ALL Ready

ALL-Ready – The European Agroecology Living Lab and Research Infrastructure Network: preparation phase

The ALL-Ready Pilot Network: Inspiring Examples and Experiences of Agroecology Living Labs and Research Infrastructures Across Europe and Canada

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INTRODUCTION

Agricultural and food systems are increasingly exposed to a variety of challenges ranging from climate extremes, biodiversity loss, soil, and water degradation to the huge inequalities between different actors in the food supply chain. The concept and principles of agroecology, mainly developed by the Food and Agriculture Organization of the United Nations (FAO) and the High-Level Panel on Food Security and Nutrition (HLPE), have been identified by the international community and the European Union as a viable alternative approach to agricultural practices, which makes it possible to address these complex challenges.

Besides the ambitions of several policies under the European Green Deal, the European Commission's commitment to agroecology is strongly reflected in the fact that it has earmarked research projects underpinning the agroecology transition in its research and innovation framework programme, Horizon Europe 2021-27. With Horizon Europe, agroecology is fostered mainly within the European Partnership for "Accelerating the transition of agricultural systems: agroecological living labs and research infrastructures" (hereafter Agroecology Partnership) planned for 2024. The Agroecology Partnership aims to mainstream the principles of agroecology, to redesign farming systems across Europe, and to build and expand collaborations to co-create and share knowledge and solutions across a wide range of agri-food actors. This approach is based on the premise that Open Innovation Arrangements (OIAs) and in particular Living Labs (LLs) and Research Infrastructures (RIs) are instruments that have great potential to contribute to accelerating agroecology transition in Europe. The Partnership will establish a European network of agroecology LLs and RIs to promote transdisciplinary, highly participatory, inclusive, and coordinated experimentation in real-life settings, ensuring an EU-wide knowledge exchange and a series of long-term research on agroecology in different European contexts.

The three-year-long ALL-Ready project (No.101000349, funded by Horizon 2020) was launched in 2019 to support the Agroecology Partnership by preparing a framework for a future European network of LLs and RIs that will enable the transition to agroecology throughout Europe. Through its results, the project lays the groundwork for the activities of the future network while relying on participatory and real-life experimentation, and therefore applying the LL approach. The ALL-Ready project fundamentally contributes to the creation of this future network by developing a vision, a mission, and a framework for agroecology transition through LLs and RIs, by piloting a small-scale network of existing LLs and RIs (the ALL-Ready pilot network) and exploring the sustainability of the future network.

Defining LLs and RIs

According to the definition of the European Network of Living Labs (ENoLL), LLs are open innovation ecosystems in real environments that use iterative feedback processes throughout the innovation lifecycle. They act as orchestrators between citizens, research organisations, companies, and government agencies. LLs focus on joint value co-creation, rapid prototyping, testing, and scaling up innovations. The three operational principles supporting LL activities are 1) co-creation, 2) user-centeredness, and 3) real-life conditions. More concretely, agroecology LLs can be identified as initiatives that meet the following criteria: 1) co-creation of knowledge and innovation in agriculture; 2) promotion of resilience, sustainability, and diversity; 3) supporting climate change adaptation and mitigation; 4) creation of synergies between ecosystem functions; 5) promotion of efficiency and responsibility in the use of natural resources; 6) developing circular and solidarity economies, and giving value to social and ecological justice.

RIs are institutions or institutional systems that provide resources and services to the research community to conduct research and deliver innovation. They allow scientists to experiment and observe agroecosystems at different scales (plot, farm, landscape, and network). Altogether, they

contribute to the creation of a knowledge base for the agroecology transition and are expected to play a significant role in education, data provision to various stakeholders, and service delivery within the open science framework.

The Agroecology Partnership builds on these definitions, highlighting that innovation and the adoption of sustainable agricultural practices can be accelerated within these structures by involving farmers and other stakeholders in developing solutions tailored to addressing local or regional challenges.

Approach & Aim of the Booklet

This booklet operates with the definitions of agroecology LLs and RIs, developed in the ALL-Ready project. **It aims to promote and increase the visibility of the ALL-Ready pilot network by showcasing inspiring examples of agroecology LLs and RIs across Europe, highlighting their achievements and expected contributions to the future network.**

The booklet discusses the aims, characteristics, and achievements of the pilot network, and presents in detail 19 pilot members - 11 agroecology LLs, seven RIs and one LL&RI - highlighting their research activities as well as their accomplishments. Moreover, it touches upon other LLs, RIs and OIAs (outside the pilot network) that were mapped in the project. This booklet was developed by using information gathered directly from the pilot members through surveys, questionnaires, and in-person exchanges, and from secondary sources during the course of the project.

Figure 1. Organic small plot trial of wheat varieties set up at an ÖMKi Living Lab partner farm (Source: ÖMKi)

THE ALL-READY PILOT NETWORK IN A NUTSHELL

The ALL-Ready pilot network is essentially a small-scale testbed to experiment, and to provide feedback on the various tools, concepts and recommendations developed in the ALL-Ready project. Moreover, it aims to build an international community through collaboration between the different agroecology LLs, RIs and OIAs across Europe, by co-creating and implementing joint network activities in line with their common interests on agroecology.

The network was officially launched in December 2021 with 15 members after a six-month selection and preparation process. Aiming for an open and dynamic network, four additional initiatives joined the network in November 2022, resulting in a total of 19 members. 11 members identify as LL, seven as RI and one (ACS) identifies as both a LL and RI:

A Danish funding programme, the Organic Research, Development and Demonstration Programme also joined the pilot network as an observer in order to learn from the members as they aim to fund enduser-centered, LL-like research projects focusing on organic farming and food systems. The membership of the network is truly diverse, representing all four European regions (Northern, Southern, Western, and Eastern Europe), with members from eight EU countries, the United Kingdom, Switzerland and Canada. The members also differ in terms of size and objective. Many have broad goals concerning agroecology, namely, to improve agronomic practices, agrotechnology across various agricultural sectors (arable farming, horticulture, etc.), while some have specific aims and focus on single areas such as the reduction of antimicrobials in animal husbandry or improving the uptake of digital tools in agroecology. Some of them are LLs certified by ENoLL, while the majority are open innovation structures representing national or territorial networks, LL-like projects, or experimental sites.

The members also differ regarding the geographic scope of their activities. Most RIs tend to have an international scope (ISF, LifeWatch ERIC, EMPHASIS), while there are some with a local (ZAPVS) or a regional focus (ReWet). Many member LLs operate on a national (PA4ALL, ÖMKi, IF, Carbonfarm, InoFA, ACS) or regional level (LLAEBIO, PFN Hessen, Guadalinfo). The members also represent diverse levels of experience, from beginners (fewer than one or two years) (Occitanum, Hessen) to mature (two-five years) (LLAEBIO, InoFA, PA4ALL, ISF, LifeWatch-ERIC, ROADMAP, EMPHASIS) and to very experienced (more than five years) (ÖMKi, OasYs, ReWet, Biobase, ZAPVS, IF, Carbonfarm, FiBL, ACS).

Network members also differ from small to large-scale initiatives regarding the number of users they work with. In agroecology LLs, users are usually farmers, but may also be consumers or other stakeholders in the agri-food value chain. In agroecology RIs, users are almost always researchers, and only occasionally farmers, advisors, or citizens. The majority of the members cooperate with small (below 50 users) (PA4ALL, LifeWatch-ERIC, OasYs, Carbonfarm, PFN Hessen, EMPHASIS) or medium scale (50 – 200 users) (LLAEBIO, ÖMKi, ROADMAP, Occitanum, Biobase, InoFA, FiBL, Guadalinfo) user communities and only a few of them have more than 200 users (ISF, ReWet, ZAPVS, IF).

The pilot network was also designed to allow real-life experimentation on the structuring and functioning of the future European network of agroecology LLs and RIs based on co-creation and participatory methods, and the lessons learned can directly inform the setting up of the future network and the Agroecology Partnership.

LLs:

- *Belgium*
  - ① Living Lab on Agro-Ecology and Organic Agriculture in Flanders (LLAEBIO)
- *Denmark*
  - ② Carbonfarm,
  - ③ ROADMAP
- *France*
  - ④ Occitanum
- *Germany*
  - ⑤ Praxisforschungsnetzwerk Hessen (PFN Hessen)
- *Greece*
  - ⑥ Internet of Food Alliance (InoFA)
- *Hungary*
  - ⑦ ÖMKi On-Farm Living Lab (ÖMKi)
- *United Kingdom*
  - ⑧ Innovative Farmers (IF)
- *Serbia*
  - ⑨ Precision Agriculture for All (PA4ALL)
- *Spain*
  - ⑩ Vuela Guadalinfo
- *Switzerland*
  - ⑪ FiBL On-farm Living Lab (FiBL)

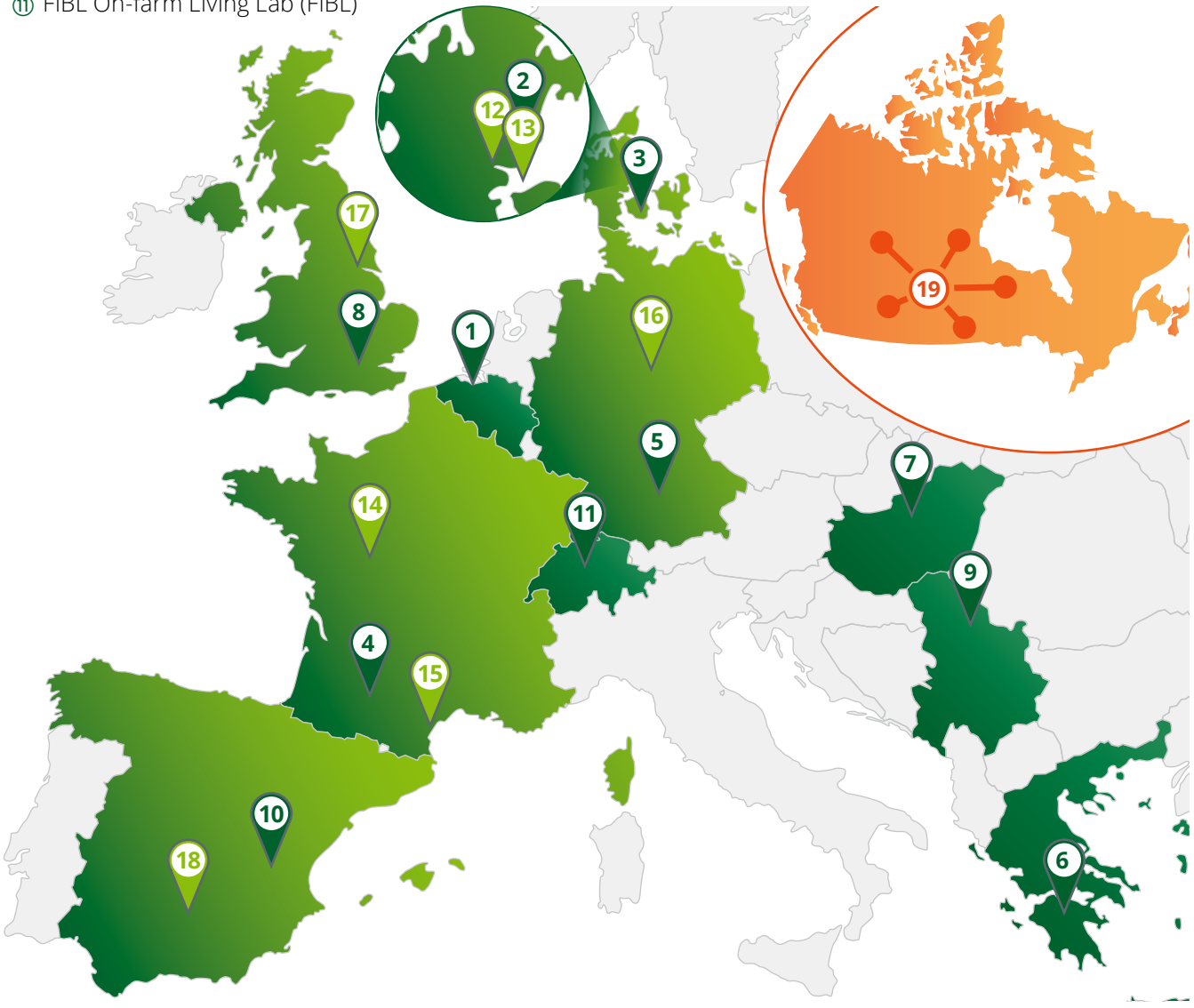
RIs:

- *Denmark*
  - ⑫ Biobase
  - ⑬ ReWet
- *France*
  - ⑭ LTSER Zone Atelier Plaine & Val de Sèvre (ZAPVS)
  - ⑮ OasYs
- *Germany*
  - ⑯ EMPHASIS
- *United Kingdom*
  - ⑰ Institute of Sustainable Food (ISF)
- *Spain*
  - ⑱ LifeWatch-ERIC

Both (LL&RI):

- *Canada*
  - ⑲ Agricultural Climate Solutions (ACS)

Figure 2.
The map of the ALL-Ready pilot network



OVERVIEW OF THE ALL-READY PILOT NETWORK MEMBERS

LLAEBIO – Living Lab Agroecology and Organic Agriculture

Belgium

Aim: "To bring people together and facilitate the mutual exchange of expertise and knowledge related to agroecology and organic farming, to spread information, and to foster and support research and experiments on agroecology and organic farming."

PROFILE

- The initiative was launched in February 2020.
- It is coordinated by the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) in Merelbeke, Belgium.
- Funding for activities is provided on an ad hoc basis by the actors involved in the LL.
- **Production sector:** a wide range of production areas.
- **Participants:** farmers (both organic and conventional), regional public bodies/ authorities, researchers/educators, advisory services, farmers organisations, NGOs, policymakers
- **End users:** varies based on projects.

To contribute to the transition to sustainable food systems, LLAEBIO is set up to support agroecology innovation. The initiative brings together organisations and individuals from the agri-food system (farmers, advisors, NGOs, researchers, policymakers, etc.) who wish to promote the development of agroecology and organic farming in Flanders (Belgium). The overarching goal of LLAEBIO is to connect people, organisations, policy, science, and practice to foster innovative research and knowledge sharing. The LL arose both from a bottom-up demand from the organic sector for more research, and a top-down request by the government to elaborate the concept of agroecology.

