

Rapid Evidence Assessment to Map UK crop science research with a
Regenerative Agriculture focus

D1: Database of information sources and key research findings/knowledge gaps



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Background

In March 2023 the Sainsbury's Family Charitable Trusts (SFCT) and members of the Sainsbury's family organised a meeting in March 2023 to bring together scientists from the Sainsbury Laboratory Cambridge, The Crop Science Centre, the Organic Research Centre (ORC), Rothamsted Research, the Sainsbury Lab Norwich, and Nick Padwick (farm manager and advisor) Ken Hill Farms & Estate. The meeting aimed to discuss plant science, soil science, research, and the future of agriculture. Some of the background information and questions discussed on the day are included in Annex 1.

One key outcome from the March 2023 meeting was the decision to run a conference (The Future of UK Agriculture: Plant Science, Soil Science and Regenerative Farming) in March 2024. Elizabeth Stockdale (Head of Farming Systems Research, NIAB) suggested (in a subsequent meeting) that a document summarising the current status of regenerative agriculture research in the UK including mapping of key stakeholders and identification of knowledge gaps, would serve as a useful briefing document for the conference. The ORC, NIAB and AgriTechE were commissioned to conduct this piece of work. This report is the first deliverable for the "Rapid Evidence Assessment to Map UK crop science research with a Regenerative Agriculture focus" project funded by a group of the (SFCT).

The key objective of this piece of work was to build a database of people, organisations, projects and resources to use for the more in-depth knowledge gap analysis to be conducted in the next phase of the project.

The evolution of regenerative agriculture

"Regenerative agriculture" or "regenerative farming" are relatively new terms for systems of farming that encompass practices including no-till (or direct drilling), cover cropping, diversified rotations and the integration of livestock into farming systems (Magistrali et al. 2022). Popularised in the UK by proponents such as Gabe Brown (author of "Dirt to Soil: One Family's Journey into Regenerative Agriculture", published in 2018) and through the Netflix documentary "Kiss the Ground" (2020), regenerative agriculture (commonly referred to as "regen ag") has rapidly grown into a food and farming movement that has captured the imagination of farmers, consumers, food businesses and policy makers around the world. In the UK, [Groundswell](#) has played an important role in helping to build the movement. Groundswell is a regenerative farming event that brings together farmers, inspiring speakers, the agricultural input sector, knowledge exchange groups and policy makers to promote dialogue through open talks, forums and discussions. Perhaps

because the emergence of regenerative agriculture has coincided with the revolution in information exchange facilitated by the internet, it has spread organically, with limited support or intervention from traditional knowledge exchange routes (e.g. extension services like the AHDB in the UK or the USDA in the United States). Platforms like YouTube and Twitter have provided quick and easy ways for messages to be conveyed directly from regen ag practitioners to wide audiences.

In the peer-reviewed, academic literature, regenerative agriculture as a term appears just once in the Web of Science search prior to 1990 and only twice in articles published in the 1990s (see details of the literature search in Annex 2 Search strategy and outcomes - regenerative agriculture in the UK). The first time it appears in a form similar to the commonly understood definition of the term, with direct reference to soil health, is in a conference paper published in the journal Applied Soil Ecology in 2000, that argues the need for a focus on soil health research for sustainable food production from relatively less land (Sherwood and Uphoff 2000). This echoes the calls for “sustainable intensification” as described by Jules Pretty in various publications (Pretty and Barucha 2014). Sustainable

