moth and butterfly populations to gather valuable data on insect biodiversity in agricultural landscapes. So far, 115 farmers have participated in the project across the Netherlands, contributing to important research on the health of butterfly populations in rural areas. The project is set to expand, with the aim of involving 150 farms annually over the next five years.

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The event took place at the Waalkens family farm in Lelystad, where a group of farmers and citizens gathered to learn about moth monitoring techniques. Led by Rik Wever from the Butterfly Foundation, participants received a detailed introduction to moth species and their significance in rural ecosystems. The presentation highlighted the role of moths as important pollinators for a variety of crops, emphasizing their ecological value and the importance of monitoring their populations.

After the presentation, the group moved outside for a practical demonstration of nighttime moth monitoring. A large white cloth was set up next to a canal with a strong UV lamp to attract moths (Figure 16). Over the course of the evening, participants observed around 60 different moth species, including some rarer species for the area (Figure 17). This hands-on experience allowed farmers and citizens to see firsthand the variety and abundance of moths in the agricultural landscape, and it sparked conversations about their role in maintaining biodiversity.

Figure 16. Set-up to attract moths for moth observation demo.

The species observed were recorded on waarneming.nl, part of observation.org, a publicly accessible platform where citizens can log observations of flora and fauna. The data collected is verified by experts, contributing to a growing database of biodiversity in agricultural areas. This platform allows both professionals and amateurs to contribute to the scientific understanding of insect populations.

Figure 17. Examples of moths observed during the monitoring event.

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The training lasted from 8 p.m. until 1 a.m., providing an immersive experience in moth monitoring. It attracted a compact group of 7 farmers, 5 citizens, and 2 experts, demonstrating the interest and enthusiasm within the local farming and citizen science communities for biodiversity monitoring.

Kanepi kihlkund – Ground dwellers and pitfall trapping

The training on the Pitfall Trapping Protocol for observing ground-dwelling insects aimed to enhance farmers' understanding of biodiversity and natural pest control agents in agricultural landscapes. It focused on Carabids (ground beetles) and Staphylinids (rove beetles), with around 280 and 500 species, respectively. These insects act as biocontrol agents, helping to regulate pest populations and reducing reliance on chemical pesticides. The primary goal was to transfer this knowledge and encourage biodiversity-enhancing practices among farmers. The one-day training involved five farmers, three organizers, and one student. Participants discussed the role of herbaceous field edges—unmanaged strips of vegetation along field borders—and how these support insect diversity. Sowing these edges with native meadow seed mixes provides essential resources like nectar and shelter for beneficial insects, including natural predators of crop pests. Farmers explored the ecological links between plant and insect biodiversity, emphasizing how natural enemies of pests can reduce the need for synthetic pesticides, contributing to a more sustainable agricultural system. The event also covered the recent updates to the Common Agricultural Policy (CAP), which now includes herbaceous field edges in designated field areas, offering financial support for maintaining these biodiversity-enhancing features.