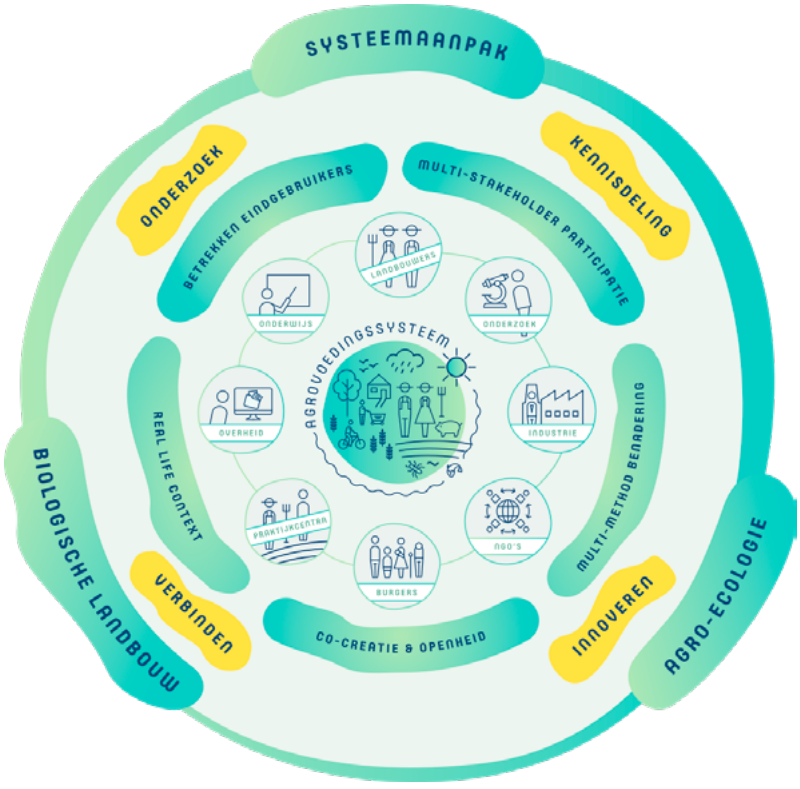


Figure 3. Structure of the LL methodology at LLAEBIO (Source: ILVO – LLAEBIO)

Core Research Activities

LLAEBIO does not directly carry out research activities but brings together actors across a broad spectrum of agroecology topics. The LL is driven by the 13 agroecology principles, as well as related practices and systems thinking. It aims to facilitate knowledge sharing and to promote research to support the transition to more sustainable, fair, and healthy food systems. LLAEBIO stakeholders participate in a co-creative workshop every year or two, to identify the themes they will focus on in the upcoming period. A temporary working group, based on voluntary participation, is then established to define, and develop activities and actions on the(se) theme(s). Tools and working methods, such as farm visits, webinars, conferences, round tables,

and policy briefs are explored and chosen based on the specific goals of the targeted end-user group. The selected theme(s) are further explored through interactive activities to identify more specific research and knowledge needs. In 2022 for instance, 'Soil health' (still ongoing) and in 2023 'Collaboration in the value chain' were the selected themes. Beyond these themes, 'Practical tools for implementation of agroecology principles' remains a constant focus of attention. A systems analysis was carried out on 'Collaboration in the value chain', aiming to identify knowledge gaps concerning the topic, by debating on what hinders the development of promising agroecology innovative collaboration models in Flanders.

Figure 4. Demonstration day at the Experimental Platform for Agroecology in Hansbeke (Source: ILVO)

Activities Beyond Research

LLAEBIO organises various interactive and educational knowledge-sharing activities to strengthen the connection between stakeholders, increase farmers' knowledge of agroecology practices and opportunities (preferably through peer-to-peer exchange), raise awareness of the potential of agroecology and bring scientific knowledge to the field. LLAEBIO also contributes to courses on agroecology in higher education and vocational training and supports teachers in agricultural secondary schools when introducing agroecology in education. They regularly organise webinars on themes of interest with short videos of farmer testimonials (e.g.: on fair pricing of food, system thinking, sustainable soil management, new policy programmes - like the CAP, innovation subsidy programmes).

Main Achievements

- Introduction of 'LLAEBIO draait door', a quarterly event that keeps stakeholders up to date about LLAEBIO activities and provides a forum to share their needs or experiences in projects or other activities.
- Organisation of the international soil health conference called 'Harnessing biodiversity for a better agronomy' with almost 200 participants, which aimed to facilitate the needed paradigm shift from the current focus of agronomy on chemistry to agronomy propelled by biodiversity. Scientists, advisors, and farmers, who have made this shift, inspired their peers as well as policymakers.
- Creation of a network database for agroecology and organic farming'
- A networking event to inform members interested in participating in research about relevant funding opportunities in Flanders and Europe and to deepen potential research themes.

More information

- *LLAEBIO website*
- *LLAEBIO LinkedIn*
- *LLAEBIO draait door quarterly event*
- *Network database for agroecology and organic farming*

Carbonfarm

Denmark

Aim: "To develop, document and implement sustainable farming systems by bringing together researchers, advisors and innovative farmers in organic and conventional farming based on the principles of conservation agriculture."

PROFILE

- Carbonfarm was established in 2017 by Organic Denmark, low-till farmers association (FRDK) and four dedicated farmers.
- Funded by Danish Green Development and Demonstration Programme (GUDP) and Fond for Organic Agriculture (FØL).
- **Production sector:** arable farming
- **Participants:** researchers, NGOs, farmers, and advisors.
- **End users:** farmers

Carbonfarm is a partnership between the Danish agricultural universities at Aarhus and Copenhagen, the Danish Innovation Centre for Organic Farming, the Danish Low-till Farmer Association (FRDK), the Danish agro-industry and four experienced and innovative farmers who wanted to implement and develop suitable practices based on conservation agriculture (CA) principles. Carbonfarm combines the research approach with strong practical considerations based on farmers' needs, to develop and demonstrate sustainable agricultural systems and to document the effects on biodiversity, soil carbon assimilation and greenhouse gas (GHG) emissions of such systems.

Core Research Activities

The Carbonfarm LL conducts large scientific trials based on four Danish farms, two of which are involved in conventional farming, while the other two are organic. One of the main research activities of the LL is the development and implementation of CA farming systems that are resilient and adaptable to Danish conventional and organic arable farming systems, compared to conventional plough and reduced tillage systems. Mechanical solutions are also being explored, mainly concerning the organic farming system, where herbicides cannot be used to control weeds and terminate the growth of catch- and companion crops, which is normal practice in conventional CA systems.

Figure 5. Carbonfarm oats and micro clover field trial under organic production (Source: Anton Rasmussen, Carbonfarm)

Currently, the focus of Carbonfarm is on qualifying GHG emissions, crop yield, soil fertility, arbuscular mycorrhiza, carbon assimilation, abundance, and ratio of the microbiome (e.g.: fungi, bacteria) soil organisms (e.g.: earthworms, collembola and surface predators) between organic and/or low tillage cropping systems. The field trials are carried out in four plots with four different treatments: ploughed, reduced tillage, low tillage, and no-tillage. In most cases, ex-

periments are done by farmers using their own machines on field plots of 20 - 24 x 50 meters. Their results already show that organic production and reduced tillage have a positive effect on both the quantity and quality of organisms below and above the soil surface. In the future, Carbonfarm plans to further investigate the impact of combining (low) tillage and under-sown catch crops/crop cover on soil fertility, microbial diversity, and climate resilience in (organic) arable farming systems.

Activities Beyond Research

Field days, seminars, webinars, local and cross-country farm visits for local and international farmers, and experts are organised in parallel with the experiments. Also, manuals, videos, and articles are produced for farmers, researchers, and advisory services to present and disseminate LL results.

Figure 6.
Carbonfarm no-till soil field trials under conventional production
(Source: Hans Henrik Pedersen, Carbonfarm)

Main Achievements

- CA has proven to be a robust and sustainable cultivation system.
- The non-organic experimental fields show that CA can be implemented, and yields can be obtained which are similar to those in traditional cultivation systems with tillage.
- There is greater interest among conventional farmers in cultivating their arable crops in whole or in part according to CA principles.
- Weed control has been shown to be a major challenge when ploughing and tillage are reduced in organic crops.
- CA has proven to have significant potential to increase biodiversity, both above (collembola and aphid predators as spiders, ground- and carabid beetles) and below ground (mycorrhiza, earthworms) in Danish fields.

More information

- *Carbonfarm website*

ROADMAP

Living Lab-like Horizon 2020 project – represented by Denmark

Aim: "To foster transitions towards prudent use of antimicrobials (AMs) in animal production in different contexts to manage antimicrobial resistance (AMR) by enhancing antimicrobial decision systems along the food and drug supply chains."

PROFILE

- A four-year-long (2019-2023) EU project, coordinated by INRAE.
- The consortium consists of 17 partners, providing an interdisciplinary framework.
- There are 12 LLs set up with a transdisciplinary and multi-actor perspective, engaging animal health professionals, policymakers, and other stakeholders. There are antimicrobial reduction case studies in 10 different countries (Sweden, Denmark, Netherlands, Belgium, UK, France, Switzerland, Italy, Vietnam, and Mozambique)
- **Production sector:** different livestock production systems (pig, poultry, dairy and beef)
- **Participants:** national public bodies/authorities, local public bodies and municipalities, researchers/research institutes, universities, advisors, farmers, retailers, SMEs, large companies, consumers, and consumer organisations
- **End users:** actors in charge of developing AMU decision systems and its users

ROADMAP studies current antimicrobial use (AMU), the drivers behind them and transition scenarios towards more prudent AMU in different contexts. A multi-actor approach is being implemented by an interdisciplinary consortium of researchers covering a diverse range of topics (economics, social, animal, and veterinary sciences) in cooperation with advisors, consultants from animal health professionals and stakeholders' organisations, and decision-makers from both national and EU levels.

Figure 7. Meeting to identify agreements and disagreements on AMU within four topics in pig production. (Source: Mette Vaarst)

Core Research Activities

ROADMAP goes beyond focusing on technical solutions and behavioural change and aims for a broader understanding of the systemic dynamics behind AMU, by applying conceptual approaches, by looking at food systems as a whole, and studying potential transition pathways. Its activities are divided into five pillars. The first pillar develops a global socio-economic analysis of the AMs decision systems in different livestock production systems to identify the main AMU drivers. Potential technical, social, economic, and institutional lock-ins are being assessed. The second pillar develops integrative strategies to reduce AMU through improved animal health management, by relying on the results

from the first pillar and on action-research programs developed in the LLs. The third pillar validates and synthesises the different strategies which have been studied or implemented to foster prudent AMU. The fourth pillar ensures effective outreach of the project towards a large community of stakeholders and end users and facilitates the exchange of information and knowledge. The fifth pillar ensures the scientific coordination of the project and maximises interactions between the different partners and disciplines. There are three case study clusters: Studying strategies to reduce AMU developed in intensive and conventional livestock production systems, studying strategies to reduce AMU developed in alternative livestock production systems, and studying strategies to reduce AMU developed in marginal livestock production systems. The LLs provide the space necessary to rethink and potentially redesign the AMU decision systems, and to encourage and engage actors in efforts to reach more prudent AMU. The LL facilitators are trained on how to use the ex-ante impact assessment method, structure the whole process, build and reach a common vision, develop a shared understanding of the problem, establish a dialogue between actors, and create an atmosphere of co-creation.

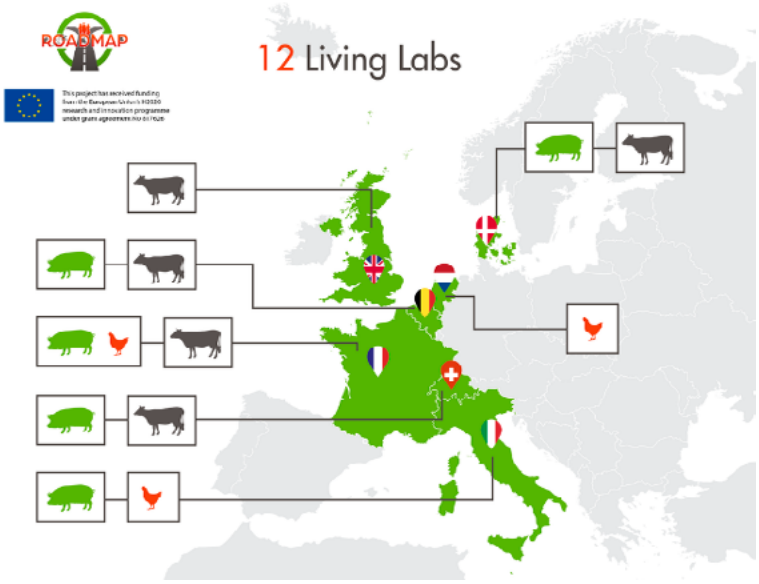


Figure 8. The 12 LLs of ROADMAP, indicating the production sectors they focus on (Source: ROADMAP)

Activities Beyond Research

Tailored strategies have been developed to support transition scenarios in diverse farm animal production systems in Europe, and in other low- and middle-income countries. Also, several online training courses and other educational materials on prudent AMU have been published.

Main Achievements

- ROADMAP established dialogues in new ways that allowed stakeholders to reach common understandings, to articulate conflicting interests, test technical and social innovations, develop synergies with existing initiatives, to accompany policy-making processes and to commit researchers and participants, and to establish collaborations beyond the project.
- Technical solutions for fostering prudent AMU, and socioeconomic tools (e.g.: the establishment of stakeholder platforms) have been developed to improve the acceptability and thus support the implementation of these solutions.

More information

- *ROADMAP project description*

Occitanum

France

Aim: "To deploy digital technologies to foster an agroecological transition in agricultural production and local food systems. "

PROFILE

- Occitanum was established in 2020 with Open Labs (OLs) that focus on seven themes (six production systems and one on local supply chains).
- The CORE is a central structure established to support the network by developing and mobilising common resources for all the partners, through several mechanisms implemented by different partners.
- The project, coordinated by INRAE, is based on a two-level governance system: the strategic management of the project, and the management of the innovative projects, with a steering committee and an innovative project committee for each innovative project.
- The Occitania Region supports Occitanum as part of the Green New Deal Action Plan.
- **Production sector:** a wide range of production systems, including field crops, viticulture, fruits, vegetables, livestock, beekeeping, and local food systems.
- **Participants:** Actors in charge of research, teaching, and other knowledge production and transfer, local and regional authorities, development facilitators, innovation enablers, farmers and their communities, consumer collectives, and founding agritech companies.
- **End users:** farmers, citizens

Occitanum is an archipelago LL based on two interacting components: a set of 10 "real-life" sites organised by the agricultural sector in seven Open Labs (OLs) and the CORE that is a resource centre set up to support the OL and the sites. In each site, communities (farmers, agritech companies, consumers, and local authorities) are managed by a site animator. Putting the farmer at the centre of the process, the task of the

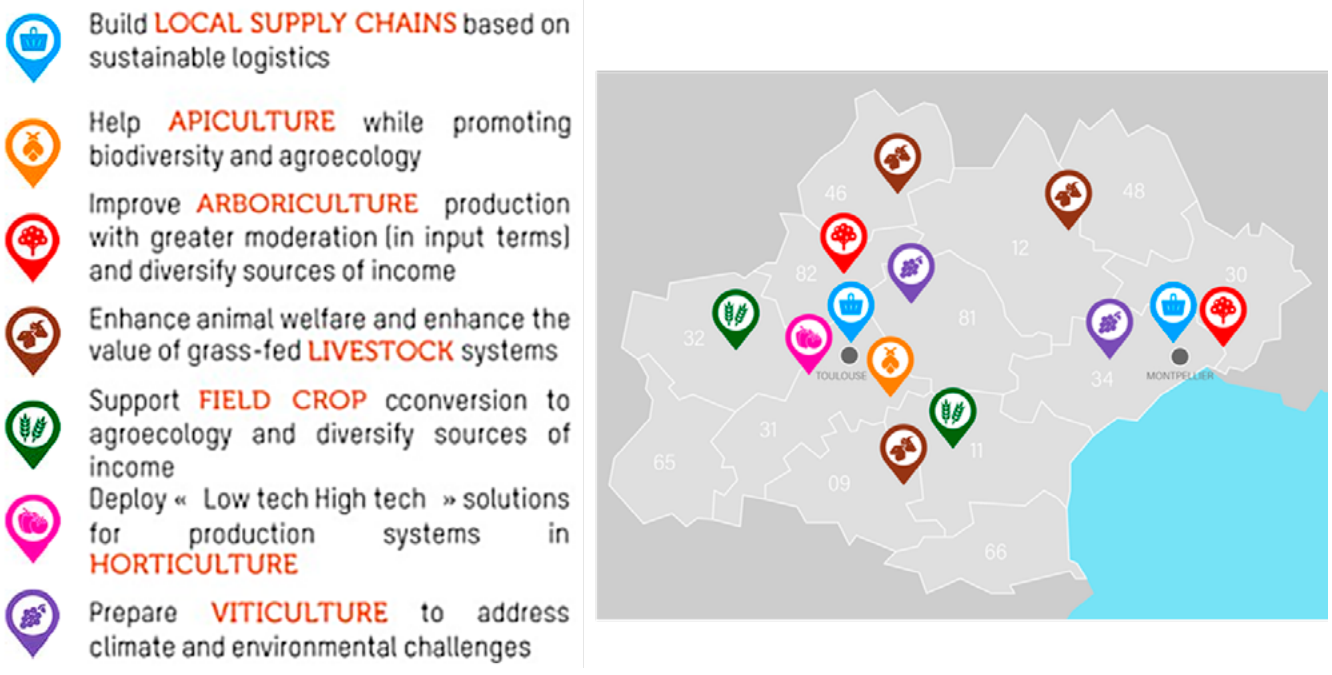


Figure 9. Map of Occitanum's OLs (2023) (Source: Copyright Occitanum)

animator is to encourage the emergence of "innovative projects" through a participatory approach (including design thinking).

