Sharing Experiences of Regenerative Agriculture:

A Transforming UK Food Systems Programme Workshop

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FixOurFood

HEALTHY SOIL
HEALTHY FOOD
HEALTHY PEOPLE

TRANSFORMING UK FOOD SYSTEMS
Strategic Priorities Fund

UKRI Biotechnology and Biological Sciences Research Council

Global Food Security
Sustainable, healthy food for all

Executive summary

This report summarises a workshop that brought together farmers, researchers and allied stakeholders with an interest in regenerative agriculture (RA) to share experiences, benefits and challenges of RA and determine priorities for future research.

This report presents (i) the findings, to date, of two current research projects (FixOurFood and H3: Healthy soil, Healthy food, Healthy people), funded by the UK Research and Innovation's 'Transforming UK Food Systems (TUKFS)' programme, with other RA research projects being carried out across the UK, and (ii) outputs from the workshop activities. The workshop highlighted the essential role of farmer-researcher partnerships in assessing the environmental and socio-economic outcomes in RA; the benefit of interdisciplinary RA research projects that combine knowledge from multiple academic disciplines and perspectives from both the social and natural sciences; the need for a co-ordinated network of RA research projects; the value of context specific knowledge; the need for building an evidence base on the efficacy of regenerative practices; the need for collaboration and shared resources between stakeholders; the importance of mentorship networks and demonstration farms to support farmers transitioning to RA; the need to engage with supply chains to ensure to successfully integrate of regenerative products into the UK food system and to align drivers in the value chain to encourage RA; and the need to engage with policymakers to ensure there are enabling policies and legislation that encourage and incentivize uptake of RA. The key findings and recommendations are provided below.

1. Importance of Co-Design and Farmer Engagement:

A significant finding was the research-practice gap, with farmers often trialling combinations of regenerative practices that are not yet being studied extensively by the academic community. To overcome this issue and ensure that research is impactful to the farming community, it is essential to include farmers and allied stakeholders in the research process. Action research and/or co-design/creation/production will ensure on-farm trials are scientifically valid, ensure academic research is addressing farmers questions and evidence requirements whilst simultaneously offering practically and financially viable evidence-based practice, with research findings synthesised and their contexts understood by a range of different stakeholders. The workshop also highlighted differences and similarities in how farmers and researchers perceive opportunities (Section 2) and barriers (Section 3) to uptake of RA. The value of farmer knowledge in developing future research was emphasised, stressing the importance of integrating these insights into research, and ensuring farmers are fairly compensated for their contributions to research projects, since this involves extra time and often additional costs and risks. Integrating diverse stakeholder insights and addressing systemic challenges will be pivotal in scaling RA practices effectively and sustainably.

2. Context-Specific Knowledge and Shared Resources:

Given the variability in soil types and climate across the UK, participants underscored the importance of context-specific RA guidelines. The extensive practitioner knowledge from pioneers in RA remains largely undocumented, especially for things that did not work well. However, during this workshop we began to gather farmer experiences of practices combinations relative to their soil type (Section 4). Farmers indicated that knowledge about effective practices for specific soil types is currently limited and they would benefit from a network of demonstration farms that showcase the efficacy of regenerative practices in different contexts. In addition, farmers highlighted the difficulty in accessing research findings, and recommendations were made for a shared data platform to centralize RA findings, which could support farmers in diverse contexts and ensure that insights are easily accessible. There is strong circumstantial and theoretical evidence that research publications tend to be biased towards reporting successful outcomes and not reporting failures and the willingness of the participating farmers to share their failures as well as successes is critical for obtaining unbiased RA evidence and practical advice.

Executive summary

3. Long-term Research Infrastructure to Support Evidence-based Practice:

Several research projects on RA are now being carried out in the UK, but often as part of large research consortia, where it forms a relatively small part of a larger set of research objectives. Furthermore, research projects are often funded on a short-term basis (3 years) compared to a farming system which could encompass a 10-year crop rotation. Given the scale of the challenges facing UK agriculture, the range of farming and soil types across the UK and the radical transformations taking place in government support for more environmentally friendly farming, there is a need for more ambitious national-scale funding to synthesise and align existing on-farm research and research projects to more efficiently establish an RA evidence-base and support RA knowledge exchange. Additional RA trials are needed which investigate combinations of practices that are currently underexplored but that offer exciting potentials to deliver RA goals. Suggested future research priorities included exploring RA outcomes across a range of soil types, investigating new ways to terminate cover crops and control weeds, improved understanding of the pros and cons of including livestock into RA systems, improved understanding of the barriers to uptake of RA, modelling the impact of a range of climate change scenarios on RA outcomes, and expanding farmer participation to encompass varied agricultural settings.

Specifically, there is a need to develop a coordinated, national RA research programme across universities and farming organizations. Research should prioritise creation of a platform with synthesis of RA research accessible to farmers, updated annually. There are significant opportunities to improve the research infrastructure to foster collaboration between research projects, farmers and allied stakeholders to improve understanding and quantification of the long-term impacts of RA on socioeconomic and environmental outcomes. Metrics to track the progress and effectiveness of RA are underdeveloped, as is the evidence needed to guide farmers and policymakers in which RA practices to adopt. The workshop called for metrics that not only validate existing farmer knowledge but also enable flexible RA definitions that incorporate different farming contexts.

4. Mentorship and Knowledge Networks:

Peer-to-peer learning, advisor-peer learning and mentorship programmes were highlighted as key support networks for farmers transitioning to RA, advising them when learning new-skills, supporting their decision to move to RA practices and providing knowledge and mitigating uncertainties tied to specific soil type and climatic conditions. Specifically, there is a need for tailored agricultural advice and support, with a focus on collaborative, farmer-led networks where coordinators provide individualized guidance (e.g. farmer clusters). Emphasis should be on direct farmer involvement in research projects, supported by funding, and where results feed into policy development. This will help reduce the likelihood of policies resulting in unintended outcomes, and develop solutions that are socially, economically and environmentally sustainable. Current agricultural education and training must also evolve to equip farmers and farm advisors such as agronomists with forward-looking knowledge and new skills that meet the demands of future farming.

5. Economic Incentives and Supply Chain Challenges:

Farmers prioritized economic viability, identifying improved profit margins and staff welfare as crucial benefits of transitioning to RA, but also highlighted the environmental benefits. However, farmers highlighted supply chain limitations as a barrier to becoming more regenerative. For example, some millers still mandate single-origin wheat, which conflicts with RA principles favouring crop diversity and thus the planting of blends of wheat. With markets not equipped to integrate regenerative products, there is increasing concern that RA could be seen as primarily producing food for livestock feed rather than people (Section 5). New finance, business and policy incentives are needed to de-risk and accelerate the transition to RA.

Contents

Introduction

Agriculture dominates UK land use (70%), causing 11% of total greenhouse gas (GHG) emissions, is the primary driver of soil degradation and biodiversity loss, contributes to water and air pollution and is vulnerable to climate impacts. To achieve net-zero GHG emissions by 2050, plus meet food needs and environmental commitments, a systemic shift is needed in agricultural production. Regenerative agriculture (RA) is gaining significant interest from farmers, agri-businesses, researchers and governments as it potentially provides a method of farming which produces food whilst simultaneously restores soil health, supports biodiversity and reduces GHG emissions.

The "Sharing Experiences of Regenerative Agriculture Workshop", funded by the Biotechnology and Biological Sciences Research Council (BBSRC), brought together farmers, researchers, and allied stakeholders for a workshop focused on sharing insights and research results from the FixOurFood and H3 (Healthy Soil, Healthy Food, Healthy People) projects, two projects funded by the Transforming UK Food Systems Programme (TUKFS), and other RA research projects being carried out across the UK. Stakeholders present at the workshop included the Game and Wildlife Conservation Trust (GWCT), Agriculture and Horticulture Development Board (AHDB), Crop Health and Protection (CHAP), Syngenta, Nature Friendly Farming Network, Environment Agency, Yorkshire Agriculture Society, ADAS, NIAB, Organic Research Center, Soil Association and Harper Adams University.

Through a series of presentations, interactive sessions, discussion and a panel, the workshop aimed to:

- **Facilitate Knowledge Exchange:** Enable farmers, researchers, and industry stakeholders from across the UK to share experiences, benefits and challenges of regenerative agriculture.
- **Incorporate Farmer Feedback:** Gather input from farmers to guide future research priorities and ensure that research align with the practical needs and insights of the farming community.
- **Identify Synergies and Opportunities for Future Research:** Identify common goals, potential synergies, and collaboration opportunities across different stakeholders to enhance the impact and applicability of RA research.

The workshop ran over two days Tuesday 7th May and Wednesday 8th May 2024. The first day focused on bringing together academics and farmers involved in the two 'Transforming the UK Food Systems' funded projects, FixOurFood and H3, to discuss current findings and future opportunities. The first day included a tour of the University of Leeds farm and RA trials. The second day of the workshop brought together a range of different stakeholders and research projects. This report focuses on the second day of the workshop and contains a summary of the research presentations, as well as the main outcomes from each of the workshop activities.

