Regenerative Agriculture in Cropping Systems: Knowledge gaps, research needs and how to address them

Challenge 6 (of 6): Socio-economics

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Thank You

Introduction

Although the term regenerative agriculture was coined in the late 1980s, the term was not widely used in the agricultural or scientific community until the late 2000s. Since then the term 'regen ag' has become commonplace in UK agriculture. Although much emphasis has been placed on the adoption of key principles by farmers, this has not always been supported by scientific knowledge and understanding. This series of reports was commissioned to provide a quick overview of the state of knowledge and research activity on a number of topics important for the development of regenerative agriculture in the UK, with a particular emphasis on priorities for farmers. The goal was to prioritise research topics and identify where the current gaps in knowledge exist so that future funding can be targeted towards topics that have previously been insufficiently studied.

This report was produced as a result of a Rapid Evidence Assessment (REA). To conduct this REA a list of research priorities was drafted based on informal conversations with key stakeholders and reviews of prior research prioritisation exercises. In addition an online workshop with stakeholders (19 in total) was used to rank the priorities and discuss best approaches to conduct the research. This was followed by a detailed scoping study of ongoing and past projects in the UK which were mapped to the list of research priorities. In parallel, searches of published academic literature were conducted and a selection of papers on each topic were rapidly reviewed and synthesised.

The results were briefly presented at the Cambridge Future of Agriculture Conference (held in March 2024), which served as a unique platform for farmers, farmer organisation representatives, and scientists to openly discuss and shape future research needs; these are reflected in this report.

It is important to keep in mind that this study was not done in isolation. There have been several reviews on similar topics conducted in the past few years. These include the rapid evidence review by Albanito et al (2022) [1] that was commissioned by the Committee on Climate Change to assess the role of agroecological farming in the UK transition to Net Zero; the DEFRA-commissioned study on the impacts of agroecological compared to conventional farming systems published by Burgess et al (2023) [2]; and most recently, the assessment of farmer priorities for research conducted by the Agricultural Universities Council. Regenerative systems and carbon sequestration have been identified through that process as new priorities while soil health and crop breeding have persisted from previous assessments.

This project focused specifically on challenges relating to implementing regenerative agriculture in cropping systems, with a particular emphasis on soil health. This makes it slightly more focused than these other studies and the information gathered complements the outcomes of these three recent studies.

1. https://www.theccc.org.uk/publication/agroecology-a-rapid-evidence-review-university-of-aberdeen/

2. See all three reports from: Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems project SCF0321 for DEFRA. 20 February 2023

Key Findings

Detailed summaries of the outcomes of the survey and discussion during the workshop along with the knowledge gaps listed above, were synthesised into 6 challenges and 34 sub-challenges. Because of the diverse topics and range of study types identified in the peer-reviewed literature, a narrative synthesis approach was used to summarise the findings for each topic. This focussed on descriptive (rather than numerical) summaries of the findings highlighting themes where the research results appeared to converge or diverge.

The six challenge areas identified were:

1. Standardisation of regenerative agriculture
2. Advice and Guidance or "How to…"
3. Crop genetic resources
4. Soil health
5. Wider system considerations
6. Socio-economics

**This publication presents the findings of Challenge 6: Socioeconomics.
The findings of the other challenges can be found in the associated series of publications on the project page on www.organicresearchcentre.com.**

6.1 Impact (and the factors affecting it) of regenerative agriculture systems on farm livelihoods

There is a lack of hard data on the financial viability of regenerative agricultural practices across the spectrum of environments and cropping systems where they may be implemented in the UK. This has been identified as an area of uncertainty and a barrier to uptake of regen ag by respondents in surveys (see details in Section 6.2). It is reasonable to expect some reductions in individual crop yields when regenerative agriculture practices are introduced, based on peer-reviewed studies that have looked specifically at yield reductions from conservation agriculture/reduced tillage intensity. The study by Van den Putte et al. (2010) focused on northern Europe is most relevant to UK conditions. They used a meta-analysis approach to assess yield impacts of reduced and no-tillage on a range of crops. Yields of winter cereals were ~6% lower on average in the no-till systems. Anecdotally, farmers report lower yields with no-till practices, but they also report much lower costs for labour and fuel, which may compensate for the lower yields: this is a confirmed in general in a review by Kazimierczuk et al. (2023).

