Characterising current agroecological and regenerative farming research capability and infrastructure, and examining the case for a Living Lab network

Report for Defra

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List of acronyms

AE	Agroecological
AES	Agri-environment scheme
AMI	Automated monitoring of insects
ASSIST	Achieving Sustainable Agricultural Systems programme
BBSRC	Biotechnology and Biological Sciences Research Council
CH_4	Methane
CSC	Centre for Sustainable Cropping
CO_2	Carbon dioxide
Defra	Department for Environment, Food & Rural Affairs
ELM	Environmental Land Management scheme
ENoLL	European Network of Living Labs
EU	European Union
GDPR	General Data Protection Regulations
GFM	Global Farm Metric
GHG	Greenhouse gas
HLPE	High Level Panel of Experts of the Committee on Food Security
LEAF	Linking Environment and Farming
N_2O	Nitrous oxide
NE	Natural England
NERC	Natural Environment Research Council
NGO	Non-Government Organisation
PFLA	Pasture-fed Livestock Association
SEEGSLIP	Sustainable economic and ecological grazing systems - learning from innovative practitioners project
SMEs	Small and medium-sized enterprises
UK	United Kingdom
UKCEH	UK Centre for Ecology and Hydrology
UKRI	UK Research and Innovation
WP	Work-package

Executive summary

Agriculture is a major cause of greenhouse gas (GHG) emissions, biodiversity loss, and pollution. Agroecological and regenerative farming have been advocated as alternative approaches that may have fewer negative (or even net positive) environmental impacts than conventional agriculture at farm- and landscape-scales, leading to considerable interest in these approaches (Newton et al. 2020; Bohan et al. 2022; Prost et al. 2023).

This report forms the third part of a Defra-funded project Evaluating the productivity, environmental sustainability and wider impacts of agroecological and regenerative farming systems compared to conventional systems. The first part of this project was a rapid evidence review of agroecological and regenerative farming systems and their impacts (Burgess et al. 2023), and the second reported interview findings to examine farmer and stakeholder perspectives on barriers and enablers in agroecological and regenerative farming (Hurley et al. 2023). This third part of the project characterised the current research capability in agroecology and regenerative farming, and explored the potential role of a new 'living lab' trial network.

Three objectives are addressed in this report:

1) Characterise the existing agroecological and regenerative farming research capability and infrastructure in the UK.
2) Explore lessons from recent research initiatives and identify key research gaps, to inform a potential UK living labs trials network in agroecology/regenerative farming.
3) Develop recommendations for a new living lab trial or research network in agroecology/regenerative farming.

Objective 1 was addressed through an online survey to gather quantitative and qualitative data on current research initiatives and networks in regenerative farming and agroecology. There were 22 respondents from 20 organisations (Section 2.2).

Key findings from the survey:

- The size and the timescales of research initiatives varied substantially from single sites to networks of 50-100 sites and with agroecological/regenerative practices applied from one to over 20 years.
- All the survey respondents applied multiple agroecological/regenerative processes and had multiple target outcomes.
- Just under 40% of respondents are not currently collecting data from their network.
- Three-quarters of the survey participants not currently collecting data stated they would like to collect data, given more funding, knowledge or support.
- Biodiversity was one of the most frequent target outcomes, and data collection most frequently focussed on biodiversity.
- Face-to-face and email communication was most frequently used between farms in a network. Around two-thirds of respondents also held farm demonstration days as a means of knowledge exchange.
- Most of the research initiatives and networks were funded by charities, NGOs or funded themselves, with a smaller number funded by UK or EU government funding.
- Growing to incorporate more farms and researchers and developing knowledge exchange further were prioritised as future aspirations by survey respondents. Incorporating more researchers and applying for funding were also a focus for many research initiatives.

- Targeted funding was seen as very important in achieving future aspirations by most respondents, along with improved connections with farmers and landowners and improved skills and information for knowledge exchange. Improved infrastructure and monitoring tools were emphasised less, but still considered important.

The online survey results illustrate the wide range of current research initiatives in agroecology and regenerative farming, which vary from small-scale trials on a few farms to robust, repeatable data collection across a large network. To illustrate the range of approaches in more details, five case studies were described (Section 2.3) which included an ongoing living lab network, three research project and a long-term demonstration farm. Key characteristics of eight European living labs were also summarised through a network of EU agroecology living labs (the ALL-Ready project; Section 2.4).

Objective 2 was addressed through an online workshop, at which participants responded to questions about research gaps and priorities, infrastructure needs, and the barriers and enablers to data sharing and access (Section 3). Participants views were gathered through online discussion boards and facilitated verbal discussion (Figure 1).

Key themes and conclusions from the workshop:

- Many of the impacts of agroecology and regenerative practices remain poorly understood, with biodiversity and greenhouse gas emissions highlighted.
- Impacts on multiple potential benefits and trade-offs (e.g. yield vs. biodiversity vs. greenhouse gas emissions) need to be understood. The variation in responses (e.g. between soil types or regions) was seen as a priority area for research to improve the understanding of scaling-up.
- Research needs to be conducted at adequate temporal and spatial scales given the timescales needed for impacts of these practices to become apparent.
- There may be a bias in farmer participation in agroecological and regenerative agriculture research (those who can afford the time and money).
- Understanding transitions to agroecology and regenerative farming across different types of farm business was raised as a research gap along with investigating the role of knowledge in these types of practice. This was reflected in the discussion of infrastructure and skills, with support (better guidance, input from advisors) and upskilling/improvements in education seen as priorities to support transitions.
- The role of economic drivers, including subsidies and supply chain structures, is a research priority to understand why and how farmers may transition to these farming practices.
- Standardised assessments and monitoring tools (including farmer apps) were highlighted to support future research, in particular standardised soil carbon assessments. Hubs to loan monitoring equipment to farmers were also suggested.
- The time commitment needed was seen as an impediment to data collection by farmers, with comments that research initiatives worked better with someone external collecting data.
- Data quality and formats were raised as barriers to data sharing in agroecology/regenerative farming. Formats that can be easily read across a range of software were suggested as a solution, along with more standardised approaches in data collection.
- Integration and sharing of data across platforms were another solution, in particular for regulatory data (e.g. pesticide usage).
- A potential tension was raised between standardising monitoring approaches and data collection, and constraining innovation by farmers.
- Our understanding of how widespread agroecological and regenerative farming practices are, and which are being used / in what combinations, is constrained by lack of uptake data. Practices are

being implemented with or without subsidies, and in varying combinations with more conventional approaches. Without these uptake data, larger scale research and modelling may be constrained.

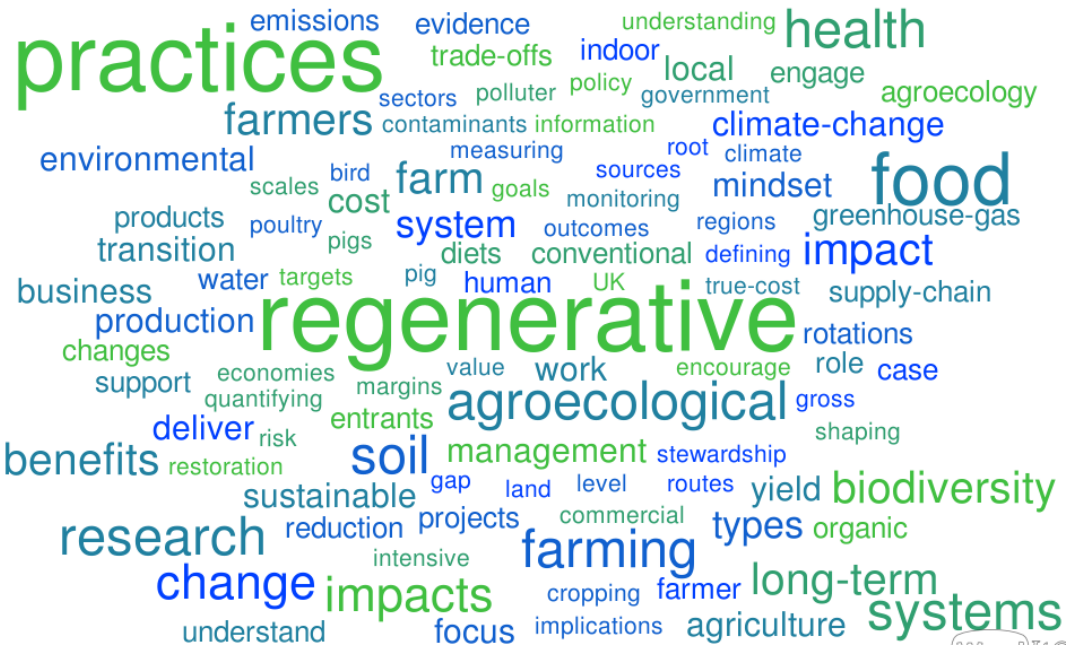

***Figure 1**. Word-cloud based on discussion board comments in response to What are the key research gaps in our understanding of agroecological and regenerative farming practices in the UK? Full discussion boards in Section 3 below.*

The online survey findings, case studies and lessons learnt from the workshop participants informed the development of recommendations for a future living labs network in the UK (**Objective 3**, Section 4). Four options were proposed:

i) Develop a standardised methodology or protocol for each of the 12 attributes listed for assessment within the Global Farm Metric, to support consistency of farm measurements.
ii) New research projects funded to collect standardised data on impacts and trade-offs across existing networks of farms applying agroecological / regenerative practices. This would maximise research synergies with existing networks.
iii) New research network set up to apply agroecological / regenerative practices on commercial farms, co-designed between farmers and researchers. Standardised data collection on impacts and trade-offs.
iv) Long-term living lab UK network set up, within which facilitation roles and research projects funded.

These options could be applied in combination (e.g. a standardised methodology (i) developed within (iv) a long-term living lab network). Which options are taken forward will depend on funding and factors such as the structure of available funding and timescales. Indicative costs were provided for field surveys of greenhouse gases and biodiversity, two of the impacts identified as research priorities in the workshop.

1 Introduction

Agriculture is a major cause of greenhouse gas (GHG) emissions, biodiversity loss, and pollution both globally and in the UK. Agroecological and regenerative farming have been advocated as alternative approaches that may have fewer negative (or even net positive) environmental impacts than conventional agriculture at a farm- and landscape-scale, leading to considerable interest in these approaches (Newton et al. 2020; Bohan et al. 2022; Prost et al. 2023).

Defra contracted Cranfield University and UK Centre for Ecology and Hydrology to undertake an eight month study of agroecological and regenerative farming approaches in 2022-23, comprising of three work-packages: 1) a rapid evidence review of agroecological farming systems (Burgess et al. 2023), 2) a series of interviews to examine farmer and stakeholder perspectives on barriers and enablers in agroecological and regenerative farming (Hurley et al. 2023), and 3) an investigation of the current research capability in agroecology and regenerative farming, and potential role of a new 'living lab' trial network.

This report describes the results of the third work-package, which addresses three objectives:

1) Characterise the existing agroecological and regenerative farming research capability and infrastructure in the UK.
2) Explore lessons from recent research initiatives and identify key research gaps, to inform a potential UK living labs trials network in agroecology / regenerative farming.
3) Develop recommendations for a new living lab trial or research network in agroecology / regenerative farming.

1.1 What are living labs?

Living labs have been used in a range of contexts including for agricultural experimentation and to drive change. The European Network of Living Labs (ENoLL) defines them as user-centred, open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real life communities and settings (Malmberg et al. 2017).

Living labs are initiatives in which experimentation is conducted in a real context, with managers and other stakeholders involved from the beginning as equal partners in proposing ideas, testing them, improving them and promoting them further. Applied to the agricultural sector, they create opportunities for farmers and other stakeholders to develop solutions together to problems they face in their locality or region, taking into account the specificities of farming systems and their environment (https://ec.europa.eu/eip/agriculture/en/news/eu-mission-soil-deal-europe). One of the key characteristics of a living lab is that anyone can ask a question to be tested. The living lab approach differs from a more typical research approach, where the researchers and / or funders may take a lead on the research focus and questions to be asked (for example on demonstration farms).

Figure **2** illustrates five common elements of living labs as defined by ENoLL (Malmberg et al. 2017):

1. Multi-method approaches: there is no single methodology, all living labs combine and customize different methodologies to best fit their purpose.
2. User engagement: the key to success is to involve the users from the beginning of the process.
3. Multi-stakeholder participation: involving all relevant stakeholders is of crucial importance. These include representatives of the public and private sectors, academia and any other stakeholders.
4. Real-life setting: activities take place in real-life settings to gain a thorough overview of the context.
5. Co-creation: mutually valued outcomes that are results of all stakeholders being actively engaged in the process from the beginning.

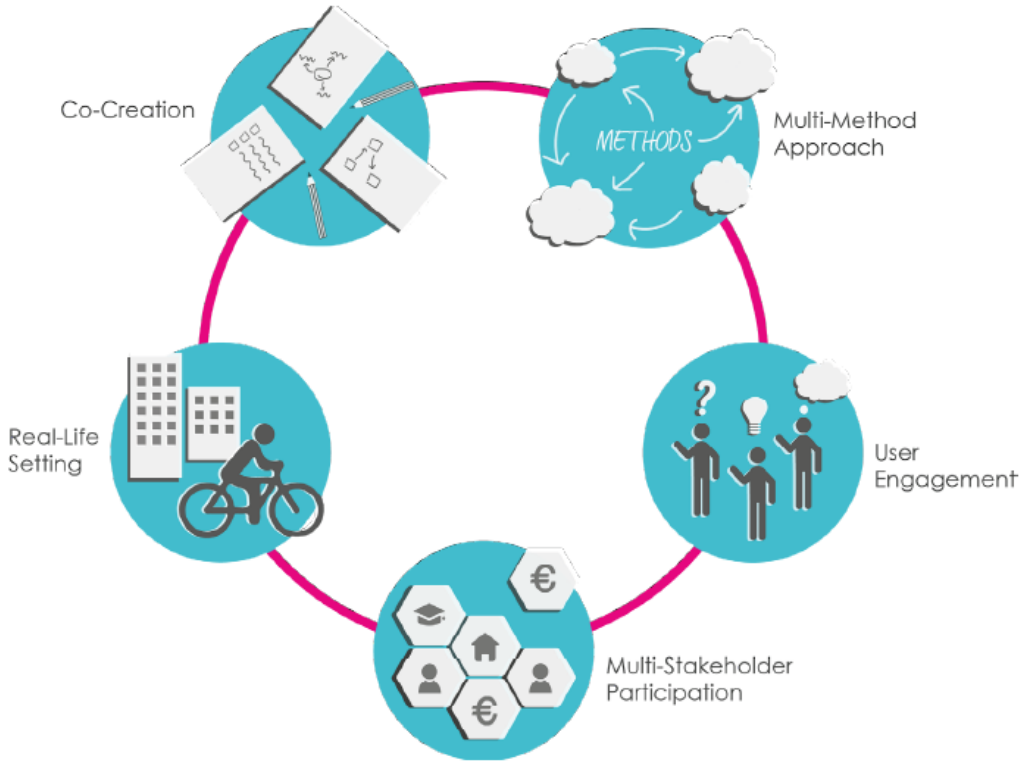

***Figure 2**. Common elements of living labs. Reproduced from Living Lab Methodology Handbook (Malmberg et al. 2017).*

2 Characterising existing research initiatives in agroecology and regenerative farming

2.1 Online survey design and circulation

UKCEH wrote and distributed a short online survey to gather quantitative and qualitative data on research initiatives (Appendix A and B), in order to meet objective 1 which was to characterise the existing agroecological and regenerative farming research capability and infrastructure in the UK.

The concept of a living lab is broad (Section 1.1). Research into agroecology and regenerative agriculture is being conducted using a range of approaches including research projects, single farm platforms, farmer led clusters, networks, and living labs. To inform a potential future living lab trial network, the online survey included all these approaches and types of research structure, referred to in the survey as 'research initiatives'.