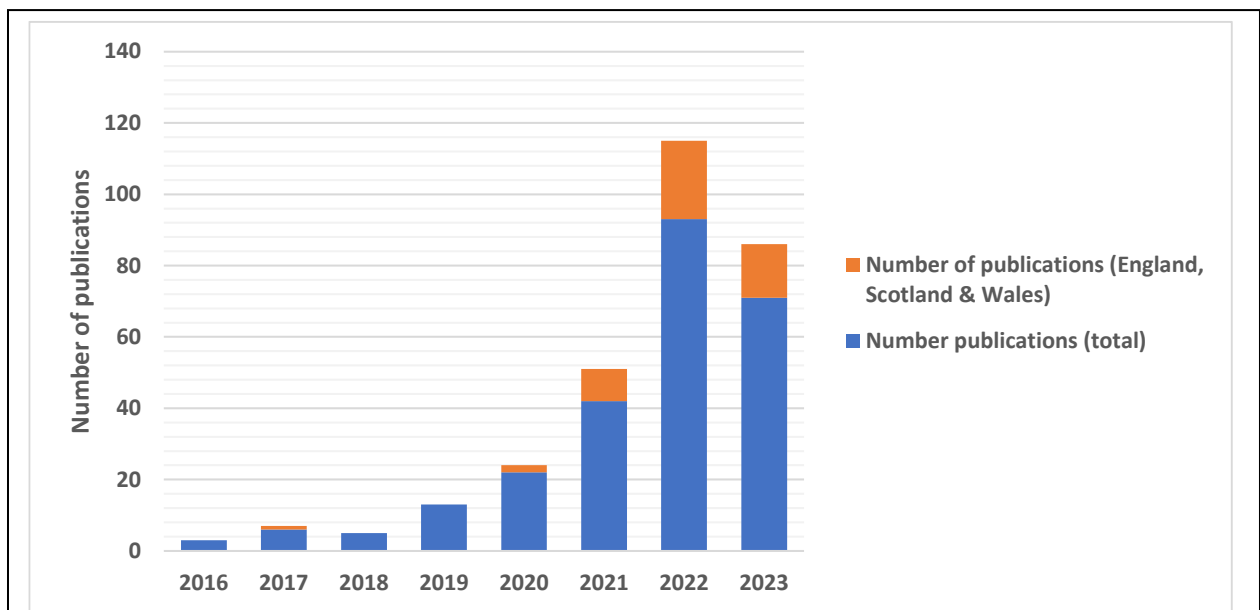


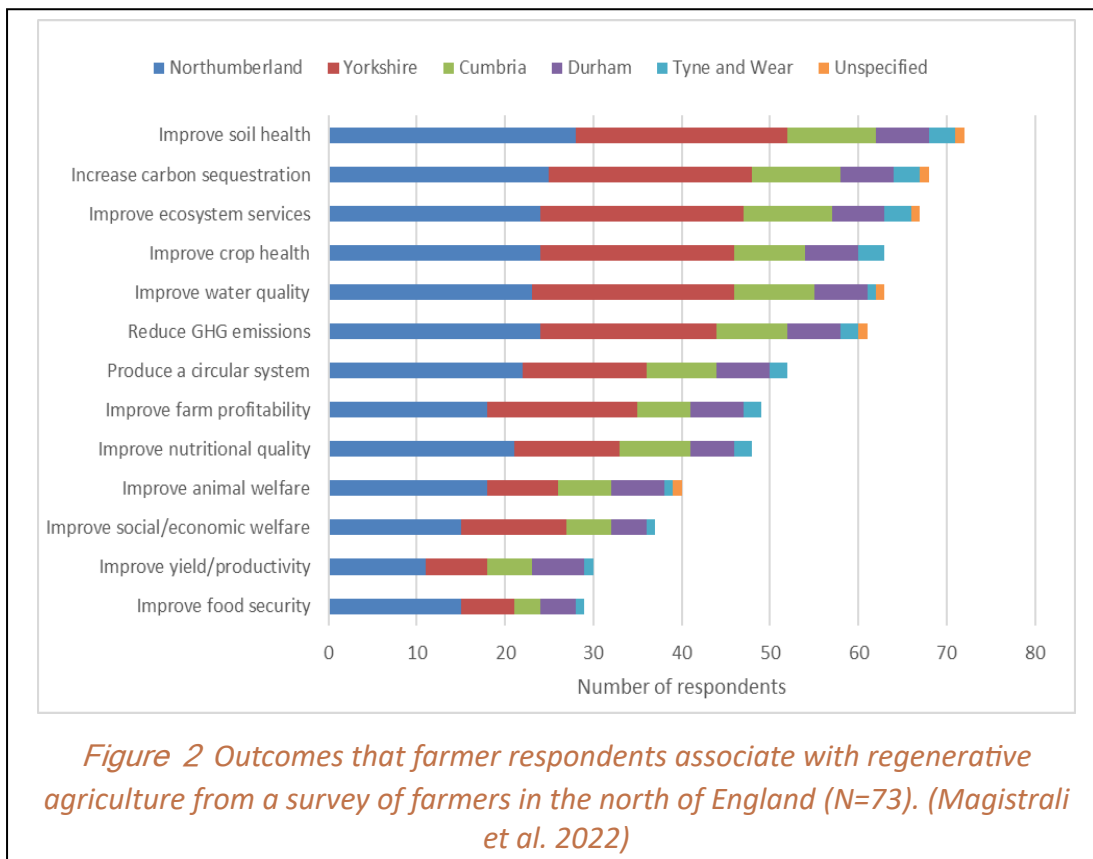
Figure 1 Total number of publications using the term “regenerative agriculture” or “regenerative farming” globally and number from England or Wales since 2010. Based on a search on Web of Science, December 2023.

intensification of production on agricultural land can only be assured if it is done in a way that preserves soil health, e.g. through regenerative farming practices. In the 2010’s regenerative agriculture was taken up by farmers and researchers as a climate mitigating strategy through the perceived impacts of regen ag on soil carbon stocks (Ridinger 2016).

There has been a sharp increase in numbers of peer reviewed papers using the term “regenerative agriculture” or “regenerative farming” since the mid-2010’s. One hundred and fifteen papers were published on the topic globally in 2022; 22 of these were from England or Wales.