While yields may be lower for regenerative farmers (for some crops), there are a variety of ways that farmers can offset these losses in income. Organic farmers have benefited from premium pricing for their products for many years, and some regenerative farmers are also developing markets for their products on the basis that consumers recognise and value the "regenerative" brand. Most prominent of these brands is WildFarmed[3] which contracts farmers to produce grains according to their own regenerative standard that includes reductions in fertiliser and pesticide inputs as well as a preference for genetically diverse seeds and intercropping (living mulches and cereal/legumes) systems.

Regenerative farmers may access alternative income streams from emerging markets in carbon, biodiversity net gain and nutrient neutrality. Local groups like the Green Farm Collective[4] are adding value to their farming system through trading in biodiversity and

3. https://wildfarmed.com/
4. https://www.greenfarmcollective.com/

carbon markets. Regenerate Outcomes(5) works with Understanding Ag(6) to support their members in the transition to regenerative agriculture and access to income streams for the carbon and biodiversity benefits they deliver.

Defra's Sustainable Farming Incentive also provides financial benefits to farmers adopting a range of practices that are "regenerative" including the use of cover crops and multispecies leys and reductions in pesticide inputs.

Stacking of these various income streams can allow regenerative farmers to build financially viable businesses even if net output in conventional terms (e.g. yields of commodity crops/ha) is lower.

The landscape for funding regenerative agriculture through government and private schemes and premium product markets is rapidly changing. We are not aware of any studies which have objectively assessed the relative benefits of these routes to funding regenerative farming systems within the UK context.

Economic benefits continue to be a key factor influencing practice changes, as Sophie Gregory emphasised at the Future of Farming conference. More information on the economic impacts of adopting regenerative agriculture practices is necessary, and this could be accomplished through farmer clusters e.g. Groundswell Agronomy or AHDB's Monitor Farm approaches. This is a high-priority area for applied research and knowledge exchange.

5. https://www.regenerateoutcomes.co.uk/
6. https://understandingag.com/

6.2 Socioeconomic factors constraining uptake of regen ag/levers for change

There is an extensive body of academic and grey literature that discusses the factors influencing farmer behaviour change and uptake of novel farming practices. The nature of this topic dictates that most of these studies have a specific geographical focus; local cultural and social conditions (e.g. land tenure, education levels, access to financial resources, government policies) are key determinants of farmer behaviour and vary depending on the country and region. For this reason, we have focussed primarily on studies conducted in the UK. Studies with a regenerative/agroecological theme are most relevant, however, studies that consider changes in farmer behaviour linked to other farming systems/practices may also be relevant.

There have been various recent projects which have addressed the question of barriers and enablers to farmer uptake of regenerative and agroecological practices (Magistrali et al. 2022; Hurley et al. 2023). Magistrali et al. (2022) used workshops and surveys to understand how farmers in the north of England viewed regenerative agriculture and what factors determined the uptake of the practice. Farmers in Cumbria, primarily involved with livestock systems, highlighted economics and soil health as key determinants of their engagement with regen ag (Figure 1). Noting that the economic benefits were largely due to lower costs of production, rather than higher yields or product prices. This resonates with reasons why many

