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Review

A scoping review of UK evidence for the impacts of regenerative agriculture practices on net greenhouse gas balances

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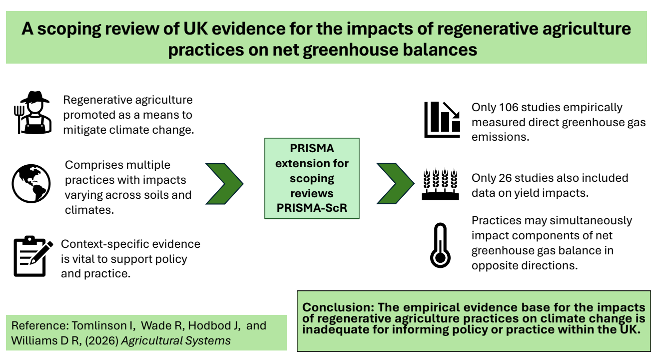
HIGHLIGHTS

- Evidence for impacts of UK regenerative agriculture on climate change is limited.
- Only 106 studies empirically measured direct greenhouse gas emissions.
- Only 26 studies also included data on yield impacts.
- Comprehensive assessment of the net greenhouse gas balances is precluded.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: ‘Regenerative agriculture’ (RA) is being advocated as a means of mitigating climate change. Global-scale meta-analysis and evidence reviews on the impacts of individual RA practices suggest some climate benefits. However, RA's climate impacts appear to be highly site specific and dependent on local climate and soil conditions. Evidence from one region may therefore not provide a robust basis for informing policy or practice elsewhere.
OBJECTIVE: Despite the momentum behind RA, we are not aware of any peer-reviewed evidence synthesis that assesses whether the UK evidence base for RA's purported climate impacts can robustly guide policy and practice. We use a scoping review of the peer-reviewed empirical literature in the UK to address this knowledge gap.
METHODS: We use the PRISMA extension for scoping reviews (PRISMA-ScR). We use a five-step framework to structure the review: identifying the research question; identifying relevant studies; study selection; extracting and charting the data; and collating, summarizing, and reporting the results. We consider empirical evidence that measures the impact of RA practices on components of net greenhouse gas balances.
RESULTS AND CONCLUSIONS: The empirical evidence for the impacts of RA practices on net greenhouse gas balances in the UK is inadequate for robustly informing policy or practice due to five main limitations. Firstly, data are only available for 30 of 90 RA practices we identified, with entire areas of RA activity having little-to-no empirical evidence. Secondly, 64% of studies were from in England, meaning that data available to support decisions for the specific farming systems, soil types, and climates in Scotland, Wales and Northern Ireland is

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further limited. Thirdly, most practices for which we found some empirical evidence are supported by very few studies. Fourthly, comprehensive assessment of the net greenhouse gas balances is precluded because data are only available for a limited range of greenhouse gas or carbon responses. Finally, only 21% of the studies considered yields alongside net greenhouse gas balances reducing stakeholders' ability to assess overall impacts.
SIGNIFICANCE: Our review found remarkably little evidence for the impacts of RA practices on net greenhouse gas balances in the UK, given the considerable interest from a range of actors. It is clear that considerable evidence needs to be generated rapidly to ensure that the most effective practices, either RA or other approaches, are promoted in appropriate locations.

1. Introduction

Originally coined in the 1980s in the USA (Rodale, 1983), the last decade has seen an international resurgence of interest in 'Regenerative agriculture' (RA) (Newton et al., 2020)· It is promoted as a solution to the multiple environmental problems caused by current agricultural systems by improving soil health, restoring biodiversity (Giller et al., 2021) and improving crop yields (Dabalen et al., 2019) while building resilience in agroecosystems (IPCC, 2019).

Despite little consensus over how to define RA (Beacham et al., 2023; Jayasinghe et al., 2023; Newton et al., 2020) which can refer to processes, outcomes or both (Newton et al., 2020) —five broad principles have emerged: *minimizing soil disturbance; keeping the soil covered; keeping living roots in the soil all year round; maximizing plant diversity*; and *integrating livestock* (Groundswell, 2025; RASE, 2025). A sixth principle of accounting for local or farm 'context' is also often included. These principles can be achieved using a wide range of individual agricultural practices ranging from the relatively mainstream (e.g. using cover crops, reduced tillage), to less widely adopted (e.g. permaculture and food forests) (Giller et al., 2021).

Significantly, RA is now being advocated as a means of mitigating climate change, primarily through soil carbon sequestration (Rehberger et al., 2023). Global-scale meta-analysis and evidence reviews on the impacts of individual RA practices suggest some climate benefits (Bai et al., 2019; De Stefano and Jacobson, 2018; Ngaba et al., 2024; Pulido-Moncada et al., 2022; Poeplau and Axel, 2015; Rehberger et al., 2023; West and Post, 2002). However, the magnitude and even direction of RA's climate impacts appear to be highly site-specific (Blanco-Canqui, 2013), dependent on local climatic and soil conditions (Bai et al., 2019; Mondal et al., 2023; Ogle et al., 2019; Pan et al., 2025) and both existing, and historical, land-use practices (Rehberger et al., 2023). Evidence from one region may therefore not provide a robust basis for informing policy or practice elsewhere (Khangura et al., 2023).

Given the importance of context, we take the UK as an exemplar region to assess the region-specific evidence base for the climate change impacts of RA practices and how this could inform agricultural practice and policy. The UK has a long history of agricultural research, for example being home to the oldest continuing agricultural field experiments in the world (Rothamsted Research, 2025). It has been a global leader in public funding for climate-change research (Sovacool et al., 2022) and was the first major economy to enshrine 'Net Zero' targets into legislation (UK Government, 2019). The 2008 Climate Change Act established the Committee on Climate Change (CCC) to advise the Government and report on progress made. The UK now has legally binding targets to achieve Net Zero for the combined agriculture and land use sectors by 2050 through 'low-carbon farming' approaches and carbon sequestration from woodland expansion and peatland restoration (Climate Change Committee, 2025. Following the withdrawal of the UK from the EU in 2020, UK agricultural policy is no longer directed by the Common Agricultural Policy and new support schemes for farmers are being developed and established across England and the Devolved Nations of Scotland, Wales, and Northern Ireland (Welsh Parliament, 2024; DAERA, 2025; UK Parliament, 2025; Defra, 2025). Understanding the impact of such schemes on greenhouse gas emissions (GHG) emissions remains a research priority for the Department of Environment, Food and Rural Affairs.