Farmer definitions of regenerative agriculture

A study for the AHDB in 2022 (Magistrali et al. 2022) drew on work by Newton et al. (2020) and explored farmer understanding of the meaning of regenerative



agriculture, using survey questions that defined the term either by a set of outcomes (Figure 3) or through a set of practices (Figure 3). Their study indicated that most farmers associated regen ag with improved soil health and carbon sequestration, as well as improved delivery of ecosystem services. Practices associated with regen ag included crop diversification and cover cropping, as well as minimum tillage and integration of livestock.

Approach

This phase of the rapid evidence assessment includes three activities that have taken place in parallel over the past month.

1. An excel database has been compiled covering: people, organisations, projects, evidence (e.g. reports, peer-reviewed publications, websites) and tools relevant

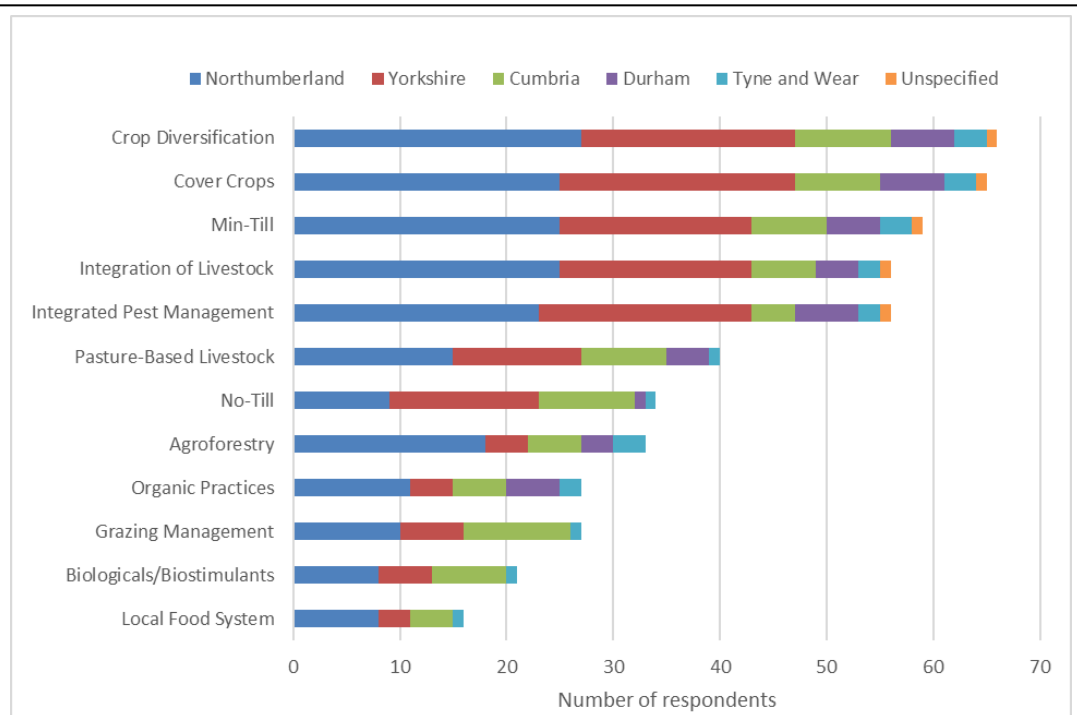


Figure 3 Agricultural practices farmer respondents associate with regenerative agriculture from a survey in the north of England (N=73). (Magistrali et al. 2022)

to regenerative agriculture in the UK. At this stage of the project, resources have been limited to those produced specifically for the UK and reports of projects and research findings on regen ag in the UK. This list has compiled through internet searches and word of mouth.

2. Key stakeholders from the “people” list in the database have been contacted for input into the knowledge gaps analysis; interviews are ongoing to provide an initial overview of the key themes and questions to be covered in the more detailed knowledge gap analysis to be delivered in February 2024.
3. Resources are being compiled and an initial review of key findings is underway along with a compilation of knowledge gaps reported in published. Internet resources have been identified through word of mouth and internet searches. Peer-reviewed papers were identified using a keyword search in Web of Science (as described above) using the search terms “regenerative agriculture” OR “regenerative farming” and restricting the “place” to the countries of the United Kingdom. A snowballing approach was also used by searching the citation lists of each paper for the term “regenerative”.

Results

Database of information sources

A excel file (not for public release) is available for review by the SFCT. The file is available on a sharepoint and can be updated by anyone with access. Email addresses are not included on the current version of the file as we have not yet obtained permission to share these. Once we have agreed on the final purpose of the database, we can pursue the appropriate permissions for the personal information stored in it.

Currently, the database includes:

Table 1 Numbers of people listed in each stakeholder category as of December 2023

Stakeholder category	Number (December 2023)
plant scientist	6
farmer	12
agronomist advisor	7
soil scientist	11
social scientist	1
input sector	2
executive role	15
ecologist	5
landowner	2
policy	1
unknown	2

1. Names of 64 people with connections to regenerative agriculture (stakeholders) categorised as shown in Table 1

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2. A set of resources to interrogate for identification of both current research findings and knowledge gaps including web-based studies and reports (Table 2) and 9 peer-reviewed papers which have been identified as relevant to this UK-focused rapid evidence assessment².

