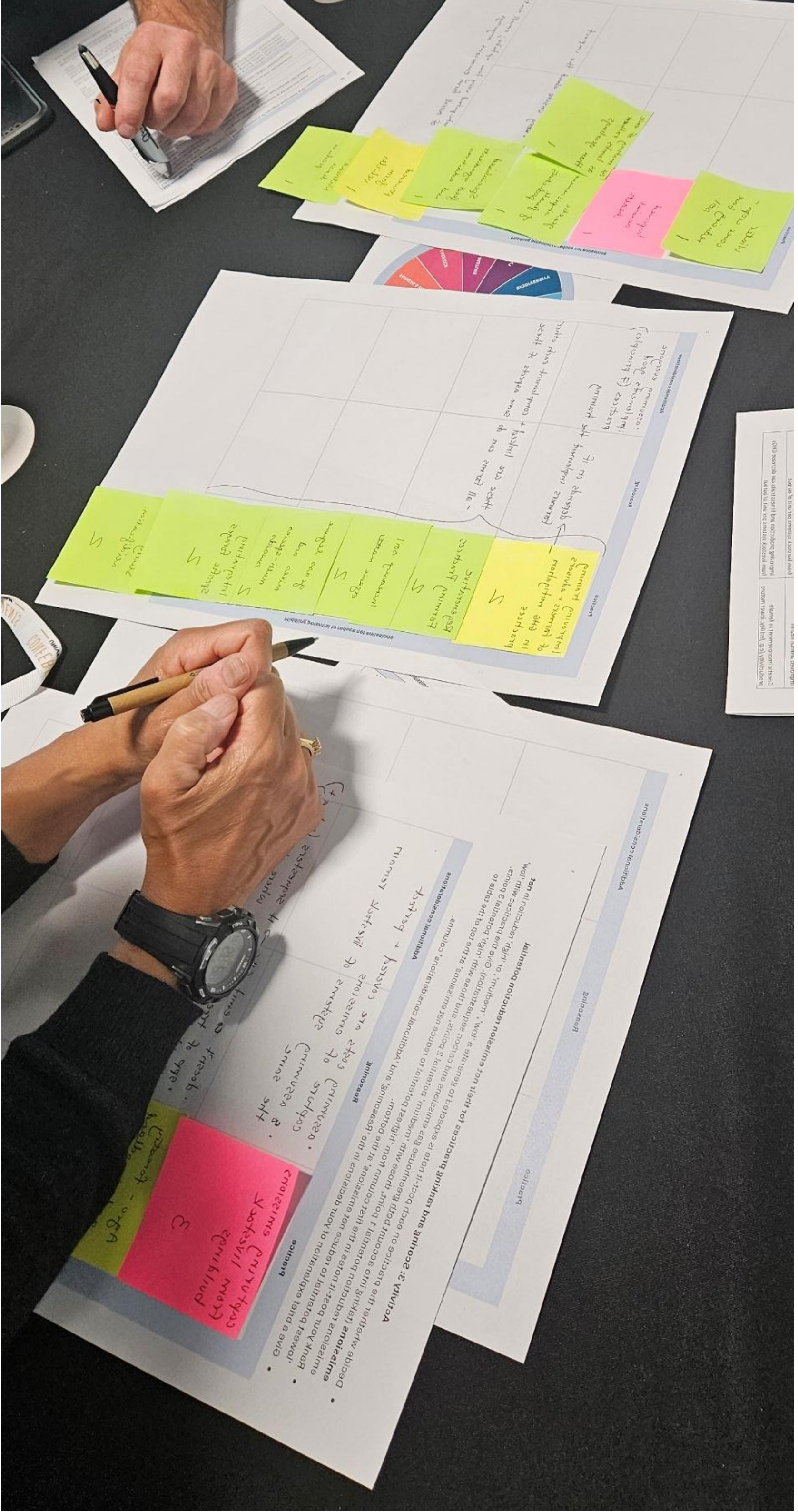

GRASSLANDS
LAND USE *for* NET ZERO

Interim findings from the LUNZ Grasslands workshops

with UK farmers and land managers on priority farming practices for achieving Net Zero.

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1. Executive Summary

This report summarises the research undertaken to date by the LUNZ (Land Use for Net Zero) Grasslands project (Work Package 1) to engage with pasture-based farmers and land managers in pursuit of a prioritised list of livestock and grassland management farming practices. These 'priority practices' are those that are acceptable to farmers *and* will move the needle on achieving the reduction in greenhouse gases that is needed to achieve the UK's Net Zero targets.

This research engaged 53 workshop participants and 85 survey respondents to shortlist their priority practices, analyse them for their strengths and weaknesses while identifying potential threats and opportunities and rank them according to their perceived potential to reduce net emissions. Through small-group discussion, participants made difficult decisions about which practices should be adopted urgently to make the best of several possible future scenarios, and which would be deprioritised should trade-offs and compromises be needed.

The three practices that gained the most overall support (scored against ten criteria indicating popularity and perceived efficacy) were *grass-legume mixtures and multispecies swards, better soil health practices,* and *improved animal health*. This is an encouraging finding: each practice reflects wholly or in part one of the key climate change mitigation measures that are recommended by the Seventh Carbon Budget, indicating that there is common ground between the advice provided to the UK Government by the Climate Change Committee and the actions supported by pasture-based farming communities. The benefits of these practices are varied and plentiful. Adding legumes to grasslands reduces the need for costly nitrogen fertilisers, improves soil health and supports biodiversity. Better soil health practices, such as optimising pH levels, increases plant quality and yields so that livestock can be fed on nutritious, locally-produced grass and herbs while sequestering carbon. We were told that *"good soil is fundamental"* to pasture-based farming. Improving animal health increases efficiency, reduces waste in farm systems, and could improve the public image of farming, though participants voiced concerns that climate change may shift the prevalence of livestock pests and diseases, asking *"are we future-proofed?"* Across the board, workshop participants stressed that doing things differently requires practical support, including reliable sources of funding and the provision of trusted, independent sources of training, upskilling and advice for farmers and their contractors, including farmer-to-farmer peer support.