1. Current Research on Regenerative Agriculture in the UK

The first session of the workshop was used to highlight and share knowledge from ongoing UK RA research. A range of speakers were invited to share information on their research projects, aims and objectives, current findings and future project directions. The audience was then given opportunity to ask questions about the projects. Below is a summary of the presentations.

1.1 The FixOurFood Project (part of the Transforming UK Food Systems Programme)

Dr Ruth Wade, University of Leeds, presented a summary of the FixOurFood project which aims to understand how to steward system transformation towards a regenerative food system using Yorkshire as an exemplar region. The FixOurFood project has several different work packages investigating the current food system, healthy eating for young children, hybrid food economies, regenerative farming systems, metrics, policy and governance, narratives, and system integration and learning. The regenerative farming systems part of the project is led by the University of Leeds and includes activities such as understanding current RA systems, supporting RA, providing evidence-based practice and sharing information.

To understand current RA systems, the University of Leeds research team distributed an online survey to UK farmers to identify their aims, motivations, practices, challenges and concerns of adopting RA. It was completed by 130 farmers, the majority from England, and over half were already practising RA and nearly all had positive feelings towards it. The results of the survey were not presented at the workshop to avoid biasing any conversations or activities carried out as part of the workshop. The University of Leeds research team also visited many farms as part of the process of understanding current RA systems and found that there were so many variables that differed between farms, it made it very difficult to make comparisons between them. Differences included combination of practices implemented, starting point, previous experience, soil type, climate, field and farm history, crop rotation, timing of inputs, inputs used, equipment available etc. However, most farmers were following five principles of RA:

1. Minimise soil disturbance
2. Maximise crop diversity
3. Keep the soil covered
4. Maintain a living root all year round
5. Integrate livestock

These five principles were therefore used to design and install a large, replicated plot trial at the University of Leeds farm with the aim to demonstrate and measure the impacts of different transition strategies to regenerative farming on the soil, crop, greenhouse gas emissions, biodiversity and profit. The plots compare seven treatments that range from a conventional system (not following any of the RA practices) to following additive RA principles including cover crops, addition of farmyard manures, mixed cereal variety blends, sheep grazing, living mulch and changing the crop rotation to include a three-year herbal ley.

The trial is currently in its third year, but needs to continue for longer to realise the full potential of transitioning to RA and to comprehensively understand the impacts of the different systems, but initial results from the first year of the trial showed no difference in yield between the different systems but that ploughing in the conventional plots had re-distributed the soil organic matter to the deeper soil profile and that greenhouse gas emissions of carbon dioxide and nitrous oxide differ between the systems.

The University of Leeds research team share information from the trial to a range of stakeholder groups through numerous events and organisation such as farm walks at the University of Leeds farm, local farm cluster group meetings and research, conferences and panel discussions for Yorkshire Agricultural Society and AHDB, soil health clinics at Great Yorkshire Show and presentations at Groundswell as well as videos, blogs, policy documents and popular press articles e.g. https://sway.cloud.microsoft/uo8t8RSQxgleHo0y

This trial is:

1. **Evidence-based best practice** through learning from and with farmers, providing a demonstration site for sharing ideas and a trusted peer-to-peer and farmer-scientist community/network;
2. **Furthering our understanding of RA systems** identifying benefits and trade-offs of ecosystem services e.g. climate change and biodiversity;
3. **Providing evidence and data** which can support model development, future scenario testing that evaluates the contribution of RA to net zero and food production and feed into policies such as the 25 year Environment Improvement and Agricultural Transition plans.

1.2 The H3 Project (part of the Transforming UK Food Systems Programme)

Dr Katherine Berthon, University of Cambridge, presented some early results of the H3 co-designed farm-scale experiment, involving two farmer clusters (south-west England cluster and East of England cluster). This included description of the co-design process, the collation of farming practices and exploration of the variation in implementation of regenerative practices within and across farms, and farming landscapes. The experiment involves twenty-five 60 ha farms distributed across two farm clusters that farmers self-allocated to one of three farm types; Regenerative farms where regenerative practices have been implemented for at least 3 years before the project started, Conventional (control) farms that have historically limited implementation of regenerative practices, and Transition/ Change farms where they have agreed to increase the implementation of regenerative practices during the project (a description of the experiment is detailed in Berthon et al, 2024). The project began its baseline year in 2022, with farmers defining a list of nine practices that were included in the experiment (no or minimum tillage, retain residues, use cover crops, spring cropping, herbal leys, controlled traffic, organic matter addition, livestock grazing, and crop diversification), and each farm was monitored for biodiversity (birds, natural enemies, pollinators), soil health (worms, water stable aggregates and bulk density) and farmer perspectives (interviews). In 2023, transition farmers adopted new practices and repeat measures of all indicators will be taken in 2024-2025.

The baseline data on biodiversity and soil health suggests that there are differences between self-reported 'regenerative' and 'conventional' farms, with clear increases in earthworm density and improvements in soil structure on farms that minimised soil disturbance by using less tillage. Self-reported regenerative farms also use less fertiliser, fuel, insecticide, molluscicide, and fungicide than conventional farms. The exception is herbicide, which is used consistently across both conventional and regenerative farms but has already begun to show decreases in the 'change' group, before they have begun their transition. Biodiversity of birds, particularly farmland specialists, tends to be higher in regenerative fields, but the response of invertebrates is more complicated and linked to other habitat features on farms or landscape effects – an area of future research.

However, the positive results for biodiversity and soil health were only present in one of our two farm clusters, possibly due to a combination of differences in soil type, farming systems, or practices farmers were implementing between the clusters (with one cluster predominately arable farms and the other dominated by mixed farms). No regenerative farm employed all nine identified practices, and all conventional farms implemented at least one of the identified practices. At baseline, the cluster which showed less difference between regenerative and conventional farms, was already implementing more minimum tillage practices, and already had high biodiversity, even in the conventional farms. Moving forward, the project is looking to develop a regenerative scoring system to classify farms in terms of the frequency with which regenerative practices are implemented, to allow for the fact that farms adopt a spectrum of regenerative practices and more accurately assess the impact of consistent application of these practices.

Dr Jonathan Beacham, University of Bristol, presented the results of the initial H3 farmer interviews, which were designed to uncover their motivations for adopting RA and the barriers they face. His findings revealed a lack of a coherent definition of RA, and that farmers adopt RA both for environmental stewardship and pragmatic economic reasons. Farmers highlighted the appeal of RA for its soil health benefits but noted challenges like policy uncertainty and mixed views on RA's distinction from organic farming. Additionally, he noted that much of the information farmers receive is shared informally, often through social media and messaging platforms like WhatsApp. One of the persistent challenges identified was the need for farmers to navigate a frequently shifting policy landscape, which complicates long-term planning and adoption of regenerative practices. The project is currently conducting interviews with policymakers to clarify how RA fits within existing policy frameworks.

Professor Jonathan Leake, University of Sheffield, presented the H3 results for changes in soil health focussing on soil structure, particularly the role of macro-aggregates in carbon capture and water management. He found that soils with larger macro-aggregates accumulate more organic matter, enhancing their carbon sequestration potential, and were more abundant in soils with reduced tillage. In contrast, soils with fewer macro-aggregates are more susceptible to flooding and poor drainage. Aggregate formation, and thus soil resilience, improves significantly by including legume and grass leys for 2-3 years in arable rotations, providing year-round living roots, and that high representation of legumes in leys builds soil fertility reducing the subsequent requirement for synthetic N fertilizer, which is one of the main contributors to greenhouse gas (GHG) emissions and environmental pollution from croplands.

1.3 Center for Sustainable Cropping, James Hutton Institute

Cathy Hawes gave an overview of the research taking place at the Center for Sustainable Cropping, which was established in 2009, as a long-term platform for agroecological/RA research. The platform combines best practice management options into an integrated cropping system for multiple benefits. It is a 42 ha site, comprising six split fields that compare the integrated cropping system versus standard (business-as-usual) practice. It is a demonstration site and aims to monitor long-term trends in environmental and socio-economic outcomes. The cropping systems includes direct drilling of the cereals and beans, non-inversion tillage for the oilseed rape and standard cultivation for potatoes, addition of organic matter via not removing the crop residue as straw and the addition of 5-10 t/ha/yr of municipal green waste, use of cover crops before spring crops, inclusion of legumes (beans) in the rotation and as an understory, use of integrated pest management, and wildflower margins to promote pollinators. Results, to date, highlight no loss in crop yield except for winter wheat, enhanced biodiversity and improved soil health. Further information can be found in Hawes et al. (2019) and George et al. (2022).