In this context, UK-based NGOs, farmers organizations and agri-food companies are promoting RA practices as a means to reduce the carbon footprint of agriculture (Nestle, 2025; Regenerative farmers of UK, 2025; WWWF, 2025). Private sector support includes certification, training opportunities, and establishing RA as a means to access carbon markets (AGW, 2025; RAU, 2025; Regenerate Outcomes, 2025). Significant private investment (£3.9 million in 2024) by multinationals in UK farms practicing RA is occurring through the Landscape Enterprise Networks (LEN, 2025).

Despite the momentum behind RA, we are not aware of any peer-reviewed evidence synthesis that assesses whether the UK evidence base for RA's purported climate impacts can robustly guide policy and practice. Here, we use a scoping review of the peer-reviewed empirical literature in the UK to address this knowledge gap. We include a broad range of potentially regenerative practices to account for the lack of clarity over defining RA. We consider empirical evidence that measures the impact of RA practices on components of net greenhouse gas balances and identify studies that measure *direct* greenhouse gases and carbon sequestration. These include nitrous oxide (N_2O) flux, net carbon fluxes between soil–plant systems and the atmosphere, and methane (CH_4) flux (Lehuger et al., 2011). We did not include indirect emissions such as off-farm N_2O emissions from nitrogen volatilization, deposition and leaching (IPPC, 2019), combustion, and use of machinery on the farm (Lehuger et al., 2011).

2. Materials and methods

2.1. Scoping review

Scoping reviews are a systematic approach to mapping the evidence on a topic (Tricco et al., 2018) to understand the extent, range and nature of published literature and identify research gaps (Arksey and O'Malley, 2005). Scoping reviews differ from systematic reviews because authors do not assess the quality of the included studies (Levac et al., 2010), and unlike meta-analysis they do not attempt to provide a quantitative assessment of the relationship between two variables or the effectiveness of an intervention (Hansen et al., 2022.

We used the PRISMA extension for scoping reviews (PRISMA-ScR) (Tricco et al., 2018). The research protocol and all our datasets and supplementary information are available on the Open Research Framework ORF (OSF | A scoping review of UK evidence for the impacts of regenerative agriculture practices on net greenhouse balances). We used a five-step framework to structure the review: identifying the research question; identifying relevant studies; study selection; extracting and charting the data; and collating, summarizing, and reporting the results (Acevedo et al., 2020; Arksey and O'Malley, 2005).

2.2. Research question

The research question is "what uk empirical peer-reviewed data are there that measures the impact of regenerative agricultural practices on net greenhouse gas balances?"

2.3. Identifying relevant studies

Our starting premise is that 'regenerative agriculture' encompasses a wide range of practices (Jayasinghe et al., 2023). The first step in this scoping review was to identify the full range of practices that a range of stakeholders are identifying as a RA practice. We conducted a search across the peer-reviewed literature; practitioner, advocate, farming and industry websites; and grey literature until data saturation, (Saunders et al., 2018) i.e. where no new practices were being identified. This resulted in 152 practices identified. We then screened these to remove duplicates, resulting in 90 unique practices (see OSF Supplementary Information (SI) File Table 7 Original practices).

We created a search strategy for searching the Web of Science Core Collection (accessed via the Web of Science database) for each of the 90 practices:

"*(Regenerative practice)*" AND "carbon" or "GHG" or "greenhouse gas" or "emissions" AND "UK" or "GB" or "britain" or "England" NOT "new england" or "Northern Ireland" or "Scotland" or "Wales" NOT "New South Wales".

We trialed it to ensure it located appropriate papers and excluded those from geographical areas we were not interested in. In total we found 1400 papers across 58 practices, reduced to 1014 after removing duplicates.

2.4. Study selection

We defined eligibility for inclusion to studies that (1) included data from the UK; (2) measured *direct* greenhouse gases and carbon sequestration: nitrous oxide (N_2O) flux, net carbon fluxes between soil–plant systems and the atmosphere, and methane (CH_4) flux (see OSF SI Table 8 GHG and Carbon); (3) focused on one or more RA practices as previously identified (see OSF SI Table 7 Original practices); (4) examined food production, not biofuel production; (5) contained empirical data (i.e. were not solely modelling); (6) contained field data (i.e. were not solely laboratory studies).

To screen the 1014 studies, we used a pre-defined screening process (see Fig. 1) with papers first screened using title only, then title and abstract, and then using the full text. Screening of title and title/abstract was carried out by two authors (IT, DRW) independently and the results compared, discussed and agreed. The full-text screening of the remaining papers was carried out by one author (IT).

2.5. Extracting and charting the data

We then extracted relevant data in two stages (data extraction templates for both stages were created – see OSF SI Table 9 Data Extraction 1 and SI Table 10 Data Extraction 2). First, we extracted data on the research site, UK region and location (when given), crop or land use type, GHG/carbon category measured, RA practices, year of publication,