Despite these points of congruence, our findings shed light on a significant gap between the farming practices outlined in the Seventh Carbon Budget and those preferred by our workshop participants and survey respondents. The Seventh Carbon Budget anticipates that waste and manure management measures and decarbonising farm machinery will account for a high proportion of the emissions reductions necessary to achieve Net Zero, but related practices fell within the bottom 50% of practices favoured by workshop and survey participants. Reducing livestock numbers is a pillar of the Seventh Carbon Budget's advice for the sector in order to release land for carbon sequestration measures including woodland creation and peatland restoration, but this prospect was not raised at all within our group discussions. Further, following the Welsh Government's controversial 10% tree cover plan for farmland in Wales, some workshop participants were reluctant to ascribe any strengths or opportunities to the practices of agroforestry and woodland grazing out of concern that doing so would be used to support tree planting policies wholesale and against their will.

While participants gave detailed and generous consideration of numerous practices throughout the workshops, several expressed their concern that certain practices *"would be forced"* upon them, highlighting the importance of engaging with farmers to find ways of bridging the gap between farmers' preferred pathways to achieving Net Zero and the advice provided by the Seventh Carbon Budget. Further, the vastly different contexts in which UK farmers are working – varying in physical environment, livestock system, and local challenges and advantages – require policies that take into account that the farming practices favoured in this report are more appropriate for some farms than for others. Identifying the factors that would make it easier for farmers across devolved nations to integrate lower-carbon farming practices into their businesses and highlighting the steps that are needed at a policy level to bridge this gap are tasks central to the second half of the LUNZ Grasslands project throughout 2026-27.

2.Introduction

This interim report presents research undertaken by the LUNZ Grasslands project team in collaboration with pasture-based farmers and land managers between May 2025 and April 2026. The research addresses the question of how sustainable, acceptable and accessible land use for Net Zero can be delivered across UK agricultural grasslands. The LUNZ Grasslands project focuses on transforming grassland systems to support the transition to Net Zero emissions while simultaneously enhancing soil health, biodiversity, farm productivity and rural economies. This interim report is intended to inform participating farmers and land managers, the LUNZ Grasslands project team, project partners and policymakers of our findings thus far, and to seek your thoughts and feedback. A final version of this report will be written towards the end of the project in 2027. The purpose of this report is to provide an overview of UK legislation and policy relating to Net Zero, agriculture and land use and connect these policy ambitions and recommendations with the knowledge and experiences of farmers involved in this research.

The report is structured in two parts. Part One synthesises relevant legislation and policy and highlights key challenges currently faced by farmers. This includes background context on agriculture across the four devolved nations, drawing attention to policy shifts, points of convergence and divergence, as well as an overview of the UK's climate change legislative framework, greenhouse gas emissions targets and carbon budgets for each nation. Part One concludes by bringing together the Climate Change Committee's and policy direction with the challenges experienced by farmers, highlighting areas of alignment and tension.

Part Two presents the research undertaken with farmers and land managers across three workshops held between May and September 2025. It begins by outlining the workshop activities and the supplementary survey that was conducted in Spring 2026 to engage with a larger pool of farmers and farm workers. It then presents our findings from the workshops and survey, followed by a discussion that links our research findings to the UK's Net Zero policy objectives. The report concludes with recommendations and next steps.

We recognise that farmers, land managers and policymakers are busy people who may lack the time to read lengthy reports. As such, we have kept Part One and Part Two as brief as possible and included an extensive appendix containing further information about our research methods and the project data. The appendix includes full details of the 32 SWOT analyses of pasture-based livestock and grassland management practices that were completed by workshop participants and provide a detailed insight into their perceptions of these farming practices. These practice SWOT analyses are grouped thematically (including categories such as *soil and nutrient management*, *sheep systems* or *planning and training*) so the reader can navigate to the sections that are of most interest and relevance to them.

We thank all participants of the workshops and online survey for their time and thoughtful engagement with this challenging but urgent issue of finding viable pathways to achieving the UK's legally binding commitments to achieving Net Zero by 2050 while sustaining farm businesses, food security, biodiversity, and the wellbeing of farming communities. We welcome your comments and feedback to support the further development of this interim report.

3. Part One

3.1 Background information on UK agriculture: Four devolved nations

Current debates about agricultural land in the United Kingdom focus on the long running questions of how limited farmland should be owned, managed and used to balance the competing needs of food production, environmental protection, development and climate change mitigation. A central challenge is how to safeguard farmland for food security while also meeting pressures to convert land for housing, infrastructure or nature restoration and enabling a just transition to Net Zero emissions (Institution of Environmental Sciences, 2024). Farming also underpins the UK food and drink industry which, currently valued at £104.4 billion, is the country's largest manufacturing sector by turnover (UK Government, 2026a). In 2022, the Gross Value Added[1] in the food and drink manufacturing sector amounted to approximately £21.7 billion in England, £4.4 billion in Scotland, £1.6 billion in Wales, and £1.2 billion in Northern Ireland (UK Government 2026b). Though outputs from grassland agriculture account for a smaller proportion of these figures, it is important to note the contribution made by this sector to the wider economy through the production of meat, dairy, and related outputs.