The survey was developed by the project team at UKCEH, and reviewed and developed further following input from Cranfield University and the Defra steering group. It was structured into seven sections, each with multiple questions, to gather information on:

1) Who is responding to this survey?
2) Research initiative structure and farming sector
3) Agroecological and regenerative target outcomes and practices
4) Data collection
5) Knowledge exchange
6) Funding
7) Future aspirations

The survey design was submitted to Defra Survey Control for review where it was approved. It was also reviewed and approved by devolved administrations in Wales, Scotland and Northern Ireland to enable national coverage. It was translated into Welsh for circulation in Wales. The survey information sheet for participants is in Appendix A, the questions and full results are in Appendix B.

The survey was emailed to organisations identified by UKCEH and Cranfield as having active research networks, living labs or research in the area of agroecology or regenerative farming, including those invited to an online workshop (Section 3) and participants in the work-package 2 interviews (Hurley et al. 2023). In total, 60 individuals from 34 organisations received the survey directly via email. Further distribution of the survey was facilitated via the Soil Association newsletter (over 6000 recipients), through UKCEH science news Twitter account (seen by over 1100 people) and by LEAF (Linking Environment and Farming) and other organisations working on regenerative farming. There were 22 responses to the online survey. The survey was open for responses for four weeks.

2.2 Results from the online survey

Key results from the online survey are reported here. Full results are in Appendix B.

2.2.1 Who completed the survey

We asked participants about their role within agroecological or regenerative agriculture to establish who was contributing to our results. The majority of contributors (8) were co-ordinating some form of living lab/farmer cluster or research platform/initiative (Table 1). Please note participants could pick multiple answers if their role crossed between two categories. We had a diverse range of contributors across the sector.

***Table 1**. Survey participant role in research initiative.*

Participant role	Count of responses
I am a farmer who implements these practices	6
I am a coordinator of a farm research network/cluster	7
I am a coordinator of a Living Lab/research platform	2
I am a researcher involved with a network/Living Lab/Research platform	6
I am an ecological consultant working for/in a network	2
I am an agronomist working within a network/Living Lab/research platform	1
I am an interested volunteer within a network/Living Lab/research platform	1
Other - NGO promoting Integrated Farm Management	1

We asked what the contributors called their research initiative – the majority took part in what they described as a farm cluster/network (8) or a research network (7) (see Appendix B for further details).

2.2.2 Research initiative structure and farming sector

A diverse range of organisations were reported to co-ordinate research initiatives, with over 20 organisations involved (Table 2).

***Table 2**. Organisations, reported in the survey, who are co-ordinating research initiatives.*

Name of organisation	Count of responses	Name of organisation	Count of responses
Agricultural college	3	LEAF	1
Agrii	0	NFU	1
AHDB	1	NIAB	0
Environment Agency	0	Organic Research Centre	2
Farming Connect	0	Pasture for Life	2
Food, Farming and Countryside Commission	0	RSPB	3
FWAG	2	Soil Association	4
Game and Wildlife Conservation Trust	0	UK Soils Living Labs	0
Innovative Farmers	4	UKCEH	1
Landworkers' Alliance	0	University / universities	3
Nature Friendly Farmer Network	1	Other	7

Organisations listed in responses in the 'Other' category included Wyre Valley Trust, NatureScot, Cairngorms National Park Authority, PlantLife Scotland, SAC.

There was a diverse range of network sizes within our sample, all initiatives had fewer than 100 farms involved (Table 3). The most common was a single farm rather than a network (6 of 22 responses), with four networks involving 6-10 farms and three involving 11-20.

***Table 3**. The count of responses for the number of farms within research initiatives.*

Network size	Count of responses
Single Farm	6
Multiple farm (2-5)	2
Multiple farm (6-10)	4
Multiple farm (11-20)	3
Multiple farm (21-50)	1
Large number of multiple farm (50-100)	2
Large number of multiple farms over 100	0
Not known	2
Other	1

The farms within the research initiatives covered a broad range of enterprise types (Table 4). These represent enterprises that are also top overall for UK producers, for example in 2021 the UK Beef industry was valued at £3.3 billion; sheep and mutton at £1.5 billion and wheat at £2.7 billion (UK Government, 2022), although there is a higher proportion of our respondents practicing agroforestry than in general. In the UK this practice only accounts for about 3% of land under production (den Herder et al. 2017).

***Table 4**. The number of responses to the question - Which of the following enterprise types do you have on your farms within the research initiative?*

Enterprise type	Count of responses
Beef	15
Sheep	14
Cereals	13
Agroforestry	8
Oilseed rape	6
Dairy	6
Vegetables	4
Pulses	4
Pigs	4
Potatoes	3
Other root crops	3
Fruit	3
Other oilseeds	2
Poultry	2
Forestry	2
Other	2
Sugar beet	1
Renewables	1

2.2.3 Agroecological and regenerative target outcomes and practices

Agroecological and regenerative farming practices had been in place for a variety of time periods, with this also varying between farms within a network for four of the research initiatives (Figure 3).

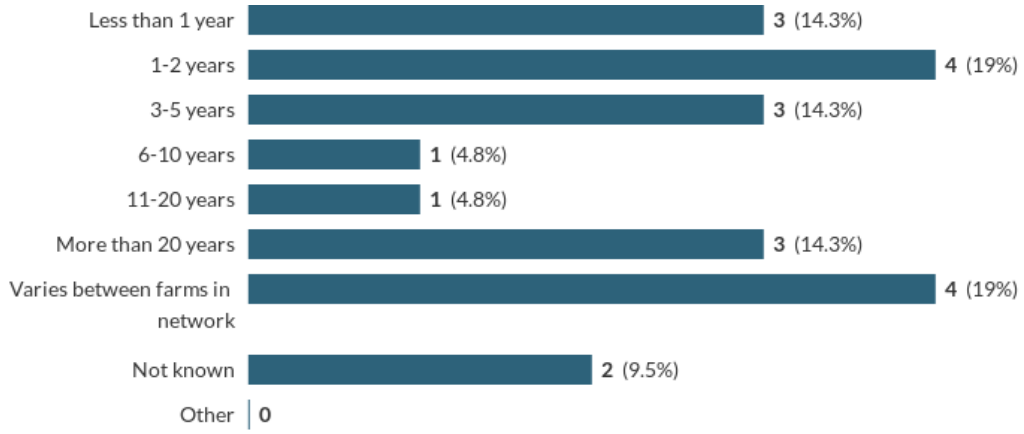

***Figure 3**. The number of responses to the question - How long have agro-ecological or regenerative practices been applied?*

The majority of research initiatives included target outcomes of improving ecosystem health increasing biodiversity, improving soil health, carbon sequestration, maintaining or improving farm productivity and increasing profitability (Table 5). The results are broadly similar to Newton et al.'s (2020) review of 25 regenerative agriculture practitioner websites and 229 published research articles, which found soil health the most frequent target outcome (86%) for practitioners and carbon sequestration the second (64%). The main difference is Newton et al.'s (2020) review found fewer mentions of biodiversity as a target (46% as opposed to 81% from this online survey).

***Table 5**. Target outcomes for agroecological and regenerative farming practices and the count of the responses from the survey*

Target outcomes for agroecological and regenerative practices	Count of responses
To improve ecosystem health (including ecosystem services)	18
To increase biodiversity	18
To improve soil health (e.g., structure, soil organic matter, fertility)	15
To increase carbon sequestration	14
To maintain or improve farm productivity	13
To increase farm profitability	12
To improve crop resilience to climate change	11
To improve the social and/or economic wellbeing of communities	11
To improve water health (e.g., hydrology, storage, reduce pollution)	11
To create a circular system and/or reduce waste	9
To improve food nutritional quality and/or human health	9
To improve integrated pest management	9
To increase crop health and/or resilience to disease	9
To improve food access and/or food security	8
To maintain or increase yields	8
To reduce greenhouse gas emissions	8
To improve animal welfare	7
To improve food safety	3
Other – to provide fresh produce for food banks which are mostly full of out of code processed products	1

Potential agroecological and regenerative farming practices were listed, and respondents asked which they practiced within their initiative. The list was based on practices in Newton et al.'s (2020) review of regenerative agriculture, with some additions from the project team. Respondents undertook practices linked with their targeted outcomes (Table 6), e.g. create habitats for beneficial species in field (14 responses) and field edge (13) and management to improve soil health (reduce tillage and use cover crops each with 13 responses).

Table 6. *Agroecological or regenerative practices applied across the research initiative. Respondents could select more than one.*

Agroecological or regenerative practices	Count of responses
Create habitats for beneficial species in field (e.g. beetle banks, in-field strips)	14
Create habitats for beneficial species at field edge (e.g. flower-rich margins)	13
Reduce tillage (or no-, minimal-, conservation-)	13
Use cover crops	13
Encourage natural pest control	11
Protect/cover the soil	11
Use diverse crop rotations, including temporary grass/herbal leys	10
Use ecological or natural principles or systems	10
Incorporate perennials and trees (including agroforestry)	9
Use compost, mulch, green manure, or crop residues	9
Use crop plant diversity (including intercropping)	9
Use no synthetic fertilizers	9
Focus on small scale systems	8
Rely on farm labour, including for local knowledge	7
Use no or low external inputs; maximize on-farm inputs	7
Use organic fertilizers	7
Use no synthetic pesticides	6
Integrate livestock into arable farming systems	5
Undersow with clover or use permaculture of clover	5
Focus on localism and/or regionality	4
Use organic methods to meet certification standards	4
Use biostimulants	3
Use digestate (from sewage, biogas, food waste) to replace inorganic fertiliser	3
Use microbial stimulations	3
Use bio-pesticides	2
Other	1

One of the main principles behind the living lab framework is the collaborative approach to asking questions (Section 1.1). In our survey, we asked who contributes towards the design of the research initiative. There was a diverse response (Table 7), indicating that this collaborative approach is being practiced widely across organisations, farm clusters and networks, with farmers especially prominent in their contributions in co-designing research initiatives.

***Table 7**. The number of responses to the question - Who contributes towards the design of the research initiative?*

Who contributes towards the design of the research initiative?	Count of responses
Farmer group / network	12
Individual farmer	10
Researchers	9
Ecological consultants	8
Non-government organisations	7
Agronomists	6
Funder	3
Other	1

2.2.4 Data collection

One of the key elements of research is the collection of high quality, reproducible data. Almost 40% of those completing the survey were not collecting data on their agroecological or regenerative agricultural practice outcomes. Those that did not collect data said they would, if funding, research support and knowledge were available (75% of those not currently collecting data). One respondent also commented:

> "*Data collection is fine as long as it doesn't impact negatively on the workings of the farm, and compensates for the time and resources it takes us to supply the information."*

The type of data being collected on research initiative reflect the target outcomes of the network i.e. biodiversity outcomes, soil health and carbon sequestration (Table 8). Data on yield and/or economic value are also being collected in most of the research initiatives that collect data.

***Table 8.** The type of data being collected on agroecological and regenerative farm networks.*

Type of data being collected	Count of responses
Biodiversity	12
Soil health	8
Carbon storage or sequestration	8
Yield	7
Economic value	5
Area of habitat	5
Habitat quality	4
Crop pests and disease	4
Water quality	4
Attitudes	3
Wellbeing	2
Impact	1
Engagement	1
Quality assurance	0

Researchers from universities or independent research organisations collect the majority of data from the networks. Farmers themselves are also collecting data (Table 9).

Table 9. *A list of who is collecting data on networks and the count of how many responses each category had.*

Who is collecting the data?	Count of responses
Farmers	6
College/ university academic	5
Independent research organisation	5
Student	2
Consultant	2
Volunteers	2
Other	2
Automated machinery/apps	1

The majority of the data from these research initiatives had been collected for 5 years or less; however there were three initiatives that had been collecting data for over 10 years with one collecting data for more than 20 years (Figure 4).

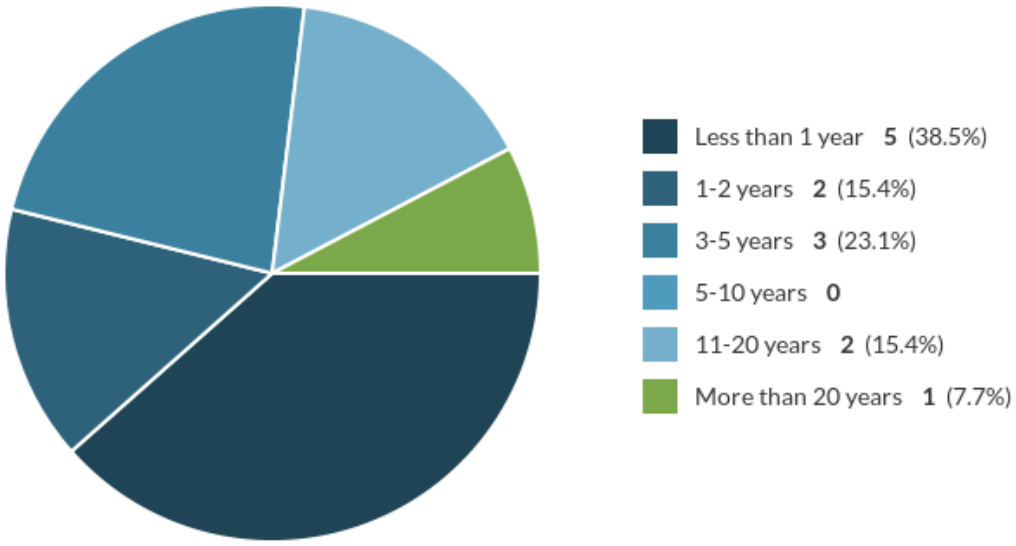

Figure 4*. Count of responses to a question about the length of time data had been collected across the research initiative.*

There was the intention to publish data across all but one research initiative (Appendix B Q20), if results had not been published already (data from three examples were published already and available for free). There was only one example where data would not be published or made available.

Information about the perceived barriers to publication of data were collected. Time commitment and the General Data Protection Regulations (GDPR) were given as perceived barriers. Two responses highlighted the difficulty of non-academics publishing through peer review with one stating

> *"Non institutional authors are not encouraged by modern editorial software - eg Springer want 5 referees nominated by the author. Social media a better vehicle for impact than academic journals."*

2.2.5 Knowledge exchange

When working in partnership across organisations and disciplines, communication and knowledge exchange are important factors for success. Within the survey we asked what form of communication and knowledge exchange events took place. Face to face meetings and email were the principal forms of communication across networks (Table 10), with 67% of respondents saying that they held farm demonstration days as a means of knowledge exchange (Appendix B Q22). These events were principally to engage with the farming community, and were aimed at all farmers, including those experienced with agroecological and regenerative techniques but also those that had little or no experience of these methods (Appendix B Q23).

***Table 10**. Methods of knowledge exchange between members within a research initiative.*

Knowledge exchange methods	Count of responses
Face to face meetings	19
Email	14
Social media (open)	8
Video /online meetings	7
Phone	5
Social media (member only)	5
Project website	4
Other	3
Online forums (member only)	2
Online forums (open)	1

2.2.6 Funding

External funding paid for the majority of the networks (15 participants), with a diverse range of organisations or types of finding contributing across our sample (Table 11). Most respondents (9) received funding from charity or non-governmental organisations for their initiative, with a substantial number funding themselves (6), followed by UK research council and EU funding (8 responses combined).

***Table 11**. Organisations that fund research networks, and the count of responses from participants of the survey.*

Type of funding received by research network	Count of responses
Charity/Non Government Organisation	9
We fund ourselves	6
UK Research councils	4
International funding - EU	4
Commercial enterprise/business	3
Farming industry	2
UK Government - Defra	2
Devolved Government	2
National Lottery	1
Other	1
International funding - rest of the world	0

2.2.7 Future aspirations

When asked about future aspirations of the projects, the majority of respondents wanted to continue to develop and grow, incorporating more farms (13 participants) and strengthening knowledge exchange (12 participants, Appendix B Q26). These principles were also reflected when asked about the importance of factors that could help reach those aspirations.

Survey participants were asked to score various factors and their importance in reaching their aspirations for the project on a Likert scale from very important to not important at all (Table 12). Targeted funding was cited as *very important* by the majority of respondents. Improving communication with farmers and landowners, and improving skills and knowledge on data collection were thought *fairly important*. Improved infrastructure and monitoring tools were considered *important* for reaching aspirations, but less so than these other factors.