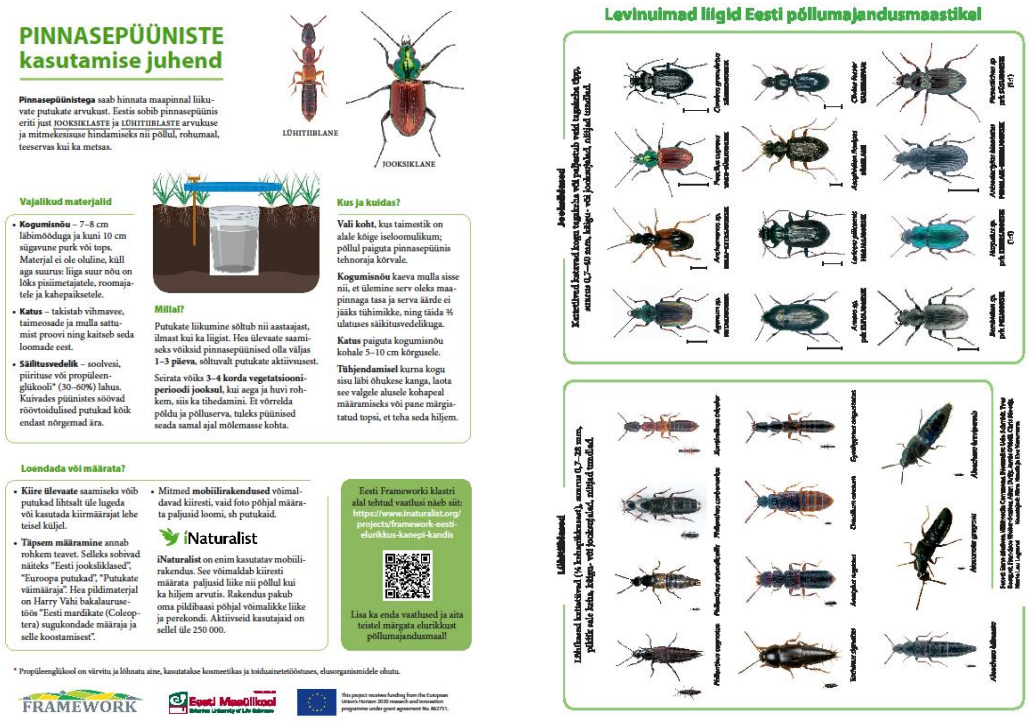

Figure 18. Simple protocol for pitfall trapping.

Farmers were introduced to the pitfall trapping protocol and identification charts, allowing them to monitor ground-dwelling insects (Figure 18). Pitfall traps, simple devices for capturing insects on the soil surface, can be used to collect information about presence and diversity of species. Farmers were

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encouraged to use the protocol for long-term observations on their farms. The session concluded with discussions on the importance of landscape diversity and the benefits of unmanaged vegetation for biodiversity and reduced pesticide use. No external partners were involved, and no specific follow-up plans were set, but farmers were motivated to implement the protocol and biodiversity practices on their land. This training was a key step in promoting sustainable agriculture and biodiversity monitoring.

6.2 Observation protocols, tools and other resources

Monitoring protocols for citizen science are structured guidelines designed to enable non-professionally trained participants to collect valuable data while ensuring a minimum desirable accuracy and consistency. These protocols are essential in citizen science projects, as they help standardize the data collection process for participants with varying levels of expertise (Tulloch et al., 2013; Vogt and Fischer, 2014). Although similar to traditional scientific protocols, citizen science monitoring protocols differ in several ways to accommodate broader public participation. Citizen science protocols are written in clear, non-technical language. Complex methodologies are simplified to make them more accessible, often supported by user-friendly tools like apps or visual guides (Stroud, 2019). Citizen science protocols often also include training aspects such as video tutorials or starter guides to help volunteers get accustomed with data collection.

A protocol commonly contains some or all of the following sections:

- **Objective and Purpose**: This section outlines the goals of an activity, explaining why the data is being collected and how it will be used. The purpose is often framed in a way that is both scientifically relevant and personally motivating for the participant.
- **Methodology**: The methodology section provides step-by-step instructions on how to collect data. These steps are simplified for clarity, often including visual aids or app tutorials. The instructions explain how to use the necessary tools and describe the data recording process.
- **Site selection and sampling design**: Unless data collection is fully opportunistic, guidelines are provided on how to choose data collection sites while accommodating participants' limited resources or access to certain sites.
- **Tools, equipment and safety**: This part details the tools and equipment needed for data collection, often emphasizing the use of readily available materials and technology like smartphones or apps, as well as any precautions needed to ensure safe fieldwork.
- **Data submission**: Instructions are provided for submitting the data, typically through an app or online platform. These platforms are designed to be intuitive and easy to use, often including automatic quality control checks before submission.
- **Feedback and Reporting**: Participants often receive feedback on their contributions. Citizen science projects place value on showing volunteers how their data contributes to the larger research goals, which fosters engagement and continued participation.

Given the number of existing protocols, tools and materials, our approach was to re-use and adapt where possible rather than devise completely new methods, which has led to the *FRAMEwork collection of citizen science protocols and materials for Farmer Clusters* (Appendix 3) published on Zenodo.