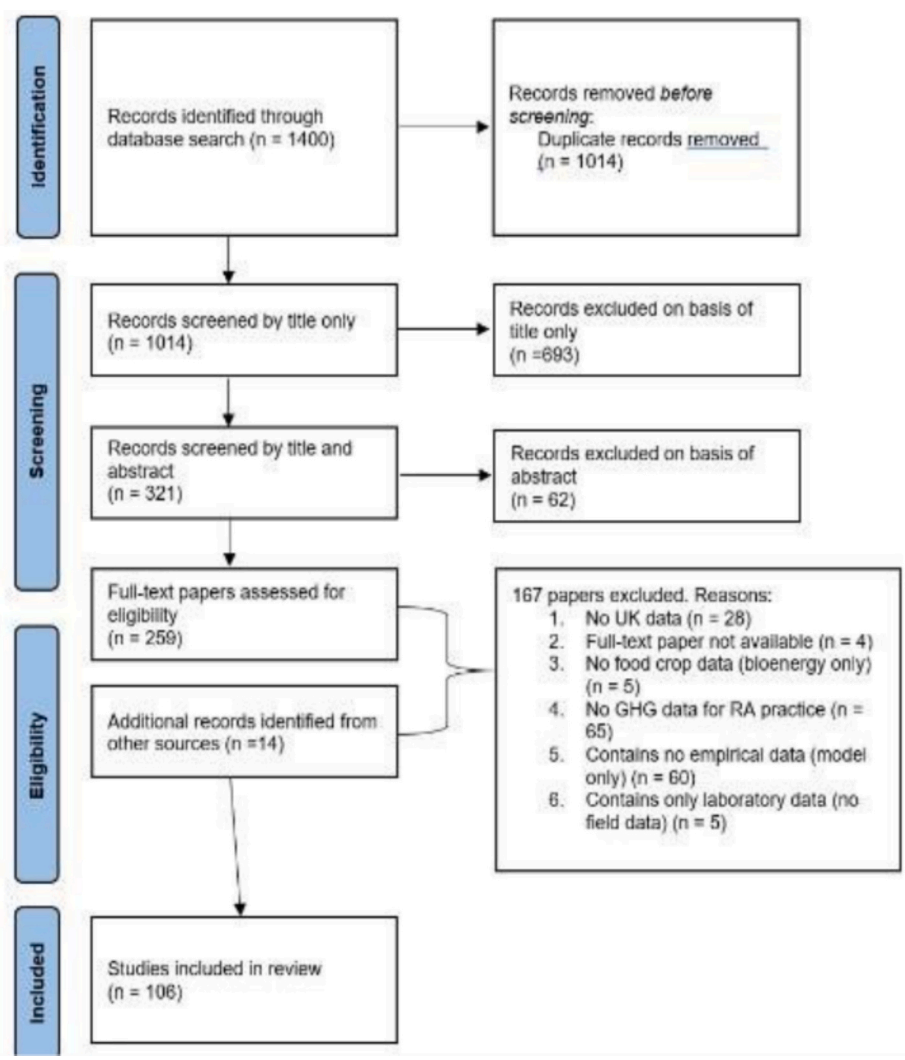

Fig. 1. A Flow Diagram of the Methodology.

and whether data on yields were also given. We also recorded background journal information (see OSF Extended Data Table 1). Second, we extracted individual '*RA practice-GHG/carbon - site*' combinations for each paper (e.g. 'No tillage – CH_4 emissions- site 1'), classifying the direction of the results as neutral (i.e. no significant effect), positive, negative or variable (see OSF Extended Data Table 2). Note that the direction of impact refers to effects on Net Zero ambitions. For example, a positive impact for CH_4 flux means *less* CH_4 being emitted and therefore a positive impact on Net Zero ambitions, whilst a positive impact for soil organic carbon means *more* soil organic carbon and likewise a positive impact for Net Zero.

This process resulted in 412 total entries as many of the research papers had more than one research site, measured more than one or more type of GHG or RA practices.

For Fig. 2, we assigned values of +1, 0, −1 for positive, neutral or uncertain, and negative responses respectively. We then took the mean value for each *RA practice – response* combination within a study to avoid biasing the visualization towards studies that reported multiple years individually. We then took the mean value across all *study – RA practice - response* combinations to display in the figure, with values bounded by (−1,1).

2.6. Collating, summarizing, and reporting the results

Finally, we summarized data by focusing on the number of studies examining each RA practice-GHG combination. We did this, rather than examining the effect sizes of different practices, because we were conducting a scoping review rather than a systematic review or meta-analysis, and due to the paucity of data.

3. Results and discussion

3.1. Overview of studies

We found 106 studies that empirically measured the direct GHG emissions of an RA practice (see OSF Extended Data Table 1). We also identified 60 UK modelling studies (either Life Cycle Analysis -type studies or scenario building) estimating the impacts of RA practices, but we did not include them in our scoping review as they did not contain empirical data. Studies were published between 1974 and 2024, with 85 since 2000 (see OSF SI Table 1 Year of publication). Across the 106 studies, we extracted details for 132 research locations (see OSF Extended Data Table 1). Most research sites were in England (85 sites), followed by Scotland (32), Wales (9), and Northern Ireland (6) (see OSF SI Table 2 Site region). We also identified the regional climate for each site using the MetOffice (2026) classification (see OSF SI Table 2a regional climate). The Midlands, (mean annual temperature [MAT] 8–10 °C, annual average rainfall [AAR] 800-1000 mm) was the region with the most research sites at 42, followed by South West England (MAT 10.5–12 °C, AAR 850-2000 mm) and Eastern Scotland (MAT 6–9 °C, AAR 700-1500 mm) both with 21 sites. Southern England (MAT 9.5–11.5 °C, AAR 550-950 mm), Wales (MAT 9.5–11.0 °C, AAR 1000-3000 mm) and North-East England (MAT 8.5–10.0 °C, AAR 600-1500 mm) each with six sites. There were five sites in Eastern England (MAT 9.5–10.5 °C, AAR >700 mm), four in Northern Ireland (MAT 8.5–10.0 °C, AAR 800-1600 mm), three in Northern Scotland (MAT 7.0–9.0 °C, AAR 700–4000 mm) and one in Western Scotland (MAT 9.5–9.9 °C, AAR 1000–3500 mm).

Of the 132 research locations, whilst 49 were only general place names, 83 specific named research sites were identifiable: 31 studies