Figure 1 Example from a farmer workshop in Cumbria indicating primary reasons for taking up regenerative agriculture practices (Magistrali et al. 2022)
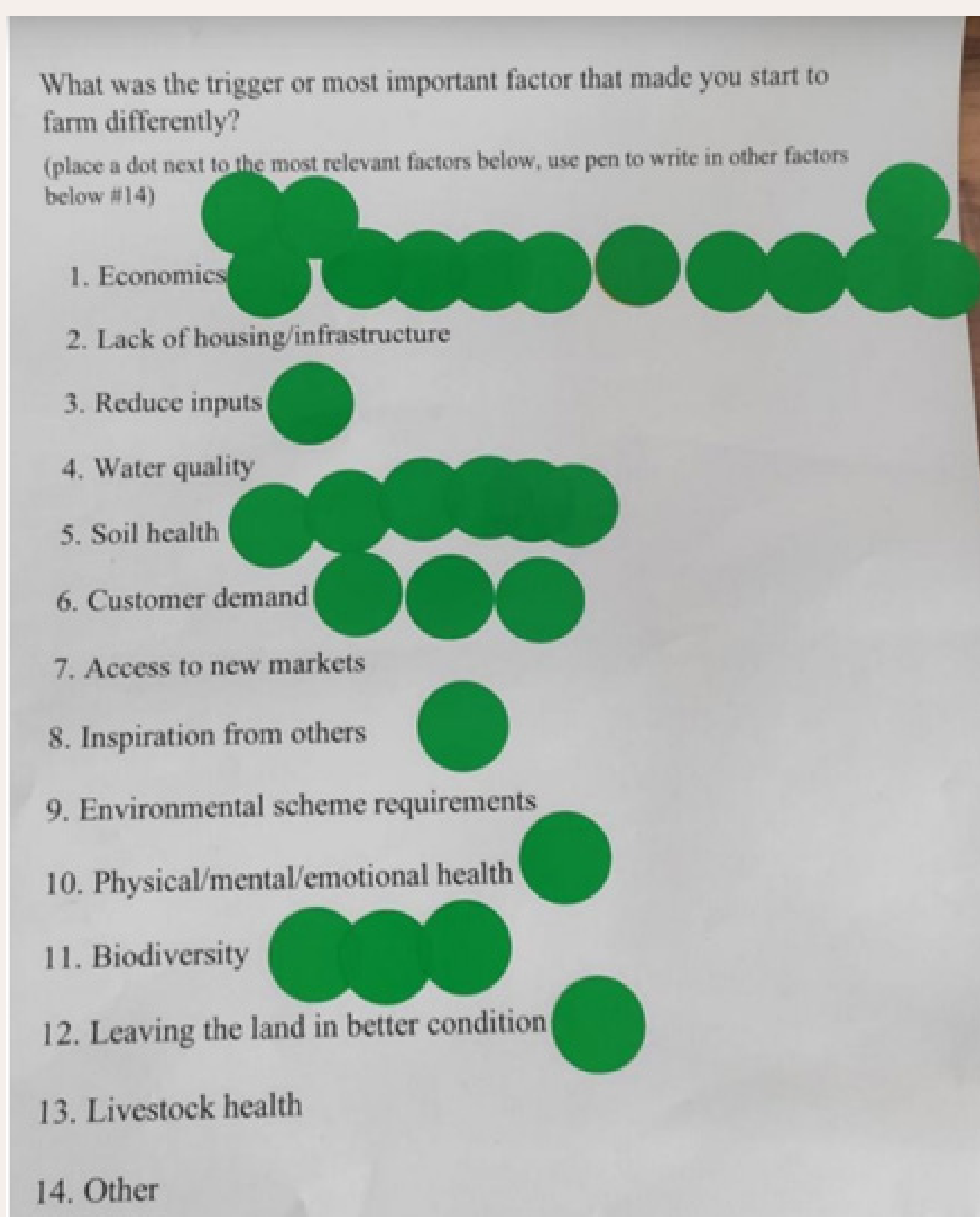
farmers take up direct drilling practices on their land; lower fuel and labour costs are an incentive that compensates for the possible reductions in crop yields. The Magistrali study also cited a lack of knowledge as a common barrier identified in workshops and surveys (Figure 2). Many farmers are relying on social media channels (e.g. YouTube) and books (e.g. Gabe Brown's Dirt to Soil, published in 2018, which is hugely influential) for guidance on how to farm regeneratively. With many of this information originating in a different social and environmental context, there is an opportunity for more UK-specific, evidence-based advice on regenerative farming methods. There is also a recognition that even within the UK, appropriate practices will vary depending on the region, so very local, practical advice is needed (Magistrali et al. 2022). The quote from study shown in the box below sums up a common theme relating to access to knowledge and information as a barrier to uptake of regenerative agriculture.

A quote from farmers interviewed as part of the Magistrali et al (2022) survey of regenerative agriculture in the north of England.