3. A list of 30 organisations involved in regenerative agriculture research or knowledge exchange in the UK. (Table 3).

¹ Note that email addresses have been removed from this version.

² The number of peer-reviewed papers may increase following more detailed review of the abstracts for the 49 references included in Annex 3 Full list of peer-reviewed publications from the UK using the term “regenerative agriculture” or “regenerative farming” since 2000

Table 2 Results of preliminary search for web-based evidence relevant to the rapid evidence assessment on regenerative agriculture in the UK

Title	Contact	Organisation	Type	Project	Website
Regenerative Agriculture - Understanding the opportunities and challenges	Geraint Perry	Association of Applied Biologists	conference proceeding		NA: Available on request from Geraint Parry geraint@aab.org.uk
Regenerative Agriculture: Context, Definitions and Drivers of Change	Danielle Semple	Farming Wildlife & Advisory Group Southwest (FWAGSW)	report	The GREAT Project	https://www.greatglos.co.uk/post/copy-of-great-report-1-regenerative-agriculture-context-definitions-and-drivers-of-change
Regenerative Agriculture: Key Stakeholders at Global, UK and County Level	Danielle Semple	Farming Wildlife & Advisory Group Southwest (FWAGSW)	report	The GREAT Project	https://www.greatglos.co.uk/post/regenerative-agriculture-key-stakeholders-at-global-uk-and-county-level
Identifying and implementing regenerative agriculture practices in challenging environments: experiences of farmers in the north of England	Amelia Magistrali	Newcastle University	report	Regenerative Agriculture in Challenging Environments	https://ahdb.org.uk/regenerative-agriculture-in-challenging-environments-farmer-experiences-in-the-north-of-england-ahdb-bbsrc-net-zero-initiative

Table 3 Projects relevant to the rapid evidence assessment on regenerative agriculture in the UK

Name	Lead Organisation	Contact	Website
The GREAT Project	Farming Wildlife & Advisory Group Southwest (FWAGSW)	Beatrix Oliver	Home The GREAT Project (greatglos.co.uk)
The Allerton Project	Game & Wildlife Conservation Trust	Alastair Leake	https://www.allertontrust.org.uk/
Fix Our Food	York University	Bob Doherty	https://fixourfood.org/
Scope of Regenerative Agriculture Practices in the UK – who is doing what and where?	Harper Adams	Samuel Eze	https://www.agrifood4netzero.net/2023-funded-scoping-studies.html
Quantifying the Potential for Regenerative Agriculture to Contribute to Net-Zero in the UK	University of Leeds	David Williams	https://www.agrifood4netzero.net/2023-funded-scoping-studies.html
Regenerative Agriculture and Net-Zero: mapping the evidence	Newcastle University	Richard Francksen	https://www.agrifood4netzero.net/2023-funded-scoping-studies.html
A systems-level investigation of the differences between conservation and conventional agricultural practices on soil health, carbon balance, and farm economics	Harper Adams	Simon Jeffries	NA
Project Lamport	Agrovista	Chris Martin	https://www.agrovista.co.uk/project-lamport-2020
H3 (Healthy Soil, Food, People)	Sheffield University	Peter Jackson	H3: Research on Healthy Soil, Healthy Food, Healthy People
Danone Regenerative Agriculture	Danone	NA	https://regenerative-agriculture.danone.com/

Table 3 (continued)

Name	Lead Organisation	Contact	Website
McCain Smart & Sustainable Farming Programme	McCain's	Elizabeth Stockdale	https://www.mccain.co.uk/sustainability/smart-sustainable-farming/
Diversify	James Hutton Institute	Ali Karley	https://plant-teams.org/#guidestoolboxes
Leguminose	Reading University	Tom Sizmur	https://www.leguminose.eu/the-project/
Cereal -legume intercropping LEGUMINOSAE field lab	Soil Association	Jerry Alford	https://innovativefarmers.org/field-labs/cereal-legume-intercropping-leguminose-field-lab/
Alternative methods for terminating cover crops	Soil Association	?	https://innovativefarmers.org/field-labs/alternative-methods-for-terminating-cover-crops/
Collective approach to improving soil health in the Westmorland Dales	Soil Association	Jane Lane	https://innovativefarmers.org/field-labs/soil-health-in-westmorland-dales/
Compost Teas In Arable Cropping - 2nd Trial	Soil Association	Jerry Alford	https://innovativefarmers.org/field-labs/compost-teas-in-arable-cropping-2nd-trial/
LIVSEEDING	Organic Research Centre	Charlotte Bickler	https://www.organicresearchcentre.com/our-research/research-project-library/liveseeding/
LiveWheat Farm-based organic variety trials network	Organic Research Centre	Charlotte Bickler	https://www.organicresearchcentre.com/our-research/research-project-library/farm-based-organic-variety-trials-network/
DiverIMPACTS - Diversification through Rotation, Intercropping, Multiple cropping, Promoted with Actors and value-Chains Towards Sustainability	Organic Research Centre	Charlotte Bickler	https://www.organicresearchcentre.com/our-research/research-project-library/diversification-through-rotation-intercropping-multiple-cropping-promoted-with-actors-and-value-chains-towards-sustainability/
Living Mulches - Reducing tillage & building soil health for regenerative farming	Organic Research Centre	Julia Cooper	https://www.organicresearchcentre.com/our-research/research-project-library/orc-living-mulches/