***Table 12**. What would help you achieve these aspirations and how important are they in reaching your goals?*

	Very important	Fairly important	Important	Slightly important	Not at all important	No opinion
Additional funding (targeted)	12	4	2	3	0	0
Additional funding (unrestricted)	8	4	3	5	0	0
Improved communication tools	3	5	6	3	4	0
Improved connections with farmers and landowners	9	2	7	1	1	0
Improved infrastructure	3	3	5	5	2	1
Improved monitoring tools, e.g. mobile apps	3	4	6	4	4	0
Improved skills and information on knowledge exchange	8	3	6	2	2	0
Improved skills and knowledge on data collection	7	8	3	1	2	0
Researcher network provision/connections	7	9	2	2	1	0
Training and capacity building	6	10	2	2	1	0
Other	1	0	0	0	0	0

2.3 Research initiative case studies

The online survey results illustrate the wide range of current research initiatives in agroecology and regenerative farming. The structure of these research initiatives varies substantially from small-scale trials on a few farms to robust repeatable data collection across a large network. To illustrate the range of approaches currently used across this type of research, five case studies are briefly described below.

Case study 1, Innovative Farmers, is a network to facilitate groups of farmers asking applied questions about their farming practices, leading to field trials. This fits in the living lab framework of collaborative research development, with the questions having direct applied relevance to farming practices. Most of the trials are fairly small scale, results may thus be applicable to the specific conditions (e.g. soil type, region) of that trial but not tested across a range of conditions.

Case study 2 (SEEGSLIP project) worked with a large, established network of 58 farmers who had been applying grazing regenerative practices prior to the start of the research project. Standardised data were collected by researchers on vegetation, soils and other public goods, under a 3 year project, leading to several journal papers (Case study 2 below).

In ASSIST (Case study 3) researchers worked with 18 commercial farms, with regenerative habitat creation (wildflower margins and in-field strips) practices being introduced using standardised methods at the start of the project. Researchers collected data on biodiversity and related ecosystem services using the same monitoring protocols across all farms.

The H3 project (Case study 4) also works with regenerative and conventional farmers to collect data soil health, biodiversity, ecosystem services and food quality. SEEGSLIP, ASSIST and H3 were all funded by research councils (BBSRC and NERC) and lasted 3 -6 years.

Case study 5, the Centre for Sustainable Cropping Platform at the James Hutton Institute, is a single demonstration farm where regenerative and conventional practices have been applied over a longer timescale (14 years). This longer timescales allows impacts of regenerative practices to be better understood, as they may take several years to become apparent. The wider applicability of these results, in other landscape types and contexts, would need to be investigated separately.

Case Study 1: Innovative Farmers

Website: https://www.soilassociation.org/farmers-growers/innovative-farming/

Innovative Farmers is a network of farmers, advisors, researchers and businesses who plan, run and analyse on-farm trials (Field Labs). Ideas are generated by a farmer or group of farmers, and developed with researchers to plan a trial, record data and analyse the findings.

Field labs run by Innovative Farmer networks address a range of research questions, including many on agroecological and regenerative farming practices. Within the Innovative Farmer network 130 Field Labs have run to date, examples include:

Herbal Leys For Arable Soil Health
This field lab aims to build soil organic matter and biodiversity as well as a good aggregate structure on fields that are difficult to manage, in order to improve drainage, soil and crop health as well as using less inputs.
(https://innovativefarmers.org/field-lab?id=d4d8f428-eb85-e811-816e-005056ad0bd4)

No Till And Cover Crops For Smarter Water Catchments
Thames Water are facilitating a no till and cover crop farming trial in the Evenlode river catchment to enable farmers to trial more water sensitive farming practices.
(https://innovativefarmers.org/field-lab?id=382575e5-ecc6-e811-816e-005056ad0bd4)

Sward Improver: Nitrogen-Free Soil Treatments For Grassland Productivity
This field lab is investigating the use of a nitrogen-free soil treatment to improve seasonal productivity of grasslands, with the aim of improving livestock gross margins and improving the drought resistance of these drought-prone landscapes/
(https://innovativefarmers.org/field-lab?id=e897db86-35ca-e911-8176-005056ad0bd4)

Organisations: Innovative Farmers is run by the Soil Association, LEAF (Linking Environment and Farming), Innovation for Agriculture and the Organic Research Centre.

Funding: The Duchy Future Farming Programme and a range of companies and farming institutions.
Three of the online survey respondents (Section 2.2) were part of Innovative Farmer Field Labs / on-farm trials.

Case Study 2: Sustainable economic and ecological grazing systems - learning from innovative practitioners (SEEGSLIP)

Website: https://www.ceh.ac.uk/our-science/projects/seegslip

Figure 5*. PFLA pasture © Markus Wagner, UKCEH.*

The SEEGSLIP project explored how innovative grassland management could benefit UK farmland. Working with the Pasture-fed Livestock Association (PFLA), this study investigated the potential for livestock farmers to adapt their management practices to ensure better ecological outcomes. The primary aim of the PFLA is to feed a natural diet of 100% pasture, with no supplementary grains or artificial feedstock. PFLA farmers are adopting innovative grazing regimes, with many focusing on more regenerative practices, including adaptive multi-paddock grazing, long rest periods and deferred grazing. 58 farms were involved in the study.

SEEGSLIP found that found that PFLA swards were taller than adjacent conventionally managed fields, and botanically more diverse containing a greater proportion of native plants and herbs, including nitrogen-fixing legumes (Norton et al. 2022). If accompanied by certification (e.g. organic or Pasture For Life) the resultant produce can be marketed at a higher level.

Organisations: UK Centre for Ecology and Hydrology (UKCEH), SRUC, Lancaster University, Organic Research Centre
Funding: Biotechnology and Biological Sciences Research Council (BBSRC) Global Food Security Programme

https://www.ceh.ac.uk/news-and-media/blogs/sustainable-and-viable-assessing-pasture-fed-livestock-system

Norton, L.R., Maskell, L.C., Wagner, M., Wood, C.M., Pinder, A.P. & Brentegani, M. (2022) Can pasture-fed livestock farming practices improve the ecological condition of grassland in Great Britain? *Ecological Solutions and Evidence,* **3,** e12191.

Norton, L., Maskell, L., McVittie, A., Smith, L., Wagner, M., Waterton, C. & Watson, C. (2022b) Learning from innovative practitioners: Evidence for the sustainability and resilience of pasture fed livestock systems. *Frontiers in Sustainable Food Systems*, **6**, https://doi.org/10.3389/fsufs.2022.1012691

Case study 3: Achieving Sustainable Agricultural Systems (ASSIST)

Website: https://assist.ceh.ac.uk/

ASSIST was a 6-year programme to test sustainable intensification approaches, model the environmental impacts of future agriculture and develop land management planning tools (e.g. E-Planner https://assist.ceh.ac.uk/e-planner).

Sustainable intensification approaches were tested using an experimental approach, applying interventions such as planting wild flower strips both at field edges and in-field (bisecting fields), addition of organic matter, and incorporation of cover crops into arable rotations. The impact of these interventions was assessed for benefits on biodiversity and specific services supported by invertebrates including pollination and pest control (Pywell et al. 2015). These innovative approaches were tested on 18 commercial farms in a large-scale, statistically robust multi-site experiment.

Organisations: UKCEH, Rothamsted Research, British Geological Society,
Funding: NERC (Natural Environment Research Council), BBSRC

Pywell, R.F., Heard, M.S., Woodcock, B.A., Hinsley, S., Ridding, L., Nowakowski, M. & Bullock, J.M. (2015) Wildlife-friendly farming increases crop yield: evidence for ecological intensification. *Proceedings of the Royal Society B-Biological Sciences*, **282**, 20151740

Case study 4: Healthy soil, healthy food, healthy people (H3) programme

Website: https://h3.ac.uk/

The H3 project (Healthy soil, Healthy food, Healthy people) addresses issues of food security and sustainability through an interdisciplinary initiative, designed to transform the UK food system 'from the ground up', focusing on the connections between sustainable growing practices and the adoption of health-promoting diets (Jackson et al. 2021). Work-package 3 focusses on the potential for environmental and social benefits from wider adoption of regenerative agriculture, using 'living laboratories' in UK arable landscapes. The transition to regenerative agriculture is being characterised and monitored in trials on commercial farms, to answer the question "What are the impacts of a landscape scale transition to regenerative agriculture on soil health, biodiversity, ecosystem services and food quality, and how can farmer groups monitor these?" The project is also investigating the changing attitudes of farmers towards regenerative agriculture throughout the project, as farmers transition to more regenerative practices.

Organisations: University of Sheffield, University of Leeds, University of Bristol, University of Cambridge, Newcastle University, City University, Game and Wildlife Conservation Trust, The Innovative Farming Network
Funding: The programme is funded by the BBSRC / UKRI Transforming the UK Food System for Healthy People and a Healthy Environment programme

Jackson, P., Cameron, D., Rolfe, S., Dicks, L.V., Leake, J., Caton, S., Dye, L., Young, W., Choudhary, S., Evans, D., Adolphus, K. & Boyle, N. (2021) Healthy soil, healthy food, healthy people: An outline of the H3 project. *Nutrition Bulletin*, **46**, 497-505. https://doi.org/10.1111/nbu.12531

Case study 5: Centre for Sustainable Cropping Platform

Website: https://csc.hutton.ac.uk/agronomy.asp

The Centre for Sustainable Cropping (CSC) is a long-term farm platform where a range of best practice management options are integrated into a regenerative system designed for multiple environmental and economic sustainability benefits. The regenerative system integrates reduced tillage, organic matter amendments, cover and companion cropping, targeted applications based on threshold levels and nutrient budgeting to reduce reliance on chemical interventions by promoting soil health, plant fitness and biodiversity. The low input system is compared against standard agronomic practice (conventional ploughed with blanket applications and prescriptive, prophylactic treatments) in a split field design over multiple six-year crop rotations running since 2009. Treatments applied also include habitat creation (wildflower margins and beetle banks) and riparian buffer strips.

Initial trade-offs between enhancing biodiversity, soil health and crop yield in the early stages of conversion from intensive to regenerative cropping appear to become less over time and the length and nature of this transition phase highlights the importance of long-term experiments in agroecological research. Short-term studies can over-emphasise trade-offs between environment (e.g. biodiversity) and economics (e.g. crop yield) due to a focus on changes at the early stages of transition.

The platform has been used as a resource for over 50 research projects including PhDs (https://csc.hutton.ac.uk/resources.asp).

Organisations: The James Hutton Institute co-ordinates and runs the platform, projects using it have been run by a range of organisations, funded through EU/Horizon Europe, Defra, UKRI and industry. See https://csc.hutton.ac.uk/resources.asp for details.
Funding: The platform is funded by Scottish Government's Rural and Environmental Science and Analytical Services Division.

2.4 European agroecology living labs

While the main focus of this work is to characterise UK research initiatives and living labs in agroecology/regenerative farming, a comparison with European living labs can help inform the options for a new living lab trial network. The ALL-Ready project is an EU network of agroecology living labs, each of which is national or regional (https://www.all-ready-project.eu/). A comparison of these living labs is in Table 13, compiled by and shared by kind permission of Rebecca Swinn (Innovative Farmers / Soil Association).

Almost all the living labs in Table 13 have a component of government funding or are run by government research institutes, one exception of the Innovative Farmers network in the UK (see Case study 1 above). All of the living labs involve a wide range of stakeholders, including farmer groups, farmers, NGOs, charities, researchers, agri-technology firms and others. Many of the living labs have an adaptive design approach, whereby research themes or trials are decided periodically through stakeholder workshops or working groups.

***Table 13**. Comparison of European agroecology living labs in the ALL-Ready EU network. Table compiled and shared by kind permission of Rebecca Swinn (Innovative farmers / Soil Association).*

	Innovative Farmers (UK)	**Ömki (Hungary)**	**Völ Hessen (Hessen, Germany)**	**LLAEBIO (Flanders, Belgium)**	**Occitanum (Occitanie, France)**	**Carbon Farm (Denmark)**	**Precision Agriculture for ALL (Serbia)**
Focus	Nationwide All farming systems sustainable / high welfare practices	Nationwide Organic focussed	Regional Organic focussed	Regional Organic focussed	Regional Digital technologies for agroecological transition	Conservation ag low-till practices at conventional & organic arable	Precision agriculture
Funding	Charitable and some project specific.	European and national projects, products, services	Agricultural Ministry of Hessen	Government covers staff for facilitation, research, other ad-hoc funding.	Government – via a competition	Government	European and national projects, products / services
Activities	Trials, workshops, events, comms and knowledge exchange, ideas put forward by farmers, matchmaking with researcher/ coordinator.	Trials, events, products occasionally taken to market.	On farm trials, workshops, events. The trial ideas are decided by farmers.	Events, workshops, exchanging agroecological practices, facilitate trials / experiments.	'Open labs' to test new digital solutions in real-world environment, codesign methods, involve AgTech firms in open innovation.	On-farm trials (4); demo and on-farm events, comms / knowledge exchange material	Co-creating precision ag products/services/tools; engagement with ag high schools, lobbying government
Notes	Managed by a charity. 130 field labs to date, multiple per topic. Coordination for each field lab usually by external staff, e.g. farming cluster or charity staff.	Managed by a non-profit Organic research institute. Each staff member manages a sector of trials.	Research institutions work on the trials. Two people coordinate/run the research groups.	Working themes chosen annually at stakeholder workshop and participatory temporary working groups.	Supported by national research institute with local divisions. Many stakeholders: farming communities, AgTech firms, researchers, engineers, technicians, citizens.	Collaboration between universities, low-till farmer association, agro-industry and an organic centre.	Run by public research institute. Stakeholders include teachers, professors, students, citizens, agriculture producers, SMEs, NGOs.

2.5 Conclusions – characterising research initiatives

The survey results and case studies above illustrate some of the range of types of research initiatives on agroecology and regenerative farming in the UK. The survey was deliberately inclusive, inviting responses from farmer clusters and networks not currently collecting data, as well as from established research networks, research projects and trials. This was to scope the potential for further research taking a similar approach used in the SEEGSLIP project, where robust, standardised monitoring was applied across an existing, large network of regenerative farms.

Key conclusions from the online survey, case studies and comparison with EU living labs:

- Three-quarters of the survey participants who are not currently collecting data stated they would like to collect data given more funding, knowledge or support (Section 2.2.3). This shows an appetite for engagement with research.
- Both the size and the timescales of research initiatives varied substantially in the survey from single sites to networks of 50-100 sites and with agroecological/regenerative practices applied from one to over 20 years.
- All the survey respondents applied multiple agroecological/regenerative processes and had multiple target outcomes.
- Biodiversity was one of the most frequent target outcomes and data collection most frequently focussed on biodiversity, across the research initiatives surveyed.
- A majority of the research initiatives in the survey were funded by charities, NGOs or funded themselves, with a smaller number funded by UK or EU government funding. This contrasts with the European living labs (Section 2.4), most of which were at least partly government funded.
- Growing to incorporate more farms and researchers, and developing knowledge exchange further were prioritised as future aspirations by survey respondents. Incorporating more researchers and applying for funding were also a focus for many research initiatives.
- Targeted funding was seen as very important in achieving future aspirations by the majority of respondents, along with improved connections with farmers and landowners and improved skills and information for knowledge exchange. Improved infrastructure and monitoring tools were emphasised less, with more respondents considering these important or slightly important rather than very important.

3 Learning lessons from current research to inform an agroecological / regenerative farming living labs network

3.1 Aims

The second objective of this work-package was to explore lessons from recent research initiatives and identify key research gaps, to inform a potential UK living labs trials network in agroecology and/or regenerative farming.