Agriculture in the UK has been strongly shaped by major policy shifts in recent decades including the influence of the Common Agricultural Policy from 1973 to 2020, the devolution of power to the governments of Wales, Scotland and Northern Ireland, and the UK's departure from the European Union in 2020 (Antonopoulos *et al*. 2022).

Since Brexit, differences between the UK nations' agricultural policies have grown, especially around direct payments and regulatory approaches, although many CAP-like principles remain. Scotland and Northern Ireland have maintained closer alignment with EU-style policies, while England and Wales have moved further away. These differences are shaped by political priorities and the specific needs of each nation (DEFRA, 2025a; Welsh Government, 2026a; Scottish Government, 2026a; DEFRA, 2026a).

Although the nations have taken different routes, they share similar long-term goals: productive and competitive farming, environmental sustainability, climate action and high animal welfare standards. All four nations embrace the idea of multifunctional agriculture, where farming contributes to wider public benefits such as climate change mitigation, rural wellbeing and ecosystem-enhancing initiatives including peatland restoration (see Peatland Action in Scotland, the National Peatland Action Programme in Wales and The PEAT+ project in Northern Ireland (ICUN Peatland Programme 2026; Ulster Wildlife, 2026)) and tree planting (Scottish Forestry, 2026a) (Whitfield *et al.,* 2011; Westaway *et al.,* 2023). Peatlands, specifically, are unevenly distributed in the UK (see Appendix A) which has implications for developing fair agricultural policies across the devolved nations. A summary of the legislation relating to Net Zero in the devolved nations is given in Table 1. The four nations also emphasise involving stakeholders in developing new agricultural policies (Attorp & Hubbard, 2022).

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[1] Gross Value Added, or GVA, is the difference between the value of goods and services produced and the cost of materials, services, and operating expenses used up in production.

3.2 UK Grasslands and land ownership

Across the UK, the Utilised Agricultural Area (UAA) covers 17 million hectares, representing 69% of the entire UK land area, and 9.4 million ha (56% UAA) is grassland. Figure 1 summarises the variety and size of farm enterprise types which comprise the UK's UAA (DEFRA, 2025b).

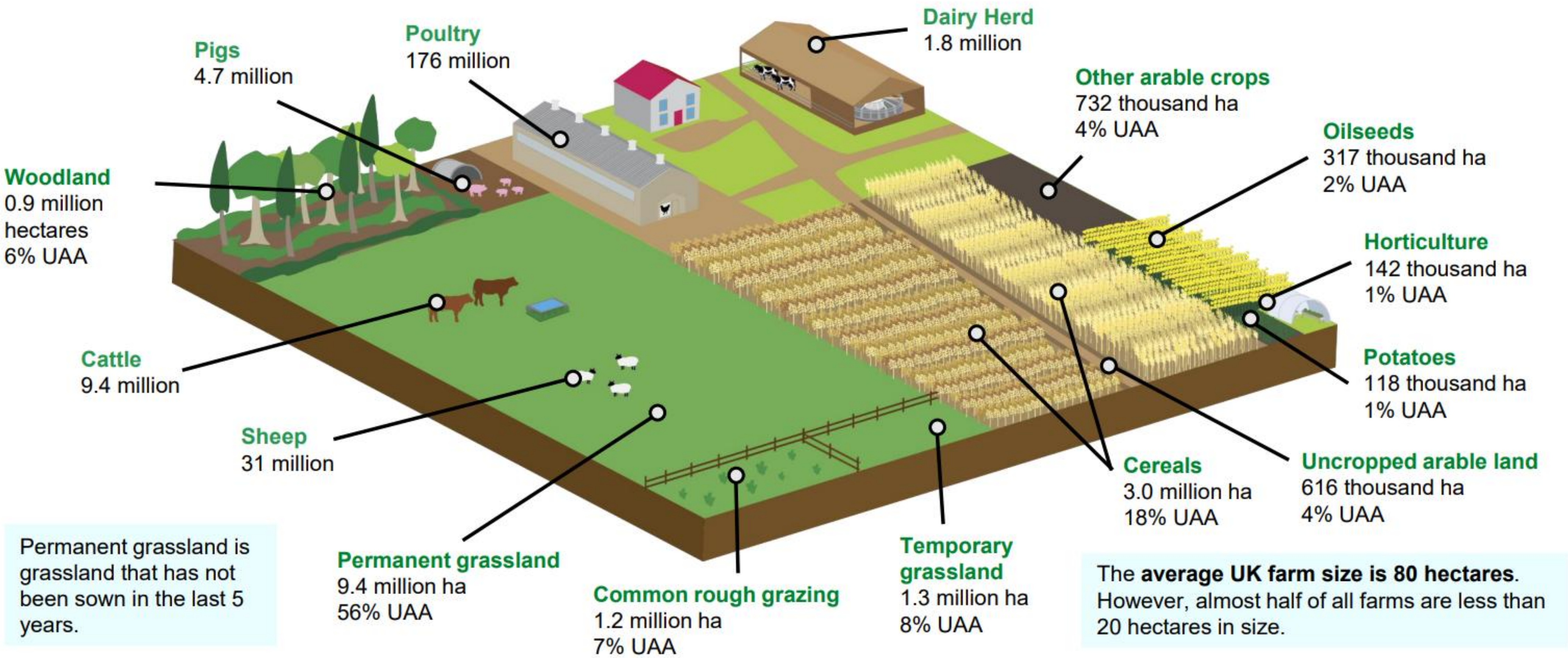

Figure 1: Structure of UK agricultural industry by farming land use. Source: DEFRA (2025b) Farming Evidence Pack. London: Government Statistical Service.