Key themes - where are the gaps?

Initial interviews with a farmer/innovator in regen ag from Yorkshire and a soil scientist working on regen ag research, helped to define the themes for the knowledge gap exploration from these two perspectives. The headings below are primarily based on those conversations and comments for each heading are based on rapid review of the resources listed in Table 2 as well as the peer-reviewed papers identified in the Web of Science search. Topics are grouped under the following themes: agronomy, variety development, soil, climate change/mitigation, system design, and economics.

Agronomy

Agronomy (defined as the farming practices required for successful establishment of a cash crop and maintenance of yield) was the most common theme that emerged in discussions and is also reflected in the literature.

Many people forget that **context** is the sixth principle of regenerative agriculture: this means that practices that work effectively in one environment and farming system, may not be easily transferable to a different environment. There are questions around **how do regen ag systems perform across different soil types and climates**. This was the focus of the Magistrali et al. (2022) study which explored the impact of environmental conditions in the north of England (particularly climate and soils) and how this may be impeding the uptake of regen ag in that region. In that study farmers expressed a desire for more regionally-specific guidance, particularly on cover crops that are suited to northern regions.

How can we include **root crops** in regen systems? The recent launch of McCain's Smart & Sustainable Farming programme (<https://www.mccain.co.uk/sustainability/smart-sustainable-farming/>) represents an acknowledgement from the industry that regenerative practices need to be implemented even for intensively managed crops like potatoes. There are still many questions about the resilience of soils managed regeneratively to high-disturbance production like potatoes and other root crops. Rotation design, the role of organic matter inputs and equipment all need to be explored to develop truly regenerative root cropping systems.

How to effectively implement **intercropping/bicropping/polycultures**³ in regen systems? Currently there is no guidance available on which crop combinations work

³ Defined as a cropping system in which more than one cash crop (usually two) are grown together and taken through to harvest.

best together, which varieties are most suited to intercropping, what are the best seeding rates, and how do fertiliser/nutrient needs differ for these systems? The H2020 DIVERSify project (<https://plant-teams.org/#guidestoolboxes>) coordinated by the James Hutton Institute, produced a wealth of information on intercropping strategies and a website with various toolboxes; this information could be revisited and built on to address some of these knowledge gaps and identify areas where further research is needed. Following on from DIVERSify, the LEGUMINOSE Horizon Europe project (2022-2026) aims to transform legume-cereal intercropping from a niche practice to a mainstream method. As part of the project, Reading University will be conducting field experiments to quantify reductions in N fertilisation resulting from use of legume-cereal intercrops; a key knowledge gap identified by farmers currently using these systems. A recent publication by Cusworth et al (2021) will provide further insight into the current state of knowledge on the potential of diversified, legume-based regenerative farming systems in the UK.

In common with the questions about intercropping, as farmers increasingly use **mixtures of varieties** (blends), there are questions about the best varieties to plant together and seeding rates for mixtures of varieties. The AHDB provides a variety blending tool online (<https://ahdb.org.uk/variety-blend-tool-for-winter-wheat>) based on “Recommended Lists (RL) data and parental diversity information to select three-way or four-way mixes for on-farm testing.” As yet, the Recommended List trials do not include varietal blends; something recognised as a gap by AHDB data analysts⁴. Some of the work that was conducted in the LiveWheat and LIVESEEDING projects run by Organic Research has included varietal blends as well as heterogenous material (e.g. plant populations).

Companion cropping is a type of intercropping where two species are established at the same time, but one of the two crops is later removed (usually with a herbicide) in the spring. Companion cropping is practised to promote soil health and biodiversity; although there is little evidence to verify these benefits. Examples of companion cropping currently used include peas or beans in wheat or barley or linseed with wheat or barley. There is a need for more information/guidance to farmers on the best combinations of crops for companion planting. Resistance to

⁴ “...One major limitation is the data is from single varieties grown individually in trial plots, and therefore it’s impossible for the mechanisms occurring in blends to be factored in, so the score is only indicative.” (<https://www.cpm-magazine.co.uk/technical/wheat-blends-blending-success/#r3z-addoor>)

pre-emergent herbicides is important for the success of these systems; more research is needed on this.