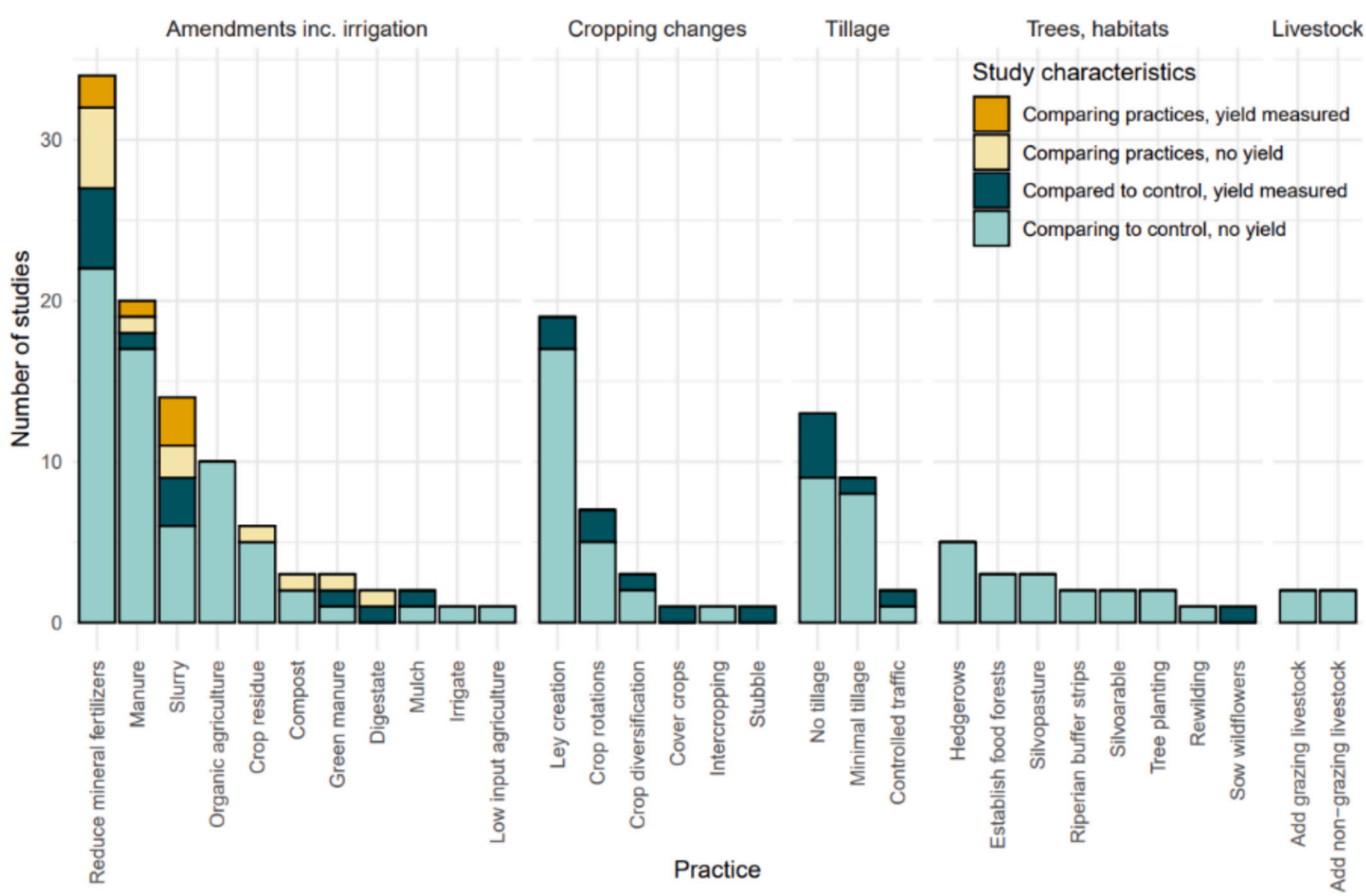

Fig. 2. Number of studies found for each regenerative agriculture (RA) practice, split by the type of comparison (control vs. another RA practice) and the inclusion or not of yield data. Note, no studies found for 60 practices (see separate file).

were based at Rothamsted Research (18 from Rothamsted and Woburn Farms and 13 from North Wyke, Devon); 15 from the Agricultural Development Advisory Service; 25 from 11 different UK University Research Farms; eight from Research Institutes; three from the Agroforestry Research Trust, Devon; and one from the Knepp Rewilding Project, Sussex (see OSF SI Table 3 Research sites).

The land use type or crop studied was identified for each study (see OSF Extended Data Table 1). The most studied was permanent pasture (35 studies), followed by wheat (28), leys (23), and barley (22). There was only one vegetable crop study (lettuce) and one fruit study (apple orchard) (see OSF SI Table 4 Crop or land use).

3.2. Regenerative agriculture practices

We found evidence on the impacts of 30 of the 90 RA practices we identified (see OSF SI Table 7 Original practices), with the majority of studies comparing the use of an RA practice to a conventional agricultural practice (control), although 18 studies compared multiple RA practices (see Fig. 2 and OSF SI Table 5 Practice Description and SI Table 6 Practice and yield). This means that for 67% of the practices identified, we could find no published empirical evidence for their impacts on direct GHG emissions in the UK. The evidence we did find was also strikingly biased, with a single practice (reducing mineral fertilizer use) accounting for 27 of the 157 studies (17% of total). There were 19 'ley creation' studies (12% of total) and 18 studies (11%) on using manure. In addition, only 26 studies across only 15 practices also included data on yield impacts—vital information for both farmers and for understanding environmental impacts (see Fig. 2 and OSF SI Table 6 Practice and yield).

3.3. Net greenhouse gas balances

The 106 studies in total measured 131 GHG/carbon responses across six broad categories with 412 individual practice-GHG/carbon combinations. Again, the evidence was biased: 58 studies measured soil organic carbon or matter and 34 N_2O flux, whereas only 14 measured soil CO_2 emissions, 12 measured CH_4 flux, seven soil microbial biomass and six carbon plant biomass (see Fig. 3, OSF Extended Data Table 2, SI Table 8 GHG and Carbon). While we did not formally analyse the results of studies (not having conducted a systematic review or meta-analysis), there was clear variation in the consistency of evidence for each RA practice-GHG/carbon combination.

Fig. 3. Number of studies found for each GHG/carbon response type and each regenerative agriculture practice. The size of the bubble indicates the number of studies (with a maximum of 16), while the colour provides a qualitative assessment of the direction of impacts (see Methods for details). Note that the direction of impact refers to effects on Net Zero ambitions. For example, a positive impact for CH_4 flux means *less* CH_4 being emitted and therefore a positive impact on Net Zero ambitions, whilst a positive impact for soil organic carbon means *more* soil organic carbon and likewise a positive impact for Net Zero.

4. Discussion

Our scoping review found that the empirical evidence for the impacts of RA practices on Net Zero ambitions in the UK is inadequate for robustly informing policy or practice due to five main limitations. Firstly, data are only available for 30 of 90 RA practices we identified, with entire areas of RA activity having little-to-no empirical evidence. These include alternative cropping patterns (such as companion, alley, double and multi- cropping or stacking systems), different grazing practices (such as Savory, intermittent, mob, cell and time-controlled grazing), and alternatives to synthetic pesticides.