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FRAMEwork collection of citizen science protocols and materials for Farmer Clusters

This collection provides more than 70 associated protocols, apps, tools and materials used during and supporting the activities in the 11 FCs. The collection consists of two parts:

A) Collection of citizen science tools and protocols which comprises one file collating metadata and links to existing citizen science protocols. Table 2 provides the structure of the collection and one example.

Table 2. Metadata structure for collection of citizen science tools and protocols.

Title	Description	Keywords	Resource Type	Language	Link
Title/Name of the resource (in original language)	*A short description of the resource in English*	*Keywords that help specify the resource*	*Types aligned with Dublin core metadata*	*Resource language in ISO 639-1 code; "multiple languages" (ml)*	*URL of the item/ resource hosted online*
Observatoire Agricole de la Biodiversité (OAB) Outils	A collection of easy-to-use protocols to monitor agrobiodiversity, butterfly, bees, arthropod on soil etc.	monitoring protocols, biodiversity, soil	Collection	fr	https://www.observatoire-agricole-biodiversite.fr/les-outils

B) FRAMEwork citizen science protocols and materials: This part includes protocols and materials developed or adapted for the FRAMEwork project and used in the FRAMEwork FCs.

Citizen science resources on Recodo

Furthermore, a dedicated citizen science section will be established on the Recodo platform, expanding on the already existing set of citizen science resources (Figure 19).

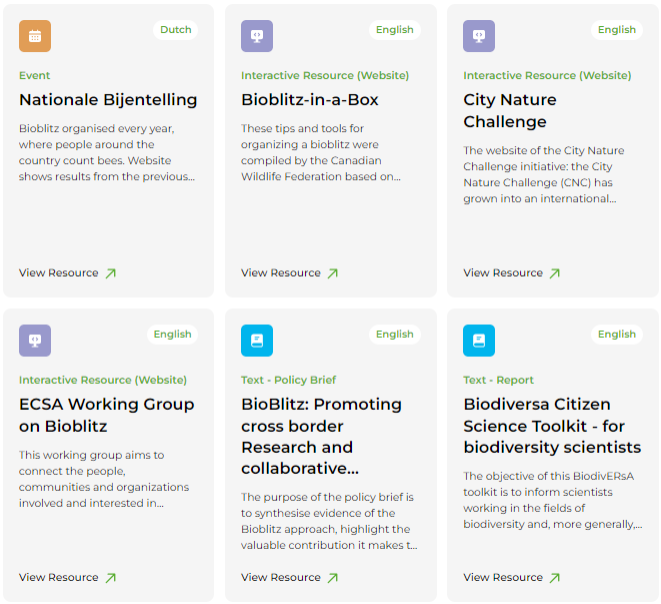

Figure 19. Illustrative screenshot of citizen science resources accessible on Recodo.

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7 Discussion and Outlook

Developing and implementing biodiversity and ES observation activities in FCs with and for farmers using an action-based approach provided rich insights and learnings in terms of challenges and opportunities.

One significant challenge was the time and effort required to conduct the activities. The role of facilitators was critical in guiding and supporting these efforts, showing leadership and securing buy-in from farmers. However, finding the right "hooks" that resonated with farmers and stirring their motivation posed a great challenge. Another challenge was collecting and sharing data, which was sometimes perceived to increase farmers' exposure and vulnerability. Farmers were often hesitant to share data about their land, including biodiversity due to concerns over privacy, control, and potential negative consequences for their business and reputation. While concerns of losing control over how the data would be used was a common topic with some farmers and FCs, others were more open to sharing their observations publicly.

Using a citizen science approach can potentially address many of these concerns by fostering a collaborative and transparent approach to data collection and empowering farmers to maintain ownership and control over their data. Actively involving farmers in deciding what data to share and how to use it can help to build trust amongst farmers in the FCs. Choosing a farmer-focused approach to citizen science also ensures that data interpretation is grounded in local knowledge, allowing farmers to contextualize the information based on their specific farming conditions and needs. Demonstrating clear benefits and practical insights can also help to reduce barriers for engagement. For example, providing farmers with data and possibilities to understand soil health or pest control that directly link with their farmland productivity can make data collection and sharing more appealing. Citizen science, overall, fosters a culture of joint knowledge generation and exchange, where farmers can learn from one another and collaborate. Transparency within citizen science projects can also support evidence-based perspectives. While enforced environmental regulation may not always be avoided, evidence gathered locally in collaboration with farmers may open new pathways for having difficult conversations and finding better resolutions.