1.4 Syngenta's Sustainable Farming project

Belinda Bailey gave an overview of Syngenta's Sustainable Farming research project, which ran from 2017-2022 at two sites in England, one on heavy soils at Loddington, Leicestershire, and the other on light soils at Lenham, Kent. At each site there was three treatments; conventional (inversion cultivation to 20 cm), sustainable system 1 (minimal cultivation to 15 cm and cover crops) and sustainable system 2 (light cultivation to 10 cm / direct drill and cover crops). Social, economic and ecological outcomes were measured and when sustainable system 2 was compared to the conventional system (averaged across the 5 years), birds, worms, soil cover, work rate (ha/hr), gross margins and net profit increased and soil greenhouse gas emissions, carbon footprint, fuel usage and operation costs decreased at both sites. However, crop establishment decreased at both sites, which resulted in a lower yield at the heavy soil site only. Soil structure also declined at the heavy soil sites.

More information can be found here: https://www.syngenta.co.uk/direct-move-sustainable-farming-systems. On the basis of these findings, Syngenta has extended the trial from 2022-2026 at the two sites but with a stronger emphasis on RA.

There are still three treatments; Conventional (plough or min till, no cover crops and standard crop protection, seeds and fertiliser); Light Till (light cultivation / direct drill + cover crops and standard crop protection, fertiliser & adjusted seeds) and Light Till+ (light cultivation / direct drill + cover crops, optimisation of crop protection, seeds and fertiliser). Light Till+ will include the use of biostimulants, organic matter additions, optimisation of nitrogen use efficiency, alternative blackgrass control, include SFI options, synergistic strategies. Agronomic, soil health and farm business metrics will be recorded over the duration of the project.

1.5 Mapping UK Plant and Soil Science Research with a Regenerative Agriculture focus: identifying the gaps

Julia Cooper gave an overview of a Rapid Evidence Assessment to Map UK Plant and Soil Science Research with a Regenerative Agriculture focus – identifying the gaps, that is being carried out by the Organic Research Centre, NIAB and Agri-TechE and funded by the Aurora, Gatsby and Mark Lenord Trusts. The project used a combination of conversations, workshops, project review and peer-reviewed literature review to come up with a list of 38 challenges that could be split into six main categories; standardising RA (2), advice and guidance (14), crop genetics (9), soil health (5), system impacts (6) and behaviour change (2). Some examples of the challenges included; (i) identification/definition of metrics that can be used to define RA systems, (ii) evidence of the potential benefits and disbenefits of developing a certification scheme for RA, (iii) how to grow intercrops (i.e. two or more crops grown together and both harvested) effectively, (iv) socioeconomic factors constraining uptake of RA and (v) levers to influence farmer behaviour change. Julia highlighted some previous/ongoing projects and reports that have investigated companion cropping, such as a Nuffield Farming Scholarships Trust Report on the potential for companion cropping and intercropping on UK arable farms (Howard, 2016), field trials with farmers, such as the DIVERSIFY project and Innovative Farmers trials, and regional demonstration projects such as LEGUMINOSE. Julia also highlighted some reports that have mentioned farmer behaviour and the barriers to RA uptake. These included the AHDB (2022) report - Identifying and implementing regenerative agriculture practices in challenging environments: experiences of farmers in the north of England, Defra SCF0321 (2023) report - Barriers and enablers to uptake of agroecological and regenerative practices, and stakeholder views towards 'living labs'. These reports and the survey in the FixOurFood project all highlight lack of knowledge and financial risk as the top barriers to RA uptake by farmers. Julia concluded by stating that there is extensive background knowledge for many of the identified challenges and that the next steps depend on the specific challenge (i.e. basic/fundamental research, applied/knowledge exchange and/or work with policy makers). To see a step change in the transition to RA integrated approaches, working across these challenges in a multi-disciplinary way is needed.

1.6 Scope of RA Practices in the UK: Who is doing what and where?

Samuel Eze, Harper Adams University, gave an overview of a project funded by the Agri-Food for Net Zero (AFN) Network+, which aims to assess the state of RA knowledge, perceptions, and practices amongst farmers in the UK. The project has carried out a literature review to identify a suite of RA practices relevant to the UK context and it has designed an online survey for farmers to identify practices considered to be regenerative and why, practices that are being implemented, perceptions of outcomes of such practices and perceived enabling factors and barriers to adoption. The output of the project will be a RA practice map that highlights where specific practices, and their combinations are concentrated.

The AFN Network+ has funded two other RA projects:

1. Quantifying the Potential for Regenerative Agriculture to Contribute to Net-Zero in the UK
2. Regenerative Agriculture and Net-Zero: mapping the evidence

1.7 RA research by NIAB

Joseph Martlew from NIAB gave a brief overview of the role of NIAB as a leading UK crop science organisation working at the forefront of the application of genetics, physiology, soil science, precision agronomy and data science to improve the yield, efficiency and resilience of crop production across the arable, forage and horticulture sectors. NIAB provide research, information and advice on RA which include their NIAB membership area and supporting researchers and agri-businesses with RA trials.

2. Goals and opportunities of regenerative agriculture:
Facilitated by Dr Katherine Berthon

Participants were asked to sit in tables that represented their main stakeholder interest: either researchers, farmers or 'allied organisations' (**Appendix A**). There were three tables of researchers, two farmer tables, and two allied organisation tables. Each table was given a list of 20 goals and/or opportunities of RA, selected from the literature and the experience of the TUKFS researchers (Full list given in **Appendix B**). Participants were asked to rank these with respect to the interests of their stakeholder group, as well as add or make amendments to any of the goals/opportunities as they saw fit. We then asked each table to provide a brief rationale for their choices. **Table 1** shows the top goals/opportunities chosen by each table.

Participants expressed difficulty in ranking the RA goals and opportunities, suggesting that goals described more process-based decisions, whereas the opportunities tended to be interpreted as outcomes of supply chain and benefits for the farm business. This may be the reason for the surprising consensus on more abstract or open goals such as future proofing the farm business, which appeared in the top five on most tables, except for the farmers. Each table (irrespective of stakeholder) approached the ranking differently, with some groups creating a linear ranking, and others creating tiered or grouped categories. Several groups also modified the goals and opportunities - for example, one table of researchers split improved crop health and improved yields into separate goals, arguing for better quality crops/livestock at the expense of increased or maintenance in yields.

There were several differences in the ways stakeholders ranked and modified RA goals and opportunities. For example, both farmer tables placed 'increase profit margins' as their number one goal for implementing RA, with 'improved soil health' as a close second. One of the farmer tables went so far as to put 'increase profit margins' in the centre with all other goals and opportunities revolving around that central goal. In their justification, they noted improved soil health as underlying improved profits, and it has been included as their second choice in **Table 1**. Most of the other tables chose a similar but slightly distinct RA goal of 'Future proofing the farming business' as the top goal with several of the other top 4/5 goals associated with different interpretations of what 'future-proofing' entailed, including climate resilience, reduced synthetic inputs, reduced GHG emissions and improved soil health (both biodiversity and function). Allied organisations did include profit margins, but under the broader umbrella of incentives for adoption, while researchers prioritised tools that might assist farmers to future proof their business, such as biological control, reduced insecticides and diversification of income streams. Similarly, researchers highlighted consumer/public opinion as one of their top motivations, whereas farmers included increased staff satisfaction, recruitment and happiness as a motivating factor.

Table 1.

The top goals and opportunities chosen by each table. Each column maintains the order of importance for each table, with those at the top of the table chosen as most important. Some goals or opportunities were grouped into themes but the variations in wording maintained to reflect the perspectives of different stakeholders. Goals and opportunities are ordered to highlight the consensus across tables, while maintaining individual table rankings, with those in earlier rows being selected across multiple tables within their top goals. Two tables (F1 and A2) contained a category for 'everything else' as part of their top rankings, and only their identified goals are included.

Farmers		Allied groups		Researchers		
Table F1	**Table F2**	**Table A1**	**Table A2**	**Table R1**	**Table R2**	**Table R3**
		Future proof farming	Future proof farming	Future proof farming		Future proof farming
Profit margins	Profit margins		Incentives - Profit margins, consumer opinion			
Improving soil structure and function	Improving soil structure and function	Regenerate beneficial soil organisms			Improve soil health and biology	Increase soil health
Resilience to extreme weather events					Resilience to extreme weather events	Resilience to extreme weather events
		Reduce GHG emissions			Reduce GHG emissions	
		Multi-functional landscapes – improve crop yield and biodiversity	Enhance public goods – welfare, health, environment		Future proofing farming – food supply and profits	
Staff recruitment and happiness						
				Reduce synthetic fertiliser use	Reduce insecticide use	
				Increase health of livestock		
				Promote IPM (natural enemies)		

3. Challenges and barriers to regenerative agriculture:
Facilitated by Dr Ruth Wade

To gain deeper understanding of the challenges and barriers to implementing RA, participants were provided with a list of 16 potential challenges and barriers from those reported in the literature and from experience and knowledge of TUKFS researchers and their networks (full list in **Appendix C**). Participants in their stakeholder groups (as described in section 2: goals and opportunities above) were given 10 minutes to rank the challenges and barriers from the 'biggest, most important challenge to the least important', initially for someone who is transitioning to RA. Of the top three challenges ranked, participants were asked to expand on why these challenges were selected and what three things about these challenges make it a barrier. Participants were then given another 10 minutes to consider if the ranked order of barriers and challenges changed for farmers who had been practising RA for several years and who wants to continue farming regeneratively. Participants were encouraged to add any additional challenges that they thought were missing. The top barriers and challenges chosen by each stakeholder group is shown in **Table 2**.