Living mulches are permanent understoreys, usually of a small-leaved white clover, that provide ground cover and N fixation within row crop production systems. Organic farmers are interested in using these systems to reduce their reliance on ploughing, thus making their systems more regenerative. Conventional farmers are also interested in developing living mulch systems as a way to reduce reliance on glyphosate. Some of the intercropping projects already mentioned (OSCAR, DIVERSify) included research on living mulch systems. Within their [Innovative Farmers](#) programme the Soil Association conducted on-farm trials using living mulches with both organic and conventional farmers in collaboration with the Organic Research Centre (2020-2022); this work is being carried on by the ORC in 2023 and 2024. Key questions emerging are related to establishment of the permanent cover, the best species and variety of clover to act as a cover, control of weeds within the cover, best row crop (wheat, barley etc) varieties to use in the system and how crop nutrient requirements need to be adjusted in living mulch systems.

There is a desire for regionally-specific information on the best **cover crop** species and mixtures to grow. Agricolgy provides a link to the “AgroDiversity Toolbox” which was an output of previous European-funded projects that focused on cover crops (e.g. OSCAR). This provides a wealth of resources on cover crops and living mulches. The recently released Cover Crops Guide ([About - Cover Crops \(covercropsguide.co.uk\)](#)) is an attempt to provide UK-specific information. It provides a selection tool that includes filters for winter hardiness that may begin to address these needs; but further robust trials are needed to confirm optimum species, mixtures and management for all regions of the UK. This should be coupled with field scale demonstrations to provide evidence and disseminate results (Magistrali et al. 2022). There are also questions around the management of cover crops: when and how is the best way to establish them? And how should they be terminated? A Soil Association Innovative Farmers project ([Alternative methods for terminating cover crops](#)) has explored this question.

Weed control, particularly black-grass, remains a concern for regen farmers. There is a lot of interest in alternative strategies to control this (and other) weeds. The role of soil microbial communities and the relevance of fungal:bacterial ratios,

recently popularised by soil advisors such as Nicole Masters⁵, in weed management needs to be explored. Allelopathy and its effects on weed competition also needs further investigation.

Insect control remains a challenge, particularly in the south of the country. Strategies to control Barley Yellow Dwarf Virus (BYDV) are needed; the impact of companion planting on the vector.

Variety development

Disease and insect tolerance this should remain a top priority in varietal development. Current **recommended list trials** may not be fit for purpose: there should be modifications made to select varieties suited to lower input systems, e.g. include reduced N, insecticide-free treatments. Blends of varieties should be tested to provide verification of the recommendations currently provided by AHDB. Some of this work has been done already by the Organic Research Centre in partnership with Organic Arable and funded by Defra in the past (e.g. LiveWheat) and more recently by Horizon Europe (LIVESEEDING); these projects have trialled modern and traditional varieties in organic farming systems and also explored the potential of heterogenous populations of wheat within organic and conventional farming systems. Measures of **quality** (not only protein) should be provided and where possible.

Varieties that are effective at scavenging nutrients and water and forming associations with beneficial soil microorganisms should be developed; the **root system** needs more attention.

Soil

A recent publication by Jaworski et al. (2023) provides an overview of sustainable soil management practices in the UK and relates them to regenerative agriculture principles. It shows that most farmers report that they are using sustainable soil management practices, even if they are not following the five principles of regenerative agriculture⁶. The study highlights the need to take into account the diversity and variety of sustainable soil management practices in future policy and research.

⁵ In articles like this one: <https://www.fwi.co.uk/arable/land-preparation/soils/new-zealanders-share-soil-fungi-knowledge-to-improve-crops>

⁶ In this study, they were listed as: minimize soil disturbance, increase crop diversity, keep the soil covered, keep living roots, increase soil organic matter (Jaworski et al. 2023)

In spite of the extensive work conducted by the AHDB in the past few years, and the development of the [Soil Health Scorecard](#), there is still a perception among researchers and farmers that better, more informative **indicators of soil health** need to be developed. There is a lack of clarity about what is the best “standard” indicator of soil health. In 2020 the Soil Association started a project on developing a “toolkit” of the most practical and useful indicators of soil health for northern upland farming (<https://innovativefarmers.org/field-labs/soil-health-in-westmorland-daales/>).

With growing interest in **soil biology**, particularly among farmers and agronomists who have completed training with [Dr Elaine’s Soil Foodweb School](#), more evidence and guidance is needed about how to interpret outcomes from studies of soil biology. Laboratories like Laverstock Park Farm offer measures of total bacteria and fungi, active bacteria and fungi, protozoans, nematodes, and mycorrhizal colonisations, while more in-depth DNA-based analyses are now also on offer (e.g. [fera’s Big Soil Community](#)). The challenge is now how to link the many available measures of soil biology with measurable change in soil health and function, and how to use outcomes of these tests to make decisions on soil management.