Grasslands form a substantial proportion of agricultural land across the UK and their composition varies between nations. Permanent grassland (61%) and rough grazing (14%) dominate agricultural land in Wales (Welsh Government, 2025a); almost 50% of Scotland's agricultural land is comprised of rough and semi-natural grassland and a further 18% is improved grassland (Scottish Government, 2025a). Northern Ireland's agricultural land is almost 60% grassland (DAERA, 2026a), and England's grassland accounts for 39% of its utilised agricultural area of 8.8 million hectares (DEFRA, 2025c). Grasslands therefore underpin a large proportion of UK farming systems.

However, changes in policies affecting grassland management are likely to have differing implications for farm businesses depending on factors such as farm size and land ownership. Due to the participant profile of the LUNZ Grasslands workshops and survey, this report is based largely on the perspectives of those working small- to medium-sized family farms, types of enterprise which often have fewer resources and less capacity to absorb rapid changes arising from agricultural policies and other external drivers (Ren *et al.*, 2024). This section examines the extent and distribution of grassland under different forms of land ownership, providing important context for the subsequent interpretation of project outputs.

The ownership of England's agricultural land is highly concentrated. While almost half of farms are under 20 hectares, the largest 20% of commercial farms control more than three-quarters of all farmlands, and 'very high output' estates generate 62% of agricultural income while occupying only a third of land (DEFRA, 2025d). Major landowners include aristocracy and landed gentry (around 30% of all land in England), private corporations (18%), and investors (17%). These figures describe the share of England's total land area held by each group, rather than the proportion of agricultural land specifically. Large rural estates - owning a substantial share of England's total land area - are shaped by policy incentives oriented toward carbon markets, rewilding, and ecosystem services, whereas small family farms face very different pressures linked to agricultural income and subsidy reform (Access to Land, 2025).

In Scotland, agricultural land covers 5.03 million hectares (65% of national land area), but 83% of rural land is privately owned, largely within extensive estates (Wightman, 2026). Although 44,698 agricultural holdings exist, most are small (under 500 hectares), and 1.27 million hectares are tenanted. Over 500,000 hectares of the Scottish Highlands and Islands are governed by the crofting system, where crofters rent small plots and share larger areas of common grazing land. Upland estate owners often prioritise carbon-offset forestry, peatland restoration and sporting land uses, whereas lowland family-owned arable farms tend to focus on food production using smaller tracts of land (Scottish Government, 2026b; SPICe, 2025; Prager *et al.,* 2026).

In Wales, 90% of national land area is used for agriculture (Welsh Government, 2025a). Farmed land totals 1.77 million hectares, plus 180,300 hectares of common land. Ownership is split between private farmers, large estates, and major public bodies such as Natural Resources Wales and the Crown Estate (Wightman, 2026). Small hill farmers - who manage most of Wales's grasslands - face very different policy pressures than large institutional landowners whose priorities include forestry, conservation, and catchment management.

In Northern Ireland, roughly one million hectares are farmed, mostly by small owner-occupied family farms (73% owner-occupied). Nearly four-fifths of farms are very small (under 20 hectares), and most land is used for cattle and sheep farming (NISRA, 2026). Large institutional landowners including Forest Service (185,000 acres), NI Water (33,000 acres) and the National Trust (27,800 acres) hold notable tracts (Shrubsole, 2026), but the overall pattern remains one of fragmented, grassland-based family farming (CAAV, 2026).

Taken together, the devolved nations show distinct landownership profiles but share a common feature: grasslands dominate the farmed landscape, and small family farms manage much of this land while having limited capacity to adapt to policy-driven change. Future agricultural policy must, therefore, differentiate between upland estate owners in Scotland, large arable enterprises in England, and small hill farmers in Wales and Northern Ireland, ensuring incentives reflect the realities of land area, ownership structure, and the vulnerability of small-scale family farm businesses.

3.3 UK climate change legislative targets

The primary climate change legislation covering the UK is the UK Climate Change Act (2008). This act sets out the legally binding framework for the UK's action on climate change. The Act was amended in 2019 to commit to a 100% reduction in greenhouse gas (GHG) emissions by 2050 compared to a baseline of GHG emissions in 1990. This is referred to as 'the net-zero target'.

Underpinning the UK Climate Change Act (2008), each of the four devolved nations defers to specific legislation and related policies to achieve the UK Climate Change Act (2008) based on its own national characteristics and circumstances. Table 1 provides a detailed summary and comparison of the key legislation, policies and delivery mechanisms that influence agriculture and land use for the UK overall and for each of the devolved nations in relation to the Net Zero target. We will refer to these throughout Part One.

Table 1. Summary of legislation, policies and progress to Net Zero for the four devolved UK nations. Sources: NAO, 2023; LUNZ Hub 2025; Climate Change Committee 2025a; UK Government, 2026c; Welsh Government 2026a & 2026b; Scottish Government, 2025b & 2026c; Department of Agriculture, Environment and Rural Affairs, 2026b, 2026c and 2026d; Natural Resources Wales, 2026a and 2026b; Nature Scotland, 2026; Scottish Forestry, 2026b; Scottish Land Commission, 2026; Department for Infrastructure, 2026; National Atmospheric Emissions Inventory, 2025; Department for Energy Security and Net Zero, 2026.