3.2 Method

An online workshop was run on 18th January 2023 to explore the lessons learnt from current research. The first part of the workshop present findings of the WP1 evidence review (Burgess et al. 2023) and preliminary results from the WP2 structured interviews (Hurley et al. 2023), and invite discussion to gather feedback. The second part of the workshop focussed on informing a future living labs network for agroecology / regenerative farming through three objectives:

1. Explore key research gaps and priorities in our current understanding of agroecological/ regenerative farming practices.
2. Identify additional infrastructure and skills needed to support research into agroecological/ regenerative farming.
3. Identify barriers and solutions to accessing data on agroecology/regenerative agriculture.

There were 34 participants, excluding those from Cranfield University and UK Centre for Ecology and Hydrology. Participant organisations included Defra, Natural England, BBSRC, universities, research organisations including NIAB, James Hutton Research Institute and Organic Research Centre, a range of NGOs (including Linking Environment And Farming, Soil Association, Royal Society for the Protection of Birds, Land Workers Alliance, National Farmers Union, Farming Carbon), an agronomy company (Agrii), and several farmers who had taken part in the WP2 structured interviews.

During the second part of the workshop, the participants were split into three smaller groups in breakout rooms, who rotated around discussions of each of the three areas. Each group spent 25 minutes discussing each of the areas. A primary and follow-on question was posed for discussion in each of the three areas:

1. Research gaps

Question 1.1: What are the key research gaps in our understanding of agroecological and regenerative farming practices in the UK?

Q1.2: What are the priorities for research?

2. Infrastructure and skills

Question 2.1: What additional infrastructure/skills are needed to support current and future research into agroecology / regenerative agriculture practices?

Question 2.2: Who needs to implement those skills/infrastructure developments?

3. Barriers and solutions to accessing data

Question 3.1: What are the biggest barriers to accessing the agroecological/ regenerative agriculture data you need?

Question 3.2: How might these barriers be overcome?

Discussions were structured around an interactive online board for each of the three areas, which allowed participants to post anonymous ideas and comments in response to the questions. Within each 25 minute break-out session, the participants had 3-4 minutes to write their ideas on virtual post-it notes. A facilitator roughly grouped the ideas into broad themes, and opened a verbal discussion on the contributions made, their grouping into themes and the second, follow-on question. Notes were taken of the verbal discussions, without attributing comments to any individual participant.

Ideas on each of the three discussion boards were built up by subsequent groups, thus the second and third groups to discuss research gaps could see and add to ideas from the earlier group(s). Each of the three groups used a single colour (white vs. blue vs. yellow) for their post-it notes, any differences between the groups or particular emphasis of a group can be seen visually on the final discussion boards (Figures 6 – 14).

After the end of the workshop, the facilitator for each area finalised the grouping of notes around common themes or concerns and added subheadings per group. Inevitably there are linkages and cross-overs between these groupings. The subheadings were added to help guide interpretation given the amount of material collected in the workshop, they do not cover the full detail of ideas contributed during the workshop which are on the notes themselves. A summary of the findings from the three areas is below, the subheadings added after the workshop are in capitals on pink notes (Figures 6 – 14).

3.3 Findings - research gaps and priorities

Question 1.1: What are the key research gaps in our understanding of agroecological and regenerative farming practices in the UK?

This question engendered a large number of ideas across the three groups, with 68 comments (see Appendix C for full research gap discussion board). The largest number of comments related to specific impacts (e.g. biodiversity, GHG emissions, yield) or outcomes (e.g. mapping nutrient density) that were considered key research gaps, and trade-offs between these impacts. Understanding why the effects of practices on these impacts might vary with context (e.g. due to region or soil type) was also highlighted, as was the role of agroecology in adaptation to climate change (Figure 6). The range of impacts, outcomes and practices listed as key research gaps indicates a perception that little research has been completed on the impacts of agroecology in the UK. This is summed up by one comment (Figure 6):

> *"All the topics put up so far! Agroecology in the UK has been so underinvested in, that really an entire research agenda is needed. Fundamentally building an evidence base to show different outcomes from agroecology and regen would be so valuable."*

The importance of research at relevant spatial and temporal scales was raised by several participants (Figure 7 top), in particular the need for studies that run for five to ten years given that some impacts take more than 5 years to become apparent. Several participants commented on the existence of barriers to farmers participating in research projects, in particular projects funded by UK Research and Innovation (UKRI) in which farmers are not paid for involvement. There was concern that this could be biasing the sample in these projects, towards those farmers who can afford to engage, and may not be representative of the wider range of UK farmers.

The potential for displacement of negative impacts was also raised (Figure 7 top). In work-package 1, we defined regenerative agriculture as "a system of principles and practices that generates agricultural products, sequesters carbon, and enhances biodiversity at the farm scale" (Burgess et al. 2019; 2023). One argument against agroecological practices is that reductions in yield at the farm scale could consequentially lead to increased production of the same products beyond the farm in different locations where the negative environmental impact is greater (Smith et al. 2018). How the consequential effects of reduced yields from increased use of agroecological practices play out in practice (i.e., are the effects absorbed by dietary change, reduced use of crop products for animal feed, and/or land use change elsewhere) remains a pertinent area for research (Benton and Bailey 2019; Feniuk et al. 2019; van der Werf et al. 2020).

The need for research to understand how and why farmers transition to regenerative and agroecological practices was another theme of several comments (Figure 7 bottom), including an understanding of how transition pathways may differ across farm businesses, for new entrants and those not yet engaged in these practices. In the verbal discussion, understanding the role of knowledge for agroecological farmers was mentioned as a research area, to compare how much time agroecological farmers invest in knowledge acquisition compared to conventional farmers.

The importance of economic drivers including supply chains, and the role of subsidies, was explored in another large group of comments (Figure 8 right). The final group of research gap comments was around the need to understand the wider policy context (Figure 8 left), including how these practices link to agri-environment schemes, such as Countryside Stewardship and Environmental Land Management Schemes, and may contribute to progress towards environmental targets. Overall, the range of comments and broad themes show a large number of gaps in current understanding of agroecology and regenerative farming, suggesting a need for additional research.

***Figure 6**. Research gaps relating to specific impacts / outcomes of agroecological or regenerative farming practices (left) and practices and farming sectors (right), and why drivers of change or effectiveness may vary. Section of the full discussion board in Appendix C.*

Figure 7. *The structure of research needed to fill gaps in our understanding of agroecological or regenerative farming practices, including spatial and temporal scales and mechanisms for farmers to contribute (top), and research questions around understanding transitions to agroecological / regenerative farming (bottom). Sections of the full discussion board in Appendix C.*

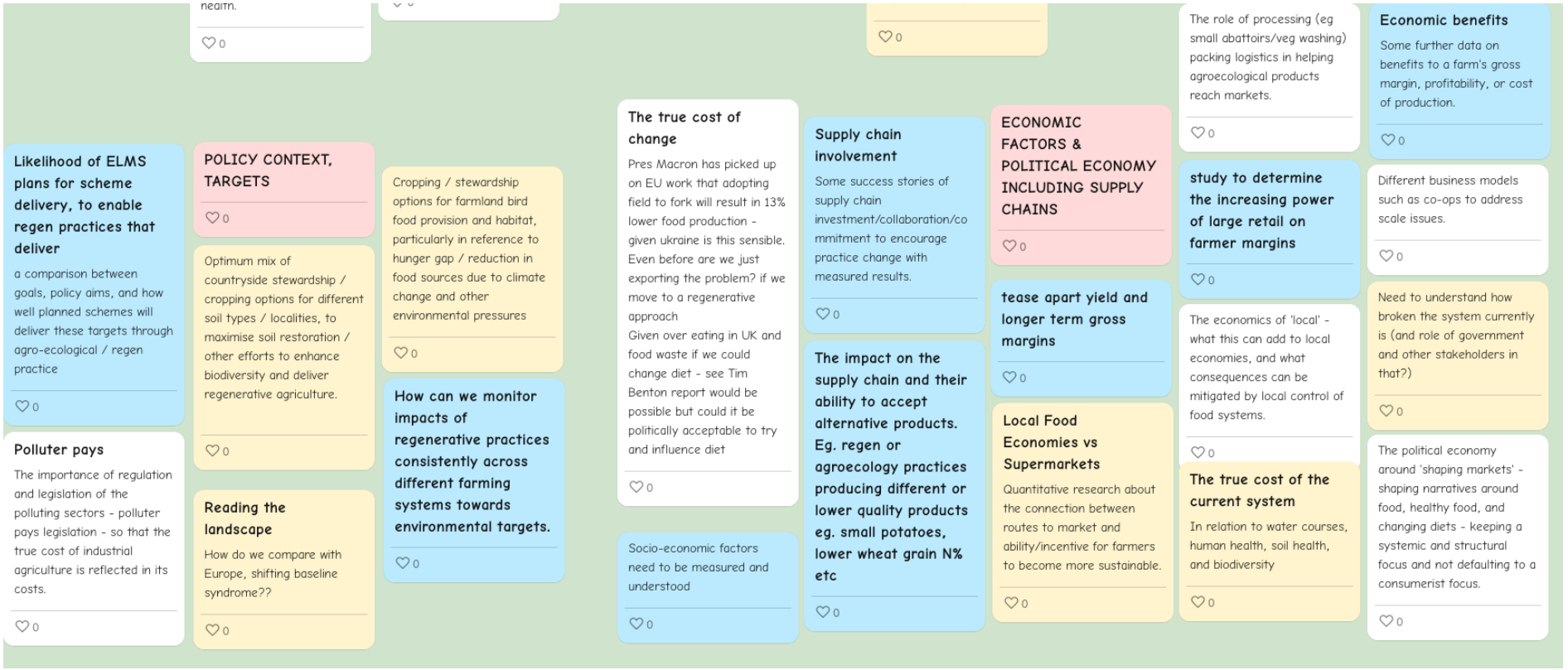

Figure 8. *Research gaps in understanding of agroecology / regenerative farming relating to the context of policies and targets (left), and economic factors including supply chains (right). Section of the full board in Appendix C.*

Question 1.2: Which of the research gaps should be addressed first?

When asked to prioritise the research gaps, there was less response during the workshop than to addressing the first question on identifying research gaps, perhaps because of the limited time or because participants felt that areas not listed as priorities might be less likely to receive research funding. Several participants stated that all the gaps identified need addressing (see comment titled '*All the topics put up so far!*' discussed above).

When the priority question was rephrased to ask 'Which of the research gaps should be addressed first?', a range of comments were received:

- To establish practical and cost effective ways of measuring outcomes – need to agree a standard for monitoring responses so data can be compared between studies.
- Timescale and scaling are coming across as key issues.
- Appropriate length of funding is a key take-home message.
- Longer term research.
- System level approach, maximise multiple benefits.
- Optimising multiple benefits at the system level.
- Lacking an overall direction that enables agroecology to thrive. Moving from a conventional to a regenerative approach, requires you to unlearn lots of what farmers thought they knew.
- Sequestering carbon – not much measurement of the greenhouse gas emissions of new practices. There are certain critical measurements that farmers will not have the time or resources to measure, may need some funding or other support.
- Prioritise understanding regional/soil type differences first, prior to scaling up.

3.4 Findings - infrastructure and skills needed

Question 2.1: What additional infrastructure/skills are needed to support current and future research into agroecology and regenerative farming?

Several key themes emerged from the written comments (Figures 9-11, full discussion board Appendix D) and verbal discussion in response to this question.

1) Need for long term networks

The largest number of comments and suggestions in response to this question addressed the need for long-term networks and experimental platforms, with emphasis on building stronger links between existing platforms, wider testing of regenerative practices, and funding (Figure 9). Comments included:

> *"Link existing networks – Create better links between universities / organisations and networks that are carrying out research for knowledge transfer and collaboration etc".*

Participants emphasised the need for ongoing funding for existing networks:

> *"The organisation 'Agricology' was funded (not now) by a farm / retail and was an excellent networking org. Core funding for this / similar organisations would help the whole community".*
>
> *"Agroecology Research Collaboration was formed to co-ordinate agroecology practitioner ideas on research and build relationships with academics to get discussions onto their agendas… support for initiatives like this would be really valuable."*

Testing of experimental results across commercial farms and across a wider range of farm types was also raised, along with the need to scale up results from individual experimental farms (Figure 9). For example:

> *"Hub and spoke model with long-term experimental farm platform linked to satellite farms to test generality of regen farming practices"*
>
> *"…farm platforms.. need to be linked together, and scaled up to a sample size that allows us to determine statistically robust patterns of landscape scale"*

2) Standardised assessments and tools

In common with the discussion of research gap priorities (Section 3.3 above), a need was identified for a range of tools to enable standardised monitoring approaches and assessments (Figure 10). Specific requirements that were identified include short-term and validated soil assessments including for soil carbon, standardised data formats, apps and other methods for farmer-friendly monitoring, hubs of shared equipment for farmers to borrow for monitoring (including for high tech greenhouse gas measures), yield modelling and farm-scale nutrient mapping (Figure 10 top).

3) Good communication and credibility

Communication needs were identified (Figure 10), including better data sharing across organisations and platforms (e.g. for carbon calculators) and links to future climate scenarios. The relationship between researchers and farmer was addressed in several comments, including the need for shared ownership of research, and a partnership relationship with farmers involved from the start as opposed to researchers reaching out once research is complete. One participant commented that communication timescales can differ between researchers and farmers, with farmers keen for rapid communication of outputs from a project to feed into their farming practices, while researchers need time for quality assurance of data, analyses and checking of results. This disparity in communication timescales can erode relationships between researchers and farmers. The WP2 stakeholder interviews (Hurley et al. 2023) also emphasised the differing expectations between researchers and farmers in relation to timescales.

Evidence developed for farmers may need to cover a range of objectives as priorities differ between farmers, e.g. yield vs. biodiversity. If collated evidence summaries are available, farmers can pick out the information helpful to their objectives.

4) Support

These comments were grouped as relating to the need for support for farmers, mainly in the context of knowledge exchange (

Figure 11 right). Infrastructure needs identified included more support for farmers who want to transition to agroecology and regenerative farming, including better guidance, more funding, input from advisors, technical officers or coordinators, and placements for farmers on other farms.

5) Upskilling/education improvements

The final group of comments relating to infrastructure needs were around upskilling and improvements in education and training (

Figure 11 left), linked to some of the comments on support. In addition to education for farmers, vets and agronomists were considered good candidates for upskilling, as they interact with farmers regularly and form a trusted source of information. Upskilling was also considered important for those working in the supply chain (buyers, processors).