Secondly, 64% of studies were from in England, meaning that data available to support decisions for the specific farming systems, soil types, and climates in Scotland, Wales and Northern Ireland is even more limited, further reducing the evidence base for Devolved Nations to develop Net Zero and agricultural policies.

Thirdly, most practices with empirical evidence are supported by very few studies (see Fig. 2). This includes those that are key aspects of current UK Net Zero policies. For example, we found only five studies on agroforestry systems, although the CCC advises that these should expand to cover 10% of UK agricultural land by 2050, and the UK Government proposes expanding coverage by 370 kha in England (Defra, 2025a). Similarly, we found only five studies on hedgerows, which the CCC advises expanding by 40% across the UK by 2050 (Climate change Committee, 2019). The use of cover cropping, reducing soil compaction, and making use of biological fixation in grasslands are RA practices supported by the Government as 'low-carbon farming practices (Eory et al., 2025) but we found only one, two and zero studies, respectively. The main exception to the lack of evidence was 27 studies on reducing mineral nitrogen fertilizer use, showing consistent reductions in N_2O emissions (Harty et al., 2016) — a practice with some policy support.

We summarized the evidence for individual RA practices, because 73 of our studies (69%) only investigated a single practice (14 studies, 13%, investigated two). However, many RA advocates describe it as a farming "system" and argue it should be assessed as such, with multiple practices implemented simultaneously and adapted in response to changing conditions. However, the lack of evidence means that this is currently impossible for the UK, meaning that synergies, trade-offs, and co-benefits between different practice combinations cannot be evaluated.

Fourthly, comprehensive assessment is also precluded because data are only available for a limited range of practice-GHG/carbon responses (see Fig. 1). Indeed, 78% of studies (83 studies) reported only a single GHG/carbon response, with 17% (18 studies) reporting two, and 5% (five studies) reporting three types of response. No studies reported on more than three. Net greenhouse gas budgets—and adequate climate impact assessments—therefore cannot be calculated for any practice because there is little exploration of synergies or trade-offs between different components of net greenhouse gas balance when RA practices are implemented (Maenhout et al., 2024).

Individual farming practices may simultaneously impact different components of the net greenhouse gas balance in opposite directions, as Fig. 3 suggests. Significant scientific uncertainty remains about the extent to which agriculture GHG emissions (primarily N_2O and CH_4) can be offset by carbon sequestration. Reflecting such uncertainty, the CCC has hitherto not supported a shift towards RA methods that may sequester soil carbon, citing concerns over soil carbon permanence and the need for evidence synthesis (Climate Change Committee, 2020; The Green Alliance, 2022). The RA principle of "*integrating livestock*", usually understood to be introducing grazing livestock into a rotation, is a significant case in point. The extent to which grazed pasture may be able to sequester and store more carbon to at least partially offset GHG emissions from the livestock themselves is difficult to calculate due to context sensitivity and complex, sometimes inconsistent, evidence (Jordon et al., 2024). We found only two studies on introducing grazing livestock into a rotation; two on introducing non-grazing livestock; and none on alternative grazing practices. This lack of data is significant because livestock were estimated to be responsible for 48% of national CH_4 emissions in 2022 through enteric fermentation and manure management (Defra, 2022), leading to the CCC 7th budget proposing a reduction of 27% in cattle and sheep numbers between 2023 and 2040 (Climate change Committee, 2025). It is unclear how this can be reconciled with the RA principle of 'reintroducing livestock', even if the livestock are shifted from other systems (rather than an absolute increase) and we found little data to inform this issue.

The fifth limitation is that only 21% of the studies considered yields alongside GHG balances (see Fig. 2) reducing the ability of farmers, policy makers, or businesses to assess overall impacts of RA practices. In particular, farmers may be unwilling to adopt new practices if impacts on yields (and therefore income) are unknown, while if RA practices reduce yields then there is the risk that food production will be shifted overseas through market leakage, reducing benefits or even increasing GHG emissions through land-use change.

Taken altogether, these limitations on the availability of data on practices, location, GHG/carbon responses and yield lead us to conclude that there is not a robust evidence base for the impact on net greenhouse gas balance of RA practices in the UK. No studies attempted a comprehensive or wide-ranging evaluation of RA, combining multiple practices, multiple GHG responses, and incorporating yield information. These data shortfalls are compounded by the known importance of soil type on the impacts of RA practices on GHG emissions (Khangura et al., 2023; Vejendla et al., 2025). The UK has more than 700 different soil types meaning that suitable data will be lacking for large areas of the country (Cranfield University, 2026).

The lack of UK-specific data is reflected in the evidence used in UK policy documents. For example, the 7th budget CCC report relies on a global meta-analysis (Poeplau and Axel, 2015) — with no UK data and only reporting SOC—to support the adoption of cover crops, having previously relied on un-published modelling work (Barnes et al., 2022). Similarly, advice on the use of biological fixation of nitrogen in grassland relies on one European review paper (Lüscher et al., 2014). In relation to policy for expanding the area of agroforestry, we found no studies measuring above-ground biomass or carbon in agroforestry, and scientific advice to Government on potential carbon sequestration of such systems relies on forestry-specific derived, rather than agroforestry specific data (Thomson et al., 2025).

We identified 60 modelling studies estimating the impacts of RA practices. While such approaches are clearly valuable, the small numbers of UK-specific data these are based on raises questions over the robustness of their conclusions for supporting policy or practice.

It was beyond the scope of our work to assess the wider ecological, social and economic impacts of RA practices, such as biodiversity, water quality and quantity, food security, local economies and the resilience of agroecosystems (Sher et al., 2024). Nevertheless, any comprehensive assessment of RA necessarily needs to include the synergies and trade-offs between different objectives. Such a nuanced assessment could provide justification for the adoption of some RA practices even without GHG benefits. For example, zero-tillage could be adopted to reduce soil erosion rather than for climate change mitigation (Mondal et al., 2023; Ogle et al., 2019) whilst cover crops could be implemented to improve soil structure and increase water infiltration and storage, even in the absence of any benefits for the net greenhouse gas balance (Koudahe et al., 2022).

5. Conclusion

To the best of our knowledge, this is the first country-specific review assessing the evidence for the impact of a range of RA practices on net greenhouse gas balances. This is despite recognition that such impacts are highly site-specific, with previous evidence syntheses focused on global or continental scales.