"I'm sure that many farmers know that things are wrong with their farm finances and their farming system … whilst they know change is necessary, they have generally known nothing else than the status quo and so when there is no one there to help them develop a vision for change and show them a way out of the predicament, they revert back to the status quo, because it is all that they know."

While some farmers take up regenerative agriculture practices for economic reasons, others are hesitant because of concerns about financial risks. At the time of the Magistrali study, there was also uncertainty about future environmental stewardship schemes. However, the rollout of the SFI with various options aligned to regenerative practices has removed some of that uncertainty.

Figure 2 Figure extracted from Magistrali et al. (2022) illustrating barriers to uptake of regenerative agriculture in the north of England
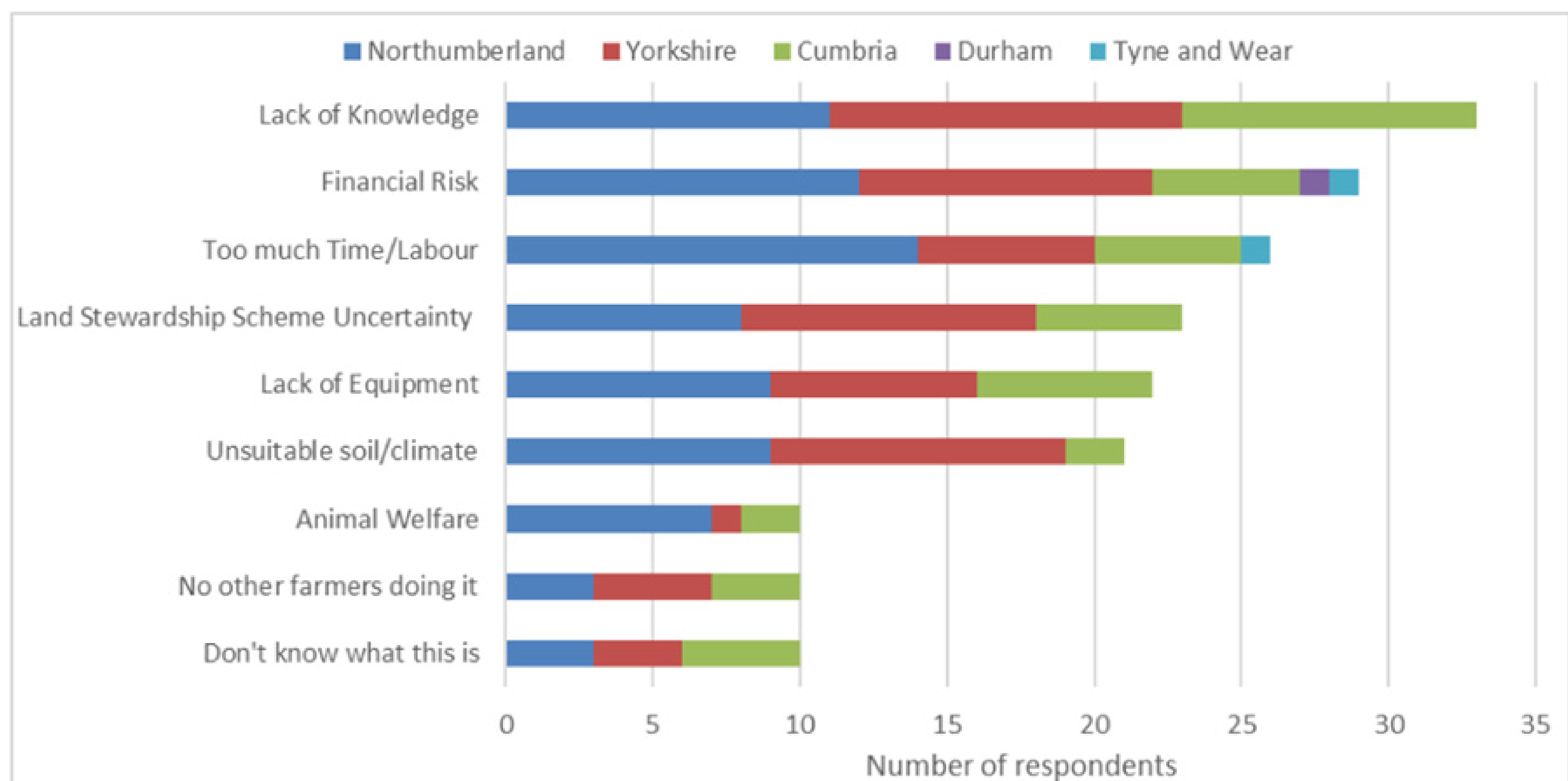