	Key Net-zero Legislation and Policies	Key Agriculture Legislation and Policies	Key Land Use Legislation and Policies	Key Biodiversity Legislation and Policies	Net Zero emissions targets	Highest-emitting sectors in MtCO2e*	Progress (2023 & 2024 figures)	Emissions reduction against 1990 baseline
England	**Legislation** • UK's Climate Change Act 2008 • UK Carbon Budgets (5 yr cycle) • Environment Act 2021 • Agriculture Act 2020 (post Brexit framework) **Policy** • Net Zero strategy • Biomass strategy • Tree/ peat action plans	**Legislation** • Agriculture Act (2021) **Policy** • Environment Land Management (ELM) schemes	**Legislation** • Environment Act (2021) • TCPA / National Policy Planning framework **Policy & Plans** • Land Use Framework • 2026–2030 Peatland Programme • DEFRA Trees Programme	**Legislation** • Environment Act (2021) • 2006, 1984, 1949, Acts **Policy** • Environmental Improvement Plan • Tree and Peat Action Plans • 30 x 30 framework	As per the UK: 2050, with an interim target which limits greenhouse gas (GHG) emissions over years 2033-2037, representing a 77% reduction on 1990 levels.	1. Surface transport, 112.9 (31%) 2. Buildings and product uses 80.4 (22%) 3. Agriculture, 45.9 (13%) 4.Industry, 41.1 (11%) 5. Fuel, 27.3 (7%) (Latest Figures – provisional 2025)	Provisional 2024 estimates for the UK overall are estimated to be 413.7 MtCO2e.	As per the UK: 50.4% (2024 provisional figures)

	Key Net-zero Legislation and Policies	Key Agriculture Legislation and Policies	Key Land Use Legislation and Policies	Key Biodiversity Legislation and Policies	Net Zero emissions targets	Highest-emitting sectors in MtCO2e*	Progress (2023 & 2024 figures)	Emissions reduction against 1990 baseline
Northern Ireland	**Legislation** • The Climate Change Act (Northern Ireland) 2022 • Northern Ireland's Carbon Budgets • Environment Act (Northern Ireland) 2021 **Policy** • Green Growth Strategy • Sustainable Agriculture Programme (SAP) (2026 rollout)	**Legislation** • The Climate Change Act (Northern Ireland) 2022 • Agriculture Act (Northern Ireland) 2025 **Policy** • Sustainable Agriculture Programme (SAP) (2026 rollout)	**Legislation** • The Climate Change Act (Northern Ireland) 2022 • Planning Act (Northern Ireland) 2011 **Policy & Plans** • Sustainable Agricultural Land Management Strategy • NI Forestry Strategy • Northern Ireland Peatland Strategy to 2040 • Northern Ireland Tree Planting Action Plan 2026-2032	**Legislation** • NI Conservation Regulations (2007) • NI Wildlife and Natural Environment Act (2011) **Policy** • Nature Recovery Strategy for Northern Ireland to 2032 (draft) • Environmental Improvement Plan • 30x30 framework	2050, with an interim target of at least a 48% reduction by 2030. An interim target for 2040 is to be established. These are against baselines of 1990 or 1995 (depending on the greenhouse gas) as set out in the Climate Change Act (Northern Ireland) 2022.	1. Agriculture, 6.19 (30.8%) 2. Surface Transport 4.32 (21.5%) 3. Residential Buildings, 2.77 (13.8%) 4. Land Use, 2.37 (11.8%) 5. Energy Supply (Electricity) 2.35 (11.7%) (Latest Figures – 2023)	Emissions in 2023 were 18.5 $MtCO_2e$, which is 7% lower than in 2022.	31%

<table>
<tr><th></th><th>Key Net-zero Legislation and Policies</th><th>Key Agriculture Legislation and Policies</th><th>Key Land Use Legislation and Policies</th><th>Key Biodiversity Legislation and Policies</th><th>Net Zero emissions targets</th><th>Highest emitting sectors (MtCO2e)</th><th>Progress (2023 & 2024 figures)</th><th>Emissions reduction against 1990 baseline</th></tr>
<tr><td>Scotland</td><td>Legislation
• Climate Change (Scotland) Act 2009 (as amended 2019)
• Scotland's Carbon Budgets (currenting setting 1st-4th)

Policy
• Scotland's Climate Change Plan – 2026-2040 (2025)</td><td>Legislation
• Agriculture and Rural Communities (Scotland) Act 2024

Policy
• Rural Support Plan: Four-tier agricultural support framework (phasing in 2025-2027)</td><td>Legislation
• Land Reform (Scotland) Act 2025
• Planning (Scotland) Act 2019

Policy & Plans
• National Planning Framework 4 (NPF4)
• Land Use Strategy for Scotland 2026-2031 (2026)
• Peatland ACTION five-year partnership plan 2025 – 2030
• Scotland's Forestry Strategy</td><td>Legislation
• Nature Conservation (Scotland) Act 2004
• Wildlife and Natural Environment (Scotland) Act 2011

Policy
• Scottish Biodiversity Strategy to 2045 (2024)
• 30x30 framework</td><td>2045, with interim targets of a 75% reduction by 2030 and 90% by 2040. These are against a 1990 baseline and set out in the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019.</td><td>1. Surface Transport, 13.0 (32.83%)