All stakeholder groups ranked 'risk to business' as the most important challenge when transitioning to RA. Other recent reports have also highlighted financial barriers are a major roadblock, particularly for small and medium-sized farming businesses (Hurley et al., 2023). One farmer group highlighted that any change brings risk to the farming business, and it is important to address 'perceived risks' as well as 'real risk' with full economic costings and evidence. Risk to the farming business is a significant challenge and/or barrier which must be addressed either with evidence to highlight how RA systems can be financially viable and/or through support from supply chains and/or incentives.

All stakeholder groups also highlighted reduced yields, lack of advisors, information on best practice and lack of evidence as major challenges for farmers transitioning to RA. "Conventional" farming practices are supported through a range of guides (AHDB growth guides, RB209 nutrient managements guide), recommended lists and advisors trained through BASIS courses. These guides and courses are based on decades of trials aimed at maximising yield. RA has not had the same investment in research and the approach which focusses on improving soil fertility and structure, is particularly context dependent e.g. soil type, farm type and business, making it challenging to provide generalised advice. Despite the challenges, there is an urgent need for evidence-based practice to support the transition to RA, to ensure that the practices are leading to simultaneous regeneration of the soil, crop and farming business.

All stakeholder groups changed their ranking order from the challenges and barriers faced by farmers who have already transitioned to those who wish to continue to farm using RA principles. Changes in weather patterns were highlighted as the main challenge for farmers wanting to continue RA. A major challenge identified was unpredictable, heavy rainfall during times when farmers need to access their land e.g. during drilling in Aug/Sept/Oct and Feb/Mar. Changes in weather patterns is not just an issue for RA farmers: farmers continuing more 'conventional' practices are also impacted particularly by unpredictable heavy rainfall events or continued periods of drought. As the impacts of climate change are felt more strongly through extreme rainfall events, there are significant risks to food production in the UK. Lack of supply chain and lack of information on best practice were also highlighted as challenges for farmers continuing RA. Products coming from RA farms may not fit the conventional supply chains e.g. less nitrogen fertiliser application can result in lower grain protein content required for milling grades, millers and maltsters will only buy single variety grains preventing the selling of mixed varieties, alternative or niche crops grown to increase diversity in the rotation.

Whilst there were some subtle differences between the ranking of the barriers and challenges between stakeholder groups, the majority were aligned particularly when discussing the major challenges. This is important to ensure that stakeholder groups are aware of the challenges for farmers and can support RA with expertise or business support.

Table 2.

Top challenges and barriers for farmers transitioning to regenerative agriculture (RA) and for farmers who have been practising RA for several years and want to continue.

Stakeholder group	Farmers transitioning to RA	Farmers continuing RA
Farmers - 1	"Increased risk to business' was ranked equally to 'reduced yield"	Change in weather patterns
Farmers - 2	Reduced yields	Learning new skills
Allied groups - 1	"Will it work in my context?" was ranked equal as "too loosely defined"	Lack of supply chain
Allied groups - 2	Increased risk to business	Lack of regulations
Researchers - 1	Increased risk to business	Change in weather patterns
Researchers - 2	Lack of information on best practice	Lack of information on best practice
Researchers - 3	Economic valuation	Change in weather patterns

Other challenges ranked in the top 5 for farmers transitioning to RA:

Stakeholder group	Ranked in the top 5 most important challenge	The least important challenge
Farmers	The outcomes depend on soil type (can't do RA on heavy soil) Learning new skills Fear of the unknown / failure Lack of financial support – no bonus for RA products Lack of RA advisors Lack of evidence of the benefits of RA Lack of peer or family support	Lack of supply chain Greenwashing
Researchers	Lack of RA advisors Increased risk to business Reducing yields Lack of financial support Financial input Translation of research Lack of supply chain Intergenerational perceptions Lack of evidence of the benefits of RA Lack of information on best practice	New skills Weather changes are a driver of change rather than a barrier
Allied/business	Financial input Requires new equipment Reduced yields Learning new skills Lack of peer of family support Lack of RA advisors Lack of financial support	

4. What practices and combinations of practices are being adopted and why?:

Facilitated by Prof Jonathan Leake and Dr Katherine Berthon

After lunch, participants were asked to think about the different ways in which regenerative practices combine, and the contexts or situations under which some practices have worked better than others. A board was set up with a grid with soil texture types in columns from light to heavy soils, and regenerative principles as rows. Participants added post-it-notes with comments on which practices and combinations of RA practices worked well (green) or presented problems (pink) on the soil type they had experience with. An additional category was made for practices that had more complicated outcomes e.g. the practice worked initially but became problematic after some years or vice versa (orange). At total of 71 post-it-notes were added to the board. The participants were encouraged to share both successes and failures, as the latter are especially important for understanding risks, but there is strong anecdotal evidence of publication bias against reporting failures. **Table 3** contains the evidence as provided by farmers and other stakeholders during the workshop - these represent the personal experience of stakeholders and may not be representative of the outcome from implementing that practice for all farms on that soil type.

Responses by soil texture:

Most of the responding participants farm relatively heavy clay soils (29 post-it-notes), and loams (19 post-it-notes) as is typical of much of the lowland cropping areas of Eastern England, so the observations are most applicable for these soil types. A lack of notes for some other soil types (1 post-it-note for silt; and 13 for sandy soils) likely reflects lack of farmers at the workshop who farm these other soil types, and the smaller farmed areas of these soils. In addition, there were 9 post-it-notes that were not assigned to a soil texture type usually because the note was applicable across all soil types.

Responses by regenerative agriculture principles:

With respect to the five RA principles presented, "Minimizing soil disturbance" (i.e. moving away from ploughing) was represented by 33% of the post-it-notes, both "Keeping soil covered" and "Reducing synthetic inputs" each received 18% of the post-it-notes; "Maximizing crop diversity" received 14%, "Maintain living roots" received 10% and "Integrate livestock" only 6%. The limited comments on livestock integration practices may partly reflect the low frequency of mixed farms in Eastern England from which most of the participants came, compared to more western and southern regions. The comments made about integrating livestock were generally positive – such as "improved soil structure with herbal ley grazed by sheep" and "pasture fed cattle out year-round grazing herbal ley no insecticides no antibiotics".

Summary findings:

There was an evident trend for more challenges being encountered in implementing regenerative practices on heavy soils (58% pink post-it-notes) compared to lighter soils (42% pink post-it-notes for loams and 31% pink post-it-notes for sandy textured soils). For example, direct drilling presented multiple challenges in heavy clay soils, resulting from issues with compaction and poor structure that are less problematic for silty or loamy soils. One farmer recommended initially transitioning from ploughing and harrowing to minimum tillage for several years, rather than going straight to direct drilling for this soil type. These observations are consistent with scientific studies showing that recovery of soil biota and reassembly of soil aggregates that are adversely impacted by ploughing takes time, and benefits from the positive feedbacks generated by greater inputs of organic matter through living roots, and recovery of earthworm populations (Guest et al., 2022).

Direct drilling also suffered failures in particularly wet periods on most soil types, likely due to problems of poor drainage and less effective soil aeration in seed beds than with ploughing. However, farms who direct drill are often able to get on the land and sow crops when conventionally managed soils would be too wet to plough- so the outcomes may depend on the extent to which soil health has been built up. It would have been useful in retrospect to know how long farmers had been practicing regenerative agriculture and what practices they followed, to assess the context of successes and failures. Extreme heavy rain after crop sowing by direct drilling was noted as a cause of crop failures on heavy soils with multiple instances indicated by several farmers. Direct drilling works better in drier areas (Huang et al. 2018) and is expected to increase infiltration by larger earthworm generated macropores.

However, farmers commented that this only happened after a few years of consistent direct drilling, once soil biota recovers and earthworm generated macropores are numerous and soil organic matter is more concentrated in the upper topsoil (Sun et al., 2011). A slower transition via minimum tillage before switching to direct drill may allow for recovery of the biology of the soil to alleviate compaction issues from removing soil disturbance. Use of leys to build fertility and structure may accelerate successful transition to direct drilling (Austin et al., 2022). One farmer strongly recommended regular low-disturbance subsoiling in combination with direct drilling to avoid soil compaction in heavier soil types consistently.