Figure 9 Farmer responses selecting barriers to adoption of regenerative agriculture in the North of England

The study by Hurley et al. (2023) included interviews with a broad range of stakeholders that included farmers, but also researchers, government representatives etc. They highlighted many barriers in common with Magistrali et al, including a lack of perceived financial viability, and limited support for knowledge sharing and networks. But they also reported land tenure constraints, lack of policy support, and cheap food narratives as additional barriers. Figure 3 illustrates these barriers and enablers grouping them under three themes: business and systemic, knowledges and networks, and cultures and practices. A survey by Lozada and Karley (2022) in Scotland echoes many of these themes, particularly emphasising the need for training and advice that takes into account local contexts.

Figure 3 Representation of the barriers and enablers for adoption of agroecological and regenerative farming practices from the study by Hurley et al. (2023)
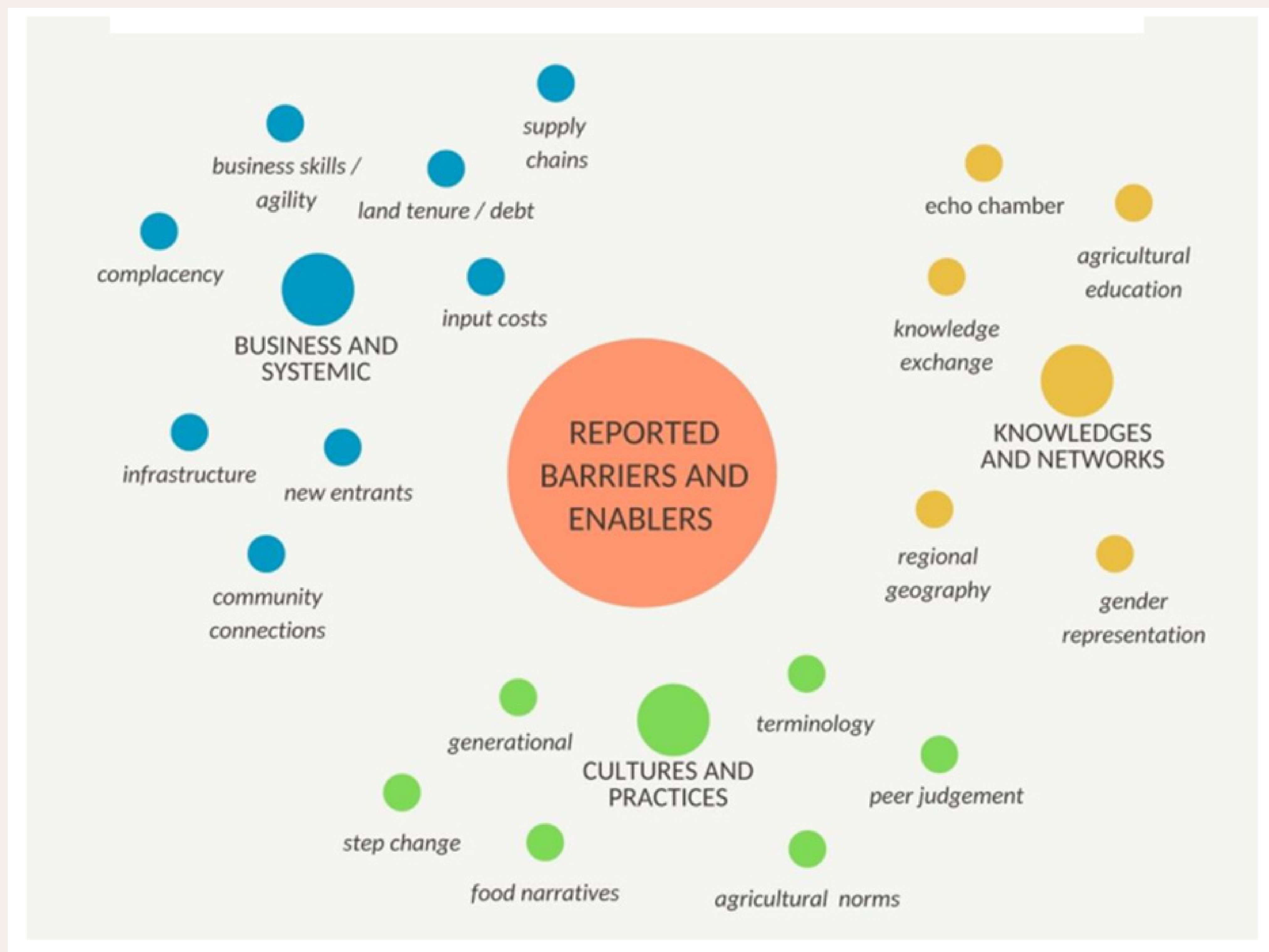
Studies have already highlighted that there are a range of barriers and constraints to the uptake of regenerative agriculture practices. Information and knowledge are identified as significant, but by no means the only, barriers in most studies. Knowledge exchange (KE) activities that integrate research outcomes with practical guidance are essential (see Challenge 2: Advice and Guidance). This is a high-priority area for policy development action underpinned by social science research.