2. Agriculture 7.5 (18.94%).

3. Business and Industrial Process 7.0 (17.68%).

4. Buildings 6.0 (15.15%)

5. Energy Supply, 3.9 (9.85%).

(Latest Figures – 2023)</td><td>Emissions in 2023 were 39.6 $MtCO_2e$, representing a 2% decrease from 2022.</td><td>51%</td></tr>
<tr><td>Wales</td><td>Legislation
• Well-being of Future Generations (Wales) Act 2015
• Environment (Wales) Act 2016
• Net Zero Wales Carbon Budgets (setting 4th)

Policy
• National Forest grant schemes</td><td>Legislation
• Agriculture (Wales) Act 2023

Policy
• Sustainable Farming Scheme (SFS) (from 2026)</td><td>Legislation
• Well-being of Future Generations (Wales) Act 2015
• Environment (Wales) Act 2016
• Agriculture (Wales) Act 2023
• Planning (Wales) Act 2015

Policy & Plans
• Sustainable Land Management framework (under 2023 Act)
• Future Wales: The National Plan 2040
• Beyond Recycling Strategy
• National Peat Action Programme
• Woodlands for Wales Strategy</td><td>Legislation
• Environment Act Wales
• Wellbeing of Future Generations Act (Wales) 2025

Policy
• 30x30 framework
• Nature Recovery Action Plan
• Area Statements (Natural Resources Wales)</td><td>2050, with interim targets for a 63% carbon reduction by 2030, 89% by 2040 as set out in The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021. These are against baselines in 1990 and 1995 (depending on the greenhouse gas) as set out in the Environment (Wales) Act 2016.</td><td>1. Industry 15.5 (31%)

2. Electricity Supply 7.5 (15%)

3. Agriculture 7.5 (15%)

4. Surface Transport 8.5 (17%)

5. Fuel Supply 5 (10%)

(Latest Figures – 2023)</td><td>Emissions in 2023 were 34.1 MtCO2e, 6% lower than in 2022.</td><td>38%</td></tr>
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3.4 The UK's greenhouse gas emissions targets and carbon budgets

Legislated through the UK Climate Change Act (2008), greenhouse gas emission targets for the UK to 2050 are implemented and tracked via the UK's carbon budgets. The UK's carbon budgets are set 12 years in advance, with each covering five years. The carbon budgets provide a cap on emissions that the UK can produce in the 5-year period. A summary of the current and forthcoming carbon budgets for the UK and devolved nations is shown in Table 2. Tackling climate change has become a devolved issue. Carbon budgets to cover the whole of the UK were first set in 2009, and carbon budgets for Wales, Northern Ireland, and Scotland were set in 2016, 2022 and 2025 respectively (Scottish Government, 2025c; DAERA 2022; Welsh Government, 2025b).

Table 2. Summary of the current and forthcoming carbon budgets for the devolved nations. The figures given for England are the same as for the UK overall. Source: Climate Change Committee (2026).

Devolved nation	Carbon Budget	Time frame	Emissions cap	Average annual emissions reduction on 1990 levels
England (as per the UK)				
	Fourth Carbon Budget	2023-2027	1,950 $MtCO_2e$	52%
	Fifth carbon budget	2028 to 2032	1,725 $MtCO_2e$	58%
	Sixth carbon budget	2033 to 2037	965 $MtCO_2e$	78%
	Seventh carbon budget	2038 to 2042	535 $MtCO_2e$	87%
Scotland				
	First carbon budget	2026 to 2030	174.64 $MtCO_2e$	57%
	Second carbon budget	2031 to 2035	125.91 $MtCO_2e$	69%
	Third carbon budget	2036 to 2040	81.23 $MtCO_2e$	80%
	Fourth carbon budget	2041 to 2045	24.37 $MtCO_2e$	94%
Northern Ireland				
	First carbon budget	2023-2027	Est. 89 $MtCO_2e$	33%
	Second carbon budget	2028-2032	Est. 66 $MtCO_2e$	48%
	Third carbon budget	2033-2037	Est. 53 $MtCO_2e$	62%
	Fourth carbon budget	2038-2042	Est. 39 $MtCO_2e$	77%
Wales				
	Third carbon budget	2026-2030	Est. 119–120 $MtCO_2e$	58%
	Fourth carbon budget	2031-2035	Est. 77–78 $MtCO_2e$	73%

3.5 The Carbon Budget's 'Balanced Pathway'

In 2020, the Climate Change Committee introduced the 'Balanced Pathway' setting out a practical route for England, Scotland and Wales to reduce greenhouse gas emissions by 78% by 2035 (from 1990 levels). This pathway is intended to guide long-term actions across sectors, including agriculture and land use, towards meeting the UK's legally binding Net Zero target by 2050. The pathway is developed by dividing the UK's emissions into sectors of the economy, including agriculture and land use, and determining plausible emissions reductions for each from 2025 to 2050. Each sector's policies and plans are assessed by the Climate Change Committee to monitor each nation's progress (Climate Change Committee, 2020).

There are some differences between the devolved nations of the UK in terms of the proportions of emissions produced by the highest-emitting sectors and the actions needed to mitigate them. The makeup of GHG emissions from Northern Ireland is different from those emitted from the UK overall, with current per-capita emissions nearly double those in the UK. Therefore, using the Balanced Pathway methodology for Northern Ireland does not reach the country's Net Zero 2050 target. As such, the Climate Change Committee developed a more ambitious pathway for Northern Ireland to reach Net Zero by 2050, referred to as *the Northern Ireland Net Zero Pathway*. The Climate Change Committee uses this pathway as the basis for recommendations on appropriate levels for Northern Ireland's Fourth Carbon Budget to be consistent with the country's existing Net Zero target (Climate Change Committee, 2025b).