Similarly, establishment of herbal leys and livestock integration into intensively cropped land were noted as more difficult on heavier soils, but the few farmers that tried implementation of these practices in lighter soils reported positive results in yields and reduced N fertilizer inputs. Multiple farmers reported using herbal leys or clover living mulches to reduce their fertiliser use while maintaining good yields in winter cereals. Notable examples included, on a sandy clay loam a 3-year grass-clover ley that was direct drilled gave wheat yields equivalent to a fertilized wheat, but using no N fertilizer additions! Direct drilling into a clover cover crop on a loam achieved 10.3 tonnes ha^{-1} wheat yields using only 110 kg N ha^{-1}, a result that was almost the same as reported for a grass clover ley at another loam site which achieved over 10 t ha^{-1} wheat with reduced N fertilizer. Additional benefits of 3-year leys included reductions of blackgrass. Interestingly, two farmers wrote their biggest challenge to reducing synthetic inputs was the need to change agronomist, and that they felt bad doing so.

Cover cropping was noted to work best when planted as a diverse mix, and early in the cropping rotation. Several farmers experienced issues in establishment and management of cover crops and transitioning from cover crops to the next arable crop, where density and timing became determining factors in success. For example, one farmer suggested that the density of cover crop planting influenced the effectiveness of blackgrass control, with lower density cover crops allowing blackgrass seed germination, which then could be successfully destroyed by grazing or and herbicide before the spring crop, thereby depleting its seed bank. Where blackgrass was not a problem denser sowing of cover crops was recommended to help maintain cover and living roots.

Several challenges were reported for establishing living mulches, either due to incompatible management strategies (e.g. slurry application destroying living mulch growth), or soil waterlogging and flooding issues. Living mulches can also compete with the crop, resulting in lower yields, and can present. In addition, thick cover crops were mentioned as keeping soils too moist in the spring on some of the clay soils, impeding establishment of spring crops, and many cover crops increased slug problems, with farmers expressing a need to increase slug pelleting.

Effectiveness of this mode of farmer engagement for peer-to-peer learning:

Overall, in a relatively short time at this workshop this session was helpful in revealing both successes and challenges in implementing RA from the participating farmers and researchers. The success of this engagement approach suggests that more workshops of this type assembling evidence from farmers experiences focussed on RA practices would provide an excellent tool to provide guidance and insights from current practitioners and support better peer-to-peer learning.

Table 3

Summary of the comments from the practice combinations discussion. Note that every point represents the experience of a farmer or researcher and should not be treated as representative of all farmers in these contexts. DD = direct drilling.

		Where it worked / was successful	Where it was unsuccessful	Places it sometimes works*
Minimise disturbance	Min till	**Clay Soil** • "Not ploughing to min till, major change in soil health including yield benefits"		
	Direct drilling	**Sandy/ Light Soil** • "Direct drilling on 3-year ley improved yields of wheat compared to long-term arable but not as much as plough" • "Direct drilling and retain straw – lower cost of establishment [with] herbicide for weed management" **Sandy/Clay soil** • "DD where used disc/ time previously" **Loam** • "Low disturbance subsoiling, allows direct drilling in heavier soil types, consistency as well" • "DD post 3 year ley wheat >10 tonnes ha with less N" • "DD wheat after grass, 9.5 t yield" • "Wheat DD into clover crop yield 10.29 t/ha N 110 kg/ha"	**Sandy/Light Soil** • DD spring barley on light land after prolonged wet winter soil had slumped- perhaps low disturbance needed • "Sowed winter wheat 2 days before storm Babette DISASTER on any soil" **Loam Soil** • "Crops drilled too late, did not grow as quick as conventionally drilled and were damaged by slugs" • "DD 2024 spring barley" • DD cereal > OSR, slug damage • "Poor crop when direct drilled and the surface has been compacted by the tractor or combine tyres at harvest" **Clay Soil** • "SLUGS- more issues = more slug pellet use in direct drilling" • "Direct drill in wet autumn 2023 on heavy clay"	**Clay Soil** • "Improved water infiltration in field direct drilled for a few years - seen after 3 years" • "Repeated direct drilling late in autumn (wet soils) → headlands deteriorated in health, lower yield caused [by] compaction from use of no till (need to use different cover crop)" **Loamy soil** • "DD not sure on this soil, waterlogging [issues], not resilient" **Sandy Soil** • Compaction – sandy land 8 years of direct drilling **Other** • DD worked in wheat/ wheat/OSR rotation

***** The 'Places it sometimes works' notes were only given with reference to direct drilling.

		Where it worked / was successful	Where it was unsuccessful
Minimise disturbance	Direct drilling	**Chalky Loam** • "Tine DD worked very well on the above soil type" **Clay soil** • "Direct drilling wheat into leys top performing wheat in rotation"	**Clay Soil** • "Sowed winter cereal 2 days before storm Babette → disaster" • "The move to a direct drill [from min till] was more challenging" • "Direct drilling wheat into a 2 year herbal ley and grass- clover ley fail" • "Spring cropping: general crop establishment is slower, % establishment reduced. Dry conditions suffer more when DD vs plough" • "DD just before intense rainfall on heavy land autumn 2023, crop failure compared to plough system - soil was too tight vs plough, slow germination and died off" **Other** • Spring drilling into green cover crops in Scotland has consistently poor establishment across all soil types
Keep soil covered	Cover crops	**Sandy/Light Soil** • "Shallow rooting cover crops" **Clay soil** • "Diverse mixes of cover crops deliver better outcomes, always have some survive/establish" • "Drilling green in the autumn i.e. into the cover crop, less soil compaction, living roots, more biodiversity" **Clay Loam** • "Militant about planting 100% cover/catch crop, straight behind the combine" **Other** • This cover crop mix works on all soil types – Phacelia, oilseed radish, tillage radish, mustard vetch, crimson clover, winter peas, buckwheat, sunflower, beans • If blackgrass present, a lower density cover crop works best, otherwise a higher density cover crop can work	**Clay Soil** • "Radishes on heavy soil means high slug burden" • "Establishing a spring crop following a cover crop (high biomass), on heavy soil - i.e. soil too wet" **Clay Loam** • "Half-life of herbicides affecting growth of next cover crop" • "Poor establishment in chopped straw (both catch crop and winter wheat/barley) especially on a windy day combining" •

		Where it worked / was successful	Where it was unsuccessful
Maintain living roots	Living mulches	**Sandy/Light Soil** • Living mulch - gives longer periods suitable for sowing crops in spring, and is easiest on sandy/loam	**Sandy loam** • "Strip crop wheat into clover. Poor seedling establishment in places and increased fungal disease pressure" **Loam soil** • "Slurry on understory of clover – clover died!" **Clay loam** • "Establishing microclover in spring beans (lynx) had a lower yield compared to same variety growing in the next door field" **Clay soil** • "Belief that worms and roots can deal with soil drainage- need infrastructure first" **Other** • Using living mulches (clovers) in organically grown cereals – challenges with managing competition and weeds
Maximise diversity	Diversify crop rotation	**Loam** • Mixed wheat varieties **Clay soil** • "Reduced blackgrass by delayed drilling in autumn and diverse rotation"	**Sandy/light soil** • "Letting out land for root crops - destroyed soil structure, land not suitable for direct drilling" **Loam** • Understory outcompeted by volunteers **Other** • Use plant populations instead of pure-line varieties, e.g. CRC Wakelyns Population across network of organic farmers in the UK (different soil types)
	Herbal leys	**Sandy/light soils** • "Herbal leys- lighter (soils), easier but heavier (soil) is more challenging, livestock health/ production, climate resilience, soil health" **Loam** • "3 year ley grazed or mown reduced black grass" **Sandy clay loam** • "A winter wheat (zero N fertiliser) following a 3-year grass/clover ley yielded equivalent to a fertilised wheat"	**Clay soil** • "Herbal leys/seed mixes implemented not as successful as expected, e.g. GS4 on upland farm"

		Where it worked / was successful	Where it was unsuccessful
Integrate livestock	Living mulches	**Sandy/Light Soil** • "Improved soil structure seen after herbal ley grazed by sheep" **Clay soil** • "Adding leys into arable rotation and grazing cattle" **Loam soil** • "Pasture fed cattle - out for a year grazing herbal ley permanent pasture, no insecticides no antibiotics"	
Reduce synthetic inputs		**Sandy/light soils** • "3 year herbal ley better than grass clover ley for subsequent wheat field using 100 kg N ha compared to conventional arable 200 Kg N ha" **Sandy loam** • strip crop wheat into clover, Reduction in fertiliser usage whilst maintaining yield and reduced pest pressure **Loam** • "3 year mown grass- clover ley direct drilled - netted UK average wheat yield with 35 kg N ha" • "3 year ley DD post glyphosate, wheat yield >10 tonnes Ha using soil N fertiliser (100 kg N per ha)" **Clay soil** • "Habitat provision - biodiversity in landscape improved so reduced need for pesticides- edges, hedges, strips" • "More scientific + crop/context specific move to regen agronomist" **Other** • A focus on soil biology helps in all soil types • Reduction in especially fungicide	**Loam soil** • OSR No insecticide – heavy [flea] beetle damage – Yield 1.7t/ha **Clay soil** • Needed to change agronomist • More issues with slugs – need to use slug pellets when direct drilling • "Remove glyphosate control so need for shallow cultivation which dried soil out in spring [leading to] reduced yield" • "Not every season but black grass (herbicide) control on heavy land is poorer than plough"

5. Contentious issues in regenerative agriculture:
Facilitated by Prof Pippa Chapman

Throughout the workshop, participants were encouraged to write topics that they felt were contentious issues in RA on cards and post them anonymously into a post box. The 40 contentious issues submitted into the post box were collected, collated and summarised (**Table 4**). Pippa Chapman chaired this session and highlighted several of the issues that had been posted and allowed an opportunity for open-floor discussion around some of the contentious issues raised. Key issues discussed in the plenary session were those that received the most mentions, such as the use of glyphosate, pros and cons of certification of RA, soil carbon (credits), market and policy drivers of RA, and the potential for offshoring food production.