Core Research Activities

The project is structured around the seven OLs with different production systems, where they experiment with digital technologies to foster agroecology practices. The OLs operate at 10 geographical sites with different pedo-climatic conditions and production systems. On each site, innovative projects are co-constructed by local and regional stakeholders, in the spirit of open innovation for a variety of agricultural and local food systems. They identify the issues critical to agroecology transitions, formulate and select digital solutions (existing or to be developed) based on the needs and interests identified, and study the effectiveness of these technologies in real-life conditions to provide them with an improvement loop if needed.

The methodologies used at different stages of the co-design process include initial brainstorming, mapping of the proposed tools or services, inviting participants and formalising their contribution, and most importantly, taking an iterative approach to co-development, testing, and impact assessment.

The process of setting up and carrying out innovative projects:

- The sites are managed by facilitators who mobilise farmers' collectives and help them express and structure the need for digital solutions to strengthen the agroecology transition.
- These needs are then translated into a Call for Expression of Interest (CEI) that identifies one or more agritech business partners.
- The members of the OL site and the company agree on objectives, an action plan, and a budget.
- The innovative project is implemented, and the selected company tests the innovative solution in real situations with end users and farmers.
- Adjustments are made according to farmers' feedback and field constraints.
- The solutions are then evaluated in terms of their contribution to the evolution of practices in favour of the agroecology transition in the three dimensions (environmental, economic, and social).
- Transfer actions are then undertaken to promote adoption and dissemination to as many people as possible.

Activities Beyond Research

The CORE is the network's common resource centre. It provides resources and mechanisms that support the OLs' innovation efforts (e.g.: establishing training programs, securing open innovation through knowledge dissemination, facilitating the implementation of open innovation approaches, and setting up collaborative workshops).

Main Achievements

- 50 partners are involved in 25 operations led by OL (including 12 innovative projects) under seven OLs at 10 geographical sites.
- The technologies developed within Occitanum are also demonstrated to students, and farmers considering the implementation of these digital solutions through dissemination efforts that aim to transfer these experiences to other end users and extensionist as well.

MORE INFORMATION

- *Occitanum website*

PFN Hessen

Practical research for organic agriculture and vegetable farming

Germany

Aim: "To develop and implement practical innovations through joint research projects that increase the resilience of farming and food systems to future challenges and foster agroecology transformation".

PROFILE

- PFN Hessen was established in 2021, under the Organic Action Plan Hessen (2020-2025).
- The LL is funded by the Hessian Ministry of the Environment (HMUKLV).
- The Association of Organic Farming in Hessen (VÖL) coordinates the participatory cooperation of its over 30 active stakeholders (organic farmers, advisory service providers, researchers from various (Hessian) research institutions, the State Office of Agriculture Hessen and a network coordinators).
- **Production sector:** arable farming and livestock (pig) production system.
- **Participants:** research institutions, farmers, extension services, network coordinators
- **End users:** farmers

PFN Hessen is a dynamic practice research network, where practitioners, researchers, and advisors from all over Hessen work together, addressing organic agriculture practices and co-developing research projects. They develop project groups through a co-creative, participatory process based on needs assessments, democratic governance structure, regular meetings, discussions, and coordinated knowledge exchange among the members and with external experts. It also provides space for regular feedback and evaluations.

Core Research Activities

There are three ongoing research projects in PFN Hessen: 1) The Intercropping and nitrogen cycle project on arable farming, which studies hummus build-up, soil fertility, and nitrogen retention under three tillage strategies with different intercrop mixtures, 2) The Eco-Soil4Resilience project, which studies the effect of compost or farm manure with a combination of leguminous and non-leguminous intercrops on the water-holding capacity of the soil and on the humus build-up, 3) a new project on the use of farm-grown fine-grained legumes in monogastric (pig) feeding, to reduce the concentrated feed ratio.

The research topics are determined by groups of organic farmers to solve real-life problems. The topic selection process includes needs assessment, group discussions with joint prioritisation, and feedback loops. It is followed by the establishment of practical research trials with peer-to-peer counselling within and between the project groups.

Activities Beyond Research

PFN Hessen put great emphasis on capacity-building efforts, targeting farmers, extension service providers and researchers. Their activities include organising information days, cluster meetings, peer-to-peer counselling, field days, workshops, seminars, conferences, and online presentations, setting up messenger groups and making all the relevant information availa-

ble through their website, therefore providing space for knowledge exchange.

Hessen also has a cooperation with the "Organic Farming and Compost Network Hessen" (NÖK), a four-year start-up project of the Organic Action Plan Hessen 2020-2025, which aims to build a sustainable network of stakeholders for the production and application of quality-assured organic and green waste composts in organic agriculture at all levels, and to develop regional nutrient cycles in organic farming. NÖK's expertise in the production and use of composts is incorporated into the design of the PFN's "Eco-Soil4Resilience" project. Results, findings, and farmers' experiences from the PFN project are also disseminated through NÖK.

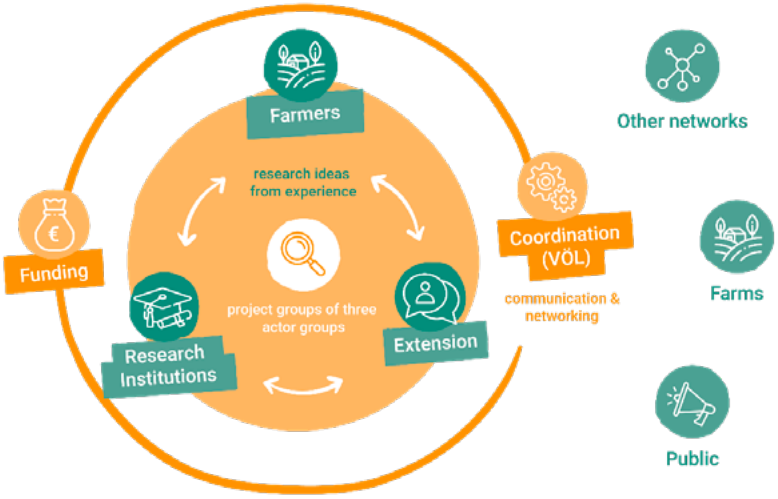


Figure 10. Structure of the PFN Hessen network (Source: PFN Hessen)

Main Achievements

- An exemplary organisational structure for a practical research network has been developed, in which participatory cooperation between farmers, advisors, and researchers, as well as their knowledge exchange and transfer and public relations work is well coordinated.
- After the joint development of the network's foundations, topic-specific expert groups were formed to develop and implement research projects through close cooperation between practitioners, extension workers and research institutions on an equal footing to solve practical problems. The network serves as a platform to make farmers' voices more clearly heard.

More information

- *PFN Hessen website*
- *VÖL (Association of Organic Farming in Hesse)*
- *NÖK (Organic Farming and Compost Network Hessen)*

Current PFN Hessen projects:

- *Project ÖkoBoden4resilienz*
- *Project Umkreis*

InoFA – Internet of Food Alliance Support Office

Greece

Aim: "To establish a permanent network of real economic actors along the supply chain, technology and service providers, RTOs and civil society institutions to promote the sustainability of the agri-food sector."

PROFILE

- InoFA started as a project in 2020, funded by the Greek General Secretariat for Research and Innovation.
- InoFA Support Office was established in July 2022 as a legal entity.
- LL certification was gained in 2023.
- Funding is based on different programmes and projects.
- **Production sector:** crop and livestock production and services
- **Participants:** farmers, packers, retailers, caterers, service providers, technology providers, research and technology organisations (RTOs) and civil society organisations
- **End users:** farmers, agronomists, market actors and scientists

InoFA as a LL is a facilitator of innovation, bringing together the market actors and research organisations around specific, impactful, innovative practices that promote the environmental and socio-economic sustainability of Greek agriculture. Its effectiveness is well illustrated by the fact that it currently has more than 80 members and covers the whole country. InoFA is a vertically integrated cluster, dedicated to fostering the digitalisation of a sustainable Greek agri-food sector.

Core Research Activities

Considering the objectives presented in the European Green Deal and the needs of market actors, InoFA designs projects and provides them with tools to minimise their environmental footprint. The main areas for stakeholder engagement include introducing them to biostimulants, as an alternative to fertilisers, ground cover plants, photonic technologies for yield and quality management, sustainable irrigation, the sustainable management of free-range bovines, and other innovative practices. InoFa also makes farmers visible by facilitating short supply chains, digital traceability, and proof of provenance, as well as digital marketing. InoFA, as a facilitator of innovation, presents farmers existing market solutions and their use, and provides new, more customised, and efficient solutions for agri-food transition. The InoFA LL involves farmers who carry out these activities in their fields, as well as agronomists, agricultural commodity traders, and scientists.

InoFA uses a methodological approach to develop microbial biostimulants that increase the quantity and quality of crop

Figure 11. Visit at an aromatic and medicinal herbs farm (Source: Dr. Ilias Kalfas)

yields by integrating economic practices into land management systems. In this context, InoFA develops an innovative approach based on both the discovery and screening of new species, and the selection of more efficient, stable, and safer strains within a species.

InoFA's methodology is based on producer-driven innovation, experimenting, piloting, and demonstrating in a real commercial environment in areas identified by economic actors. Communication between stakeholders takes place in person, informally and occasionally through organised meetings on local and interregional levels. A similar approach is used with farmers, although peer-to-peer events among farmers from different regions are also very important. After the identification of the area to be improved, farmers carry out all the data generation activities with the InoFA's guidance and support. Researchers and farmers are jointly involved in the evaluation of the results, the latter mostly in terms of impact and economic viability. During the development of the projects, progress is discussed, and results are disseminated through focus groups and workshops.

Figure 12. On-site meeting organised by InoFA (Source: Dr. Ilias Kalfas)

Activities Beyond Research

To promote the use of digital technologies by agronomists and farmers, InoFA is involved in the creation of demonstration and piloting farms in collaboration with local vocational schools, universities, and civil society organisations in Amaliada (Peloponnese – Southern Greece) and Voio (Western Macedonia – Northern Greece). InoFA also organises knowledge-sharing and co-creative planning activities with all its members for scaling.

Main Achievements

- The active engagement of the primary sector in testing new scientific hypotheses.
- The creation of a large, open, private, rural Long Range Wide Area Network (IoT RoRAWAN) open to farmers inside the coverage area allows access to hardware for different technology suppliers who incorporate LoRA telecommunications protocols in their devices.

More information

- *InoFA Youtube channel*

ÖMKi – On-Farm Living Lab

Hungary

Aim: "To promote and improve the competitiveness of organic agriculture and agroecology through scientific research and to accelerate the transition toward sustainable agri-food systems in Hungary."

PROFILE

- The LL's host organisation is the Hungarian Research Institute of Organic Agriculture (ÖMKi), which was founded in 2011.
- In 2012, ÖMKi launched its on-farm participatory research network, which gained LL certification from the European Network of Living Labs (ENoLL) in 2020.
- Funding sources include European and national projects and income from products/services offered by the LL.
- **Production sector:** arable farming, horticulture, animal husbandry, viticulture
- **Participants:** farmers, researchers, advisors, universities, authorities, processors, retailers, consumers, and other industry stakeholders
- **End users:** farmers, hobby gardeners, consumers

The ÖMKi On-farm LL is an organic agriculture-focused, nationwide, participatory experimentation network that includes a variety of field trials and technology tests co-designed and co-implemented with farmers and other agri-food stakeholders to improve and develop new organic and agroecology practices, products, and technologies.

Core Research Activities

ÖMKi On-Farm LL is an ecosystem in which several LL projects with different levels of maturity run simultaneously, focused around three main themes: 1) crop diversification for food system stability with ancient cereal, soybean, and landrace tomato variety testing and related product and technology development, 2) adaptation of precision farming tools to organic agriculture: testing remote sensing technologies for plant protection and sensors for developing customised feed and disease prevention system, and 3) soil-building cultivation technologies: developing a species-rich cover crop mixture for vineyards and orchards and experimenting with

Figure 13. Map of the core research activities of ÖMKi's on-farm network (Source: ÖMKi)

herbicide-free, reduced tillage cultivation methods and organic nutrient management techniques.

ÖMKi combines two methodological processes into one complex system that ultimately results in product/service/technology development. The so-called 'on-farm method' is an open innovation process that is used by the LL to improve agricultural production practices in real-life farm settings (on the farm). The research involves farmers (or other end users) in all the steps, therefore they become active participants in the co-creation of the research from the first steps. The real environment in every case is the actual farm of the producer and the experiments are always adjusted to the farmers' production or environmental goals. As the LL started to develop products, the on-farm method merged with the classical product development stages, thus creating its specific ÖMKi LL product development process. In this process, the on-farm research is used to define and/or test agricultural product ideas and services and adjust them to market gaps.

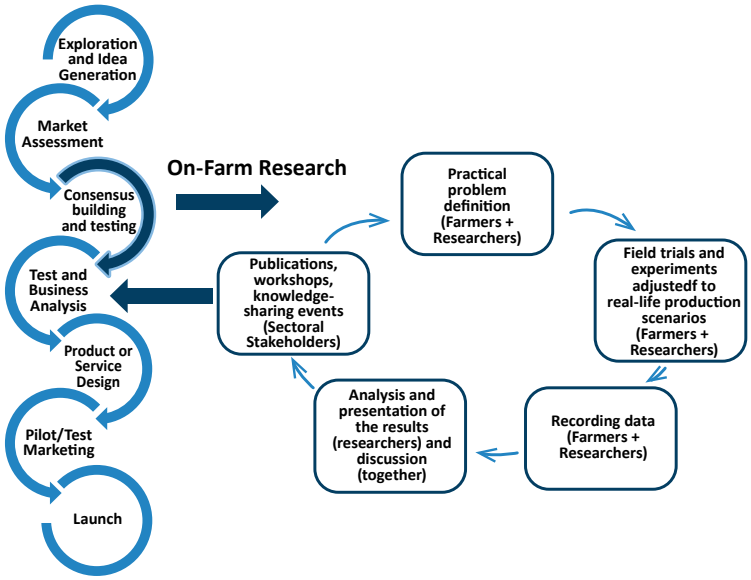


Figure 14. The combined processes of on-farm method and product/service development at ÖMKi On-Farm LL (Source: ÖMKi)

Activities Beyond Research

To provide space for peer-to-peer learning and knowledge sharing, ÖMKi organises on-farm demos, farm visits, lectures, roundtable talks, and workshops for farmers, supply chain actors, SMEs, authorities, and policymakers. ÖMKi is heavily involved in the dissemination of their research results to a broader audience. They offer practical guides and educational materials, both printed and online formats (including video recordings). The LL also advocates a better integration of organic agriculture into national agricultural policies, and both national and European strategic documents.