Project Summary

Appendix A summarises the results of the gap analysis based on the evidence reviewed in this project. To be considered a high priority for research, topics needed to have received more than 10 votes in the critical or high-importance categories in the initial stakeholder workshop. Topics were also considered priorities if there were few peer-reviewed papers found on the Web of Science (<20 indicating minimal research activity globally on this topic) and a low number of UK projects and reports (fewer than five are shaded green to indicate a deficiency of activity in this area).

Impacts of the production system on product quality and end-market use (5.4), particularly with reference to wheat and effects on the feed vs. bread wheat market, ranks as a high-priority area for further applied research: few academic papers on this topic exist, and only three current and past projects were assessed as relevant to this topic. Multidisciplinary work across the supply chain, including nutritionists and food system modellers, is necessary to fully understand the implications of changes in product quality on markets and food security.

A key factor affecting uptake of regenerative agriculture is its impact on farm economics, and a better understanding of socio-economic factors constraining uptake of regenerative agriculture (6.2) is of critical importance to many stakeholders. This ties in with topic 6.1, The impact of regenerative agriculture systems on farm livelihoods, which workshop participants ranked as the top research priority. More information on the economic impacts of adopting regenerative agriculture practices is necessary, and this could be accomplished through farmer clusters e.g. Groundswell Agronomy or AHDB's Monitor Farm approaches.

"How to…" implement regenerative agriculture featured as a top priority, with the need for regionally adapted cover crops (2.6) of high importance to stakeholders and relatively few ongoing projects. However, some existing reports on cover crops should be referred to when developing future research activities. The Cover Crop Guide, recently developed by the Yorkshire Agricultural Society, has laid much of the groundwork for further work in this area.

Other "How to..." topics that were considered important included: 2.1 Growing root crops in regenerative systems, 2.2 Intercropping arable crops successfully, 2.5 Effective termination of cover crops; without herbicides, 2.7 Impacts of cover crops on weeds, pests and diseases, 2.8 Reducing herbicide use in regenerative systems, and 2.9 Integration of livestock into arable regenerative systems. The latter two topics emerged during discussions at the workshop and the Future of Farming conference. Some of these topics already have a large body of scientific information to support the development of applied research in the UK, e.g. root crops in regenerative (low disturbance tillage) systems are discussed in more than 100 academic papers. The same is true for intercropping, which has been researched extensively and would benefit from an applied/KE approach. Termination of cover crops is also discussed in many academic studies, but since its success is so dependent on the local environment, it will still be important to conduct research under UK conditions. Livestock are recognised as integral to regenerative agriculture but can present challenges to arable farmers; more applied research is needed to overcome the barriers to including animals in regenerative farming systems. All of these topics are best suited to applied research on farms, recognising that implementation of these diversified cropping approaches is highly context-dependent.