Overall, citizen science practices and activities offer farmers opportunities for empowerment. They turn the challenges of data sharing into opportunities for improving farming practices and building stronger, more resilient communities. One important next step in the project will be to investigate the effects of farmers' engagement in observation activities on their attitudes towards biodiversity-friendly farming. The results of this study will support a growing body of knowledge and evidence to better inform the design and direction of future citizen science activities with farmers.

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Appendix 1: Interim self-evaluation survey

* Required

FC self-evaluation and outlook

Dear FC facilitator team,

Thank you for taking the time to reflect on your work and providing us with much valued insight. Your inputs to this survey will guide us in joint planning and delivery of **WP3 and WP2 related tasks** in the upcoming two years. Furthermore, we may use your input and the results of this evaluation across clusters for WP3, WP2 and WP6 deliverables. By submitting this survey, **you agree that we use your contributions for these purposes**.

Please answer this survey **together as a Farmer Cluster facilitating organisation or team**, rather than one person of the team only, unless you, as a single person, are solely responsible for facilitating WP3-2 related tasks in a cluster. Also, to be able to fully answer the survey, please **first read and consider this document.**[2]

To get to the level of detail desirable, we recommend you download and **use this survey template**[3] to:

1. Discuss the survey as a team.
2. Take notes on each question during the discussion.
3. Circulate the notes for feedback, additions, or modifications within the team.
4. **Submit the consolidated responses online via this form**.

Questions 2 to 17 relate to **farmer-focused activities** (T3.2), questions 18 to 20 to **activities for and with the wider public** (T3.3). That said, while the tasks represent a specific focus, they are also **non-exclusive**. On-site activities may be designed to address and engage farmers, volunteers, and other public audiences alike and where suitable.

Please send your responses no later than **Fri, Feb 10th**. You can find all relevant documents in the FRAMEwork MS Teams > WP3 > General > Files.

General

Which Farmer Cluster (FC) are you managing (as a team)? *

Activities for and with farmers

These are primarily cluster farmers, but you can always include farmers in the area/region as potential target audiences and actors.

- P1 - Sporadic engagement and interaction
- P2 - Recurring engagement and interaction
- P3 - Continuous engagement and interaction
- P4 - Other types of active engagement and interaction

We have identified and selected four basic categories/pathways of engaging farmers in biodiversity observation and monitoring activities. Please tell us, which of those categories you feel you have contributed to already, are currently contributing to or planning to within your cluster. *

Please briefly describe these past/current activities for each selected pathway and try to be as comprehensive as possible, covering all your activities instead of just giving a few examples. *

How would you assess your **FC facilitating team's motivation** in engaging farmers in on-site activities related to biodiversity observations and monitoring in the cluster? (1-Not at all motivated, 6 – Very motivated) *

Please briefly describe why you, as a FC facilitating team/person, are, or are not, motivated. *

How would you assess the **cluster farmer's motivation in participating** in on-site activities related to biodiversity observations and monitoring? (1-Not at all motivated, 6 – Very motivated) *

Please briefly describe why you think the cluster farmers are, or are not, motivated. *

[2] This document initially identified and described pathways for farmer engagement.
[3] The survey template is identical with the survey form.