The paucity of UK evidence for the climate impacts of RA practices that we have found through carrying out our scoping review is concerning. Given the importance of agricultural practices and land-use in driving GHG emissions any widespread change could have profound impacts for the global climate. Recently, there have been calls to implement rigorous long-term trials to address the shortcomings of the current evidence base and monitor multiple responses (Khangura et al., 2023; Vejendla et al., 2025). With significant financial investment, UK trials have begun at Rothamsted (Li et al., 2023), the University of Leeds and the University of Cambridge (Berthon et al., 2024; Fix Our Food, 2025). However, the impacts of RA practices may take considerable time to emerge, with robust data on soil carbon sequestration, for example, taking years to produce (Li et al., 2023). Thus, long time-frames may be required for sufficient evidence to be generated. This could be too late to avoid catastrophic climate change. It is therefore also vital to collate and disseminate industry, academic, and informal RA field trial data, ensuring it is made available to all stakeholders. Informal knowledge sharing does occur (e.g. at RA-focused events such as the Groundswell meeting) but there is clear scope, recognized by the UK government, for greater knowledge-transfer between the research community and farmers (DEFRA, 2025a).

Our review found remarkably little evidence for the GHG impacts of RA practices, given the considerable interest from a range of actors. While we do not want to suggest that RA practices do not bring benefits, it is clear that considerable evidence needs to be generated rapidly to ensure that the most effective practices, either RA or other approaches, are promoted in appropriate locations. Advocates for the global integration and scaling of RA are calling for increased investment, metric standardisation and policy alignment (Coalition of Action 4 Soil Health, 2026; Global Alliance for the Future of Food, 2024; SAI, 2025; WBCSD, 2025). We wish to add a cautionary note – that whilst the *principles* of RA may be broadly transferable across global contexts, it is clear that the *practices* of RA must be adapted and appropriate to local soil types, climate conditions, existing agricultural systems and economic realities if they are to deliver the widely promoted benefits. Integrating informal farmer knowledge with scientific studies can enhance sustainable and resilient agriculture (Šūmane et al., 2018). Given the urgency of the multiple environmental crises that RA purports to tackle, and the speed at which RA is being promoted, this integration, as well as the rapid implementation of formal trials, is a clear priority.

Availability of data and material

The research protocol and all our datasets and supplementary information are available on the Open Research Framework ORF (OSF | A scoping review of UK evidence for the impacts of regenerative agriculture practices on net greenhouse balances).

CRediT authorship contribution statement

Isobel Tomlinson: Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation, Formal analysis, Data curation. **Ruth Wade:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Jenny Hodbod:** Methodology, Funding acquisition, Conceptualization. **David R. Williams:** Writing – review & editing, Visualization, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors have no relevant financial or non-financial interests to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.agsy.2026.104738.

Data availability

Research Link Provided

Open Research Framework

A scoping review of UK evidence for the impacts of regenerative agriculture practices on net greenhouse balances (Original data)

References

Acevedo, Maricelis, Pixley, Kevin, Zinyengere, Nkulumo, et al., 2020. A Scoping Review of Adoption of Climate-Resilient Crops by Small-Scale Producers in Low- and Middle-Income Countries. Nat. Plants 6 (10), 1231–1241. https://doi.org/10.1038/s41477-020-00783-z.

AGW, 2025. Certified Regenerative by AGW available at Certified Regenerative – A Greener World accessed 21/7/25.

Arksey, Hilary, O'Malley, Lisa, 2005. Scoping Studies: Towards a Methodological Framework. Int. J. Soc. Res. Methodol. 8 (1), 19–32. https://doi.org/10.1080/1364557032000119616.

Bai, X., Huang, Y., Ren, W., Coyne, M., Jacinthe, P.-A., Tao, B., Hui, D., Yang, J., Matocha, C., 2019. Responses of soil carbon sequestration to climate smart agriculture practices: A meta-analysis. Global Change Biology 25. https://doi.org/10.1111/gcb.14658.

Barnes, A.P., Eory, V., MacLeod, M., 2022. Delivering Clean Growth through Sustainable Intensification. DEFRA. Available at 15506_SCF0120CGSIevid4_Final_1_.pdf accessed 21/7/25.

Beacham, Jonathan D., Jackson, Peter, Jaworski, Coline C., Krzywoszynska, Anna, Dicks, Lynn V., 2023. Contextualising Farmer Perspectives on Regenerative Agriculture: A Post-Productivist Future? *Journal of Rural Studies* (Oxford) 102, 103100. https://doi.org/10.1016/j.jrurstud.2023.103100.

Berthon, Katherine, Jaworski, Coline C., Beacham, Jonathan D., et al., 2024. Measuring the Transition to Regenerative Agriculture in the UK with a Co-Designed Experiment: Design, Methods and Expected Outcomes. Environ. Res. Food Systems 1 (2), 025007. https://doi.org/10.1088/2976-601X/ad7bbe.

Blanco-Canqui, H., 2021. No-till technology has limited potential to store carbon: How can we enhance such potential? Agriculture, Ecosystems & Environment 313, 107352. https://doi.org/10.1016/j.agee.2021.107352.

Climate change Committee, 2019. Net Zero Technical Report available at Net-Zero-Technical-report-CCC.pdf accessed 3/12/25.

Climate Change Committee, 2020. Land-use policies for a Net Zero UK available at Land-use-Policies-for-a-Net-Zero-UK.pdf accessed 21/7/25.

Climate change Committee, 2025. The Seventh Carbon Budget available at The Seventh Carbon Budget - Climate Change Committee accessed 21/7/25.

Coalition of Action 4 Soil Health, 2026. Plan to Accelerate Regenerative Agriculture for Healthy Soils and Healthy Diets available at CA4SH and Partners Develop Plan to Accelerate Regenerative Agriculture for Healthy Soil and Healthy Diets for COP30 Action Agenda — Coalition of Action for Soil Health accessed 25 2 26.

Cranfield University, 2026. National Soil Map available at Mapping and understanding soil types across England and Wales accessed 3/326.

Dabalen, Andrew L., Goyal, Aparajita, Song, Ruozi, 2019. Regenerative Agriculture in Practice: A Review (English). In: Policy Research working paper; PLANET. World Bank Group, Washington, D.C.. http://documents.worldbank.org/curated/en/099509109192492007

DAERA, Northern Ireland, 2025. What is Farming with Nature Transition Scheme available at What is Farming with Nature Transition Scheme (FwNT) | Department of Agriculture. Environment and Rural Affairs.