Figure 9*. Need for long term networks, part of discussion board on additional infrastructure / skills needed to support current and future research into agroecology and regenerative farming.*

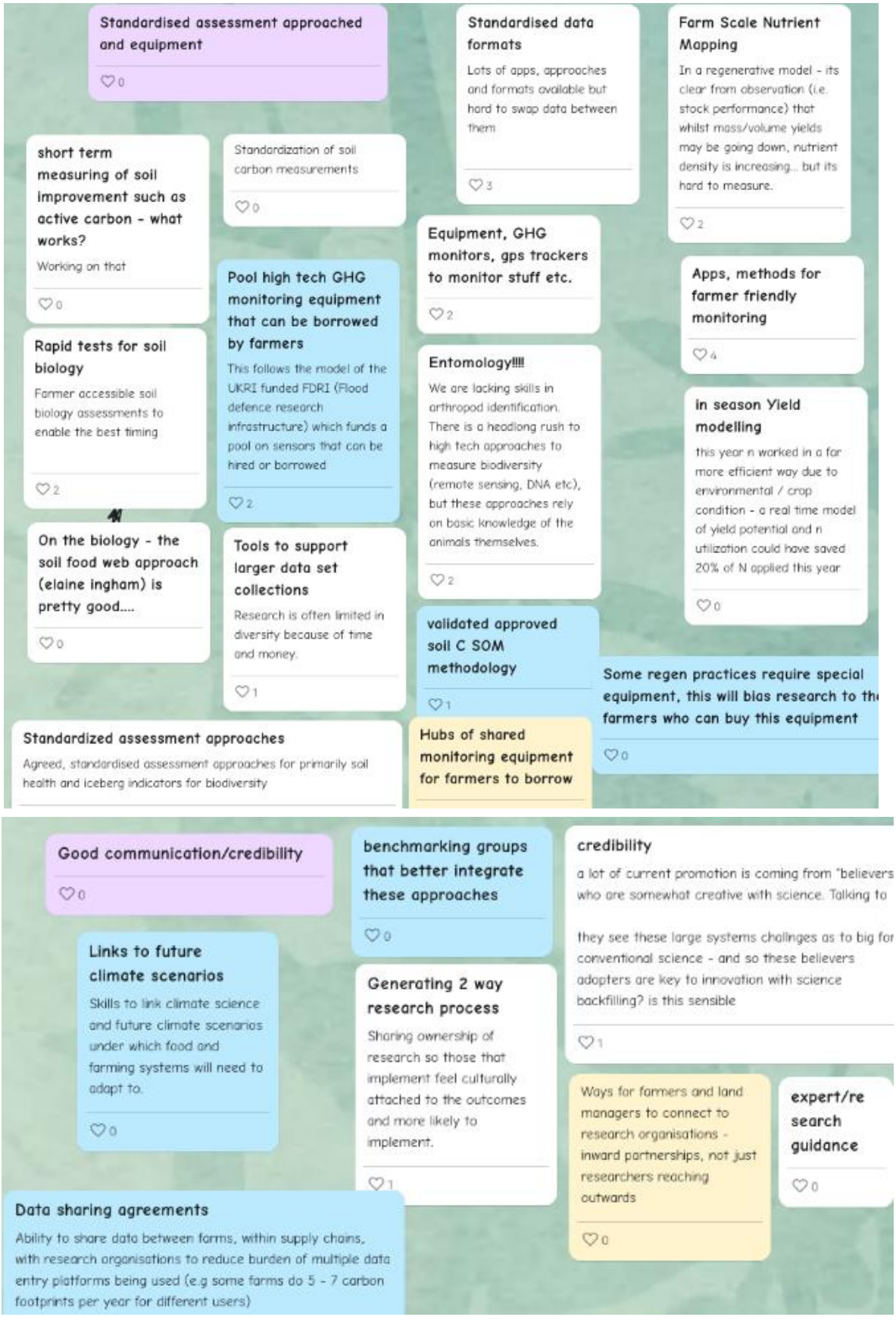

Figure 10. *Comments on standardised assessment approaches and equipment (top) and good communications / credibility (bottom), parts of discussion board on additional infrastructure/skills needed to support current and future research into agroecology and regenerative farming.*

Question 2.2: Who needs to implement those skills/infrastructure developments?

The discussion on who should be implementing the advances needed in infrastructure and skills covered several themes:

- Research and development is in the hands of industry partners. Need to be sure they think about what farmers really want.
- Interesting case study of a farmer going to a university saying I am doing this, on this land, close to the university. Students are now involved in the research/ engaged with the practices going on. Connections are being made that were initiated by the farmer.
- National Capability Funding - e.g. ASSIST programme etc. - is scaling up, things are starting to happen. Access to information, knowing what is available, funding calls that allow you to use that information would be useful.
- Upskilling agronomists and vets – these are people who farmers already have close relationships with. Through upskilling they could understand agroecological and regenerative practices, what funding is available for research into those practices or links with researchers. There will be a need to keep this up to date. Some farmers who have voiced interest in regenerative farming or agroecology have commented that they were put off by their agronomist who said they were crazy to think about it.
- Upskilling farmers - a need to upskill the farmers to help themselves, and a concern that agricultural colleges do not put enough focus on agroecology and regenerative farming.
- Worry that a lot of information is tied to big corporate business and there is a need to make it independent.
- Concern around speaking to the converted / always the usual groups of farmers there at e.g. Oxford Real Farming conference. Potential for regional conferences to be more accessible to those farmers who are not already engaged with agroecology.
- Innovative farmers scheme – funding needs to be increased.
- Need for small farms / tenant farmers / less profitable businesses to potentially have a subsidy that would allow them to hit Environmental Land Management (ELM) targets.

Figure 11*. Comments on upskilling and education (left) and support (right), parts of discussion board on additional infrastructure / skills needed to support current and future research into agroecology and regenerative farming.*

Figure 12. *Word cloud based on discussion board comments in response to What additional infrastructure/skills are needed to support current and future research into agroecology / regenerative farming practices? Discussion board notes are in full in Figures 9 - 11.*

3.5 Findings - barriers and solutions to accessing data

In total, 74 comments were made in relation to data access for agroecology and regenerative farming, on the discussion board for this area (Figure 13).

Question 3.1: What are the biggest barriers to accessing the agroecological/ regenerative agriculture data you need?

Barriers were identified in written comments which were then grouped under six broad themes (Figure 13):

- *Access to research data*, which included comments on '*Knowing where to get the right data'*, '*Is it relevant to me?*', and the time needed to find and identify what data are needed. This theme also covered the need to identify pathways to ensure data were discoverable and accessible to non-academic institutions (or those without an institutional affiliation).
- *Data sharing*, with barriers listed including '*Commercial sensitivity – wanting to be ahead of competitors*', GDPR and the need for consistent data recording and reporting, to be supported by data sharing standards. However, one participant commented verbally that time may be more of a barrier to data sharing by farmers, rather than confidentiality concern, especially where the value of sharing such data was made evident.
- *Data quality/trust*, with comments that '*Lack of consistency in methods of collection – may make it uncomparable*', '*Quality*' and '*Variability and relevance'* including the need to understand / know data context if impacts differ between soil types, regions or other factors.
- *Balancing data types / sources,* with several comments emphasising practitioner-led experience, e.g. '*Art vs Science - Ensuring opportunities so practitioner led experience and research led data can meet in middle*'.
- *Data gaps*, focussed on specific gaps in the availability of data and knowledge. Examples were '*gap in knowledge of soil biology…*' and '*microbial biodiversity especially plant micro symbionts*'
- *Data collection* – included comments on who collects the data, e.g. '*If the onus is on farmers to collect data, we've found it is less likely to be collected even with the best will, due to other priorities and practicalities of collecting it. So it has been better when someone external has collected it*' and the cost / time needed for data collection, '*Expensive methods and time consuming, e.g. GHG emission measurements, bulk density (very time consuming!), some soil test etc*'.

During the verbal discussion of barriers, the difficulty of obtaining funding to collate data (rather than collect new data) was mentioned:

- A struggle to get funding for collating knowledge/evidence.

The lack of data on who is implementing agroecological practices was mentioned, as lots of farmers may be implementing practices with or without subsidies, some conventional, some non-conventional.

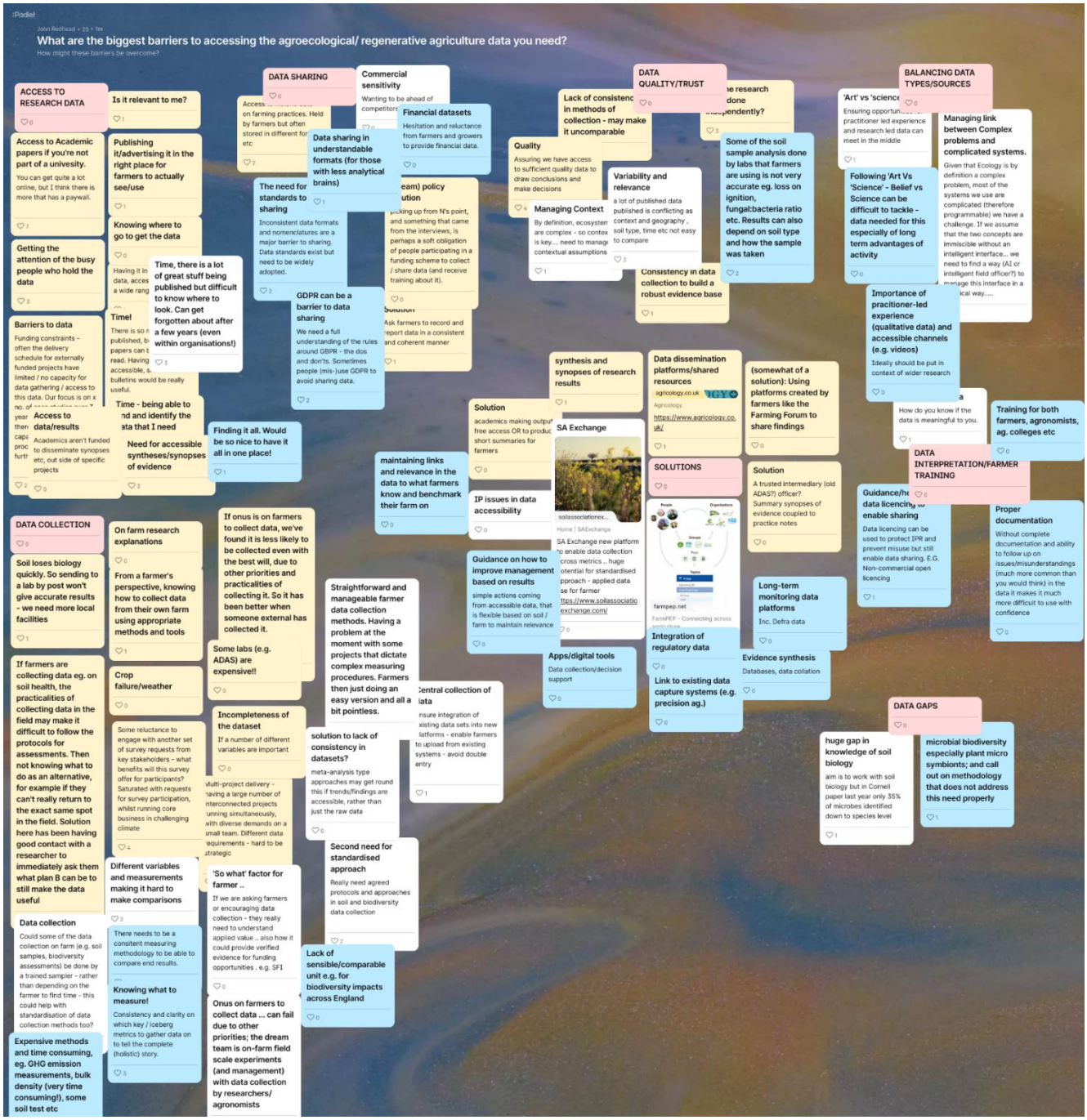

Figure 13. Discussion board on barriers and solutions to data access on agroecological and regenerative farming in the UK. Pink notes were added later and give themes for broad groupings of participants' notes.

Question 3.2: How might these barriers be overcome?

On the discussion board, the comments were grouped around two broad themes, one on data interpretation and training, the second more widely on solutions to barriers. Many solutions addressed multiple barriers simultaneously – the arrangement of solutions on the board (Figure 13) indicates by their proximity to the barrier groupings which of these they were intended to solve.

The data integration and training theme was originally identified as a barrier (i.e. a lack thereof), but the discussion subsequently highlighted this as a key area for the delivery of solutions, again with multiple barriers potentially being resolved by improvements to training and knowledge exchange. The suggestions to overcome barriers included: '*Training for both farmers, agronomists, ag. colleges etc*', '*Proper documentation*' and '*Guidance / data licensing to enable sharing*' (Figure 13). The wider solutions included *'Long-term monitoring data platforms'*, *'Apps/digital tools'*, and a focus on synthesis of evidence and results-based guidance (e.g. '*Academics making output free access OR to produce short summaries for farmers*'). Three data dissemination or knowledge exchange platforms were mentioned:
Agricology (https://www.agricology.co.uk),
Soil Association Exchange (soilassociationexchange.com), and
FarmPEP (https://farmpep.net/).

The verbal discussion focussed more on data-related solutions than on the barriers, and expanded on some of the written comments (Figure 13) as well as raising additional points:

- Sharing data in understandable formats is needed, to try to avoid proprietary formats that are only associated for example a particular machine format. A format that is machine readable by anyone, anywhere, would be useful.
- Needs to be a balance between the sharing of experience-lead data vs. the scientific consensus – there needs to be a way for these to meet in the middle.
- Enabling farmers to share data - standardised approach has to come in e.g. sharing data amongst farmer clusters, supply chain (e.g. soil metrics, biodiversity data) - just becomes hard and annoying. Balance between usefulness and being easy enough to collect on-farm.
- This approach cannot constrain innovative 'mad' experiments being done by a farmer in a field - sometimes hard to recreate this approach in a lab. Can science capture farmer-led innovations?
- Manage the data between heavily contextual data and more landscape scale - balancing the practitioner led bottom up and the science, academic-led top down.
- Easily accessible and easy to use apps for data collection or to let farmers know what assessments need to be used would be useful.
- Knowledge and evidence synthesis in a digestible form for farmers and researchers to collaborate across institutions.
- Training farmers and agronomists on how to interpret the data they are getting back from tests – e.g. Defra training days or workshops on how to collect, access, and interpret the data.
- Long term monitoring data platform for sharing data.
- An up to date and location-relevant platform is needed of all the current projects and the data from them, collated in one place for the farmers and researchers to use.
- Integration of regulatory data (e.g. pesticide usage) into our data sharing/data analysis platforms to avoid farmers having to enter duplicate data into different platforms.
- Qualitative approaches might work well for combining the quantitative assessments with observational approaches - combine data into a hierarchy for sustainability assessment, so we aren't restricted into the types of data being collected and how they are being collected.

Several of the comments above point to a potential tension between trying to make data consistent (in relation to format, standardised protocols for data collection etc) and not constraining farmers from trying out new innovations that may not be part of rigorous, standardised data collection. However, comments also identified existing platforms (e.g. Soil Association Exchange, FarmPEP, and Agricology websites) for data discovery and/or dissemination that participants felt provided good examples of how several of these data barriers might be overcome, whilst allowing for this flexibility in approach and the presentation of practitioner-led experience.

3.6 Conclusions – learning lessons from current research

The workshop brought together a diverse range of stakeholders (farmers, researchers, NGOs, policy makers), and generated many ideas and comments to inform future research in agroecology and regenerative farming. There were a range of conclusions within each of the three areas (research gaps, infrastructure and skills, data) from the discussion boards and verbal discussions, which are summarised above (Section 3.3). Some similar themes came up across the three discussion areas.

Key themes and conclusions from the workshop:

- Many of the impacts of agroecology and regenerative practices remain poorly understood, with biodiversity and greenhouse gas emissions in particular highlighted by multiple stakeholders. Greenhouse gas emissions can be challenging to assess due to their temporal and spatial variability, which may be one reason why they have been addressed less than other impacts. Table 2 in the evidence review (work-package 1, Burgess et al. 2023) shows GHG emissions responses were inconclusive for many of the regenerative practices reviewed. While some biodiversity evidence is available for some regenerative practices, often this is for a single taxon or group, and the wider impacts across a range of taxa remain poorly understood.
- Impacts on multiple potential benefits, and trade-offs between them (e.g. yield vs. biodiversity) need to be understood. The variation in responses (e.g. between soil types or regions) was seen as a priority, before scaling-up (e.g. nationally) could be attempted.
- Research needs to be conducted at adequate temporal and spatial scales, given the timescales needed for impacts of these practices to become apparent (5 or more years). This is illustrated by findings from the Sustainable Cropping Platform (Section 2.3 above), that initial trade-offs between enhancing biodiversity, soil health and crop yield in the early stages of conversion from intensive to regenerative cropping appear to become less over time. The infrastructure discussions also raised the need for longer term projects, with an emphasis on long-term networks between researchers and practitioners.
- There may be a bias in farmer participation in agroecological and regenerative agriculture research (those who can afford the time and money). Payments for farmers should be considered in research funding structures, to allow more equitable participation in research.
- Understanding transitions to agroecology and regenerative farming, across different types of farm business, was raised as a research gap, along with investigating the role of knowledge in these types of practice. This was reflected in the discussion of infrastructure and skills, with support (better guidance, input from advisors) and upskilling/improvements in education seen as priorities to support transitions.
- The role of economic drivers, including subsidies and supply chain structures, is a research priority to understand why and how farmers may transition to agroecological and regenerative farming practices. The WP2 interviews (Hurley et al. 2023) also showed reliable evidence on changes to yield over time was a priority.
- Standardised assessments and monitoring tools (including farmer apps) were highlighted as needed to support future research, in particular standardised soil carbon assessments. Hubs to loan monitoring equipment to farmers were also suggested.
- The time commitment needed was seen as an impediment to data collection by farmers, with comments that research initiatives worked better with someone external collecting data. The online survey (Section 2.2) showed this across the research initiatives surveyed, with data collected more frequently by researchers/academics, students or volunteers, than by farmers.