The identification of metrics to support the definition of regenerative agriculture (1.1) was identified as important by workshop attendees, and there are few academic papers or projects on this topic. There is a recognition that the main drive to define regenerative agriculture comes from researchers and a solid definition and metrics will be important if robust research on regenerative agriculture's effects is to be conducted. A few UK projects have attempted to define regenerative agriculture and a consensus could be reached on a definition by collecting stakeholder input. It does seem key to decide if a practice-based definition (which is conducive to the development of standards and a certification system) or an outcomes-based definition (more inclusive of a range of practices and aligned with Defra targets like the Environmental Improvement Plan) is the way forward for the movement in the UK. An inclusive definition based on outcomes could facilitate more rapid uptake of practices and ultimately have a wider impact but may not allow niche access to markets that compensate farmers adequately for any loss in production.

Wider system impacts of regenerative agriculture need to be better documented to demonstrate the benefits of these practices. Impacts particularly on the water cycle (both flood risk and drought resilience; 5.1) need to be studied and understood. In addition, the net effects on greenhouse gas emissions are not known. Integrating legumes into rotations (5.2) can have a range of knock-on effects on emissions in the field and beyond the farm gate. A slightly broader statement on the wider impacts of regenerative agriculture on the environment also ranked highly (5.3 Practice and options to be assessed in terms of wider impacts), but it should be noted that there have been many papers published globally on environmental impacts of regenerative agriculture which should be reviewed before designing UK studies; various projects are ongoing that will also address these topics in the UK.

There is a perception that more crop breeding efforts should be targeted at traits important for regenerative farming. Variety evaluation and breeding for low N and pesticide inputs (3.3) was a high priority among workshop participants and has also been identified as important to levy payers in the recent AHDB Recommended List review process. Variety evaluation and breeding for weed competitiveness (3.4) and performance in reduced tillage systems (3.5) emerged as important topics at the workshop. These topics have been covered in peer-reviewed studies, but there have been few projects in the UK.

In addition, this study has highlighted the predominance of cereals, particularly wheat, in most breeding efforts. There is tremendous scope to extend breeding programmes to the less dominant arable crops (e.g. pulses, minor cereals like oats, spelt) and cover crops to help facilitate the transition to regenerative agriculture in the UK.

Among the topics within the Soil Health challenge, the need to understand the impacts of changes in soil biology on weeds (4.2) was particularly highly scored. There is some basic knowledge on the underlying mechanisms (a moderate number of peer-reviewed papers relating to the topic) but further basic soil science and applied research is needed. We did not identify any relevant projects on this topic and only one report from the grey literature. The impacts of strategic (occasional) tillage vs glyphosate on soil health (4.5) garnered significant interest among stakeholders at the workshop and was also identified in discussions at the Future of Agriculture conference.

There have not been many papers published that explicitly address this topic, however, there are several past and current experiments in the UK that include rotations, tillage and herbicide use as factors that could be used to begin to address this research topic.

Authors' Recommendations

This study has clearly mapped out the status of the research needed to support the transition to regenerative agriculture in the UK. It has showcased the extensive knowledge accumulated from past projects and the expertise of scientists, industry experts, and farmers in the sector. The detailed report and database are key resources that can be used to build an action plan to tackle the obvious knowledge gaps. The database could be made publicly accessible and maintained as a living resource for anyone looking for information on past and current projects and research relating to regenerative agriculture.

The next steps should be to develop a strategy to tackle each of the six challenge areas by forming working groups with the key individuals and organisations identified in the database. These groups could develop action plans that include accessing the Farming Futures funding opportunities that are currently live and partnering with research organisations and farmer groups (clusters) to develop local solutions to production challenges. In addition, the report can be used as evidence to lobby Defra and UKRI to support research programmes in these high-priority areas. Many of the priority areas reflect actions within the Sustainable Farming Incentive. Research on these topics will help build the evidence base for the SFI and other future farming and land management policies.

Key to the success of new programmes to support regenerative agriculture will be efficient and targeted use of resources. This means not reinventing the wheel and building on past experiences and knowledge. This study has helped to develop the resources needed to do this effectively.