De Stefano, A., Jacobson, M.G., 2018. Soil carbon sequestration in agroforestry systems: a meta-analysis. Agroforest Syst 92, 285–299. https://doi.org/10.1007/s10457-017-0147-9.

Defra, 2022. Official Statistics Agri-climate report 2022 available at Agri-climate report 2022 - GOV.UK accessed 22/7/2025.

DEFRA, 2025. Farming Blog available at An update on the Sustainable Farming Incentive – Farming accessed 21/7/25.

DEFRA, 2025a. Land Use Consultation available at Land Use Consultation - Defra - Citizen Space accessed 21/7/25.

Eory, V., Mckay Fletcher, D.M.F., MacLeod, M., Duthie, C.-A., Rees, R.M., Topp, C.F.E., 2025. Greenhouse gas abatement in UK agriculture 2024-2050: Report submitted to support the 7th carbon budget in the UK. In: Prepared for the Climate Change Committee. Available at https://www.theccc.org.uk/publication/greenhouse-gas-abatement-in-uk-agriculture-2024-2050-sruc/. accessed 21/7/25.

Fix Our Food, 2025. Regenerative Agriculture trials at Leeds University Farm. In: available at Regenerative Agriculture trials at Leeds University Farm - Fix Our Food accessed 21/725.

Giller, Ken E., Hijbeek, Renske, Andersson, Jens A., Sumberg, James, 2021. Regenerative Agriculture: An Agronomic Perspective. Outlook on Agriculture (London) 50 (1), 13–25. https://doi.org/10.1177/0030727021998063.

Global Alliance for the Future of Food, 2024. Cultivating Change available at GA_CultivatingChange_Report_052124.pdf accessed 2/3/26.

Groundswell, 2025. Principles of Regenerative Agriculture available at Principles of Regenerative Agriculture - Groundswell Groundswell accessed 21/7/25.

Harty, M.A., Forrestal, P.J., Watson, C.J., et al., September 2016. Reducing Nitrous Oxide Emissions by Changing N Fertiliser Use from Calcium Ammonium Nitrate (CAN) to Urea Based Formulations. Sci. Total Environ. 563–564, 576–586. https://doi.org/10.1016/j.scitotenv.2016.04.120.

IPCC, 2019. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems: Chapter 4: Land degradation. In: available at Chapter 4: Land Degradation — Special Report on Climate Change and Land accessed 3/12/25.

IPPC, 2019. Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories available at CHAPTER 11 accessed 29/7/25.

Jayasinghe, Sadeeka L., Thomas, Dean T., Anderson, Jonathan P., Chen, Chao, Macdonald, Ben C.T., 2023. Global Application of Regenerative Agriculture: A Review of Definitions and Assessment Approaches. Sustainability 15 (22), 22. https://doi.org/10.3390/su152215941.

Jordon, Matthew W., Buffet, Jean-Charles, Dungait, Jennifer A.J., et al., 2024. A restatement of the natural science evidence base concerning grassland management, grazing livestock and soil carbon storage. Proc. R. Soc. B Biol. Sci. 291 (2015), 20232669. https://doi.org/10.1098/rspb.2023.2669.

Khangura, Ravjit, Ferris, David, Wagg, Cameron, Bowyer, Jamie, 2023. Regenerative agriculture—a literature review on the practices and mechanisms used to improve soil health. Sustainability 15 (3), 3. https://doi.org/10.3390/su15032338.

Koudahe, Komlan, Allen, Samuel C., Djaman, Koffi, 2022. Critical Review of the Impact of Cover Crops on Soil Properties. Int. Soil and Water Conservat. Res. 10 (3), 343–354. https://doi.org/10.1016/j.iswcr.2022.03.003.

Lehuger, Simon, Gabrielle, Benoît, Laville, Patricia, Lamboni, Matieyendou, Loubet, Benjamin, Cellier, Pierre, 2011. Predicting and Mitigating the Net Greenhouse Gas Emissions of Crop Rotations in Western Europe. Agric. For. Meteorol. 151 (12), 1654–1671. https://doi.org/10.1016/j.agrformet.2011.07.002.

Levac, Danielle, Colquhoun, Heather, O'Brien, Kelly K., 2010. Scoping Studies: Advancing the Methodology. Implementat. Sci. IS 5, 69. https://doi.org/10.1186/1748-5908-5-69.

Li, Xiaoxi, Storkey, Jonathan, Mead, Andrew, et al., 2023. A New Rothamsted Long-Term Field Experiment for the Twenty-First Century: Principles and Practice. Agron. Sustain. Dev. 43 (5), 60. https://doi.org/10.1007/s13593-023-00914-8.

Lüscher, A., Mueller-Harvey, I., Soussana, J.F., Rees, R.M., Peyraud, J.L., 2014. Potential of legume-based grassland–livestock systems in europe: a review. Grass Forage Sci. 69 (2), 206–228. https://doi.org/10.1111/gfs.12124.

Maenhout, Peter, Di Bene, Claudia, Cayuela, Maria Luz, et al., 2024. Trade-offs and synergies of soil carbon sequestration: addressing knowledge gaps related to soil management strategies. Eur. J. Soil Sci. 75 (3), e13515. https://doi.org/10.1111/ejss.13515.

MetOffice, 2026. UK Regional Climates available at UK regional climates - Met Office accessed 25/2/26.

Mondal, Surajit, Chakraborty, Debashis, Paul, Ranjit Kumar, Mondal, Arun, Ladha, J.K., 2023. No-till Is More of Sustaining the Soil than a Climate Change Mitigation Option. Agric. Ecosyst. Environ. 352, 108498. https://doi.org/10.1016/j.agee.2023.108498.

Nestle, 2025. Our road to Net Zero available at Our Net Zero roadmap | Nestlé Global accessed 21/7/25.

Newton, Peter, Civita, Nicole, Frankel-Goldwater, Lee, Bartel, Katharine, Johns, Colleen, 2020. What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. FRONT. SUSTAIN. FOOD SYSTEMS (Lausanne) 4, 577723. https://doi.org/10.3389/fsufs.2020.577723.