Main Achievements

- Building a community with more than 100 farmers who voluntarily take part in the on-farm network from all over the country.
- Marketed LL products and services: Tomato landrace seedling package, "Living interrow" seed mixture for vineyards, ancient emmer flour, and an organic advisory service.
- Number of technology and production guides about organic farming (tomato, grapevine, potato, fruit trees, soya bean, etc.) are published for farmers.

MORE INFORMATION

- *ÖMKi website*
- *ÖMKi on-farm research network*
- *ÖMKi Youtube channel*

Innovative Farmers

United Kingdom

Aim: "To speed up the adoption of innovative practices that increase farm sustainability, resilience, animal health and welfare, enhance farmers' confidence in on-farm experimentation, and foster new collaborations."

PROFILE

- Established in 2012 (under the name of Duchy Future Farming Programme).
- The network is led and managed by the Soil Association. Past delivery partners have included the Organic Research Centre, Linking Environment and Farming (LEAF) and Innovation for Agriculture.
- In the last decade, they have launched over 150 field labs and awarded over £620,000 in small grants to their farmer groups.
- Several top UK agricultural research organisations have been involved in the field labs.
- **Production sector:** all production sectors
- **Participants:** farmers, researchers, advisors, NGOs, and industry stakeholders
- **End users:** farmers, agronomists, and researchers

Figure 15. How to set up a field lab (Source: Innovative Farmers)

Innovative Farmers is a non-profit network that gives farmers in the UK research support and funding on their terms. This helps farmers find lasting solutions to practical problems, from managing weeds and pests with fewer chemicals to testing more sustainable animal feeds. Members of the network can connect with other innovative farmers, researchers and stakeholders who share a passion for finding new ways to farm and can take part in farmer-led trials, known as "field labs" (FLs).

Core Research Activities

At any time, around 25 active FLs are underway, covering all farming sectors and involving both conventional, regenerative, and organic farmers. These focus on finding alternatives to plastic film mulch, no-till techniques with living mulches, mob grazing to build soil carbon, improving hop soils through cover cropping, growing, and grazing diverse forage crops for sustainable livestock wintering, etc. For testing methods, Innovative Farmers uses on-farm field trials and collects a range of data as required on indicators such as soil health, biodiversity, water quality, animal health, and welfare. The duration of most FLs is

between one and three years. Meanwhile, those that focus on changes in soil health can last up to five years. Data is also collected on yields and comparative costs of the innovative practices trialled vs current practices. They respond to farmer requests, then run meetings and workshops to co-design trials, and set up the trials in commercial environments using an eight-step methodology (Figure 15). They are dedicated to making their results available through demonstration activities including farm walks and inviting farmers and researchers to speak at sessions they organise at agricultural conferences, but they also offer e-workshops.

Activities Beyond Research

Innovative Farmers is dedicated to sharing practical knowledge from the FLs, particularly targeting farmers, agronomists, and researchers. They connect farmers with other farmers to facilitate the co-design process and connect farmers with researchers for advice on trial design and support to do assessments, monitoring, and analysis. Coordinators are assigned to these groups to keep the FL on track and facilitate the co-design process, and the researcher is available for advice on trial design and time to do assessments, monitoring, and analysis. They also organise network events, conference sessions, and other open days. Other forms of communication include webinars, monthly e-newsletters, knowledge exchange videos, and blogs, social media, open-source publishing of progress and findings, dedicated web content for each FL, and working with the farming media to feature FLs and the farmers in the network. Their reporting efforts include evaluating their work with quality assurance from a steering group of industry experts and academics who assess FL applications.

Main Achievements

- Over the last decade, over 150 FLs have been established, with around 750 farmers taking part in on-farm trials, half of whom have made changes to their farming practices (e.g.: growing cover crops in their hop yards, growing buckwheat in permanent rotation for couch grass control). Over 40 research organisations have also taken part. Over 12,000 farmers have engaged in activities such as attending on-farm demonstration events and conferences, watching knowledge-exchange videos, and reading the newsletter (over 3,700 subscribers).
- FLs have increased farmers' confidence in on-farm experimentation and innovation, highlighted to the research community the benefits of collaboration with farmers, and nurtured a culture of sharing across the farming industry.
- Identifying innovative solutions can increase farm sustainability and reduce costs. Half of the farmers have made changes to their farming practices due to their participation in a FL.

More information

- *Innovative Farmers website*
- *Directory of FLs*
- *Case studies from 2022*

PA4ALL – Precision Agriculture for All at BioSense

Serbia

Aim: "To create a new generation of open innovations (precision agriculture tools), which will be readily used and bring benefits across the entire value chain"

PROFILE

- PA4ALL (Precision Agriculture for All) was established in 2013, as the first living lab in Serbia. It is hosted by BioSense, the Institute for Research and Development of Information Technology in Biosystems.
- BioSense Institute (Institute for Research and Development of Information Technology in Biosystems) is a public digital innovation hub. As a host for PA4ALL, it focuses on bringing together various stakeholders across the value chain (e.g.: promoting ICT technologies to local farmers and assisting them, developing synergies with agri-business companies).
- The LL is funded through European and national projects, and through their own products/services.
- They plan to create a future network of actors who are expected to closely cooperate in the field of agroecology.
- **Production sector:** arable farming
- **Participants:** researchers and teachers, students, citizens, farmers, SMEs and entrepreneurs, NGOs government bodies, policymakers
- **End users:** farmers, students

PA4ALL LL facilities are designed to provide an enabling environment for prototyping innovative ICT (information and communication) tools for precision agriculture in a real-world setting. By engaging end users to test and validate these innovations using the framework of responsible research and innovation (RRI), the LLs allow end users to gain a more in-depth understanding of these tools, while motivating them to adopt these tools.

Core Research Activities

The co-creation efforts focus on digitalising rural areas by making precision agriculture tools available to small communities. There is a methodology developed for long-term data collection, by soil sampling which can then be used for precision soil fertilisation. The co-creation methods used include feedback gathering, drone imaging, and knowledge dissemination through online platforms and face-to-face presentations. The testing methods used for the tools developed include A/B testing, feedback gathering, and the presentation of technologies.

PA4ALL has further developed an educational model focused on introducing precision agriculture to high school students specialising in agriculture. Through the SISCODE project, they provide schools specialised in agriculture with meteorological stations, supporting equipment, and relevant training workshops. This low-cost equipment enables students to record crucial agricultural parameters and allows them to learn about ICT. An additional module on agroecology is to be added soon to the project.

Activities Beyond Research

PA4ALL is generally lobbying for the inclusion of precision agriculture into the curriculum of schools specialised in agriculture. Furthermore, it engages policymakers and representatives of civil society in a discourse about the importance of equipping society with precision agriculture tools. PA4ALL also runs the so-called Digital Village, a three-year-long project in Mokrin (Serbia), with 30 agricultural holdings, expecting the participation of over 100 farmers. The project includes the implementation of a wide range of tools (satellites, drones, sensors, meteorological stations, software for farm insurance, crop monitoring and other apps on mobile phones, etc.), educational workshops, and on-farm demonstration events, which are free of charge and accessible for all, showing how to apply digital technologies in agricultural production. In a long term, the project aims to improve the quality of farmers' lives, to prevent emigration.

PA4ALL also promote and demonstrates the AgroSense App, a digital platform that provides support to farmers and agricultural companies in monitoring the growth of crops and planning agricultural activities. It covers the following basic services, free of charge: a diary of agricultural activities, weather forecast for the location of the parcel, satellite-derived indicators of plant growth, photosynthesis intensity and the availability of water and nutrients, an overview of soil analysis, an overview of photographs of crops, information about smart technologies used in agriculture, and the latest information about the occurrence of pests and plant diseases.

Figure 16. Meteorological station developed for agricultural use by PA4ALL. (Source: BioSense Institute)

Main Achievements

- The development of a co-creation process in PA4ALL as a methodology, connecting actors and creating synergies.
- The Digital Village project, which provides space for capacity-building through information events, peer-to-peer knowledge sharing and on-farm demonstrations, introducing precision agriculture tools, and ICT concepts.
- The development of a new educational model for precision agriculture.

More information

- *PA4ALL website*
- *Mokrin Digital Village*
- *PA4ALL—Innovative Learning Methods for Education in Agriculture: An ICT Based Learning Programme for High Schools (2021)*

Vuela Guadalinfo

Spain

Aim: "To improve citizens' opportunities and digital skills, fight against depopulation, facilitate e-government and reduce the digital gap between rural and urban areas."

PROFILE

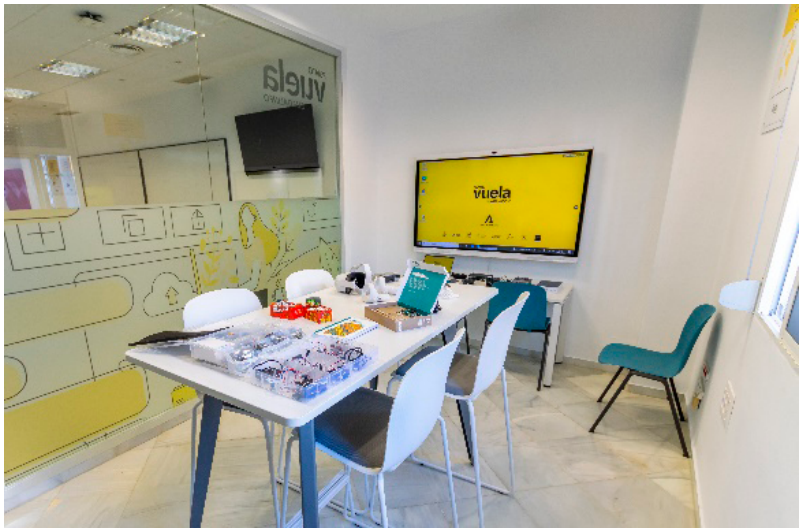
- The first Guadalinfo LL was established in 2004. Currently, there are over 760 LLs in villages and neighbourhoods in Andalusia. In 2022, a new strategy was developed to focus on digital skills, digitalisation, and the introduction of new technologies.
- Funding comes from regional and provincial governments.
- **Production sector:** relevant for all production sectors
- **Participants:** Andalucía's Regional Government, provincial governments, educational centres, students, farmers, SMEs
- **End users:** rural population in Andalusia

Vuela Guadalinfo is a social rural LL network. Its main objectives are to improve living conditions in rural areas and fight the trends of depopulation by reducing the digital gap between rural and urban areas. This is achieved by securing the availability of digital services, educating citizens on the use of digital technologies, and improving their digital skills. The Puntos Vuela are easily accessible public local service points that provide space for training and information events and for knowledge exchange. Farmers can learn about e-governance and the use of innovative information and communication technologies (ICTs), and are supported to learn about the use of digital tools (e.g.: apps on smartphones and drones).

Core Research Activities

The main activity of Guadalinfo is to support Andalusian citizens (including farmers) in learning how to use digital tools. As such, they co-develop training materials with their users and coaches and train their users on how to use and apply various new technologies and e-services. They work with more than 760 LL trainers in the region to co-design training events and activities related to the farmers digital needs (for example on obtaining various licences for agricultural activities, using geographical information systems, uploading, and managing data related to agricultural production, using digital apps relevant to production, etc.). Currently, Guadalinfo is co-developing social research with its users to measure the impact of the ICT, social networks, the introduction of e-government, and digital competences in rural society.

Figure 17. One of the Punto Vuela office spaces (Source: Consorcio Fernando de los Ríos)



Activities Beyond Research

Most of the educational programs offered by the network support digital transition and the use of ICTs in rural areas. Vuela Guadalinfo is dedicated to improving the digital competencies of farmers and rural SMEs. They provide training events presenting ICTs (e.g.: the use of digital administration platforms like TRADE, DAT, and GEA), mobile apps, and other emergent technologies (e.g.: drones, energy consumption, and meteorological apps). The service points are managed by coaches who specialise in such new technologies and have good social skills. They assist users in improving their digital skills and support them in the process of adapting the technologies they need. Efforts have also been made to spread agroecology best practices in rural areas.

Main Achievements

- There has been a 5% increase in the number of users. Over 80,000 participants attended just the Digital Skills training events in 2023 alone.
- A new strategy has been developed for the 2022–2025 period, focusing on the improvement of e-governance and digital competencies for work, on tackling depopulation, and on retaining the expertise and talent in the rural areas. The Guadalinfo LLs will be redesigned and adapted to social needs, with more portable devices offering users a new concept of dynamic use and a reference point regarding digital issues near their home.
- The service points have been redesigned. Now they are ready to host new services, such as providing space for teleworking and networking, and access to new technologies (e.g.: drones, 3D printers and scanners, and electronic sensors) and up-to-date devices to improve the user experience.

More information

- *Vuela Guadalinfo website*
- *Guadalinfo blog, article on a workshop on the use of digital tools in agriculture*

FiBL On-Farm Network

Switzerland

Aim: "To improve organic farming by facilitating innovative approaches for a climate resilient and sustainable future."

PROFILE

- The Research Institute of Organic Agriculture (FiBL) was founded in 1973 and the FiBL On-Farm Network was certified as LL by ENoLL in 2021.
- The on-farm network and the numerous projects that build on it are funded by the Swiss Federal Office for Agriculture (FOAG) and other federal offices, cantonal authorities, private organisations, and EU projects.
- **Production sector:** wide range sectors from arable farming, livestock farming to consumer research and agri-food policy.
- **Participants:** Researchers, farmers, advisors, and multistakeholder group of experts and practitioners
- **The end users:** farmers

The Research Institute of Organic Agriculture's on-farm network aims to serve as a platform for farmers, and to foster innovation in farming practices through applied and basic research, advisory services, and dissemination. The network provides an opportunity for farmers to share their needs and problems, which serves as inspiration for the development of new research and innovation projects. Experiments are carried out on the farms with the involvement of other stakeholders, which can range from top-down to fully co-creative, depending on the nature of the project. The method is essentially based on mutual exchange, which ensures a win-win balance between researchers, advisors, farmers, and other stakeholders.

Figure 18. Exchanging experiences on strip cropping amongst farmers and researchers in November 2022. (Source: FiBL CH, Tim Schmid)

Core Research Activities

The LL's research areas cover a wide range of production sectors such as variety testing (e.g.: cereals and potatoes), intercropping of grain legumes and cereals, weed control (precision farming), improving cropping techniques (legumes, rapeseed, sugar beets), cultivation systems (reduced tillage and strip cropping) and improving crop quality.

One of the main focus areas of the LL, full participatory development of strip cropping in the Swiss context, started in 2022. Throughout the process, a series of meetings are being organised to discuss the on-farm experimental designs. Once the experiment starts in the field, various indicators such as pest and disease abundance or yield are determined in contrast to the normal field size reference. In addition, a multistakeholder group is involved in the process to support the core group with additional reflections. Given that research topics are always changing according to farmers' and society's needs, FiBL is particularly keen to invest in capacity building for participatory research involving all stakeholders.

Activities Beyond Research

The FiBL On-Farm Network provides farmers, advisors, and other stakeholders a platform for regular exchange (e.g.: farmer meetings, field visits, demonstrations), which guarantees knowledge transfer and a peer-to-peer process in all directions. FiBL provides training programmes, courses, and a wide range of services (e.g.: assessment of farm sustainability, assessment of the quality assurance of organic inputs) for both farmers and advisors. FiBL is also very strong in producing and disseminating scientific results and knowledge based on LL outcomes and in influencing the direction of international organic research.