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Overall, how do you estimate your success so far in **developing and delivering interesting and relevant activities for farmers** in relation to biodiversity training, observations, and monitoring? (1- Not at all successful, 6 – Very successful) *
If you have, or have not, been very successful in developing/delivering interesting activities, what do you think are the reasons? *

Overall, how do you estimate your success in **engaging the farmer cluster farmers in participating** in those activities? (1- Not at all successful, 6 – Very successful)*

If you have, or have not, been very successful in engaging the farmers, what do you think are the reasons? *

Have you devised any strategies to try to improve success for a) **developing and delivering** interesting and relevant activities and b) for **engaging** the farmer cluster farmers in participating in those activities on the other?
If yes, what were they? *

In the upcoming two years, no harmonised FRAMEwork monitoring will take place. Hence, the project aim is to push Pathways 2 and 3 in the next two years. Which of the identified pathways (1-4) can you commit to work towards? *

If none of the above, please suggest a viable alternative to ensure we can still deliver on our project commitment.

Please briefly elaborate on your selection and any plans or ideas, unless already described above (then, please note "already described above"). Please also consider how the selected pathways can be linked with key indicator species defined, or any measures and changes in land management to promote biodiversity in the cluster. *

- Planning of recurring events (series) and thematic threads aligned with cluster interests
- Participatory methods for collaboration during farmer cluster meetings
- Devising a robust sampling and monitoring strategy that works for our farmers
- Easy-to-use monitoring protocols for farmers for selected species or animal/plant groups
- Getting started with iNaturalist in our cluster
- Hands-on demos of specific monitoring protocols for our team, so we can use them in the cluster
- Strategy for local stakeholder engagement
- Agenda setting for farmer cluster meetings
- Communication and creating engaging local stories about biodiversity
- Much clearer and straight forward top-down plan of what should be done with the farmers, similar to theharmonised FRAMEwork cluster monitoring (via WP2).
- None of the above

Considering the different pathways and minimum requirements for the next two years, **how can we help** to improve or secure your success in the future and what are your **needs of support**?*

If none of the above, is there something else you would appreciate support with?

Do you have more specific information on your selection above? Please elaborate here. *

Are there any **external factors out of your control** which clearly hamper or pose a risk for success in the cluster related to farmer engagement? If yes, what are they? *

Activities for and with the wider public

We have also identified and selected four general types of engaging the wider public in biodiversity observation and monitoring activities in and around the clusters. Please tell us, which of those activities you feel you have done already or are currently doing in your cluster. *

Please briefly describe these activities *

- Large-scale BioBlitz, e.g., City Nature Challenge (100+ participants) – wide audience
- Smaller-scale BioBlitz (15+ participants) – Specific audiences, e.g., scouts, school classes
- Other tailored biodiversity-related events (e.g., joining and supporting existing events and initiatives such asnational bee counting day) (15+ participants)
- Other tailored biodiversity-related activities (e.g., creation of local, self-guided biodiversity walk) (15+participants)

Looking into the future, which of the four types of engaging the wider public can you commit to implementing in the next two years in and around your cluster? *

- Planning of events
- Suggestions for how to engage the public in monitoring specific species/species groups

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- Getting started with iNaturalist for public monitoring
- None of the above

Considering the different types of engaging with the wider public, how can we help to improve or secure your success and what are your needs for support? *

If none of the above, please let us know how we can support you otherwise.

Is there anything you would like to add or comment?

Thank you very much for taking this survey!
Please submit your responses below.

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Appendix 2: Farmer Cluster Activity Briefs

The collated activity briefs provide a full documentation of farmer-based biodiversity observation and monitoring activities between 2021 and 2024 in 11 FRAMEwork FCs across Europe.

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Appendix 3: FRAMEwork collection of citizen science protocols and materials for Farmer Clusters

The collection consists of two distinct parts:

A) Collection of citizen science tools, protocols and materials which comprises a collection of metadata and links to other existing citizen science tools, protocols and materials which were used in the FCs.

B) FRAMEwork citizen science protocols and materials

This part includes protocols and materials developed or adapted for the FRAMEwork project used in the FRAMEwork FCs. The documents can be found on Zenodo and are named with the following convention "Document type_Language_Topic", for example: "PRTC_de_Earthworm survey".

Document types and associated abbreviations are:

1. PRTC_Observation protocols or instructions
2. INF_ Other information material
3. DC_Data collection sheets
4. SM_Other supporting materials

For language, ISO 639-1 two-letter codes are used, e.g., "de" for German.

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