3.6 Agricultural greenhouse gas emissions and progress across the UK towards meeting Net Zero

Agriculture remains a significant source of UK greenhouse gas emissions. In 2022, agriculture was the fourth highest-emitting sector overall, contributing 11% of emissions (47.7 $MtCO_2e$), while net emissions from land use, land use change and forestry[2] were close to zero at 0.8 $MtCO_2e$. In Wales, agriculture was the third largest emitting sector in 2022, accounting for 16% of emissions. Emissions in Wales have fallen by 8% since 1990, from 6.1 $MtCO_2e$ to 5.6 $MtCO_2e$. In Scotland, agriculture was the second largest source of emissions, responsible for 19% of the total. Emissions in Scotland declined by 12% between 1990 and 2022, from 8.8 $MtCO_2e$ to 7.7 $MtCO_2e$. Land use emissions were much smaller, representing around 1% of total emissions in 2022 and falling sharply from 6.0 $MtCO_2e$ in 1990 to 0.2 $MtCO_2e$. In Northern Ireland, agriculture was the largest emitting sector in 2022, producing 29% of emissions. Unlike the rest of the UK, emissions from agriculture increased by 15% between 1990 and 2022, reaching 6.2 $MtCO_2e$. Land use emissions accounted for 10% of emissions in 2022, declining to 2.2 $MtCO_2e$ since 1990 (Climate Change Committee, 2025a).

[2] Net emissions from Land Use, Land-Use Change, and Forestry (LULUCF) represent the balance between greenhouse gases released into the atmosphere and those removed from it through direct human management of land. For example, this includes carbon absorbed by forests and soils (sinks) compared with emissions from agriculture, land use and other sectors (sources). LULUCF plays a key role in reaching net-zero targets because it can function either as a net sink or as a net source of emissions. (Committee on Climate Change, 2013).

Progress towards net zero targets so far has mainly been through decarbonising electricity systems through coal and gas being replaced by renewables. From 2024 until 2030 over 80% of the emission savings need to come from sectors other than energy supply, for example, from transport, buildings, agriculture and aviation. Beyond 2030, to achieve the sixth carbon budget (2033-2037), progress requires wider change as the electricity system becomes decarbonised, with a target of 90% of emissions savings coming from other sectors. Increasing emissions reductions from agriculture, land use, aviation and accelerating engineered carbon removal are required, as well as maintaining major contributions towards the target from surface transport, buildings, and industry. As little progress has been made in reducing emissions from agriculture and land use in recent years, urgent and substantial action is needed to meet future targets **(**Burnett *et al.,* 2025).

The UK's Sixth and Seventh Carbon Budgets set out a range of key mitigation measures for UK agriculture and land use to reduce emissions in line with the Balanced Pathway and the Northern Ireland Net Zero Pathway, covering soil and livestock, crop yields, energy crops, and agroforestry and hedgerows (Eory *et al.,* 2025). While the same key mitigation measures are used within Northern Ireland, Scotland and Wales Fourth Carbon Budgets, the targets to achieve them differ according to the geography of each nation and the greater prominence of certain livestock systems (e.g. sheep, beef or dairy) in some nations rather than in others. For example, Table 3 summarises which of the 26 key soil- and livestock-related mitigation measures identified by the Climate Change Committee are expected to deliver the greatest reductions in emissions for each devolved nation.

Table 3. Most impactful soil and/or livestock key mitigation measures identified by the Climate Change Committee (Eory *et al.,* 2025).

Devolved nation	Description of soil and/or livestock measures
UK/England	Assumption that current output is maintained as productivity is improved by the use of soil and livestock measures, leading to a reduction in livestock numbers of around 5% for cattle and sheep in 2040. Measures to improve soil health, while reducing nitrous oxide emissions, include the planting of crops that can reduce the need for fertiliser use and more efficient use of nitrogen.
Northern Ireland	In 2040 Livestock measures deliver 81% abatement. Feed additives, waste and manure management measures (including anaerobic digestion (AD)) abatement (cost-effective AD is limited to pig waste only) achieve 60% abatement. Soil measures (e.g. cover crops and reducing nitrogen excess) achieve 19% abatement
Scotland	By 2035, the largest group of savings are delivered by measures for waste and manure management, livestock feeds and diet, and the reduction of fertiliser use on soils, with each delivering around 6% of the total sector abatement in 2035.
Wales	The largest group of savings are delivered by measures for livestock feed, and the reduction of fertiliser use on soils, mainly grassland (for example, grass-legume mixtures), with each delivering around a quarter of the abatement in 2033. Waste and manure management measures account for a further 20% of emissions savings.

The LUNZ Grasslands project combined the key mitigation measures identified in the UK Carbon Budgets (Department for Energy Security and Net Zero, 2023; Eory, *et al.* 2015, 2025), a number of carbon-reducing farming practices identified in reports (CIEL, 2022; McNicol, *et al.,* 2024; Nature Friendly Farming Network, 2019), and farming practices being trialled by LUNZ Grasslands cluster farms to compile a priority list of livestock and grassland management practices that we presented to farmers during our workshops. Please refer to Part Two of this report for further details of this list of practices and how it was used within this research.