Biostimulants in parallel with the growing interest in soil biology, there has been a growth in interest from commercial companies and individuals in developing products that can modify the biology of the soil (e.g. to shift the community towards a more favourable fungal:bacterial ratio) or the leaf surface. The impact of biostimulants on soil and crop health is not yet well understood; there are questions around the efficacy of many products. There has been growing interest in production of compost teas, e.g. using methods such as those advocated by [Regeneration International](#). The Soil Association Innovative Farmers has recently supported a project testing compost teas in the field (<https://innovativefarmers.org/field-labs/compost-teas-in-arable-cropping-2nd-trial/>).

Mob grazing, while not directly linked to crop science and regen ag, is practiced by many regen farmers who are integrating livestock into their systems. In 2021 Defra commissioned ADAS and a group of other research institutions to conduct a study into the environmental and productivity benefits of mob grazing systems in the UK. The impacts particularly on soil health and soil carbon sequestration will be assessed in this project; results are not yet available.

Herbal leys arable regen farmers are exploring the use of ley phases, especially herbal leys (also being actively promoted by Defra in the new Sustainable Farming Incentive offer: SAM3: Herbal leys). Further evidence on the benefits of herbal leys

for soil health as well as impacts on the livestock that graze them, is needed. Of particular importance is the mixture of species and establishment methods; management including nutrient needs, are also not yet well understood. The recent papers by Jordon et al (2022c; 2023) will provide useful insights into this topic.

Climate change/mitigation

There is still insufficient evidence for the impact of regenerative farming systems on **GHG emissions** to support some of the claims being made by the industry. More measurements in the field are required to assess the effects of reduced tillage on nitrous oxide emissions. The emissions from legumes in the field and how the use of biostimulants affects emissions and GHG balances is also unclear. And the contentious issue of soil C sequestration; impacts of regen farming practices on levels of C in soils and how this affects net C balances at the ecosystem level are still not certain in the UK context. Recent publications by Jordon et al (2022a; 2022c) will provide useful evidence on this topic.

Along with potential positive impacts on carbon balances, regen ag may also improve **water relations**. But more evidence is needed on the impacts of adopting regenerative agriculture on resilience of soils and farming systems to floods and drought. Collins et al (2023) and Liu et al. (2023) provide insights into some of this in the UK context. Impacts on water quality should also be monitored, e.g. sediment loads in reservoirs and nutrient and pesticide runoff and leaching.

System design

Rotations diversification of crop rotations and the inclusion of cover crops with more spring cropping are all changes to arable cropping in the UK that are an outcome of the transition to regenerative agriculture practices. Designing complex rotations that take into account local pedoclimatic conditions is crucial to the success of RA. Effects of legumes in rotation on the system level N needs are still not well understood; modelling studies are needed to explore implications of changing the duration of legume phases and the sequence of crops on nutrient balances. Pest levels are also affected by rotational position (following a ley phase that has been sprayed with glyphosate directly with a cereal can result in serious pest problems; while counterintuitive, a bean crop can be a better choice).

Economics

Interestingly, although there are gaps in information relating to the economics of regen ag systems, perceived benefit was the top reason for taking up these practices for farmers surveyed in Cumbria in the Magistrali et al. (2022) study. Nonetheless, there is still a lack of easily accessible, documented impacts of

regenerative practices on yields and margins. With the large number of farmers taking up regen ag, there is potential for ongoing monitoring of costs and margins alongside characterisation of the system properties (e.g. location, size, crop rotation, practices used etc) to get a clearer understanding of the factors that contribute to a profitable regenerative farm.

Regenerative food systems

Projects like [FixOurFood](#) and [H3](#) both include regenerative agricultural methods within a wider study of strategies to radically transform the UK food system. They have highlighted the knock-on effects that changes in farming practice can have on the wider farming and food systems. As an example, the use of lower rates of N on wheat crops, while clearly better for the environment, can result in wheat of a lower protein content that is not suitable for bread making. This has implications for the structure of the farming sector since this lower protein wheat can be marketed as animal feed, meaning less is available for direct consumption by people. This simple example highlights the importance of considering the whole food system when studying regenerative farming practices.

Next steps

This document has provided a brief overview of the evidence available for review to identify knowledge gaps and future research needs for the regenerative agriculture sector. The next steps of this study will be to:

1. Meet with the Sainsbury's Family Trust funders for a review of progress and update on study objectives (Oxford Farming Conference).
2. Conduct a more detailed analysis of the evidence and knowledge gaps in each of the theme/topic areas listed above using reports, peer-reviewed information, websites and tools identified in this report.
3. Refine the knowledge gaps identified within the project team.
4. Run an online workshop with a selection of "experts" from the People database to prioritise the knowledge gaps.
5. Finalise the report on "Summary of key knowledge gaps, research needs and ways to address them"

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Annex 1 Summary of background information and topics covered at the Cambridge plant, soil and future of agriculture discussion, 10 March 2023