Glyphosate use:

This was the most common contentious issue raised, with seven people independently writing it on the posted cards. The main concern was around its use to terminate cover crops in RA, with several farmers saying that glyphosate was the only viable way to terminate cover crops. However, some were worried about increasing resistance of weeds to herbicide use. This was followed by a discussion about responsible and irresponsible use of glyphosate, that included the following comments; it's easy to be lazy and over apply when it's widely available; the way you apply glyphosate matters - the likelihood of resistance developing is higher if you use less product per application than advised on the label, better to use the recommended product per application; pre-harvest desiccation is an irresponsible use of glyphosate. There were also comments about looking to the organic farming community for inspiration on reducing pesticide use. However, organic farming has traditionally used ploughing to control weeds, so there is currently a trade-off between glyphosate usage and ploughing. There were also comments about the fact that the current (business as usual) farming system is extremely chemical based, and that new solutions are needed. Overall, the discussion on glyphosate highlighted the challenges of terminating cover crops and controlling weeds in RA and that these are areas where further research is required.

Certification of RA:

Three people mentioned whether there was a need for certification of RA and therefore the pros and cons of certification were discussed. The benefits of certification were considered to be: (i) Avoiding greenwashing as certification can help inform consumers that products have been grown according to certain standards. (ii) Helping open-up markets for products, as some distributors may be looking for certified RA products and being paid a premium for the products. The downside to certification of RA were considered to be: (i) Expensive for both farmers and consumers. (ii) Could restrict the transition to RA. Overall it was felt that farmers needed multiple ways to adopt RA, which may vary for farm type and soil type, so certification schemes would also need to have inbuilt flexibility to reflect this, but not so much that greenwashing is prevalent. Some farmers said that weather has more effect on the success of RA than soil-type and given the increase in extreme weather events (floods and droughts) it is important for farmers to be flexible in how they implement RA. Whilst premiums for RA products was seen as favourable by many, it was acknowledged that this may not be possible as more farmers adopted RA. It was also felt that it is important to avoid gate-keeping of what RA means, particularly if the goal is to see most farmers adopt RA. It was noted that some agri-food businesses have already begun to implement premiums for RA. For example, the milk cooperative *First Milk* announced they will pay farmers an additional 0.5p per litre of milk for adopting regenerative farming practices at field level. Similarly, the Landscape Enterprise Networks (LENs) led by 3Keele and involving companies such as Nestle and Diageo are also rewarding regenerative farmers for environmental outcomes.

Table 4. Contentious issues posted by attendees in a post box at the workshop

Issue	Additional comments
Glyphosate use	Increased use of to spray off cover crops; Use as a desiccant; Chemical companies don't want farmers to move to RA
How to include the supply chain/big businesses in the transition to RA?	
Market demands/ties/drivers	Can restrict diversification of crop rotations & associated benefits; millers and maltsters not taking blends of wheat/ barley or requiring high protein contents in wheat
Disjunct between time to transition to RA and political cycles	
Soil carbon – baseline/credits	Baseline soil carbon stocks across England with a government approved scheme – would stop procrastination
Is GMO and gene editing of crops acceptable in RA?	
Impact of RA on GHG emissions – limited data	
Biodiversity benefits of RA – not measured at appropriate scale	
Need to hear more about how dairy and livestock farming systems move to RA	Grasslands need to be represented as well as arable in research projects
Impact of outwintering on animal welfare issues, especially in upland areas	
Is RA producing more food for livestock or humans?	Links to market demands issue
Do RA farming journeys have an end point?	How far along this journey do you need to be to get there?
What is the trade-off between GHG emissions and RA?	
Businesses are co-opting RA/corporate greenwashing	
Is there an over-riding presumption that RA is always better in all farm systems and for all sol types?	Does this presumption affect the direction of research and lead to bias in results and conclusions?
Diet	People need to eat less meat
Land sparing (sustainable intensification) versus land sharing (agroecology/RA)	Yields may be lower in RA systems – so need more agricultural land or offshore food production
Does RA need to be defined?	
Pros and Cons of RA certification	
Reducing synthetic inputs key to RA	How are AgriChem companies adjusting their business models? Are agronomist trained to give advice to farmers transitioning to RA?
Long-term data from RA farms	Are we collating data, making a data base
Synthesizing the Evidence	Can generate evidence gaps and research questions
RA food labelling and tracing	Passport system that clearly documents the additional value of RA food
Failures in implementing RA	

Soil carbon:

Four people mentioned soil carbon as an issue. In particular they raised the issue of how carbon sequestration in being monetarised (via credits) without adequate monitoring, reporting and verification (MRV) schemes. There were also concerns about the level of farmer understanding and engagement around soil carbon (credits) and the need for clear 'plain English' statements around the topic. There was concern about the lack of a soil carbon baseline on farms, and the use of insetting by agri-food businesses to use carbon on farms to reduce their GHG emissions (scope 3). Some felt that a soil carbon baseline, with a government backed methodology (as being carried out in Northern Ireland via the Soil Health and Nutrient Scheme), across England would encourage farmers to participate in projects/farming practices that sequester carbon, rather than procrastinating.

Market and policy drivers:

There were many issues raised about the role of the supply chain/agri-businesses/government in influencing/controlling the type of agricultural products produced in the UK and that there was need for change to promote uptake of RA. It was felt that one of the main drivers for changing agricultural systems is changing diets. However, it was felt that this requires policy change and more support from the government. The other way many participants felt RA could be promoted is to get large-scale food producers (e.g. Nestle, McCains, etc) on board for system-wide mainstreaming of RA. Several major financial investors, including Barclays and Lloyds, have recently committed substantial investments to RA, and some brands such as Nestle, McCains and Diageo have begun promoting RA in their supply chains.

However, it was felt that if RA becomes mainstream then premiums would be diluted, as it is likely that only small number of farms will be able to get premiums for RA products. It was felt that diversification of crop rotations (one of the key RA principles) should include adding new crops and not just relying on traditional crops. But it was acknowledged that this needs new markets and consumers to change their diets. For example, more legumes could be grown in RA systems as they help regenerate soil health and fix nitrogen, and therefore reduce the use of synthetic fertiliser. Beans are also healthy as they are high in protein, and low in fat. However, the UK's consumption of legumes is low, and we import most of the beans we eat, except for fava beans. Most beans grown in the UK go to livestock feed. Farmers also mentioned that there are currently technological and financial barriers to harvesting companion crops (practice used in RA to increase soil health and crop productivity) in terms of the need to separate the harvested seeds and the potential for additional drying costs. Other limitations on selling RA products are associated with the fact that most millers do not buy mixed varieties of wheat. Others felt that there were opportunities to make brand and marketing opportunities out of RA products.

Offshoring food production:

Three people mentioned the fact that yields in RA systems may be less than in conventional systems and would this not result in the UK importing more food and therefore offshoring food production. Long-term data from RA systems are needed to better understand the impact on yield and quality of crop/product.

Overall, the session was successful in achieving its aims, as it facilitated and encouraged different stakeholders discussing some of the contentious/difficult topics surrounding RA.

6. Priorities for future research and other issues:

Facilitated by Dr Katherine Berthon

The final session of the day was a panel discussion to summarise the priorities for future research and key take away messages from other workshops sessions. Five panellists, Karen Fisher (Soil Association), Fraser Hugill (farmer), Belinda Bailey (Syngenta), Prof Jonathan Leake (H3, University of Sheffield) and Dr Ruth Wade (FixOurFood, University of Leeds), were invited to share their experience of the workshop before an open discussion with questions from the room. Key themes from the discussion were the importance of context, the need for collaboration and rapid synthesis of information, mentorship and sources of advisory information, and appropriate metrics for measuring change.