Main Achievements

- Building a dynamic on-farm network in Switzerland with more than 50 farmers and good cooperation, with learning opportunities for all.
- Openness for testing innovations (e.g.: weeding robot in sugar beet, new soya, and lupine varieties for cultivation under Swiss conditions, alternatives to ploughing)

More information

- *FiBL website*
- *FiBL Cultivation Techniques for Arable Crops*
- *FiBL Switzerland as new member of ENoLL (news)*
- *Bioaktuell*
- *FiBL Youtube Channel*

BIOBASE – Aarhus University research framework for agricultural biomass production

Denmark

Aim: "To establish and maintain a framework of field trials for providing high-quality data from a plethora of agroecosystems with cereal and industrial annual crops, perennial grasses, legumes and their combination, as well as knowledge dissemination and industry outreach."

PROFILE

- Biobase RI was established in 2013 by the Innovation Fund Denmark BioValue SPIR (Strategic Platform for Innovation and Research on Biorefining) and in 2018 became part of the permanent research infrastructure of the Department of Agroecology at Aarhus University.
- Biobase is funded by Aarhus University internal funding and externally funded projects and has enjoyed more than a decade of fruitful research and education.
- **Production sector:** wide range of agricultural biomass production systems and approaches, ranging from arable cereal and industrial farming, double- and intercropping, to perennial grasses, legumes and their mixtures and combinations.
- **Participants:** universities, research institutes, national and international industry stakeholders
- **End users:** academic and industry actors

Biobase RI is part of the Centre for Circular Bioeconomy (CBIO) at Aarhus University and the Danish Centre for Food and Agriculture (DCA). It focuses on research and development of novel agricultural biomass production systems involving cereals such as wheat, maize and triticale, industrial crops such as hemp and beet, perennial grasses, and clovers, with low leaching and gaseous emissions of nitrogen and soil carbon build-up. The biomass is destined for future biorefineries for the production of various products and value chains in bioeconomy and recirculation concepts. In addition to the long-term and comprehensive field experimentation, visualisation, quality control and data analysis, Biobase RI is committed to sharing new findings and building a strong network of academics and industry players.

Core Research Activities

Biobase RI investigates and develops agricultural production systems and technologies for refining biomass to various products such as protein for feed or food and lignocellulose for biofuel, based on current and innovative scientific knowledge of the agronomy and the physiology of different crops. Innovations are currently taking place in agricultural systems in terms of botanical composition, agronomic management, and nutritional profile. The field experiments are carefully tailored for establishment- sowing and resowing crops and varieties in complex double- and intercropping conditions, fertilisation and irrigation, pest and disease management, equipment installation, and data collection.

The data from Biobase span many years (>10) covering both agronomic (biomass and

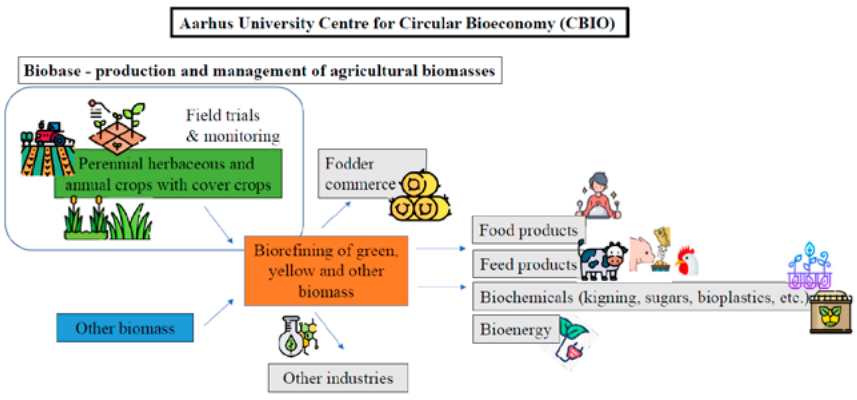


Figure 19. Biobase RI biomass production and management (Source: Kiril Manevski, Biobase)

Figure 20. Biobase activities in the fields (Source: Søren Sommer Pedersen, Department of Agroecology - Research facilities Foulumgaard, Aarhus University)

nitrogen/protein yields), environmental (effects of cultivation on soil and air) and economic performance (use of external inputs) areas. Based on empirical and modelling results, two main cropping systems are being tested, namely double-/inter-cropping of annual crops and perennial crops. Their selection is based on the principle that the soil should be covered for as long as possible with canopy cover for photosynthesis and nutrient uptake. Further, the crops should have a certain market value, e.g., minimum established market and potentially high protein content. These systems are then compared with reference grain systems such as monocultures (maize, triticale) or standard crop rotations in the region. The main results of decades of data collection clearly show that double-cropping and perennial systems are environmentally more suitable than annual monocropping for producing biomass to supply protein biorefinery, with at least 30% lower nitrogen leaching and nitrous oxide emissions, while providing significantly more nitrogen in the biomass. Perennial systems also help to increase the soil carbon and nitrogen stocks, especially when legumes are involved.

In the future, Biobase plans to investigate the impact of perennial system renewal on the carbon and nitrogen status in the crop and the soil, as well as the effects of drought and heat stress on crop growth and biodiversity aspects. The depth and stability of carbon and nitrogen deposition in the soil are important areas to be looked at, as is the identification of social barriers to systemic adaptation by farmers.

Activities Beyond Research

The knowledge-sharing efforts and stakeholder engagement of Biobase, besides producing scientific publications, includes sharing their results by participating in scientific and industrial conferences, webinars, and summer schools. The results are also conveyed to students through academic courses at Aarhus University and at the Sino-Danish Center Water and Environment program, as well as to other academic and industrial partners affiliated with the CBIO network and beyond.

Main Achievements

Biobase has identified agronomic and environmental characteristics of novel agricultural biomass systems favourable for the European green transition:

- Prolonged coverage of the soil with crop canopy increases biomass production and reduces nitrogen leaching and has positive impacts on soil carbon and nitrogen sequestration compared to conventional cereal monoculture systems.
- Perennial herbaceous systems produce large protein yields as a local alternative to the environmentally costly overseas export of soy for animal feed. Some findings also suggest lower nitrous oxide emissions from these agroecosystems compared to annual monocultures, despite their intensive field management.

More information

- *Centre for Circular Bioeconomy website*
- *Danish Centre for Food and Agriculture website*
- *CBIO research on the production and management of agricultural biomasses*
- *CBIO research on green protein*
- *Article on the Fundamentals of bioeconomy - The Biobased Society*
- *Publications on biomass productivity and radiation utilisation of innovative cropping systems for biorefinery*

ReWet – Wetland observatories for rewetting of drained peatlands

Denmark

Aim: "To facilitate climate-smart management and land-use change related to agriculture and forestry on soils with high organic carbon content."

PROFILE

- ReWet is a national infrastructure project (2021-2028), funded by the Ministry of Higher Education and Science.
- It is coordinated by the Department of Agroecology at Aarhus University (AGRO)
- Their partners include the Department of Bioscience at Aarhus University (BIOS), the Department of Geosciences and Natural Resource Management at the University of Copenhagen (IGN)
- **Production sector:** arable farming
- **Participants:** national, regional and local public bodies/authorities, researchers, advisors, farmers, SMEs, NGOs
- **End users:** actors in charge of rewetting action

In Denmark, 10% of the GHG emissions result from drainage of peatlands, and the national 70% GHG reduction goal (by 2030) cannot be achieved without rewetting a substantial area of drained peatland. ReWet provides infrastructure and a research platform to study peatlands at an ecosystem scale, under different management practices both before and after rewetting. The project contributes to the development of research-based guidelines for rewetting peatlands and provides input for models on paludiculture-based biomass utilisation in short supply chains, which is key to rewetting action.

Core Research Activities

Four observatories have been established on agricultural and forest peatland sites in Denmark, serving as platforms for ecosystem monitoring, experimental research, technological development, and demonstration. They measure gas fluxes. GHG emissions (CO2 and CH4) are being monitored in larger areas (>1 ha) at all sites by eddy covariance (EC) towers to represent the fluxes at an ecosystem scale, as well as hydrology and water quality. Nutrients and hydrological changes are also measured.

EC towers, autochambers, and the Skyline 2D autochamber systems are being used to measure GHG emissions. Nutrient fluxes are measured using water samples collected from piezometers along with a hydrogeological characterisation of the peatlands. ReWet has facilities for biorefining at lab scale and at a large demonstration scale. Together with a farmer's cooperative, a paludiculture-based biomass utilisation is being developed for bioenergy and for biorefining grasses into higher-value products. There is a need to co-create local circular bioeconomy models that focus on farm-scale implementation of flood-adaptive crops and growing techniques. Further research to enhance the understanding of carbon and other nutrient cycles and hydrology is also needed. A combination of state-of-the-art equipment and comprehensive monitoring of the different sites constitutes the infrastructure that aims to provide a strong base for ground-breaking research in the fields of biogeochemistry, microbiology, and ecosystem restoration.

The rewetting of drained peatlands is a complex issue with many pitfalls, with diverse factors impacting the pursuit of high-

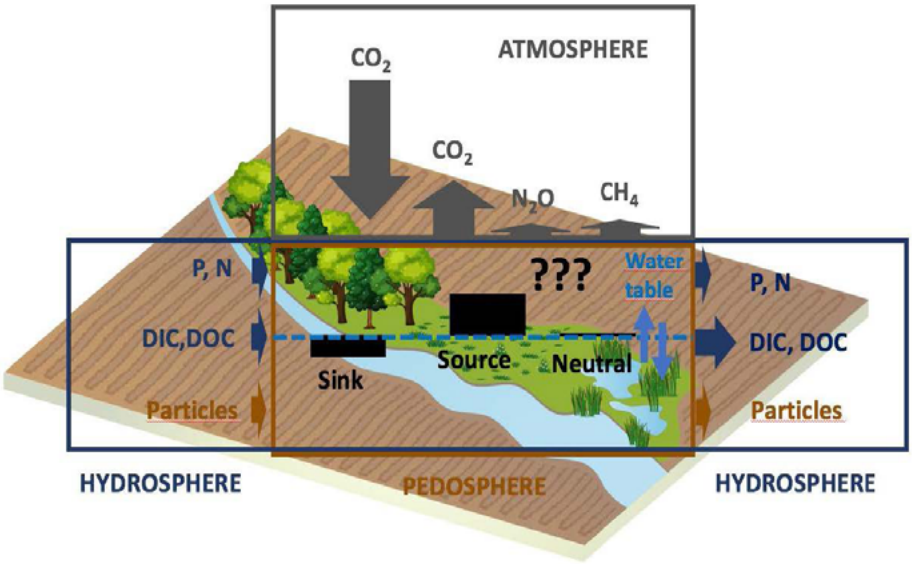


Figure 21. The focus areas of ReWet's ecosystem monitoring and experimental research activities (Source: Departments of Agroecology and Ecoscience, Aarhus University; Department of Geosciences and Natural Resource Management, University of Copenhagen)

ly place-based and knowledge-intensive solutions. There are various co-creation models currently at play with clear and well-demarcated territorial/ecosystem/landscape characteristics (e.g.: river valleys, bogs); and a heterogenous range of stakeholders involved, relying on (common) property regime institutions (e.g.: drainage associations), farmers associations, nature conservationists with high levels of social capital, and a shared commitment to finding solutions.

Activities Beyond Research

The ReWet observatories strengthen the links between the restoration of ecological and biogeochemical functions of peatlands and the wider benefits these territories can provide to society. The data and knowledge generated at these observatories contribute to efforts to solve the mosaic of challenges in wetland restoration, and to support awareness-raising efforts by informing the public about the importance of peatlands for nature, the environment, and the climate, and informing decision-makers.

Main Achievements

- An overall landscape strategy and a multifunctional land consolidation scheme has been co-created, where wetlands under agricultural use are exchanged for agricultural land in less sensitive areas.
- 8 hectares of agricultural peatland are used for data collection, sampling and analyses of drainage water, measurement of greenhouse gas emissions, paludiculture, and for the testing of light machinery.
- In early 2023, an EC tower and automatic chambers have been installed at two study sites.

More information

- *ReWet website*

LTSER ZAPVS – Long-Term Social-Ecological Research platform

- Zone Atelier Plaine & Val de Sèvre

France

Aim: "To foster transformative change in the agricultural landscape to enhance its resilience and health."

PROFILE

- LTSER Zone Atelier Plaine & Val de Sèvre (ZAPVS) was established in 1994. It became part of the "Zone Atelier" in 2009. There have been socio-ecological experiments conducted with farmers to promote nature-based solutions and foster agroecology transition since 2013. The RI Platform and the Aliment'Actions project was launched in 2018.
- It comprises 435 farms with quite diversified farming systems (organic farming, conservation agriculture, precision agriculture, or conventional agriculture). 450 km² intense cereal plain, with 24 municipalities with more than 40 villages, the sizes of which vary between 390 and 5,740 inhabitants.
- LTSER is also part of the RECOTOX network, and the European eLTER and international iLTER long-term monitoring networks.
- **Production sector:** arable farming (both organic and conventional)
- **Participants:** local public bodies and municipalities, researchers/research institutes, farmers, consumers/consumer organisations, NGOs
- **End users:** farmers and citizens

The Long-Term Social-Ecological Research (LTSER) platform - Zone Atelier Plaine & Val de Sèvre (ZAPVS) is a large-scale RI. It comprises of an open-air laboratory, which is a pilot site for the analysis of long-term trends in change of biodiversity and ecosystem functions.

Core Research Activities

Transform'Actions, the research programme of the LTSER ZAVPS, explores the functioning and resilience of agricultural socio-ecosystems, taking in account the role of biodiversity in these systems. To achieve this, an innovative research approach is being applied, which combines action research, observation, and full-scale experimentation at the regional level, to stimulate the transformation of regional agricultural and food systems, in order to make them more resilient. The research is interdisciplinary (agroecology, ecology, economics, management sciences, political science, social sciences, statistics) and transdisciplinary (local actors are being engaged as stakeholders in the research conducted). Since 2013, socio-ecological experiments have been set up with farmers on site, to explore how the reduction of inputs or soil interventions could positively affect biodiversity and in turn benefit crop production (and farmers' revenues) through enhancing ecosystem services. Farmers' decision-making processes are analysed subsequently, to identify efficient tools and policies. There are also on-farm testing projects set out to look for solutions to reduce the negative impact of agriculture on the environment, biodiversity, and human health, focusing on biodiversity in crop production and economic performance in low input conditions. The RI further explores how to design multifunctional and resilient agricultural landscapes.

There are three clusters within Transform'Actions:

- **The Agroecology** cluster aims to demonstrate that a successful transition towards a multifunctional, multi-performing agricultural model (agroecology transition) is based on the use of nature-based solutions through collective, participatory actions (social resilience). The cluster further explores management pathways and organises empirical, experimental, modelling and design workshops. The research is based on long-term data monitoring, and on a wide range of experiments and modelling.

- **The Aliment'Actions** cluster is an adaptive platform project, based on the premise that consumers' and other professional stakeholders' commitment is essential for making an agrifood system truly sustainable. It aims to initiate and accelerate the transition towards resilient food systems, to develop collective actions on a regional scale, and to develop sustainable food production and consumption models. Their actions include an assessment of food consumption behaviour, different workshops, and the mapping of local food producers to connect consumers with producers.

- **The EcoHealth** cluster aims to understand how ecosystems can buffer pesticide persistence as well as sub-lethal effects of pesticides and pathogens threatening the health of crop plants, insect and bird populations, as well as humans in agroecosystems.

Activities Beyond Research

By engaging a wide range of stakeholders in the region, ZAPVS sets out to improve individual and collective awareness of issues around food, agriculture, and the environment; and to foster collective design processes and actions to facilitate food and agroecology transitions. Other awareness-raising and knowledge dissemination activities include communication with local farmers and schools, national authorities, and the international community through publications.