BACKGROUND

The starting premise

- We all want a resilient UK farming system that supports healthy soils and ecosystems which produce the crops needed for our well-being including affordable and nutritious food, textiles and tradable commodities.
- Our current farming systems are not enabling this. For most UK farms, farming is not profitable without subsidy, soil health and biodiversity is declining and made worse by climate change and our diets are making many of us sick. The National Food Strategy Plan considers how we can address problems in our food system and what this means for land use.
- We know already that scientific research and agricultural innovations are not readily taken up by the agricultural sector, that farmers are often resistant to change or trapped in systems reliant on agricultural inputs which are becoming unaffordable and worsening soil health and biodiversity.
- Market forces within the agrochemical (ag-chem) sector often seem at odds with nature. The idea of regenerative agriculture (regen-ag) and greater crop resilience via reduced inputs and healthy soils does not necessarily fit with many of the big ag-chem companies' business plans.
- Change is needed and soil and crop research have crucial roles in enabling this change.

DISCUSSION TOPICS

General

- How can we understand better relationships between a healthy crop, soil and the rhizosphere and how crops interact and impact on farm ecosystems and soil health in situ.
- What should our research goals be? Supporting a food system that makes us well, not sick and is resilient to global shocks? Helping restore nature and be resilient to climate change? To what extent is this different to the current focus and goals?

- How can we enable learning and exchange between researchers working in different fields and with different approaches (singular and holistic)? Where are the opportunities to codesign research programmes? Or, more immediately, to engage and consult researchers working with different approaches. Approaches and crossing disciplines
- Is it fair to say that there is a tendency in scientific research towards a singular focus and if so, does that create blind-spots when it comes to, for example, the complex influence of the rhizosphere and soil on crop resilience and plant disease resistance? How can we bridge that?
- What is the best way to understand the biological processes underlying regenerative farming practices? Can we protect crops from disease without using chemicals?
- Where do you see the intersection of regenerative farming and plant science?
- Can we find common ground between regenerative approaches to agricultural production and the use of modern genetic methods?
- How can combining approaches revolutionise agriculture in the face of the climate emergency and the need for healthy, affordable food?

Soil

- How can we improve approaches to soil science research to:
 - understand better the interplay between soil health, and crop health and resilience?
 - attract more government funding? o help inspire change in UK farming towards more sustainable practices through better evidence, improved understanding and simpler guidance?
- What is the best way to bring various stakeholders together to investigate something like soil that has so many variables?

Effecting change on the ground

- How do we support farming in the UK to adopt practices that can help it be more sustainable, resilient and produce healthy, affordable food?
- Is there an education piece e.g., modernising the teaching of agriculture in the UK, briefing policy-makers?
- What useful forums already exist that connect the various stakeholders seeking to inspire the change we need to make UK farming part of our climate solution?

Annex 2 Search strategy and outcomes - regenerative agriculture in the UK (20 December 2023; Web of Science)

Search terms	Number of articles
"regenerative agriculture" OR "regenerative farming"	309
Excluded three publications prior to 2000	306
AND ("England" OR "Scotland" OR "Wales")	49

Annex 3 Full list of peer-reviewed publications from the UK using the term “regenerative agriculture” or “regenerative farming” since 2000

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Annex 4 Audience survey template, OFC Partnership Event: NIAB Breakfast Event, Oxford Farming Conference, 4 January 2024

A rapid, real-time survey of audience perceptions will be conducted at the above session (Chaired by Elizabeth Stockdale) using an interactive system e.g. Google Forms or Slido. The following questions are proposed:

1. From the list below please select the top three topics that you think should be prioritised in regenerative agriculture research programmes in the future:
 - Performance of regen ag systems across a range of soils and climates in the UK
 - Development of regen ag systems for high disturbance crops like potatoes and carrots
 - Optimisation of species and variety mixes for intercropping
 - Nutrient management guidance for intercropping
 - Variety testing for mixtures/blends in wheat and barley
 - Testing of best cover crop mixtures for the full range of UK environments
 - The role of soil biology in weed management
 - Recommended list trials in regen systems, including low N and pesticide-free
 - Development of soil health indicators for regen ag systems
 - Screening of biostimulants for use in regen ag systems
 - Development of composting systems and compost teas for regen ag systems
 - Development of advice and guidance on herbal leys including establishment and nutrient management
 - Evidence on impacts of regen ag on GHG emissions and climate change
 - Evidence on impacts of regen ag on water cycle including flooding, drought and water quality
 - Research into optimal rotation design for regen ag systems
 - Documentation on the impacts of regen ag on farm net margins
 - Research on impacts of transitioning to regen ag on the food system and food security
2. Select the term below that best describes your primary occupation:
 - farmer
 - agronomist advisor
 - soil scientist

- social scientist
 - input sector
 - executive role
 - ecologist
 - landowner
 - policy
 - none of the above
3. Would you be willing to be contacted to complete a survey or interview to help us shape future programmes in regenerative agriculture research? If yes, please provide an email address below.