- Data quality and formats were raised as barriers to data sharing in agroecology / regenerative farming. Formats that can be easily read across a range of software were suggested as a solution, along with more standardised approaches in data collection.
- Integration and sharing of data across platforms were also solutions, in particular for regulatory data (e.g. pesticide usage).
- A potential tension was raised between standardising monitoring approaches and data collection, and constraining innovation by farmers, for example 'Can science capture farmer-led innovations?'. Ensuring that future research networks provide opportunities for practitioner-led experience and research-led data to meet in the middle was flagged as a priority.
- Our understanding of how widespread agroecological and regenerative farming practices are, and which are being used / in what combinations, is constrained by lack of uptake data. Practices are being implemented with or without subsidies, and in varying combinations with more conventional approaches. This links to Section 5 in the WP1 evidence review (Burgess et al. 2023), which identified a need for standardised data on the uptake and quality of agroecological and regenerative practices. Without these data, larger scale research and modelling will be constrained.
- An appetite for engaging further with research was shown both from the online survey of research initiatives and living labs (Section 2.2 above), with most of those not currently collecting data keen to do so, and in the WP2 stakeholder interviews which emphasised that any living lab should be farmer driven (Hurley et al. 2023 Section 4.3.3).

4 Recommendations for a new living lab trial network in agroecology / regenerative farming

The third objective of work-package 3 was to recommend the research, infrastructure and tools needed to address current evidence gaps related to agroecological and regenerative farming and to set out the case for a UK living lab R&D platform / network.

4.1 Context

There is a strong argument that research and development of agroecological practices should follow the social and governance principles of agroecology described by the High Level Panel of Experts of the Committee on Food Security (HLPE, 2019). These include greater participation, decentralised governance, an appreciation of culture and equity, co-creation of knowledge, and connectivity (Table 14).

Table 14. *The 13 agroecological principles described by HLPE (Modified from HLPE 2019; page 41) categorised as environmental and technical or social and governance.*

Environmental and technical principles	Social and governance principles
Soil health: secure and enhance soil health for improved plant growth, by managing organic matter and soil biological activity.	Participation: encourage greater participation in decision-making and decentralised governance of agriculture and food systems.
Biodiversity: maintain and enhance genetic, species, and functional diversity and overall agroecosystem biodiversity at range of scales.	Social values and diets: food systems based on the culture, social and gender equity of local communities that provide healthy, diversified, seasonally and culturally appropriate diets
Input reduction: reduce or eliminate dependency on purchased inputs and increase self-sufficiency.	Fairness: support dignified and robust livelihoods for all actors based on fair trade, employment and intellectual property rights.
Economic diversification: diversify on-farm incomes thereby supporting greater financial independence for farmers.	Land and natural resource governance: strengthen institutional arrangements to support of family farmers and smallholders
Recycling: preferentially use local renewable resources and help close resource cycles of nutrients and biomass.	Co-creation of knowledge: including horizontal sharing of knowledge and farmer-to-farmer exchange.
Synergy: enhance positive ecological interactions amongst the elements of agroecosystems (animals, crops, trees, soil and water).	Connectivity: ensure confidence between producers and consumers through fair and short distribution networks
Animal health: ensure animal health and welfare.	

4.2 Potential options

The characterisation of research initiatives and lessons learnt from current research (Sections 2 and 3 above) have demonstrated a wide range of research gaps as well as suggesting priorities, approaches and solutions to barriers (for example to data sharing). The gaps range from specific impacts of individual practices (e.g. GHG emission responses to cover crops), to the need to understand trade-offs across a range of impacts and practices, the drivers of variable responses, a requirement for large-scale and longer-term research, and the suggestion to better integrate existing research initiatives and networks. Due to the range of gaps and priorities, we have developed four potential options for a new research project, research network or living lab network (Table 15), each of which has a different structure and focus. The options are not mutually exclusive and could be combined. This current scoping work focusses on the UK, with some lessons learnt from European living labs, due to the aims and objective of the project.

4.2.1 Option 1: Supporting consistency of farm attribute measurements

The first option focuses on encouraging local decision making, by encouraging farmers and growers to systematically appraise their farm operations from a range of perspectives. The Global Farm Metric (Figure 14 and discussed in more detail in work-package 1 report, Burgess et al. 2023) identifies 12 attributes for assessment, but does not include standardised methodologies which can be applied by farmers for each attribute. A similar approach is promoted through the LEAF audit. In some cases, establishing more standardised methods for assessment for some attributes would be helpful. One option might be to extend or build on the LEAF audit, depending on the funding and organisational structures within which Option 1 was implemented.

For example, the stakeholder interviews conducted in work-package 2 (Hurley et al. 2023) identified that carbon calculations are still being developed:

> *"One of the things that's holding all this back is everybody's trying to find the holy grail of calculating carbon and actually, we're still some distance away…"*

Figure 14. *The Global Farm Metric comprises of 12 segments (Global Farm Metric 2022).*

A range of farm carbon calculators are available, each based on slightly different assumptions. A guide to how they differ, and which may apply in different contexts, could give farmers more confidence in these assessments and potentially result in more standardised data. Hence, Option 1 in Table 15 includes the proposal to develop standardised methodologies or toolkits for all 12 Global Farm Metric attributes, which could be applied on farms using agroecological and regenerative practices, or those undergoing transitions to these systems. This option would help to meet the infrastructure need to develop standardised assessments and tools, identified in the stakeholder workshop (Section 3.4). There is some ongoing work in this area (e.g. by DairyUK and Defra).

4.2.2 Option 2: Maximise research synergies with existing agroecological / regenerative farm networks, standardised data collection.

The scoping of current research initiatives (Section 2) identified eight farm networks or clusters applying agroecological or regenerative practices that are not currently collecting data, and an appetite for additional engagement with research. Three-quarters of the participants who are not currently collecting data stated they would like to collect data given more funding, knowledge or support. Option 2 in Table 15 involves funding and setting up research initiatives to maximise the synergies between research and existing networks of farms. This approach was used successfully in the SEEGSLIP project, which involved researchers working with members of the Pasture-Fed Livestock Association (an established network) to survey 58 farms on which regenerative grazing practices had been applied over varying timescales prior to the start of SEEGSLIP. Standardised data were collected by researchers on vegetation, soils and other public goods, under a 3 year project (Case study 2, Section 2.3). This approach of standardised data collection by researchers across an existing network of agroecological / regenerative farms used by SEEGSLIP could be applied to other farming systems (e.g. a network of arable regenerative farmers) and to collect data on other impacts (e.g. wider biodiversity beyond plant responses, greenhouse gas emissions).

4.2.3 Option 3: New research network applying agroecological / regenerative practices on commercial farms, standardised data collection.

One of the risks around Option 2 is the potential for highly variable data, which are less likely to show clear impacts of regenerative or agroecological practices. Variability may be increased by farms in a network varying in when these practices were first applied, and also potentially applying different types and combinations of regenerative practices. Hence, Option 3 is to fund a research initiative that creates a new network with similar regenerative practices applied from around the same starting date (Option 3, Table 15). This may require long research projects or initiatives, as impacts and trade-offs between impacts have been shown to take time to become apparent and/ or to change over time (Case study 5, Section 2.3).

The research initiative possibilities outlined in Options 2 and 3 above include some aspects of living labs, for example the potential to co-design research questions with farmers and other stakeholders. However, neither of them include all five aspects of a living lab, as defined the European Network of Living Labs (Section 1.1).

4.2.4 Option 4: Establishment of a UK living lab network in agroecology

Option 4 is the establishment of a UK living lab network in agroecology / regenerative farming, drawing on aspects of the European agroecology living labs summarised in Section 2.4. This would be a longer-term initiative, with a focus on facilitating links between stakeholders and existing research in this area, in addition to potentially setting future research priorities.

Option 4 (Table 15) could meet the recommendation coming out of the stakeholder interviews in work-package 2, that some aspects of living labs may require a co-ordinating role from government (Hurley et al. 2023). Examples of this coordinating role include fostering collaboration between farmers and the research community, standardising data collection and sharing and helping to make the most of existing demonstration sites belonging to different institutions (Hurley et al. 2023). This form of living lab network would also address some of the recommendations about infrastructure (Section 3.4) and data (Section 3.5) from the stakeholder workshop. For example, setting up shared equipment hubs to load scientific equipment to farmers, and helping to facilitate upskilling and improving education on agroecology and regenerative farming.

4.2.5 Combinations of options

Combinations of the options in Table 15 are possible. For example, Option 4 could be combined with Option 1, where standardised methodologies and toolkits for assessment of Global Farm Metric attributes could be developed within a new living lab network. A living lab could take an adaptive approach, with research priorities and focus changing over time, which may help to meet the concerns raised at the workshop (Section 3.5) that:

> *"This approach cannot constrain innovative 'mad' experiments being done by a farmer in a field - sometimes hard to recreate this approach in a lab."*

All of options 2-4 rely on funding for data collection by researchers, either in discrete research project/networks (Options 2 & 3) or in any research conducted within the living lab (Option 4), following recommendations at the workshop on who collects data (Section 3.5). There was also a strong recommendation that any research into agroecology or regenerative farming includes analyses of yield and/or profit, and a consideration of trade-offs between economic factors and other potential benefits.

Table 15. *Recommendations for a new living lab network / research network in agroecology and regenerative farming.*

Option	Suggested structure	Pros	Cons	Timescales / funding sources
Baseline: No additional funding/ involvement from Defra	Research in agroecology and regenerative farming continues to develop as it currently is, discrete research projects and limited/no long term funding for research networks.	• Requires little to no government investment. • Agroecology/regenerative farming is partially a bottom-up, practitioner led movement which may continue to develop on its own.	• Risk that opportunities for synergy between research initiatives is lost. • Risk that on-ground innovation development by farmers and evidence gathered by researchers are less well connected.	
1. Supporting consistency of farm attribute assessments	Development of a standardised methodology or protocol for UK farms, for each of the 12 attributes within the Global Farm Metric. This could include a portal to collate consistent data, and/or funding for farmers to collect these data.	• More consistent data collection within the Global Farm Metric approach. • Increase farmer confidence in value of collecting data on some or all of the 12 attributes.	• Onus on data collection remains with farmers, may be sporadic. • Not a formal comparison of agroecological/regenerative vs. conventional farms.	• 1-2 years • Defra funding likely to be needed (NB see ongoing work on this area Section 4.2.1)
2. Maximise research synergies with agroecological /regenerative farm networks. Standardised data collection on impacts and trade-offs, at networks of farms applying these practices.	Specific research projects to collect standardised, rigorous data from farms already applying agroecological / regenerative practices, and already linked through a network. Farmers and other stakeholders involved in specifying research focus, co-design. Priorities for data collection could include the impacts identified as research gaps in Section 3 above (greenhouse gas emissions, biodiversity).	• Efficiency in working with existing farm networks, often coordinated through a NGO. • Co-design - opportunity for farmers in network to contribute to research focus and questions. • Time for impacts to have built up - agroecological / regenerative practices already applied for several years, on at least some farms in network. • Real-world setting - agroecological/regenerative practices applied on commercial farms. • Standardised data collection ensures consistency of methods and common time period. Robust data collected to assess specific impacts. • Potential for longer-term data collection or future resurveys to assess how impacts change.	• Agroecological / regenerative practices applied in varying combinations which may change, impacts attributable to combination of practices rather than specific ones. • Risk of variable data making it harder to detect effects - agroecological / regenerative practices applied over varying timescales across farms in a network.	• 3-5 years • Defra or UKRI funding likely needed.

Table 15 continued. *Recommendations for a new living lab network / research network in agroecology and regenerative farming.*

Option	Suggested structure	Pros	Cons	Timescales / funding sources
3. New research network applying agroecological / regenerative practices on commercial farms. Standardised data collection on impacts and trade-offs.	Long-term research project sets up a new network of farms applying agroecological / regenerative practices from a common start date. Standardised, rigorous data collected. Farmers and other stakeholders involved in specifying research focus, co-design. Priorities for data collection could include the impacts identified as research gaps in Section 3 above (greenhouse gas emissions, biodiversity).	• Agroecological/regenerative practices applied once project starts. Potentially less variable data as impacts accrue from similar start dates. • Common practices / combinations of practices could be used across farms, may allow impacts to be attributed more to specific practices or particular combinations. • Baseline data could be collected before agroecological/regenerative practices are applied. Potential to assess change in impacts over time compared with conventional farms. • Co-design - opportunity for farmers in network to contribute to research focus and questions. • Real-world setting - agroecological/regenerative practices applied in combination on commercial farms. • Standardised data collection by researchers within the timespan of a specific project ensures consistency of methods, all farms sampled in the same years. Robust data that can be analysed to assess specific impacts. • Potential for longer-term data collection or future repeat surveys to assess how impacts change with time.	• Impacts likely to take time to build up, may not be detectable over first few years. Longer-term funding may be required. • Additional resources needed to build up network of farms, engage wider stakeholders.	• 5-10 years • Defra or UKRI funding likely needed.

Table 15 continued. *Recommendations for a new living lab network / research network in agroecology and regenerative farming.*

Option	Suggested structure	Pros	Cons	Timescales / funding sources
4. Living lab UK network set up, facilitation roles and research projects funded.	UK living lab network in agroecological / regenerative farming, bringing together range of stakeholders. Focus on building links and maximising opportunities across current and future research initiatives. Similar structure to some aspects of the European agroecology living labs in ALL-Ready network (Section 2.4 above). For example, research themes and priorities could be set periodically by established stakeholder groups within the living lab, or temporary working groups.	• Multi-method approaches - methods customized and combined for specific research initiatives within the living lab network. • User engagement – long term network, more opportunities to engage range of users than for individual research initiatives or projects. • Multi-stakeholder participation - long term network, more potential to engage different stakeholders including supply chains, agricultural colleges, range of NGOs and research institutions than for individual research initiatives or projects. • Real-life setting – research initiatives linked to living lab apply agroecological / regenerative practices on commercial farms and farm networks. • Co-creation – stakeholders involved in setting broader research priorities as well as in design / priorities of individual research initiatives.	• Long-term funding required to ensure continuity of living lab, beyond timeframe of individual research projects / initiatives. Funded staff time needed to facilitate living lab. • Risk of issues arising over top-down versus bottom-up nature of co-ordination, trust in co-ordinating partners would be required.	• Long term (10+ years) • Shorter projects funded within network. • Defra funding likely needed to start living labs network • Potential to attract some industry funding (see European examples Section 2.4 above)

4.3 Indicative costs to assess specific impacts identified as research gaps

Impacts of regenerative and agroecological practices on greenhouse gas (GHG) emissions and biodiversity were flagged as research gaps by multiple participants at the stakeholder workshop (Section 3.3 above). GHG emissions vary substantially across a farm and over time, making it an expensive impact to measure. This may be one reason why less evidence was found for GHG emissions across several of the practices reviewed in work-package 1 (Burgess et al. 2023), as well as at the workshop. Biodiversity evidence was found for the majority of the practices reviewed (Burgess et al. 2023), but often for a single taxon or a limited number of taxa. Wider biodiversity responses at the farm scale to multiple agroecological and regenerative practices have been less well studied. In particular, monitoring taxa that form part of the UK species abundance indicator (Defra 2022) would enable an assessment of whether agroecological and regenerative practices might help to halt the decline of biodiversity and contribute to meeting the UKs legal targets.

4.3.1 Potential research activities to assess how soil carbon and greenhouse gases change under regenerative and agroecological practices.