Main Achievements

- There are more than 100 farms taking part voluntarily in the research activities annually.

- The research outcomes and many publications (e.g.: on the efficiency of nature-based solutions for crop production and farmers' economic performance, such as crop competition to regulate weeds, and on crop pollination by pollinators).

- Significant efforts have been made to establish relationships with locals by engaging them in the transformation of their local agri-food system, both as citizens and as consumers. The local producers of the territory have been mapped, making the information available to all inhabitants.

More information

- *LTSER website*
- *Publication on Towards sustainable and multifunctional agriculture in farmland landscapes: Lessons from the integrative approach of a French LTSER platform*

OasYs

France

Aim: "To enable farmers to make a living from their dairy cattle system in a context of climate change, while saving water and fossil energy resources and contributing to a sustainable agriculture".

PROFILE

- OasYs was set up in June 2013 on an INRAE facility as a long-term system experiment, with a minimum of 20 years long operational period.
- Its funding comes from INRAE, the French Ministry of Agriculture and Research, the Fondation de France, and other European and national projects.
- **Production sector:** livestock production system (dairy cattle)
- **Participants:** researchers, farmers, advisors, industry stakeholders
- **End users:** farmers, students

OasYs is long-term systemic experiment based on agroecology principles, designed through a collaborative approach with various stakeholders, which aims to adapt low-input dairy cattle farming systems to climate change by innovations in forage resources and livestock breeding strategies. The system was developed through a collaborative process facilitated by workshops, where different stakeholders identified the objectives and innovations they would focus on. The production performance and the environmental and economic performance of the experiments are evaluated. OasYs also aims to test and evaluate long term agroforestry practices at field scale to determine coherent ways of integrating these practices in a productive dairy cattle farm.

Core Research Activities

The experimental system assesses the question of whether a greater diversity of agricultural system components and functions, combined with their optimal management, can reconcile high levels of production with environmental performance, while also increasing the system's resilience to climatic hazards. The studied aspects include diversified forage resources, drought-adapted crops, large use of legumes, agroforestry, maximised grazing, two calving periods, extended lactation, three-way crossbreeding, trials on the use of fodder beet for dairy cattle, and sorghum together with legumes and fodder trees. The testing methods include system experiments, factorial trials, and demonstration tests. There is a multicriteria assessment at farm level. There is already data available on crop yields and quality, forage quality, grazing practices, milk production and quality, cattle conformation, reproduction, health, tree growth, biodiversity (pollinators, flora, weeds, amphibians, reptiles), soil fertility (physicochemical properties, earthworms, nematodes, enzymes), water and energy consumption, economic data (cost, incomes, subsidies), the carbon and nitrogen footprint of the farm, the life-cycle analysis of milk production, and the nutritive values of fodder trees.

Description of the experimental system:

- 90 ha of temporary grassland and crops, a non-grazed rotation alternating stock meadows and dual-purpose crops (grain, forage), 30 plots including four agroforestry plots, with no irrigation and limited use of nitrogen fertiliser.

- 72 dairy cows (plus around 20 replacement heifers) with two calving seasons (spring and autumn) to limit the herd's needs to critical periods. Early calving at two-years and extension of the lactation

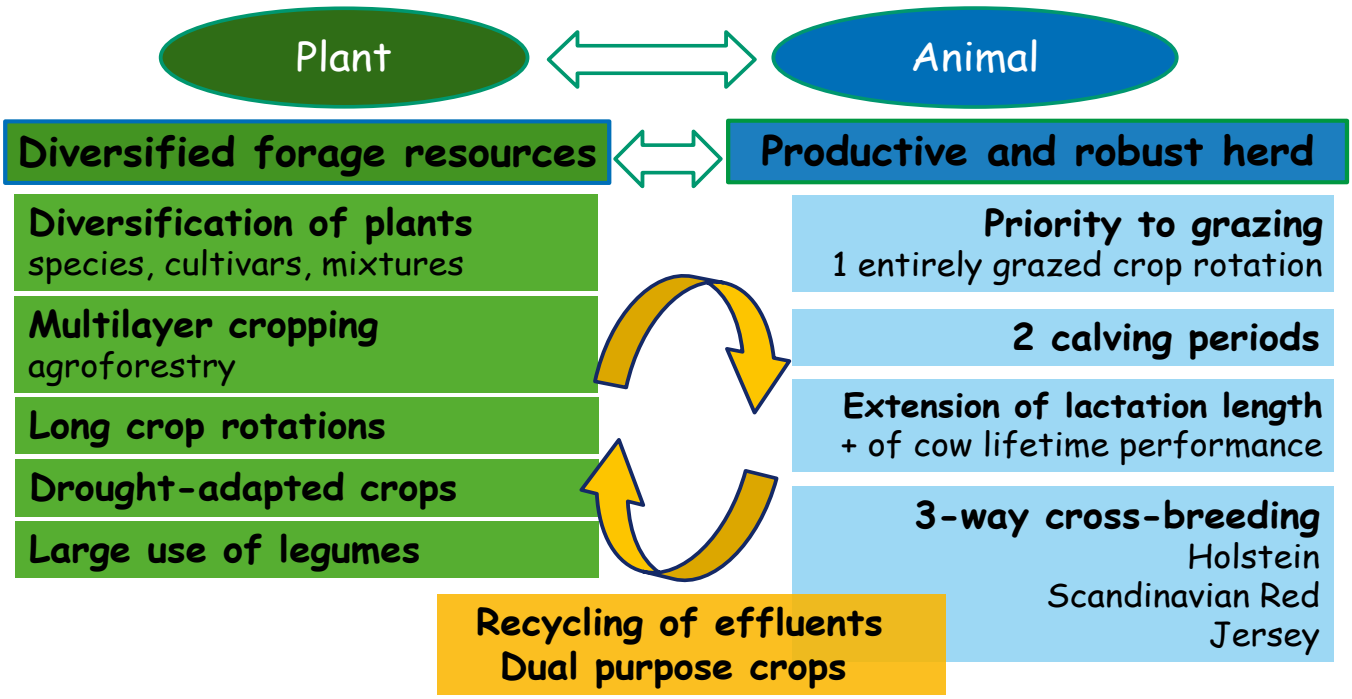


Figure 22. Activities included in the experimental system developed by OasYs (Source: Sandra Novak, INRAE)

period to limit non-productive periods. Rotational three-way crossbreeding with specialised dairy breeds to enhance heterosis.

- grazing to cover 100% of the animals' needs in spring, 50% in summer and autumn, and 25% in winter.
- woody plants planted in the plots provide an aerial fodder resource in leaner periods and may also delay grass growth and limit heat stress for the animals.
- oceanic climate with summer droughts and deep soils (loamy clay).

Activities Beyond Research

Excursions and workshops are organised on-site where stakeholders deliver presentations, introducing the system and its achievements. In addition, students from all over the country (from agricultural schools and universities), aim to present ongoing work and research to advisors and farmers.

Main Achievements

- Extension of the grazing period by increasing the diversity of the grazing resources.
- Assessment of the nutritive value of 31 tree, 14 shrub, and seven liana species.
- Offsetting the decrease in milk production by increasing the milk's fat and protein contents.
- Proof of the efficiency of the system under which 1.5 labour units may be remunerated at a rate equivalent to the income of two minimum wage earners.

MORE INFORMATION

- *OasYs website*
- *Oasys article about fodder trees on dairy farms*

EMPHASIS on plant phenomics

Germany

Aim: "To foster future food security and agricultural business in a changing climate by providing services on plant phenotyping."

PROFILE

- EMPHASIS was included in the ESFRI Research Infrastructures Roadmap in 2016. Up to now, EMPHASIS has provided pilot services, and is expected to be fully operational by 2024, as a pan-European RI on plant phenotyping.
- Services cover access to plant phenotyping facilities (with their technologies and competencies) and related services such as FAIR (findable, accessible, interoperable, reusable) data availability, training, and innovation support.
- **Production sector:** agri-food, feedstock, and bio-based products sector
- **Participants:** researchers, scientists, and policymakers from multiple disciplines
- **End users:** plant phenotyping experts (e.g.: sensor technologies, robotics, AI, Machine Learning (ML), plant breeding, agricultural management, agroecology concepts), policymakers, businesses, and the broader public.

"Plant Phenotyping" has been identified by the European Strategy Forum for Research Infrastructures (ESFRI) as one of the priorities of the European Research Area. EMPHASIS offers researchers (and further stakeholders) access to facilities, resources, and services for plant phenotyping across Europe with the main aim to help scientists better understand plant performance and to translate this knowledge into applications.

Core Service Activities

EMPHASIS is dedicated to fostering innovation in plant phenotyping technologies to ensure long-term, sustainable excellence. To achieve these goals, EMPHASIS provides a wide range of services, such as access to nearly 200 different field phenotyping technologies where researchers can either predefine the plant environment in-house or monitor environmental conditions in the field while performing their experiments. While doing so, EMPHASIS promotes and fosters harmonisation among the wide range of experiments carried out.

The broader context is that plant phenotyping facilities enable research into plant performance and productivity as a source of food, feedstock, and bio-based products. The functional body (phenotype) of a plant is formed during its growth and development from the dynamic interaction between its genetic background (genotype) and the physical world (environment). Plant phenotyping installations make it possible to explore this interaction and test plant performance under different conditions (e.g.: climatic or agricultural practices). EMPHASIS collects and delivers large amounts of data on plant performance from the experience at its facilities, in particular on the structure and function of individual plants,

Figure 23. EMPHASIS phenotyping trials on winter wheat (Source: Oliver Knopf, FZJ)

up to whole agricultural systems. This data is collected at different temporal and spatial resolutions, from minutes to months, from individual plant cells to agricultural field size.

As most of this data is managed and stored in the facilities where the experiments are carried out, EMPHASIS helps users to access the data. To facilitate the accessibility of the datasets to the wider scientific community, a local information system has been set up following FAIR principles (findable, accessible, interoperable, reusable). It helps facilities to develop their local data management systems while fostering the reproducibility and reusability of data.

Figure 24. Plant phenotyping installations (Source: - Angelo Petrozza, ALISA)

Activities Beyond Service Provision

EMPHASIS coordinates and supports a wide range of training activities on plant phenotyping, such as the application of phenotyping technologies, plant breeding, the use of phenotyping data, and the development of ML and data management systems. It provides a centralised information portal on the latest developments in the European plant phenotyping community via its website, which includes information on plant phenotyping facilities in Europe and their services.

With food security and related topics being a major global challenge, EMPHASIS collaborates closely with the International Network on Plant Phenotyping, supporting the development of a global community. Various methods are used to engage stakeholders, such as peer-to-peer events, exhibitions, joint R&I projects, and direct approaches to potential co-creators based on initial stakeholder monitoring.

Main Achievements

- Expected launch of the full EMPHASIS service portfolio in 2024.
- EMPHASIS has been a partner in several RI cluster projects and communities such as Life-Science-RI, ENVRIcommunity, EOSC-Life, ENRIITC, AgroServ, PHENET, AI4Life, CROPINNO, and RI-VIS.

More information

- *Scribble movie "What are research infrastructures"*
- *Scribble movie "What is plant phenotyping"*
- *Scribble movie "What is EMPHASIS"*
- *Movie "FAIR data in plant sciences"*
- *EMPHASIS digital flyer*

ISF – The Institute for Sustainable Food

United Kingdom

The University Of Sheffield. Institute for Sustainable Food.

Aim: "To find dynamic solutions to the challenges of food security and sustainability."

PROFILE

- The Institute for Sustainable Food (ISF) was established in 2019 by the University of Sheffield, to transform how we grow, produce, and consume food.
- **Production sector:** wide range of fields
- **Participants:** Researchers, farmers, industry stakeholders, policymakers
- **End-users:** researchers, policy makers, and a wide range of stakeholders of the food system

The Institute for Sustainable Food (ISF) at the University of Sheffield brings together an interdisciplinary team of experts from across the University, drawing on research from across science, engineering, social sciences, arts and humanities to find dynamic solutions to the challenges of food security and sustainability. The ISF focuses on making agri-food systems more sustainable, considering the impacts on the environment, food, and the health of the world's population. The interdisciplinary research in the ISF is done in collaboration with a wide range of stakeholders, bringing together passionate problem-solvers, innovative research facilities, and novel engagement with stakeholders, including the public, to influence policy and practice.

Core Research Activities

The ISF is exploring new ways and opportunities to understand the complexity of food production systems as a whole, from "farm to table", not just in terms of its separate parts. The research activity within the ISF is based on three pillars: 1) plant production and protection, 2) food consumption, health, and sustainability; and 3) translational and transformative research.

Research on plant production, protection and environmental change has the potential to work at multiple biological scales, from the molecular, gene, and cellular level through to field and global crop research. The complex interactions between soils, plants, and microbiomes that promote plant growth are investigated. This work benefits from the major research facilities used by the ISF, including plant growth facilities, mass spectrometry, next-generation DNA sequencing, high-resolution microscopy, and plant phenotyping equipment. By using high-resolution microscopy, next-generation DNA sequencing, and mass spectrometry equipment, researchers can investigate the biochemical and (epi)genetic basis of plant immunological pathways and interactions with beneficial soil microbes that improve plant resistance to biotic and abiotic stresses. This theme also includes population biology, which studies evolutionary interactions between plants, pests, diseases, and beneficial organisms. The institute's phenotyping facility provides an important resource, with a high-throughput capability to establish functional links between durable resistance, plant genotype, and environment. The research on food consumption, health, and sustainability combines the nutritional aspects of social science and public health with the latest scientific insights on the future of food and identifies pathways to achieving multiple food security objectives. Translational and transformative research focuses on translating research into real-world applications and works to facilitate knowledge exchange with agribusinesses

and decision-makers. They use technology and science valued by farmers and the wider food supply chain, as well as consumers, to improve local and global food security. ISF works towards this goal by understanding and working within the political, social, and cultural context of agri-food chains. The transformative research includes embedding waste prevention and mitigation in agri-food chains, addressing soil health and quality as systemic issues for the agri-food industry, and promoting more joined-up thinking on health and sustainability.

Figure 25. Sir David Read Controlled Environment Facility at Institute of Sustainable Food (Source: University of Sheffield)

Activities Beyond Research

The ISF hosted an event as part of a collaboration between the University of Sheffield's Make It Grow project and Gateway Zimbabwe. Discussions explored the critical links between food, community building, and community voice, amplified by the Make It Grow project through capacity-building workshops. The more than three-month-long project resulted in a multitude of video proposals for sustainable food and community projects.

Main Achievements

- Working with more than 100 different industry partners from across the farm-to-fork spectrum, including policymakers.
- 145 research groups are working to address challenges to food security and sustainability.
- The Healthy Soil, Healthy Food, Healthy People (H3) project is a £6m consortium grant funded from the Transforming UK Food Systems call, which will transform the UK food system from the ground up.
- Scientific results on the potential contribution of urban gardening to local and national food security.

More information

- *H3 Project Video*
- *Desert Garden Project Video*
- *Research projects*
- *Institute for Sustainable Food website*

LifeWatch ERIC

Spain

Aim: "To provide e-science research tools for the scientific community to support decision-making processes and to increase knowledge and understanding of biodiversity organisation, ecosystem functions, and services."