Farm context:

A key theme throughout the workshop and highlighted in the discussions was the importance of soil type and farm context for the successful transition to RA, but also the key need for flexibility in the face of climate change and extreme weather events. The differences in the implementation of regenerative farming in the two farming clusters of the H3 project, and biodiversity outcomes for the two farming clusters emphasises the need for context specific guidelines on best practice. Similarly, the workshop activity on practice combinations began to dissect which practices work best in different soil types but needs to be expanded upon to include more soil types and more regions of the UK. In addition, there is a need to expand research to test RA principles and practices in all farming contexts.

Negative results:

Crop and/or practice failures are very rarely published in popular press articles and academic journals, nor are they often discussed or highlighted but are commonly experienced by farmers when performing RA (see practice combinations discussion). This is a significant issue: without the knowledge of what hasn't worked, other farmers are likely to make the same mistakes potentially impacting farm business, food production and farmer welfare (feeling like they have failed at something not realising that others have had the same issue). There are further risks such as without knowing the failures exist researchers may continue to invest research time into things that don't work, and governments may underestimate the challenges associated with specific practise and not provide enough support or target support where it is needed. How to ensure research maintains unbiased and does not dismiss negative results is a key challenge.

Research funding:

Current agricultural research approach is focussed on maximising yield and gross margins. An alternative research method is to prioritise a systems-based approach based on long-term collaborations across multiple disciplines, sectors and networks to create effective, efficient regenerative food production systems. RA systems can be based on a 10-year rotation which includes a diversity of crops and practices. Research projects are typically funded for 1-5 years, which does not provide enough time to fully measure and realise the potential of RA in different years (different weather patterns) and across diverse rotations. Longer-term funding is needed to support on farm trials and knowledge exchange hubs to provide RA evidence-based practice. In particular, the financial viability of RA needs to be evidenced.

Collaboration across projects:

There is a lot of research engagement from universities, agricultural businesses, advisory bodies, NGOs, charities, government, and farmers, all who are working to better understand and support the transition to RA. The presentations indicated that there was a diversity of RA research going on across the UK, but that most of research projects were disconnected from each other. There is not currently a co-ordinated programme for research on RA and the potential for overlap, collaboration, evidence and database building and alignment across existing projects was highlighted as a major future priority for RA research.

There is a need for synthesis and dissemination of research in a form that farmers can understand, utilise and apply. Similarly, farmers have been trialling regenerative practices for a long time and research needs to capture and synthesise this knowledge in a way that respects farmer expertise and allows for tailored advice for farmers thinking about, and during their transition to RA. There was a suggestion that the RA movement could benefit from learning from medical literature for rapid synthesis of information to attempt to collate all the existing literature for dissemination to farmers (who are often disconnected from current research). It was suggested that such a synthesis would work best not as a static entity but something that was constantly updated, perhaps as frequently as once a year with an event to facilitate distribution of the latest findings.

This kind of project would require significant investment and resource, and there was some discussion on who could be responsible for co-ordinating and funding a RA data base and annual synthesis event. Could one of the following organisations support such a scheme: researchers, advisory bodies like AHDB or DEFRA, or farming institutions like the Innovative Farmers Network? Several existing projects in other areas, e.g. conservation evidence, could be used to guide setting up a structure for rapid synthesis for UK agriculture.

Mentorship and sources of information:

The transition to RA is an uncertain process, with potential risks, and there was much discussion about how to guide farmers on their regenerative journey, especially considering that soil type and context play such large roles in success. Most farmers gain their information from peer-to-peer networks, highlighting the importance of farming forums, and communities as support systems for transitioning farmers. Farmer clusters were highlighted as key social elements for knowledge sharing and support networks for farmers that are transitioning practices. Farmer clusters can also serve as useful structures to allow engagement with research while limiting the burden on individual farmers. For researchers, farmer clusters represent an already well-coordinated group of farmers who already know each other and work well together, which can reduce administrative burdens on projects. Similarly, there is a large and active network of regenerative farmers on social media platforms (e.g. X, formerly known as Twitter), and farmer networks such as farming clusters, The People's Food & Farming Alliance (PFFA), and mentorship programmes were highlighted as key mechanisms to support newly transitioning farmers. However, these projects need to be fully funded so that farmers and researchers time are covered as well as funding to collect samples, sample analysis and importantly data analysis, synthesis and dissemination of results.

There was also a call for a review to the advisory material produced by AHDB and ADAS which is based on conventional practices. Farmers have begun to generate their own advisory material to fill this gap (e.g. the Cover Crops Guide funded by Innovate UK and a partnership between farmer, researchers, and allied organisations). Formal advisory advice could be updated or created, particularly covering the following topic areas:

- How to begin reducing fertiliser and pesticide inputs, and new guidelines on nitrogen additions.
- Recommended grassland and cover crop species – including consideration of provenance of seed.
- Understanding which crop varieties perform well under RA practices in different soil types, particularly those tolerant to lowered inputs and reduced tillage.

As part of the discussion, AHDB announced that the RB209 nutrient management advice is under review and seeking input from farmers. AHDB are similarly open to a review of their recommended grassland and clover species lists.

Research is needed to support farmers as innovators to continue to trial and develop new approaches or expand knowledge to different contexts. This could be farmer led via funding from Innovate UK, Innovative Farmers and British on Farm Innovation Network (BOFIN), that engages with researchers and agri-businesses to test and evidence new farming practices and technologies on real farms. It is crucial to collate and synthesise the experience and learnings of well-established regenerative farmers and measure the outcomes of what is already being done, while respecting farmers ownership over their knowledge, data and supporting farmers as innovators.

Future research should consider how best to set up systems for two-way communication between researchers and farmers for providing background information related to practices to researchers, and to allow researchers to quickly and efficiently disseminate their findings.

Defining regenerative agriculture and appropriate metrics:

Flexibility in the definition of RA has allowed farmers to adapt regenerative principles that suit their farming context, and this has been a large part of the success of the RA movement, but this also created challenges. Without a unified definition, it is difficult to define and measure the impacts of RA. Lack of a unified definition has also hindered the development of a premium for regeneratively grown crops, like that for organically grown crops. The H3 project are currently trialling a metric system, which could allow farmers to track where they are on their regenerative journey and how that matches to the outcomes they expect to see.

The appropriateness of the metrics and measurement of RA transitions will depend on the purpose and aims of the farmers and/or research. Understanding the impact, and the outcomes of regenerative practices is important to align funding structures to reflect the true delivery of public goods, such that farmers are appropriately compensated for the cost of producing goods and incentivised to improve the delivery of ecosystem services. There are large demands for metadata on farming systems (e.g. order of implementation, crop type, soil characteristics, inputs, cultivations etc.) for researchers to better understand the outcomes of implementing regenerative practices. However, the metrics that researchers use to understand the RA system may not be the same ones that farmers use to make management decisions.

Conclusions

In conclusion, the workshop illuminated the need for comprehensive, context-sensitive RA research and the value of farmer-driven knowledge and co-design/creation/production. Industry and government stakeholders are increasingly concerned about rising risks to the UK food system, including soaring input costs such as fertilizers, and pesticides, driven in part by geopolitical instability, as well as escalating issues like flooding and species decline. RA offers potential to help mitigate these risks, yet more research is needed to understand its practical impacts, including any trade-offs in yields and profitability, and impacts on environmental outcomes, including soil health, biodiversity and GHG emissions.

Suggested future research priorities include exploring RA impacts across multiple soil types, tracking success rates for different practices over time, research on weed control in RA systems, and expanding farmer participation to encompass the full range of farm types. Integrating diverse stakeholder insights and addressing systemic challenges will be pivotal in scaling RA practices effectively and sustainably across the agricultural sector. Therefore, future funding towards RA research should prioritise multi-actor approaches to ensure effective, and impactful outcomes. There are existing precedents for this kind of research approach; for example, the European Horizon programme includes a clear requirement for multi-actor approaches to guarantee successful co-design.

Specifically, there is a need to develop a coordinated, national RA research programme across universities and farming organizations. Research should prioritise creation of a platform with a synthesis of RA research accessible to farmers and updated annually.

There is also a need to engage with policymakers in all devolved nations of the UK (e.g. the Department for Environment Food and Rural Affairs in England) to ensure that agri-environment schemes are effective in incentivising change and consider the long-term process-based nature of regenerative transitions. For example, 'Regenified' is a farmer-led independent evaluation body for RA that has developed a tiered system to encourage and support transitioning farmers. In addition, there is a need for researchers to provide data and information on the environmental outcomes of RA, to estimate the contribution that RA could make to environmental targets set out in the 25-year Environment Plan, including net zero.

Participant feedback from the workshop

At the end of the conference, participants were asked for feedback on how they perceived and applied RA post-workshop, as well as topics for future discussion that were underrepresented. There was a low response rate (n=20), but the feedback was overall positive, and several participants commented that they had not thought much about RA before the workshop and had gained a deeper understanding of its application and associated challenges throughout the day. Some farmers commented that they would try integrating more utilisation of livestock grazing, companion or cover crops in their rotation following the workshop, suggesting that the research and conversations during the workshop had increased the confidence of farmers to implement regenerative practices.