The full report on this project (including full bibliography and appendices) and the database listing projects and reports can be found at
www.organicresearchcentre.com

Appendix A

Summary table of top priority research topics based on outcomes of the stakeholder workshop, Future of Agriculture Conference and scoping of past and ongoing research. Projects included are only UK-based activities. Code numbering relates to the Challenges identified in this series of publications. "Grey literature" refers to reports from UK government and industry bodies, e.g. AHDB, NIAB. Colour shading is provided to indicate highest priority/largest gap (green), moderate priority/gap (amber) and lower priority/smaller gap (putty). Topics with the most "green" shading can be interpreted as top priorities.

		Workshop Outcomes		Scoping Study Outcomes			
Code	Description	Critical+High Votes >10	Research Type	Peer-reviewed papers	Ongoing projects (total 27)	Past projects (total 28)	Grey literature (total 76)
High priority with few academic papers or UK projects							
5.4	Impact of regenerative agriculture on product quality and end-market use	13	Applied	<20	1	2	0
6.2	Socio-economic factors constraining uptake of regenerative agriculture	11	Policy	<20		1	6
2.6	Regional adaptation of cover crops, particularly for cool, wet, temperate climates	11	Applied	<20	2	2	13
1.1	Identification of metrics to support definition	10	Policy	<20		1	6
High priority, some academic papers, some UK projects							
6.1	Impact (and the factors affecting it) of regenerative agriculture systems on farm livelihoods	19	Applied/KE	20-100	11	2	7
5.1	Impacts of regenerative agriculture systems on the water cycle (flood risk, drought)	13	Applied	20-100	3	2	3
3.3	Variety evaluation and breeding for low N and pesticide inputs	12	Applied	20-100	3	3	7
2.7	Impacts of cover crops on weeds, pest and diseases	11	Applied	20-100	3	3	4
4.2	Impact of changes in soil biology on weeds, particularly blackgrass	11	Basic/Applied	20-100			1
High priority, many academic papers, some UK projects							
2.2	Intercropping arable crops successfully	12	Applied/KE	>100	2	4	7
2.5	Effective termination of cover crops; without herbicide; impacts on the following crop	13	Applied	>100	3	2	8
5.2	Impacts of integration of legumes throughout the cropping system on N cycling including GHG emissions	12	Applied	>100	7	3	
5.3	Practice and options for regenerative agriculture to be assessed in terms of wider impacts	12	Applied	>100	8	3	13
2.1	Growing root crops in regenerative systems	11	Applied	>100	3		2
Topics not ranked during the stakeholder workshop							
2.8*	Reducing herbicide use in regenerative systems	NA	NA	20-100	1		9
2.9*	Integration of livestock into arable regenerative systems	NA	NA	<20	2	1	2
3.4*	Variety evaluation and breeding for weed competitiveness	NA	NA	>100	1		3
3.5*	Variety evaluation and breeding for performance in reduced tillage systems	NA	NA	>100	1	1	
4.5*	Impacts of strategic (occasional) tillage vs glyphosate on soil health	NA	NA	20-100	7	4	7

Bibliography

Hurley PD, Rose DC, Burgess PJ, Staley JT (2023) Barriers and enablers to uptake of agroecological and regenerative practices, and stakeholder views towards 'living labs'

Kazimierczuk K, Barrows SE, Olarte M V., Qafoku NP (2023) Decarbonization of Agriculture: The Greenhouse Gas Impacts and Economics of Existing and Emerging Climate-Smart Practices. ACS Engineering Au 3:426–442. https://doi.org/10.1021/acsengineeringau.3c00031

Lozada LM, Karley A (2022) The Adoption of Agroecological Principles in Scottish Farming and their Contribution towards Agricultural Sustainability and Resilience

Magistrali A, Cooper J, Franks J, et al (2022) Identifying and implementing regenerative agriculture practices in challenging environments: experiences of farmers in the north of England. Newcastle Upon Tyne

Van den Putte A, Govers G, Diels J, et al (2010) Assessing the effect of soil tillage on crop growth: A meta-regression analysis on European crop yields under conservation agriculture. European Journal of Agronomy 33:231–241. https://doi.org/10.1016/j.eja.2010.05.008

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