PROFILE

- LifeWatch ERIC was established in March 2017 as a European Research Infrastructure Consortium (ERIC).
- The Statutory Seat and the ICT e-Infrastructure Technical Offices are located in Spain. However, the Service Centre is in Italy, the Virtual Laboratories and the Innovations Centre are in the Netherlands, and the other eight jointly supported facilities are distributed between different Member States.
- Funding is provided by ERIC Member States, as well as European and national projects.
- **Production sector:** wide range of agricultural sectors
- **Participants:** researchers, farmers, SMEs, entrepreneurs, policy makers, local communities
- **End users:** international biodiversity and agroecology research community

The e-Infrastructure for Biodiversity and Ecosystem Research (LifeWatch ERIC) is an internationally distributed RI designed to support biodiversity and ecosystems research. It addresses major environmental challenges and provides strategic data-driven solutions for environmental protection. This is done by providing access to a wide range of datasets, services and tools that enable the creation and operation of Virtual Research Environments (VREs) or Virtual Labs. LifeWatch ERIC applies high-performance, grid and big data computing systems to understand the complex interactions between species and the environment. They also develop advanced modelling tools to support the implementation of measures to preserve threatened species and biodiversity.

Core Research Activities

LifeWatch ERIC uses participatory approaches that involve stakeholders in the design and development of Virtual Research Environments. Methods may include workshops, focus groups, brainstorming sessions, and online collaboration platforms to gather input and feedback. LifeWatch ERIC aims to be a first-class provider of information and services to the international biodiversity research community, combining a wide range of ICT tools and resources with specialised knowledge. To achieve this goal, LifeWatch ERIC provides new opportunities for large-scale scientific development, enables accelerated data capture with new technologies, and supports knowledge-based decision-making in biodiversity and ecosystem management.

LifeWatch ERIC is also involved in experimenting with various agroecology practices, such as sustainable soil management, integrated pest management, agroforestry, conservation agriculture, and crop-livestock integration using digital tools (e.g.: soil sensors). They can also support the traceability of the services and products provided by agroecosystems by providing blockchain solutions (tokenisation). They provide advanced technology for transparent, accountable, and immutable information sharing and data tracking.

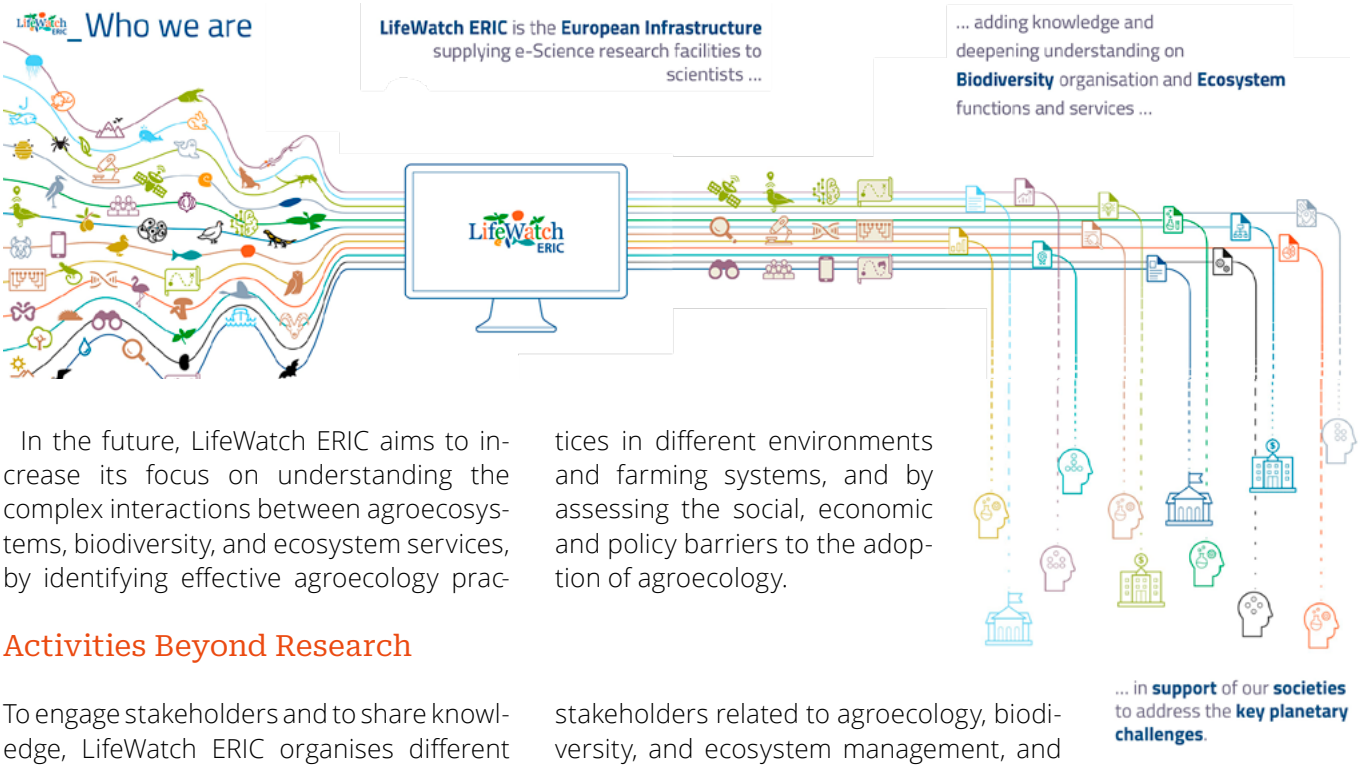


Figure 26. The focus and activities of Lifewatch ERIC (Source: LifeWatch ERIC)

In the future, LifeWatch ERIC aims to increase its focus on understanding the complex interactions between agroecosystems, biodiversity, and ecosystem services, by identifying effective agroecology practices in different environments and farming systems, and by assessing the social, economic and policy barriers to the adoption of agroecology.

Activities Beyond Research

To engage stakeholders and to share knowledge, LifeWatch ERIC organises different peer-to-peer events, demonstrations, conferences, webinars, and workshops among stakeholders related to agroecology, biodiversity, and ecosystem management, and compiles and disseminates educational and training materials.

Achievements:

- LifeWatch ERIC developed an Agroecology Virtual Lab in the ALL-Ready project, which is an interface for researchers, farmers, SMEs, entrepreneur, government, and funding bodies to facilitate the agroecology transition, using co-designed and co-developed tools to improve data, information sharing, and networking between the stakeholders of the agroecology research community.
- To analyse patterns and trends in biodiversity data and predict the impacts of different management scenarios, LifeWatch ERIC also developed artificial intelligence, GIS, big data, and machine-learning-based tools, as well as decision-support tools to help stakeholders make informed decisions on agroecology, biodiversity, and ecosystem management.

MORE INFORMATION

- *LifeWatch ERIC video*

ACS – Agricultural Climate Solutions at Agriculture and Agri-Food Canada

Canada

Aim: "To accelerate the development and adoption of sustainable practices and technologies co-developed by farmers, scientists, and other partners to address urgent agri-environmental issues, such as climate change, soil health, water quality and biodiversity."

PROFILE

- Since 2018, Agriculture and Agri-Food Canada has been building a nationwide network of 13 agroecosystem LLs.
- Internationally, Canada presented the concept of "agroecosystem living labs" during the May 2018 G20 Meeting of Agricultural Chief Scientists in Argentina.
- Agriculture and Agri-Food Canada's Agricultural Climate Solutions (ACS) is a new 10-year (2021–2031), $185 million programme, which now has at least one LL in every province of Canada.
- **Production sector:** wide range of agriculture sectors
- **Participants:** farmers, researchers, producer associations, environmental organisations, conservation groups, non-profit organisations, industry, universities, local and regional governments, academia, and indigenous communities.
- **End users:** farmers

Agriculture and Agri-Food Canada (AAFC) is the Government of Canada department responsible for supporting the agriculture and agri-food sector through research and innovation. AAFC launched a nationwide network of LLs to accelerate the development and adoption of sustainable practices and technologies by Canadian farmers. They apply an integrated approach to agricultural innovation, which means that the LLs focus on co-developing innovative solutions and transferring knowledge to other farmers, apply solutions that are tailored to each region, and promote environmental sustainability and resilience in the agricultural sector. With a user-centric approach to innovation, farmers are directly involved in the innovation activities from start to finish.

Core Research Activities

AAFC's LLs are based on three basic principles: 1) focusing on farmers' needs and involving them throughout the innovation process; 2) broad and diverse partnerships; and 3) testing in the user's real-life context. At the beginning of the projects, local collaborators (farmers, researchers, and other interested stakeholders) come together to learn and discuss the farmer's needs and to identify common priorities and objectives. Innovative new practices or technologies are then jointly designed to help address these needs. The innovations are then tested, evaluated, and further developed through a series of iterative steps. An important aspect is that innovations are tested where they will be used, on real farms by farmers. In addition, scientific research helps to assess the performance of practices or technologies, including their environmental and socio-economic impact. The collected data and evaluations ensure that farmers and scientists have useful and scientifically proven solutions that can be easily adopted by others. As the cycle is repeated, innovations are continually adjusted to address feedback from farmers, collaborators and scientists and the relevance regarding to agri-environmental challenges. As the resulting innovations are co-developed with farmers from beginning to end, they are more likely to be adopted by other farmers. The co-development process ensures that the inno-

vations are economically viable, technically feasible, and desirable for farmers, as well as being scientifically sound. Therefore, collaboration with farmers throughout the innovation cycle is essential.

Examples of practices being examined across the network of LLs are crop rotations and cropping systems, land use changes, pasture, and forage management, feeding strategies, nutrient and pesticide management, fertiliser use optimisation, soil health enhancement, restoration, and enhancement of perennials. With its new Agricultural Climate Solutions – Living Labs programme, the emphasis is on increasing carbon sequestration and reducing greenhouse gas emissions, in addition to providing other environmental co-benefits. In addition to many specific studies to better understand the effectiveness of the innovations being tested in the LLs, key areas of focus include measurement techniques, evaluating LL processes and outcomes, and broad-scale capacity building in key knowledge areas.

Figure 27. AAFC field visit to one of the LL partner farms (Source: Agriculture and Agri-Food Canada)

Activities Beyond Research

Through a series of national working groups, the network builds connections between LLs and individual experts, and builds capacity in the areas of soil health, water, agrometeorology, biodiversity, crop health and productivity, modelling and geomatics, data integration, socio-economics, and innovation and knowledge. Additional cross-network sharing is facilitated by an annual workshop, where all the LLs come together to share insights, experiences, and learn new tools, techniques, and approaches.

Main Achievements

- In 2022, the network rapidly scaled up to 13 LLs with nine new LLs being launched in six of ten Canadian provinces under the new Agricultural Climate Solutions program.
- New LLs will be launched in 2023 in the four provinces that hosted the original four LLs under the AAFC's Living Laboratories Initiative (Prince Edward Island, Manitoba, Quebec, and Ontario), which ended in March 2023. Highlights from the original four LLs include:
  - >50 beneficial management practices co-developed and tested on real farms in four areas: (1) mitigating and adapting to climate change, (2) improving soil and water conservation, (3) reducing water contamination, and (4) maximising habitat capacity and biodiversity.
  - >250 active participants (expanding to over 1000 under the new Agricultural Climate Solutions program)

More information

- *AAFC's Living Laboratories Initiative*
- *Living Laboratories video: The Value of Research Collaboration*
- *Living Lab - Ontario: Collaborating towards sustainable farming (Video)*
- *Agricultural Climate Solutions program*
- *Agricultural Climate Solutions – Living Labs video*
- *Publication on the defining characteristics of Agroecosystem Living Labs*

ACHIEVEMENTS OF THE PILOT NETWORK

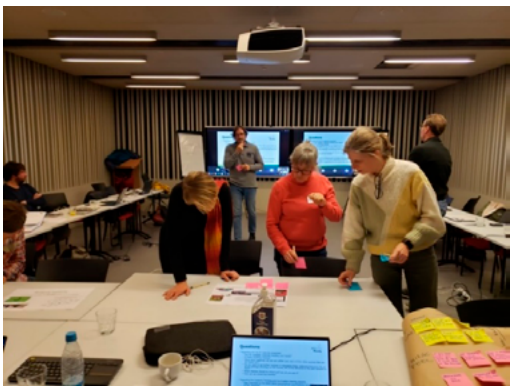
Within the frame of the ALL-Ready project, the pilot network was able to lay the foundations in terms of objectives, network structures, operations, methods, networking tools, thematic areas, and activities for the future network of agroecology LLs and RIs using continuous co-creation, knowledge exchange, and experimentation, with the facilitation of the project partners.

First, the members **co-constructed their joint activities** with a common understanding of their expectations and the potential benefits of the network. Setting dynamic knowledge exchange, knowledge sharing (e.g.: challenges, co-creation-methods, best practices of LL models) and co-creation opportunities between the member LLs and RIs at the top of the benefit list. Moreover, the creation of a platform for future collaboration in international research projects on agroecology, enhancing the networking potential of the members, and the organisation of training sessions for members to broaden their knowledge in new methodologies and approaches for agroecology transition were also recognised as essential elements of the future network. The members set three main collaborative themes for the pilot network based on their shared challenges and interest: 1) Collaboration for knowledge exchange and information sharing among agroecology LLs/RIs; 2) Facilitation of networking for research between members and 3) Awareness raising about the pilot network.

The members created an action plan around the three themes with an eighteen-month outlook through which, for example, they collaboratively made a pilot network inventory of agroecology LL and RI-related knowledge and results, organised peer-to-peer exchanges, as well as a series of roundtables on topics of interest (e.g. co-creation methods), and field visits, self-organised to contribute to the development of the Agroecology Partnership, and evaluated their activities. They also produced a set of recommendations and lessons learned for the future network based on the barriers, highlights, and limitations they encountered in the pilot. Therefore, the eighteen months of the pilot network were essentially just the very first step in a network-building exercise that will be continued and strengthened in the future network.

Another important achievement was the **co-design of a prototype Capacity Building Programme and an Agroecology Virtual Lab**, both suited to the needs of the pilot members. The programme aimed to support the further development of, and exchange between, the LLs and RIs in the area of agroecology. After exploring the specific competencies and skills needed for the transition to agroecology and to run LLs and RIs (e.g.: design thinking, leadership & agility, organisational, networking, and facilitation competencies), they prototyped the programme with five competency areas: 1) common understanding of agroecology, 2) practical farming skills and knowledge related to agroecology, 3) knowledge of agroecology research, 4) systems thinking, and 5) understanding

Figure 28-29. Knowledge exchange events and field visits organised for the pilot network (Source: ALL-Ready)



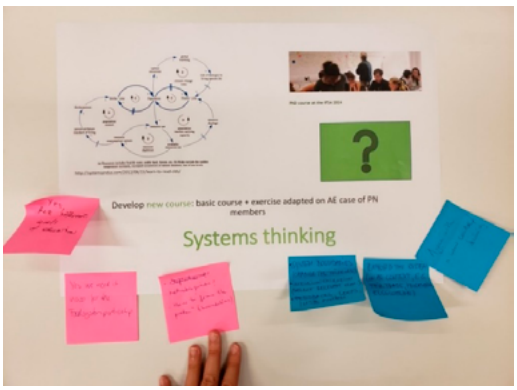


Figure 30-31. A selection of photographs taken during the co-design of the Capacity Building Programme (Source: ALL-Ready)

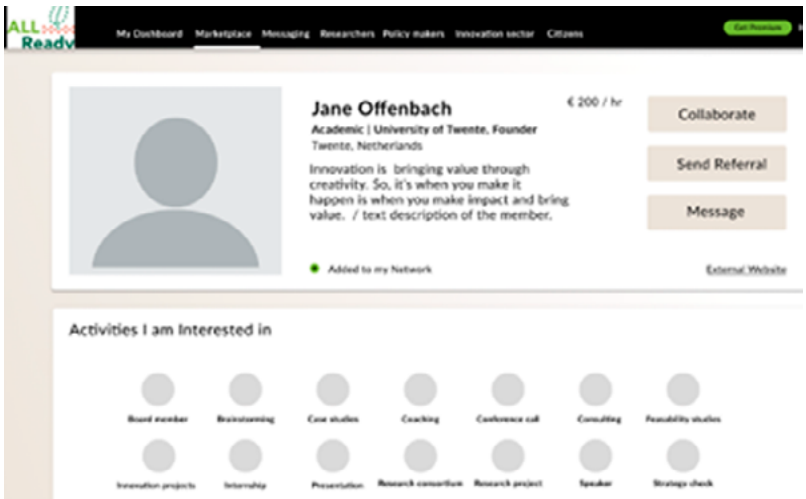
co-creation. The programme was tested and evaluated through four training modules. Besides enhancing their knowledge and their skills on agroecology LLs and RIs that they can directly use to improve their individual initiatives, the members validated a programme that can be further scaled up in the future network.