Potential broad approaches and indicative costings for two approaches to assess GHG emissions, and soil carbon are given below. These could be applied to research projects/networks under any of Options 3-5 in Table 15. Indicative cost estimates are for equipment and recurrent, and for staff time in the field. Travel, project management, data analysis and reporting costs are not included, nor are costs such as the staff time required for setting up a research network, engaging and liaising with stakeholders.

1. Soil carbon: measuring soil carbon stock change following agricultural interventions is essential and reflects the balance of carbon inputs and outputs from the soil system. Soil carbon changes slowly so measurements are made every 5 to 10 years in order to detect change. Alternatively, paired site or chronosequence studies can be used instead as space-for-time substitution studies. Soil carbon can vary with soil depth, the use of deep cores allows this to be quantified.

The measurement of carbon stocks a study network could be conducted by taking to 1 m depth from 10 farms, with 15 soil cores per farm. This would provide 150 1 m deep soil cores (4 depth increments) and the provision of data on soil organic carbon, total nitrogen, bulk density, pH, and soil texture.

Indicative costs £5K recurrent and £15K staff time for 1 year of sampling.

2. Nitrous oxide and methane chamber measurements: agricultural interventions can alter soil N_2O or CH_4 emissions after changing fertilisation or cropping strategies. These GHGs vary rapidly in space and time such that many measurements are required to determine an accurate emission inventory. There are many approaches and one example used by UKCEH is given below.

Greenhouse gas chambers connected to fast greenhouse gas portable analysers. To compare two adjacent fields, visits are made on average every two weeks over one year, more frequently following high fluxes (e.g. post-fertilisation) and less frequently following low fluxes (e.g. cold winter).

Indicative costs – equipment approximately £44K for a N_2O/CO_2 GHG analyser or £42K for a CH_4 analyser. Later in 2023 a new analyser will be available to simultaneously measure CO_2, N_2O, CH_4 with a capital cost of £69K per analyser.
The staff costs for the sampling outlined above is estimated to be £54K.

3. Eddy covariance: this is the gold standard for measuring CO_2 exchange at the field scale (Figure 15) and provides a very accurate field carbon budget measuring carbon exchanges on a per second basis. CH_4 measurements are also possible using this approach whilst N_2O is challenging.

Indicative costs – capital equipment costs of around £55K are required for CO_2 and an additional £54K for CH_4, to instrument one field with eddy covariance. An annual maintenance cost of £3.2K is required.
Staff time to install and operate the system for one year is estimated at £32K, dropping to £24K in the year following installation.

***Figure 15**. Eddy covariance tower, used to measure GHG emissions.*

4.3.2 Potential approaches to monitor biodiversity under regenerative and agroecological practices

Potential broad approaches and indicative costings for two approaches to survey a range of biodiversity taxa are given below. These could be applied to research projects / networks under any of Options 2-4 in Table 15. As for 4.2.1, indicative cost estimates are for staff time in the field, and for equipment and recurrent costs. Travel, project management, data analysis and reporting costs are not included, nor is the staff time required for setting up a research network, engaging and liaising with stakeholders etc.

1. Established survey methods to monitor butterflies, pollinating insects, butterflies and plants
Large-scale projects looking at the effects of agri-environment schemes (AES) on biodiversity have successfully followed monitoring approaches that are broadly compatible with national recording schemes (e.g. Staley et al. 2021), with data collection conducted by professional field surveyors. For example, in the landscape-scale species monitoring of AES project birds were surveyed using a more intensive version of the Breeding Bird Survey (https://www.bto.org/our-science/projects/breeding-bird-survey), butterflies with a more intensive version of the Wider Countryside Butterfly Survey (https://ukbms.org/wider-countryside-butterfly-survey), and pollinating insects using a pan trap station method (**Error! Reference source not found.**) developed for the National Pollinator Monitoring Scheme (https://ukpoms.org.uk/). Data were collected as abundance per species (Staley et al. 2021).

Using methods consistent with established monitoring schemes may allow changes in biodiversity on farms in response to agroecological and regenerative practices to be compared to wider changes in each taxon, assuming data are collected for long enough to analyse temporal responses.

Indicative costs – professional field surveyor time for a single year of repeat surveys between April – August, to monitor butterflies, breeding birds, pollinating insects and plants, across each of 10 farms in a study network. £46K
Equipment and identification of invertebrate samples. £10K

***Figure 16**. Pan trap station used to survey pollinating insects.*

2. Automated biodiversity monitoring

Automated monitoring using technological approaches is a rapidly expanding research area. Some technologies such as acoustic monitoring of bats have been applied for years, while others such as AI recognition of images from moth light traps are still being developed and tested. Automated stations to monitor several taxa at once are in development. For example, the Automated Monitoring of Insects (AMI) trap monitors moths, birds and bats (https://www.ceh.ac.uk/news-and-media/news/autonomous-monitoring-station-supports-research-wetlands-site).

In common with other autonomous monitoring stations, the AMI trap (
Figure **17**) has been proved to collect data for a range of species in these taxa. Further development work is needed to compare the data against biodiversity data collected by more traditional methods, for example to determine the sensitivity of these automated methods to detect biodiversity responses to habitat or farmland management. Automated monitoring offers continued recording which may allow rare species to be more accurately detected, but detection accuracy differs between species and for some taxa automated methods may not give abundance estimates.

Indicative costs – two paired AMI traps with solar panels on each of 10 farms in a study network, capital equipment costs of around £100K. Staff time to install and for maintenance visits, around £15K year.

***Figure 17**. AMI trap station developed at UKCEH to monitor moths, birds and bats.*

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Appendix

A. Online survey - information for participants

Current research initiatives and networks for agroecology and regenerative agriculture practices

Background

Thank you for your interest in this survey.

This voluntary research survey aims to explore the current status of the existing network of agroecological research and development in the UK.

We are interested in a diverse range of agroecological and regenerative agricultural practices and where these include research or data collection, or have been developed into what we are calling research initiatives. This term is intended to cover a variety of research projects, networks and Living Labs. We are interested in hearing from anyone managing research relating to agroecology or regenerative agriculture.

This includes farmer led clusters and project networks looking at ways to improve and develop practical solutions and practices, research platforms, and single experimental farms managed specifically with research into agroecology in mind. It also includes research projects developed by universities or colleges looking into single agroecological practice in detail across multiple settings or platforms.

We are funded by Defra to conduct this research and as part of this process would like to hear from existing networks and researchers about where research gaps fall.
The whole survey should take around 15-20 minutes and contains a series of multiple choice questions, followed by an optional free text question where we would like to get your ideas on research gaps.

Ethics, consent and GDPR statement

Please read the UKCEH GDPR policy and confirm your consent to this study using the box below.

B. Online survey – full results

1. Please read the UKCEH GDPR policy and confirm your consent to this study using the box below.

Option	Count
Yes	21
No	0

Who is carrying out this survey?

2. Which of these best describes your role within the agroecological or regenerative agriculture farming context? If you have multiple roles, please tick all that apply.

Option	Count
I am a farmer who implements these practices	6
I am a coordinator of a farm research network/cluster	7
I am a coordinator of a Living Lab/research platform	2
I am a researcher involved with a network/Living Lab/Research platform	4
I am an ecological consultant working for/in a network	2
I am an agronomist working within a network/Living Lab/research platform	1
I am an interested volunteer within a network/Living Lab/research platform	1
Other	3

2a. If you selected Other, please specify:

NGO promoting Integrated Farm Management
Undergraduate Researcher
PhD student studying integrating trees into pastures for biodiversity

3. How would you describe what you are taking part in as part of agroecological or regenerative agriculture research? Please tick all that apply.

Option	Count
I am part of a Living Lab	4
I am a demonstration farm or monitor farm	4
I am part of an agroecological research network	7
I am part of a farm cluster/network	8
I am part of a research platform	3
Other	5

3a. If you selected Other, please specify:

This is a personal initiative
I rent out plots to organic growers and develop robotics for horticulture
My organisation hosts a network of demo farms
Conducting primary research on farms
Just an agroecological farmer

Organisational details

This part of the questionnaire will focus on the details of the research initiative you are part of.

4. Which organisation(s) host/coordinate the research initiative?

Option	Count
Agricultural college	3
Agrii	0
AHDB (Agriculture and Horticulture Development Board)	1
Environment Agency	0
Farming Connect	0
Food, Farming and Countryside Commission	0
FWAG (Farming and Wildlife Advisory Group)	2
Game and Wildlife Conservation Trust	0
Innovative Farmers	4
Landworkers' Alliance	0
LEAF (Linking Environment and Farming)	1
Nature Friendly Farmer Network	1
NFU (National Farmers Union)	1
NIAB (National Institute of Agricultural Botany)	0
Organic Research Centre	2
Pasture for Life	2
RSPB (Royal society for the Protection of Birds)	3
Soil Association	4
UK Soils Living Labs	0
UKCEH (UK Centre for Ecology and Hydrology)	1
University	3
Other	7

4a. If you selected Other, please specify

None
Just me
Wyre Rivers Trust
RRG Solutions Mexico
NatureScot, Cairngorms National Park Authority, PlantLife Scotland, SAC Consulting, and independent agents

5. If your research initiative has an official title and you are happy to provide it please let us know what it is here, please include a link to any project website if possible.

SEEGSLIP
www.digitalagritech.com not much on site yet I only took it over on 1/12/22 and robot is being built now.
UK Centre for Ecology & Hydrology
Strathspey Wetlands and Waders Initiative
We have various research projects https://leaf.eco/about-leaf/working-in- partnership

5a. I would prefer to remain anonymous

Option	Count
Yes	7
No	13

6. How many farms does your research initiative operate over?

Option	Count
Single farm	6
Multiple farm (2-5)	2
Multiple farm (6-10)	4
Multiple farm (11-20)	3
Multiple farm (21-50)	1
Large number of multiple farms (50-100)	2
Large number of multiple farms over 100	0
Not known	2
Other	1

6a. If you selected Other, please specify:

Different research projects involve differing farm numbers
Hopefully 15 farms but sites have not been found yet.

7. What geographical area does your research initiative operate over?

Option	Count
England - South East	3
England - South West	5
England - East Anglia	1
England - Midlands	4
England -Yorkshire & Humberside	1
England - North East	2
England - North West	4
Scotland - Aberdeen and North East	3
Scotland - Highland and Islands	4
Scotland - Tayside, Central and Fife	2
Scotland - Edinburgh and Lothians	3
Scotland - Glasgow and Strathclyde	0
Scotland - Scotland South	2
Wales - North	0
Wales - Mid	0
Wales - South	0
Nationally all of UK	0
Nationally - all of England	1
Nationally - all of Scotland	1
Nationally - all of Wales	0
Nationally - all of Northern Ireland	0
Internationally outside UK (Europe)	0
Internationally outside UK (Rest of the world)	3
Other	1

7a. If you selected Other, please specify:

We liaise with researchers in Canada, USA, Sweden, Denmark, Australia and New Zealand, as well as the UK.

Farming details

8. Which of the following enterprise types do you have on your farms within the research initiative? Please tick all that apply.

Option	Count
Cereals	13
Potatoes	3
Sugar beet	1
Other root crops	3
Fruit	3
Oilseed rape	6
Other oilseeds	2
Vegetables	4
Pulses	4
Beef	15
Dairy	6
Sheep	14
Pigs	4
Poultry	2
Forestry	2
Agroforestry	8
Renewables	1
Other	2

8a. If you selected Other, please specify:

Winter wheat, grass/hay
Maize
Research has not been finalised yet but will most likely be livestock sheep farming

Agro-ecological or regenerative practices

9. Which agroecological or regenerative practices are applied? Please tick all that apply.

Option	Count
Create habitats for beneficial species (e.g. pollinators, natural enemies of crop pests) at field edge (e.g. flower-rich margins)	13
Create natural habitats for beneficial species in field (e.g. beetle banks, in-field strips)	14
Encourage natural pest control	11
Focus on localism and/or regionality	4
Focus on small scale systems	8
Incorporate perennials and trees (including agroforestry)	9
Integrate livestock into arable farming systems	5
Protect/cover the soil	11
Reduce tillage (or no-, minimal-, conservation-)	13
Rely on farm labour, including for local knowledge	7
Undersow with clover or use permaculture of clover	5
Use bio-pesticides	2
Use bio-stimulants	3
Use compost, mulch, green manure, or crop residues	9
Use cover crops	13
Use crop plant diversity (including intercropping)	9
Use digestate (from sewage, biogas, food waste) to replace inorganic fertiliser	3
Use diverse crop rotations, including temporary grass/herbal leys	10
Use ecological or natural principles or systems	10
Use microbial stimulations	3
Use no or low external inputs; maximize on-farm inputs	7
Use no synthetic fertilizers	9
Use no synthetic pesticides	6
Use organic fertilizers	7
Use organic methods to meet certification standards	4
Use sewage sludge/cake	0
Other	1

9a. If you selected Other, please specify:

Rotational grazing, organic soil building, water conservation

9b. If you would like to add any further details about your practices please feel free to do so here:

Rotational grazing - or 'mob' grazing
This is a network of over around 70 farms with diverse management practices. The one thing they have in common is creating and maintaining good habitat for breeding waders in the area, with the support and encouragement of SWWI
The focus is on intercropping of arable crops for grain, forage or anaerobic digestion
Looking specifically at how scattered trees impact biodiversity vs set aside land for woodland
Use high animal welfare to enhance health, productivity, resource efficiency and business resilience.

9c. How long have agroecological or regenerative practices been applied?

Option	Count
Less than 1 year	3
1-2 years	4
3-5 years	3
6-10 years	1
11-20 years	1
More than 20 years	3
Varies between farms in network	4
Not known	2
Other	0

9d. If you selected Other, please specify:
No responses

10. What are the target outcomes for these practices? Please tick all the apply.

Option	Count
To create a circular system and/or reduce waste	9
To improve animal welfare	7
To improve crop resilience to climate change	11
To improve ecosystem health (including ecosystem services)	18
To improve food access and/or food security	8
To improve food nutritional quality and/or human health	9
To improve food safety	3
To improve integrated pest management	9
To improve soil health (e.g., structure, soil organic matter, fertility)	15
To improve the social and/or economic wellbeing of communities	11
To improve water health (e.g., hydrology, storage, reduce pollution)	11
To increase biodiversity	18
To increase carbon sequestration	14
To increase crop health and/or resilience to disease	9
To increase farm profitability	12
To maintain or improve farm productivity	13
To maintain or increase yields	8
To reduce greenhouse gas emissions	8
Unknown	0
Other	1

10a. If you selected Other, please specify:

Showing 1 response
To provide fresh produce for food banks which are mostly full of out of code processed products.

10b. If you would like to add any additional thoughts about your target outcomes please feel free to do so here:

It is early days but we are building collective actions.
The main aim is to maintain and enhance breeding wader populations in the area without negatively impacting on farm productivity or profitability.
To increase business resilience and public support.

11. Who contributed towards the design of the research initiative? Please tick all that apply.

Option	Count
Agronomists	6
Ecological consultants	8
Farmer group / network	12
Funder	3
Individual farmer	10
Non-government organisations	7
Researchers	9
Other	1

11a. If you selected Other, please specify:

Showing 1 response
In process, some already practicing many not.

12. If you would like to tell us anything more about your research initiative please feel free to do that here:

Trying to develop weeding robotics as a service to growers and allotment holders
Please see: https://assist.ceh.ac.uk/hillesden
The SWWI was set up in 2009 to safeguard farm wader and wetland habitats and the future of the nationally important wader population in Badenoch and Strathspey, which is the largest of its kind in mainland Britain.
Our cow-with-calf project takes the concept of an efficient, nature-based food system to another level. From soil and plants through to the ruminant and the people who work here and their contribution to a truly holistic, sustainable food system.

Data collection

13. Are data on the impacts of your regenerative or agroecological practices being collected or have they been collected in the past?

Option	Count
Yes	13
No	8

13a. If you answer No - please could you give an indication if you would be interested in data collection in the future?

Option	Count
Yes, if additional funding was available	2
Yes, if research support and knowledge was available	2
Yes, if technology was available, e.g. mobile phone apps	0
Yes, if other things were available (please indicate below)	2
No	1
Other	1

13a.i. Please provide more information here if you selected: Yes, if other things were available.