Ngaba, Mbezele Junior, Yannick, Abubakari Said, Mgelwa, Geshere Abdisa, Gurmesa, et al., 2024. Meta-Analysis Unveils Differential Effects of Agroforestry on Soil Properties in Different Zonobiomes. Plant Soil 496 (1), 589–607. https://doi.org/10.1007/s11104-023-06385-w.

Ogle, Stephen M., Alsaker, Cody, Baldock, Jeff, et al., 2019. Climate and soil characteristics determine where no-till management can store carbon in soils and mitigate greenhouse gas emissions. Sci. Rep. 9 (1), 11665. https://doi.org/10.1038/s41598-019-47,861-7.

Pan, Jiachen, Chen, Shutong, He, Dejun, et al., February 2025. Agroforestry increases soil carbon sequestration, especially in arid areas: a global meta-analysis. CATENA 249, 108667. https://doi.org/10.1016/j.catena.2024.108667.

Poeplau, Christopher, Axel, Don, February 2015. Carbon Sequestration in Agricultural Soils via Cultivation of Cover Crops – A Meta-Analysis. Agric. Ecosyst. Environ. 200, 33–41. https://doi.org/10.1016/j.agee.2014.10.024.

Pulido-Moncada, Mansonia, Petersen, Søren O., Munkholm, Lars J., 2022. 'Soil Compaction Raises Nitrous Oxide Emissions in Managed Agroecosystems. A Review. Agron. Sustain. Dev. 42 (3), 38. https://doi.org/10.1007/s13593-022-00773-9.

RASE, 2025. The Principles of Regenerative Agriculture available at The principles of regenerative agriculture Royal Agricultural Society of England accessed 21/7/25.

RAU, 2025. PG Cert Regenerative Farming. available at PgCert Regenerative Farming. Royal Agricultural University. accessed 21/7/25.

Regenerate Outcomes, 2025. How it works available at How it works — Regenerate Outcomes accessed 21/7/25.

Regenerative farmers of UK, 2025. Restoring Soil Health and Biodiversity available at Regenerative Farmers of UK – Connecting regenerative farmers in the UK to share learning and scale up the change accessed 21/7/25.

Rehberger, Emily, West, Paul C., Spillane, Charles, McKeown, Peter C., 2023. 'What Climate and Environmental Benefits of Regenerative Agriculture Practices? An Evidence Review'. *Environmental Research.* Communications 5 (5), 052001. https://doi.org/10.1088/2515-7620/acd6dc.

Rodale, Robert, 1983. Breaking new ground: The search for a sustainable agriculture. Futurist 17 (1), 15–20 available at ERIC - EJ275343 - Breaking New Ground: The Search for a Sustainable Agriculture., Futurist, 1983-Feb.

Rothamsted Research, 2025. The History of Rothamsted Research available at The history of Rothamsted Research | Rothamsted Research accessed 21/7/25.

SAI, 2025. A Global Framework for Global Agriculture available at sai-platforms-regenerating-together-framework-linking-practices-and-outcomes-1-1.pdf accessed 25/2/25.

Saunders, Benjamin, Sim, Julius, Kingstone, Tom, et al., 2018. Saturation in Qualitative Research: Exploring Its Conceptualization and Operationalization. Qual. Quant. 52 (4), 1893–1907. https://doi.org/10.1007/s11135-017-0574-8.

Sher, Alam, Li, Hongxing, Aman ullah, Yasir Hamid, Bukhtawer Nasir, and Jiwang Zhang., 2024. Importance of Regenerative Agriculture: Climate, Soil Health, Biodiversity and Its Socioecological Impact. Discov. Sustain. 5 (1), 462. https://doi.org/10.1007/s43621-024-00662-z.

Sovacool, Benjamin K., Daniels, Chux, Rafiu, Abbas Abdul, 2022. 'Science for Whom? Examining the Data Quality, Themes, and Trends in 30 Years of Public Funding for Global Climate Change and Energy Research'. *Energy Research & Social.* Science 89, 102645. https://doi.org/10.1016/j.erss.2022.102645.

Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., Rios, I., Rivera, M., Chebach, T., Ashkenazy, A., 2018. Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. J. Rural. Stud. 59, 232–241. https://doi.org/10.1016/j.jrurstud.2017.01.020.

The Green Alliance, 2022. The Opportunities of Agri-Carbon markets: A summary by James Elliott, Jonny Ritson, Mark Reed and Oscar Kennedy-Blundell available at The_opportunities_of_agri-carbon_markets_summary.pdf accessed 21/7/25.

Thomson, A., Young, H., Nickerson, R., 2025. CB7 Land Use Emission Pathways: Updates to the CCC CB6 Land Use Emissions Pathways. Issue number 1 Centre for Ecol. Hydrol. available at CB7 Land Use Emission Pathways accessed 21/7/25.

Tricco, Andrea C., Lillie, Erin, Zarin, Wasifa, et al., 2018. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann. Intern. Med. 169 (7), 467–473. https://doi.org/10.7326/M18-0850.

UK Government, 2019. UK becomes first major economy to pass net zero emissions law available at UK becomes first major economy to pass net zero emissions law - GOV. UK accessed 30/3/26.

UK Parliament, March 2025. Sustainable Farming Incentive: Questions for DEFRA, UIN 39244, tabled on 18 March 2025 Written questions and answers - Written questions, answers and statements - UK Parliament accessed 21/7/25.

Vejendla, L.C., Janaki, P., Parameswari, E., Suganthy, M., Krishnan, R., Meena, S., 2025. Harnessing regenerative agriculture for climate change mitigation: a comprehensive review and meta-analysis. Discov Agric 3, 180. https://doi.org/10.1007/s44279-025-00266-9.

WBCSD, 2025. A Global Framework for Regenerative Agriculture available at A Global Framework for Regenerative Agriculture. WBCSD accessed 25/2/26.

Welsh Parliament, 2024. Sustainable Farming Scheme: your questions answered available at Sustainable Farming Scheme your questions answered accessed 3/12/25.

West, Tristram O., Post, Wilfred M., 2002. Soil Organic Carbon Sequestration Rates by Tillage and Crop Rotation. Soil Sci. Soc. Am. J. 66 (6), 1930–1946. https://doi.org/10.2136/sssaj2002.1930.

WWWF, 2025. What is Regenerative Agriculture? available at Regenerative agriculture | WWF accessed 21/7/25.