Furthermore, the network also co-designed a dynamic and user-friendly online platform for themselves called Agroecology Virtual Lab. It presents a geographical overview of the network, the main characteristics of the LLs and RIs that work on agroecology, visualises the best practices of the members, and provides networking and data repository tools. The Virtual Lab strengthened the collaboration and sharing of data between the members, and the members helped to create a tool for the future network that can virtually bring together and connect several diverse LLs and RIs for agroecology research and innovation across Europe.

The pilot network was also continuously involved in the identification of added value and in the co-development of guidance for an **implementation plan and long-term sustainability for the future European network** of LLs and RIs. The members would like to see the European network actively ensure the transfer of knowledge to initiatives and co-learning in participatory research and innovation activities at the European and national levels. They also emphasised the network's potential to represent the interests of actors active in the agroecology transition to policymakers at the EU level. Further recommendations for the future European network include: 1) implementing an adaptive governance structure, responding to changes in size and experiences of members, where the representatives from national, regional, and different thematic subgroups are represented and involved, 2) carrying out outreach activities to national ministries to safeguard long-term funding for specific network activities, 3) developing additional revenue streams for the network to complement public funding, 4) ensuring that the network formally cooperates with other Horizon Europe Partnerships such as Agriculture of Data, and 5) upscaling the network step by step, allowing for the consolidation of infrastructure, relationships, and joint activities.

Furthermore, the members were consulted regarding concepts and documents developed by the project, such as the framework for agroecology transition, and the criteria, vision, and mission of the future network, therefore contributing to the success of the ALL-ready project.

Figure 32. Mock-up for Profile section in the Virtual Lab (Source: ALL-Ready)



EXPLORING THE LANDSCAPE – LLs AND RIs IN EUROPE

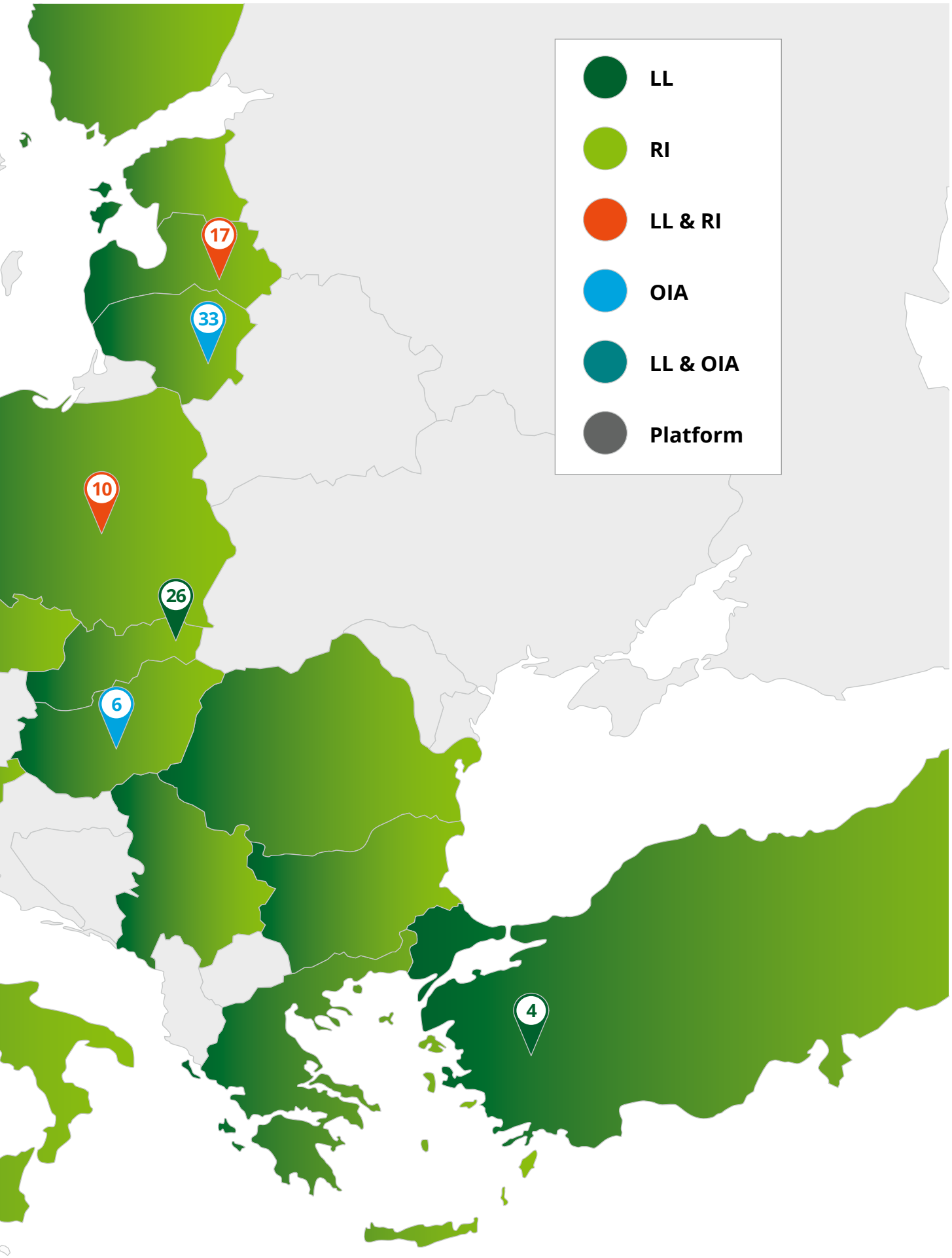
The ALL-Ready project also conducted a European-wide mapping of agroecology LLs, RIs, and OIAs with the help of a questionnaire entitled "Accelerating the agroecology transition: Your potential role and benefits of contributing to a European network of living labs and research infrastructures". The aim of the questionnaire was to improve the understanding of the key characteristics, activities, and values of agroecology LLs and RIs across Europe, and to help organisations understand the extent to which they can engage in the agroecology transition. The questions were designed to understand the activities and actual involvement of each initiative in the transition, regardless of how they name or define themselves. Currently, the questionnaire has been filled in by 33 initiatives beyond the ALL-Ready pilot members. Seven initiatives describe themselves as LL, nine as RI and six as OIA, and there were ten initiatives that defined themselves as both LL and RI or OIA, as the questions were not limited to one possible answer, plus there was one initiative that acts as a platform. The questionnaire was also used to identify candidates for the pilot network.

Similarly, to the pilot network members, these organisations are similar in purpose but very different in scale, scope, and activities. For example, ECO - FARM Sosnówka has been working in the field of organic farming, sustainable development, and renewable energy since 2013 in Poland. They have established a national platform for learning, exchange of experience, co-designing agroecology business innovations and building cooperation between entrepreneurs, NGOs, innovation brokers, and farmers, and on the implementation of agroecology production models. The DHDA Forest Inn Lab in France brings together academics from the "Territoire d'innovation", "People and Trees" and involves researchers and teachers from several disciplines (forest engineering, ecology, economics, management sciences, sociology, systems design, and innovation management) in the co-design of agroforestry systems solutions to adapt traditional crop-livestock production. The map on p. 50-51 illustrates all the organisations by name and country who responded to the questionnaire to show the number and diversity of such initiatives who are already working towards agroecology transition and potentially will do so as part of the future network.

LIVING LABS, RESEARCH INFRASTRUCTURES AND OTHER OPEN INNOVATION ARRANGEMENTS IN EUROPE

	NAME	COUNTRY	TYPE
1	AnaEE-ERIC HQ	France	RI
2	Andalusian Agency for Agriculture and Fisheries	Spain	OIA
3	Association Climatologique de la Moyenne-Garonne	France	RI
4	Bodrum Living Lab	Turkey	LL
5	CambioNet	France	LL & RI
6	CEEweb for Biodiversity HQ	Hungary	OIA
7	Consorzio ARCA	Italy	OIA
8	DEMETRA	Italy	LL & RI
9	DHDA – Forest Inn Lab	France	LL & RI
10	ECO-FARM Sosnówka sp. z o.o.	Poland	LL & RI
11	Forest' InnLab	France	LL
12	Fundecyt Science and Technology Park of Extremadura	Spain	RI
13	IFAPA	Spain	RI
14	Inagro	Belgium	RI
15	INRAE UERI Gotheron	France	RI
16	Institute for Bio- and Geosciences: Plant Sciences, Forschungszentrum Jülich	Germany	LL & RI
17	Institute of Horticulture, LatHort	Latvia	LL & RI
18	IPMWORKS HQ	France	OIA
19	Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF)	Germany	RI
20	Living Lab BACCHUS INRAE	France and Germany	LL
21	LTSER ZA Armorique	France	RI
22	Mære agricultural high school	Norway	LL & RI
23	MedThecLab	France	LL & RI
24	Menter a Busnes	Wales	LL
25	P3M	France	RI
26	PD Krakovany - Stráže	Slovakia	LL
27	Red Agroecológica de Granada	Spain	LL
28	Solutopus- Recursos e Desenvolvimento, Lda.	Portugal	OIA
29	Syntezia	Switzerland	LL
30	Territoire d'innovation DHDA	France	LL & OIA
31	TP Organics HQ	Belgium	Platform
32	University of Kassel (Department of Organic Farming and Cropping Systems and associated Teaching, Research and Transfer Center for Organic Farming and Sustainable Regional Development)	Germany	LL & RI
33	Vytautas Magnus University, Agriculture Academy	Lithuania	OIA

Figure 33.
Living Labs, Research Infrastructures and other Open Innovation Arrangements in Europe


LL
RI
LL & RI
OIA
LL & OIA
Platform
17
33
10
26
6
4

CONCLUSION

Through 19 inspiring examples of agroecology LLs and RIs of the ALL-Ready pilot network, this booklet shows that even in a short period of time, such a test network can bring together and mobilise diverse agroecology experiences and expertise to lay the foundations for the future network of agroecology LLs and RIs while individually working towards agroecology transition at the local, regional, and national levels.

Most member LLs and RIs have similar aims: to accelerate the creation, improvement, and adoption of sustainable solutions by developing (or facilitating the adaptation of) practical agroecology innovations, or research tools that support decision-making processes. Through their research activities, the member LL and RIs are looking for new ways and opportunities to understand the complexity of agri-food production systems at different scales, including their biophysical and socio-economic aspects using interdisciplinary (agroecology, ecology, economics, management sciences, political science, social science) and transdisciplinary (local actors are being engaged as stakeholders in the research conducted) approaches. These initiatives cover a diverse range of research topics (e.g.: crop rotation, land use changes, pasture and forage management, nutrient and pesticide management, soil health enhancement, increasing carbon sequestration, farmers' decision-making processes) from all production sectors, and involve conventional, regenerative, and organic farmers. They also apply methods or combinations of methods from different disciplines (e.g.: action research, citizen science methods from social sciences, or on-farm research and system experimentation from agronomy and natural sciences). Essentially, they are very consciously striving to find adequate responses to urgent agri-environmental and socio-economic challenges through collecting a broad range of high-quality data from diverse local agroecosystems which support them in developing adequate solutions to local problems. The stakeholders themselves are enabled through co-creation to become actors of transformation, as they are involved throughout the whole innovation process. The innovations are continually adjusted to address feedback from farmers, collaborators, and scientists, and in terms of relevance to agri-environmental and socio-economic challenges. While LLs and RIs are not only helping local communities to address their agricultural, climatic, or socio-economic problems, they have the potential to bring together and amplify their research efforts on a larger scale in the future European network. Moreover, they could contribute to the creation of a scientific evidence-base that can support local, regional, national, and European policy efforts to accelerate agroecology transformation while bringing benefits across the entire value chain using their co-creative approach, including through a future network.

The activities of member LLs and RIs go far beyond research and innovation. They put great emphasis on capacity-building efforts targeting a wide range of stakeholders in the agri-food system, and on providing access to their practical research findings and other relevant information (e.g.: they publish open-access articles, put together manuals for practitioners, and other relevant information through online information platforms or their websites, in the form of videos, blogs, social media posts, e-newsletters). Most of them provide space for knowledge sharing by organising webinars, workshops, farmers' or citizens' meetings, field days, on-farm demonstrations, networking and training events, and also integrating results into academic courses. Many dedicate time and effort to peer-to-peer knowledge exchange, peer counselling, lobbying at national levels, and attempting to stay innovative in awareness-raising efforts to engage a wide range of (especially local) stakeholders, and the public. The experience from these supporting activities in the LLs and RIs was mobilised to build the Capacity Building Programme and implementation plan in ALL-Ready. Through this work, they have the ability to create a unique knowledge and information sharing platform in the form of the future network that supports the replication or adoption of various agroecology solutions while fostering the pro-

duction of new and diverse knowledge and agroecology innovations across Europe.

The co-creation of joint pilot network activities not only helped to test the internal workings and management of the future network, but the LLs and RIs reported specific knowledge and research needs, such as the need to access background information, specific agroecology research data, knowledge of new technologies, basic ICT knowledge, the dynamics of participatory research, a better understanding of certain structures, their levers and barriers (social, economic and policy barriers) or how to mobilise certain stakeholders. At the same time, most of their research needs are related to complementing and building on their current efforts in term of agrotechnology, agronomy, redesigning farming, and local food systems, and sustainably managing natural resources covering various production sectors. They would like to explore new research methodologies and have funding that would allow for the setting up of long-term field, on-farm trials, and participatory action research. The eighteen months of the pilot network did not allow for the planning or setting up of research activities among the members, but the members did collect their common research interests and needs, which were included in the Agroecology Partnership proposal and its Strategic Research and Innovation Agenda (SRIA). Thus, it is important that the future network – besides being a knowledge exchange and networking platform – enables agroecology research to be conducted based on the interests of the LLs and RIs, accelerating the co-creation of innovative solutions and building stronger cooperation between initiatives.

One of the biggest achievements of the ALL-Ready project was that, through building and experimenting with a pilot network of diverse agroecology LLs and RIs, it first proved the relevance and urgency of a European network. Second, it tested how such a network would function at a European scale, applying co-creation methods by bringing together and building on the experiences of diverse initiatives. All the experiences and lessons learned regarding co-creation and the different tools and programmes co-designed in the pilot network will serve as recommendations about the dos and don'ts, opportunities, and potential barriers for the future network to overcome in order to bring about the agroecology transition in Europe.

Figure 34. Diverse edible crops to support sustainable production and diet (credit: Dániel Bori, ÖMKi)

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IMPRESSUM

About ALL-Ready: ALL-Ready is a Coordination and Support Action (CSA) funded by the European Commission (EC) with the aim of preparing a framework for a future European network of Living Labs (LL) and Research Infrastructures (RI) that will enable the transition towards agroecology throughout Europe. Based on the premise that agroecology can strengthen the sustainability and resilience of farming systems, the project will contribute to addressing the multiple challenges that they are facing today including climate change, loss of biodiversity, dwindling resources, degradation of soil and water quality.

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