While many participants enjoyed seeing the results from the TUFKS research projects, for many, the main takeaway was that research is behind practice, solidifying the need to have farmers involved in co-designing future research programmes. The ability to converse across disciplines, and with farmers on different soil types was seen as a hugely positive aspect of the workshop, and many would have liked to have heard more from farmers themselves at future events. Learnings from farmer experiences, particularly during the practice combinations exercise was also a highlight. A few participants noted an imbalance in attendance from different sectors - more than 50% of participants were from research or allied organisations - and suggested the next event should have higher farmer representation.

Multiple participants commented that there is fantastic work being undertaken, but there were seemingly very similar projects going on in different locations, emphasising the need for future collaboration across research institutions, landscapes and across sectors. Many saw the possibility for synergies between related projects, particularly for providing joint learnings across FixOurFood and H3, but also a lot of repetition which could be avoided by fostering greater collaboration and information sharing across projects. In addition, a holistic systems-based approach, as used in the TUFKS programme, was seen as necessary to creating resilient and sustainable farming systems.

Moving forward, a few participants commented that large retail chains and supermarkets should be involved in the discussion, so they are not as disconnected with the challenges farmers face on the ground. We did invite several large retail chain representatives to the workshop, but unfortunately none could attend. Several participants thought there was an opportunity to more explicitly engage with mixed farming systems and meat production, particularly the balance between use of grazing and manures, and the environmental impacts of livestock e.g. for GHG emissions, or alternative N sources (e.g. foliar amino acids). Many emphasised the need for context specific information and would like to see the TUFKS projects scaled up to encompass multiple soil types and or production systems to act as case studies for farmers to use.

Participants also emphasised how RA was not a one size fits all solution, requiring adaptive farming, and context specific knowledge. This requires engaging with the lived experience of farmers, for their soil and farming context, and better understanding of why and how things are working, or not working for different landscapes and farming systems. There is a need to find win-win scenarios and ensure that RA remains inclusive and rewards farmers for environmentally sustainable soil management, even if they don't want the regenerative label. Multiple participants mentioned that research outcomes were not available to practitioners, and there was a need for accessible platforms for communicating the best practices for different soil types, climatic conditions and farming systems.

References

Austen, N., Tille, S., Berdeni, D., Firbank, L.G., Lappage, M., Nelson, M., Helgason, T., Marshall-Harries, E., Hughes, H.B., Summers, R. and Cameron, D.D., 2022. Experimental evaluation of biological regeneration of arable soil: The effects of grass-clover leys and arbuscular mycorrhizal inoculants on wheat growth, yield, and shoot pathology. ***Frontiers in plant science,*** 13, p.955985.

Berthon, K., Jaworski, C. C., Beacham, J. D., Jackson, P., Leake, J. R., McHugh, N. M., ... & Dicks, L. V. (2024). Measuring the transition to regenerative agriculture in the UK with a co-designed experiment: design, methods and expected outcomes. *Environmental Research: Food Systems*. https://doi.org/10.1088/2976-601X/ad7bbe

George, T., Hawes, C., Valentine, T., Karley, A.J., Iannetta, P.P.M., Brooker, R.W. (2022). Harnessing ecological principles and physiologic mechanisms in diversifying agricultural systems for sustainability: experience from studies deploying nature-based solutions in Scotland. ***Frontiers of Agricultural Science and Engineering***. 9(2): 214-237 https://doi.org/10.15302/J-FASE-2021437

Guest, E. J., Palfreeman, L. J., Holden, J., Chapman, P. J., Firbank, L. G., Lappage, M. G., ... & Leake, J. R. (2022). Soil macroaggregation drives sequestration of organic carbon and nitrogen with three-year grass-clover leys in arable rotations. ***Science of the Total Environment***, 852, 158358.

Hawes, C., Young, M.W., Banks, G., Begg, G.S., Christie, A., Iannetta, P.P.M., Karley, A.J., Squire, G.R. (2019). Whole-Systems Analysis of Environmental and Economic Sustainability in Arable Cropping Systems: A Case Study. ***Agronomy***, 9, 438. https://doi.org/10.3390/agronomy9080438

Huang, Y., Ren, W., Wang, L., Hui, D., Grove, J. H., Yang, X., ... & Goff, B. (2018). Greenhouse gas emissions and crop yield in no-tillage systems: A meta-analysis. ***Agriculture, Ecosystems & Environment***, 268, 144-153. https://doi.org/10.1016/j.agee.2018.09.002

Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023). Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp. https://dspace.lib.cranfield.ac.uk/server/api/core/bitstreams/73e67d8d-3644-44a6-a4fc-3723681bc39c/content

Jaworski, C. C., Krzywoszynska, A., Leake, J. R., & Dicks, L. V. (2024). Sustainable soil management in the United Kingdom: A survey of current practices and how they relate to the principles of regenerative agriculture. ***Soil Use and Management***, 40(1), e12908. https://doi.org/10.1111/sum.12908

Sun, B., Hallett, P.D., Caul, S., Daniell, T.J. and Hopkins, D.W., 2011. Distribution of soil carbon and microbial biomass in arable soils under different tillage regimes. ***Plant and Soil,*** 338, pp.17-25.

Acknowledgements

This workshop was funded by BBSRC under the Global Food Security Programme in collaboration with the Transforming UK Food System Programme.

We would like to thank the numerous contributions from farmers, researchers and industry representatives that shared their experiences and knowledge, which led to the rich discussions at the workshop and that informed this report. Tracey Duncombe from the Transforming UK food systems programme carried out video interviews with some of the workshop participants, which are linked below:

Ruth Wade, FixOurFood researcher

Angus Gowthorpe, Regenerative Farmer

Martin Lines, Regenerative Farmer

Bob Doherty, Principal Investigator, FixOurFood

Lynn Dicks, H3, University of Cambridge (Part 1)

Lynn Dicks, H3, University of Cambridge (Part 2)

Niamh McHugh, Head of Farmland Ecology Research, GWCT

A special thanks to Sophie Stewart, Belinda Morris, Rebecca Newman and Rebecca Goodman who helped facilitate the workshop, and Peter Jackson and Lynn V. Dicks who assisted with finalising the report text.

Report to be cited as: Berthon, K., Wade, R., Leake, J.R. and Chapman, P.J. (2024) *Sharing Experiences of Regenerative Agriculture: Report on Workshop*. Transforming UK Food Systems Programme.

DOI: 10.5281/zenodo.14144400

Appendix A: Workshop attendees

Representation from the following organisations attended the workshop:

5m Books
AHDB
NIAB
Allenford Farms
BBSRC
Breckenholme
CE & SJ Mills
Cranfield University
Cumulus
Direct Driller Magazine
Farmer Scientist Network / Yorkshire Agricultural Society
FERA Scientific Ltd
Bradford council
GWCT
Harper Adams University
J & E Dickinson
K M & C A W Gowthorpe
Nature Friendly Farming Network
North York Moors National Park Authority
Rowbottom ltd
RSK ADAS
Soil Association
Sustainable Soils Alliance
Syngenta
Systems4food Ltd
The Organic Research Centre and UK Grain Lab
UK Agri-Tech Centre
UK Centre for Ecology and Hydrology
University of Bristol
University of Cambridge
University of Leeds
University of Lincoln
University of Sheffield
University of Surrey
University of York
West Cambridgeshire Hundreds Farm Cluster
Yorkshire Dales National Park Authority

Appendix B: Opportunities and goals

The 20 opportunities and goals as presented to participants were:

1. Increase soil organic carbon
2. Improve soil structure and functioning
3. Improve infiltration rates and drainage to reduce flooding
4. Increase crop system resilience to extreme weather
5. Reduce persistent weeds (such as blackgrass)
6. Improve crop health and yields
7. Diversify rotations
8. Regenerate beneficial soil organisms, earthworms, mycorrhizas, beneficial bacteria
9. Increase above-ground biodiversity
10. Promote biological controls and natural enemies of pests
11. Reduce synthetic fertilizer use
12. Reduce fuel used in ploughing
13. Reduce use of insecticides and other pesticides
14. Increase profit margins
15. Increase livestock health and meat production (on cover crops, leys and grazed crops)
16. Future proof the farm business and increase commercial opportunities
17. Improve consumer opinion
18. Reduce greenhouse gas emissions
19. Save time/ reduce staff costs
20. Gain access to government subsidies

Appendix C: Challenges and barriers

The 16 challenges and barriers presented to participants were:

1. Lack of evidence of the benefits of RA
2. Lack of information on best practice
3. Lack of financial support
4. Increased risk to business
5. Reduced yields
6. Learning new skills
7. Financial input
8. Lack of peer or family support
9. Lack of supply chain
10. Requires new equipment
11. Too loosely defined
12. The outcomes depend on soil type
13. Lack of RA advisors
14. Climate in weather patterns
15. Greenwashing
16. Lack of regulations