We are probably too small in scale and not attached to any initiatives
Crop yields, crop management inputs, birds, moths, small mammals, invertebrates, beneficials, pollinators, moths, butterflies, plants, pests, soil carbon
Please see website for various reports from our projects
Data collection is fine as long as it doesn't impact negatively on the workings of the farm, and compensates for the time and resources it takes us to supply the information

13a.ii. If you selected Other, please specify:

Showing 1 response
data will be collected in years 2&3 of PhD

14. What kind of data are you collecting? Please tick all that apply.

Option	Count
Yield	7
Economic value	5
Biodiversity	11
Area of habitat	5
Habitat quality	4
Crop pests and disease	4
Soil health	8
Carbon storage or sequestration	8
Quality assurance	0
Water quality	4
Wellbeing	2
Impact	1
Engagement	1
Attitudes	3
Other	1

14a. If you selected Other, please specify:

Showing 1 response
Breeding wader population, density and productivity changes in response to management works

15. Who is carrying out data collection? Please tick all that apply.

Option	Count
Farmers	6
Student	2
College/University academic	5
Independent research organisation	5
Consultant	2
Volunteers	2
Automated machinery/apps	1
Other	1

15a. If you selected Other, please specify:

Showing all 2 responses
Wyre Rivers Trust staff
We collect the data, but it is inputted by farmers

15b. Please tell us a little about how data are collected? The approaches used e.g. transect walks for butterflies, soil core for soil health, yield mapping combine etc.

Leaf tissue Yield Biomass Disease % Soil core
Questionnaires, social science interviews, quadrats (CS style), soil cores
Soil surveys assessing multiple biological, chemical and physical parameters. Then baselined and relationships between these measures and soil health modelled for soil types specific to the upper Wyre catchment
Please see: https://assist.ceh.ac.uk/hillesden Precision yield mapping, transect walks and timed observations for pollinators and butterflies, moth traps, bird transects (breeding and winter use), longworth trapping for small mammals, quadrats for plants, standard soil cores for soil carbon
RSPB coordinates a network of staff and volunteers from organisations involved with the project to survey waders across all participating farms every 5 years, following a modified O'Brien and Smith methodology of three survey visits per farm. The first survey was undertaken in 2000. Some sites are also surveyed between these main surveys to collect data on the impacts of management work for waders.

16. How long have data be collected for?

Option	Count
Less than 1 year	5
1-2 years	2
3-5 years	3
5-10 years	0
11-20 years	2
More than 20 years	1

17. What is the frequency of data collection?

Option	Count
Ad hoc - as and when it is possible	4
Once	1
Monthly	1
Yearly	5
Biennially	0
Other	2

18. At what scale are data collected? Please tick all that apply.

Option	Count
Individual plot (within a field)	7
Field	9
Whole Farm	6
Landscape	2
Regional	0
Other	0

18a. If you selected Other, please specify: No responses

19. Are data publicly available?

Option	Count

Yes - available for free	4
Yes - available with a license/for a price	0
Not yet, but it is intended to publish or make them available	7
No, and unlikely to become available	0
Other	2

19a. If you selected Other, please specify:

Data are publicly available in a reduced format, i.e. for the whole area surveyed, rather than on a farm-by-farm basis to comply with GDPR and farmer wishes. Farmers are given survey data for their own farm.
We create supplier only reports and a publicly available report on a regular basis

19b. If there are barriers you have experienced in making your data publicly available please let us know here:

GDPR issues relating to individual farmers and their locations
Just the time and effort to collect data, collate into a standardised format and quality check it before making public

Dissemination of results

20. Have you published any results from your research initiative?

Option	Count
Yes - the results are free to access for everyone	5
Yes - the results are published internally within the project	0
Yes - the results are published in Scientific journals/literature	1
Not yet (but it is intended to publish)	11
No, they are not going to be published	3
Other	1

20a. If you selected Other, please specify:

Showing 1 response
Results are published in a cut-back format, with overall numbers for the project area, not on a farm-by-farm basis

20b. If you have experienced barriers to publishing your results please let us know what they were here:

Some data still to be published. Social science and questionnaire data yet to be published.
Non institutional authors are not encouraged by modern editorial software - e.g. Springer want 5 referees nominated by the author Social media a better vehicle for impact than academic journals.
Time, and a credible, independent partner.

Knowledge exchange

21. What form of communication is used across participants and project partners? Please tick all that apply.

Option	Count
Email	14
Face to face meetings	19
Online forums (member only)	2
Online forums (open)	1
Phone	5
Project website	4
Social media (member only)	5
Social media (open)	8
Video/online meetings	7
Other	3

22. What type of knowledge exchange or public engagement events are held?

Option	Count
Demonstration days / farm visits	14
Educational events (e.g. for schoolchildren)	3
Public events (e.g. Open farm days)	9
Talks	11
Webinar	10
None	3
Other	1

23. Who are the people you want to engage with most at these events?

Option	Count
Farmers/land managers with good experience of agroecology/regenerative agriculture	17
Farmers/land managers with little experience of agroecology/regenerative agriculture	16
New audience of farmers/land managers with no previous experience in agroecology or regenerative agriculture	16
Researchers	7
NGO community	6
Volunteers	2
General public	5
Other	4

23a. If you selected Other, please specify:

Policy makers, Defra, Natural England.
All farmers in the project area who are interested in wader conservation and willing to get involved with the project.
Policy people.
Other animal and landowners and graziers.

Funding

24. Do you receive external funding for your research initiative?

Option	Count
Yes	15
No	6

25. Please give an indication of the type of funding you have received?

Option	Count
We fund ourselves	6
Farming industry	2
UK Government - Defra	2
UK Research councils	4
Devolved Government	2
International funding - EU	4
International funding - rest of the world	0
National Lottery	1
Charity/Non-Government Organisation	9
Commercial enterprise/business	3
Other	1

25a. If you selected Other, please specify:

Showing 1 response
Friends and family

The future

26. What aspirations do you have for your research initiative looking forward? Please tick all that apply.

Option	Count
We will develop and grow, incorporating more farms	13
We will develop and grow, incorporating more researchers	7
We will maintain our current focus to consolidate knowledge and experience	9
We will develop within our existing network as guided by our members	5
We aim to strengthen our knowledge exchange	12
We are looking for or applying for funding to continue research initiative	8
This particular project only operates for a short time so is due to close.	2
Other	0

26a. If you selected Other, please specify:
No responses.

27. Please do expand on your aspirations for your research initiative if desired.

But, I am retaining links with the PFLA research group and continuing to look for possible future work
InnovateUK/Defra Future Farming looks interesting
Please see: https://www.ceh.ac.uk/our-science/projects/agzero
To provide evidence that agroecological practices support social and economic farming objectives as well as environmental objectives
The cow-with-calf, agroecological farming model could be critical for the survival of small to medium sized dairy herds going forward, and enable ruminant-based meat and dairy to be an integral part of an efficient yet compassionate food system fit for the future.

28. What would help you achieve these aspirations and how important are they in reaching your goals?
Please don't select more than 1 answer per row

	Very important	Fairly important	Important	Slightly important	Not at all important	No opinion
Additional funding (targeted)	12	4	2	3	0	0
Additional funding (unrestricted)	8	4	3	5	0	0
Improved communication tools	3	5	6	3	4	0
Improved connections with farmers and landowners	9	2	7	1	1	0
Improved infrastructure	3	3	5	5	2	1
Improved monitoring tools, e.g. mobile apps	3	4	6	4	4	0
Improved skills and information on knowledge exchange	8	3	6	2	2	0
Improved skills and knowledge on data collection	7	8	3	1	2	0
Researcher network provision/connections	7	9	2	2	1	0
Training and capacity building	6	10	2	2	1	0
Other	1	0	0	0	0	0

28a. If you would like to, please feel free to provide more details on what would help you achieve your research initiative aspirations here.

Recognise that innovation is driven by people outside traditional research institutions and agriculture. Academic research and ag training is detached from reality except on a couple of sites Lincoln & Harper.
We are seeking an in-depth, independent assessment of the environmental, social, welfare and financial outcomes of this food system.
Time for data collection is always the challenge often because it interferes with harvest or other urgent farm business activity.

Utilising your experience and knowledge from the initiative you work on we would be extremely grateful if you had time to complete this next free text section.

29. What do you see as the current research gaps and what should the priorities be for research on agroecology / regenerative agriculture over the next five years?

Refined understanding of impacts of regenerative practices, that incorporate the variety of contexts where they are most likely to have a positive impact within a farming system - developed based both on farm type, soil type, farmer type, alongside knowledge and time input requirements to achieve effective outcomes.
Openness and transparency in government policy and direction.
I feel we have lots of technical knowledge, it is the barriers to implementation we need to overcome.
We need to transform agriculture away from where we are to a totally different model. It's a big leap which won't happen in a hurry, farmers need to know that they can make a living producing food in a new way. We haven't invested in agro-ecological fieldscale approaches to production so we need to work with farmers to discover how this is possible. The social structure of farming also needs to change, more people on the land, smaller mixed farms producing livestock cereals and vegetables. How do we move to this model when we have gone so far in segregating production systems and minimising the numbers of people on land. These are huge integrated research challenges.
Provide evidence that demonstrates that a meatless society is not the answer!
InnovateUK setting up project areas already 5 years behind industry which is lurching into the valley of disillusionment with plant-based foods. Focus on how to upskill existing growers and systems. Shut down anything reliant on chemical inventions, work on how to protect soils and crops from extremes of weather. Practical management things not magic bullets.
Closing nutrient cycles. Restoring soil functions. The role of subsoils in landscape processes e.g. water storage
Quality control of biological amendments, optimal species arrangements, tools for large scale successional agroforestry
Incorporating farmers of all scales and practices to contribute to conversations about transition, management, solutions and funding.
A systems approach - understanding how different management actions interact to affect the agro-ecosystem; Consistent and accurate measurement of greenhouse gases, and soil carbon stocks and condition; Socio-economic factors - what is the sentiment around regen agr and what are the barrier to uptake; The long-term view - need funding to monitor the impacts of farm practices in the long term (over full rotations), need farmers to be consistent with management during the study; Innovations - need for experimentation and demonstration of new regen ag innovations to achieve net zero - e.g. undersowing, intercropping, addition of biochar

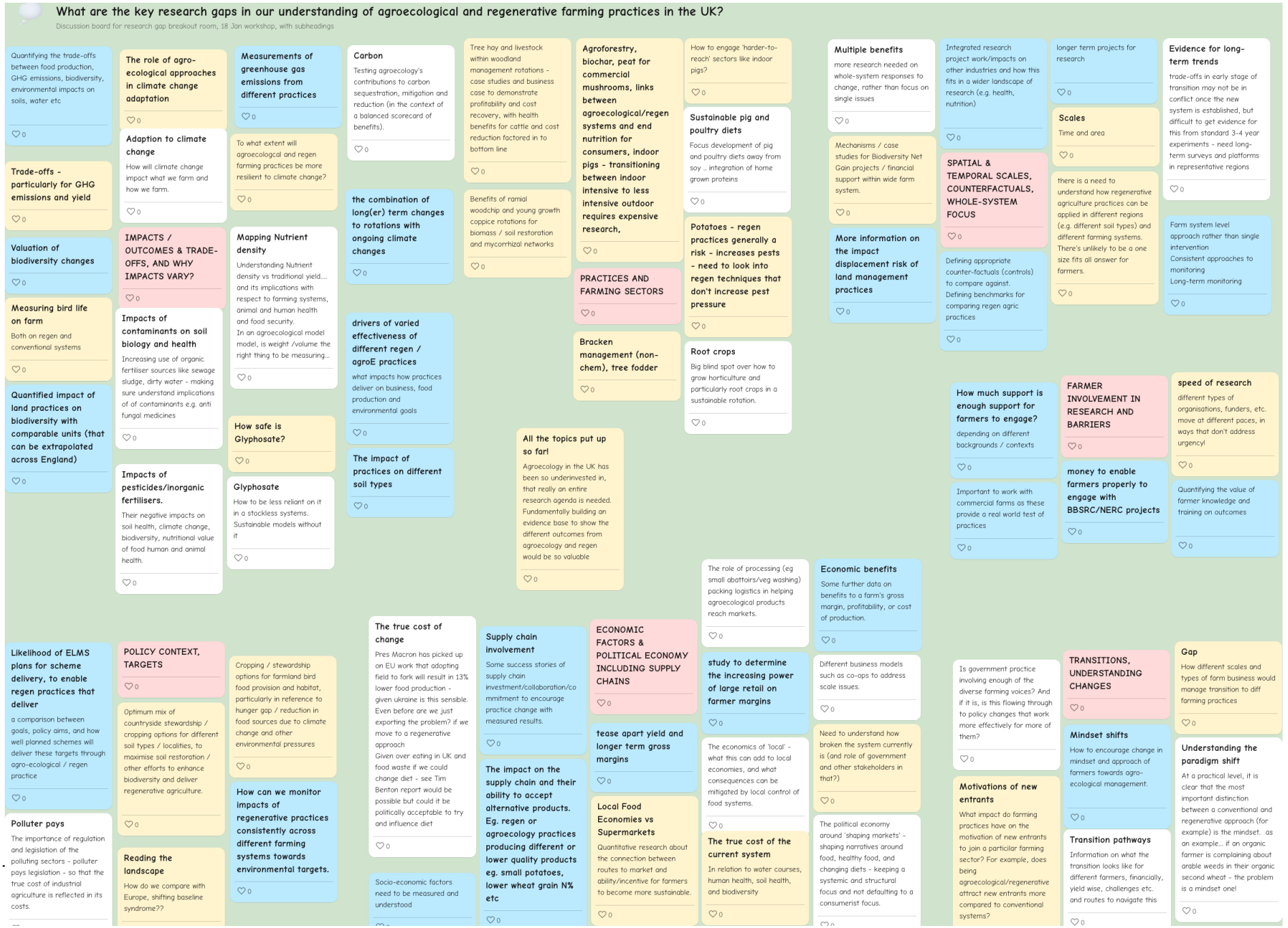
How agroecology in particular will impact on our threatened populations of breeding waders, and where this will leave the project if agroecology becomes more widespread. What are the best agri-environment options to maintain and enhance breeding wader populations on farmland - what works and what doesn't? How can this be improved for future schemes? How can farmers continue to produce high enough yields to maintain profitability whilst also leaving space for nature - what is the best way forward.
Economics
To understand how land managers want to engage with research - Living Labs might only work for some parts of the farming community, and other mechanisms might be needed to facilitate peer-to-peer or researcher-peer knowledge exchange
Financial resilience of Regenerative Agriculture as an alternative to industrial high input agriculture
Evidence on outcomes for food production, biodiversity and climate change mitigation/adaptation.
It is widely believed and reported that high welfare, agroecological farming will make food dearer. Our evidence is that this is not necessarily correct. The closer our system has come to a closed loop, the lower the cost per unit of output has come. Indeed the recent spike in commodity prices has highlighted the fragility of the high input model. The higher retail cost of high ESG products is much more a reflection of the higher unit cost of getting the products to the customer. Getting back to the question, the success of our counter-intuitive model has hinged on our, eventual, better understanding of natural processes and how to manage them. That includes microbial processes from the soil right through to the food end-product and its impact on human health and wellbeing.
100% pasture fed systems Bale grazing and overwintering systems
Hands on experience increasing knowledge transfer. We are looking to increase to knowledge of plant bacterium and fungal biota, with composting to enhance soil microbiology, fertility and yield in arable, grassland and local sustainable grazing environments.
research into resilience and yield of multicropping complex production systems such as agroforestry

Final page

Thanks very much on behalf of UKCEH for your time in completing this survey on agroecological and regenerative farming research initiatives. At the end of our research project (2023), the results from this survey will be published as part of the final project reporting and available through: http://randd.defra.gov.uk/

If you would like any further information about the survey or the wider research project, please contact Morag McCracken (memcc@ceh.ac.uk).

C. Workshop – research gaps full discussion board



D. Workshop – infrastructure and skills full discussion board