3.7 Agriculture and land use policy across the UK

Agricultural policy objectives across the devolved nations are set in different ways. In England, objectives are articulated through 'priorities for payment' set out in the Agriculture Act (2020), while in Northern Ireland they are defined through policies led by DAERA. Both England and Northern Ireland rely primarily on scheme-based enforcement. In contrast, Scotland and Wales have explicit statutory objectives that legally shape agricultural policy. Table 4 summarises how these differing approaches contribute to sustainable land management practices in each nation.

Table 4. Statutory objectives for agriculture and sustainable land management across the UK. Sources: Agriculture Act, 2021; Department of Agriculture and Rural Affairs, 2026; Agriculture and Rural Communities (Scotland) Act 2024; Agriculture (Wales) Act 2023.

Devolved nation	Statutory Agricultural Objectives	Enforcement mechanism	Sustainable Land Management Focus
England	No objectives. But a list of purposes for payments within the Agriculture Act (2021).	Agriculture Act 2021 + Environmental Land Management schemes; compliance linked to payments.	Embedded indirectly through schemes: purpose-based payments for environmentally friendly produced food and increased productivity, alongside the protection and conservation of climate, land, water, livestock, plants, soil and cultural heritage.
Northern Ireland	No single statutory list	Secondary legislation via DAERA (e.g. Farm Sustainability Standards 2025, Farming with Nature schemes) tied to payment eligibility.	Embedded indirectly; covers soil, water, biodiversity, climate, animal welfare.
Scotland	Within the Agriculture and Rural Communities (Scotland) Act 2007.	Primary legislation.	Direct statutory objectives: sustainable/regenerative farming practices, high quality food production, climate adaptation, on-farm nature restoration, rural community support.
Wales	Within the Agriculture (Wales) Act 2023.	Primary legislation	Four statutory Sustainable Land Management (SLM) objectives: produce food sustainably, mitigate/adapt to climate change, maintain/enhance ecosystem resilience, conserve/enhance countryside, cultural resources, and promote public engagement & Welsh language.

3.8 Net Zero targets and pressures on farmers

While people in the agricultural industry will need to do things differently to reach Net Zero targets, it is vital that policies and recommendations for action recognise that many farmers in the UK are under pressure. These pressures matter first and foremost for the ways in which they influence farmers' quality of life, but they can also reduce farmers' capacity to change course and take up new systems and practices without adequate support. Farmers in the UK are also a varied group, working across a wide range of farming systems, types of terrain, and devolved contexts, so pressures are not distributed evenly. Nevertheless, the challenges identified by farming charities, academic researchers and government bodies include widespread poor mental and physical health and wellbeing, including on-the-job injury, long-term pain, and social isolation. Many farming people also report stressful, physically demanding and high-stakes working conditions. Many farmers also experience financial pressures due to fluctuating costs and subsidies, small profit margins, and changing consumer habits. The unpredictability of changing regulations, as well as changing patterns of extreme weather also places significant pressure on farming people and their businesses. Further information about current pressures on farmers and farming communities is given in Appendix B.

With these challenges affecting a significant proportion of the farming community and limiting their capacity to act with the future in mind, asking farmers to do things differently to achieve Net Zero is a sensitive prospect. And yet, the agricultural sector must do its share to reduce emissions alongside the other highest-emitting sectors in the UK, including transport, housing, industry, electricity supply, and aviation (Climate Change Committee, 2025a). By considering these challenges in conjunction with the Seventh Carbon Budget's key mitigation measures to reduce emissions in the agricultural and land use sectors (Climate Change Committee, 2025a), there are several areas in which the needs of farmers and the need for actions to mitigate climate change may conflict or align.

The Climate Change Committee's Seventh Carbon Budget states that greater uptake of low-carbon farming practices and technologies will reduce emissions from managing soils, managing livestock, and the use of on-farm machinery. The Carbon Budget identifies 26 measures that can reduce emissions directly (e.g. through better management of animal waste or the use of feed additives to inhibit methane from cattle) or improve productivity, upping output per animal. Decarbonising farm machinery through the use of electricity- or hydrogen-powered alternatives is also identified as a key measure. However, given the financial pressures upon many farm businesses, financial support will be necessary to enable these changes. While initial high costs will be a problem for many farmers, these changes may have benefits for farmers by reducing labour and easing financial pressures in the longer term by increasing farm productivity. Pressures to move away from fossil-fuelled farm vehicles and machinery became more acute in the months preceding the publication of this report, as Farmers Weekly (2026) reported that farmers in England may pay an additional £337m for red diesel over the twelve months following US strikes on Iran and the resulting fuel crisis. Though challenging in the short-term, enhancing a business's resilience against financial shocks such as those associated with geopolitical crises will likely benefit farmers' health, wellbeing and working conditions in the longer term.

Similarly, the Seventh Carbon Budget suggests that governments "support opportunities to diversify farm businesses and incomes [...] beyond agricultural production" as schemes to replace the EU's CAP will pay much lower levels of public subsidies for maintaining agricultural land (Climate Change Committee, 2025a: 194). Farmers will need funds, training and advice to diversify their businesses effectively. Though diversification may generate new opportunities and increase farm resilience, the stress and increased workload involved in transitioning to different farm systems or taking up new ventures should not be underestimated.

An aspect of the Carbon Budget which may conflict with the needs of a subsection of UK farmers is the destocking of upland farms and increasing of stocking densities in lowland areas (Climate Change Committee, 2025a: 195). This would allow for the restoration of upland peatlands, increased carbon sequestration and potential payments for maintaining peatlands in good ecological condition. However, there will be unequal spatial implications of the uptake of this practice (i.e. farmers in some devolved nations or regions will be more affected than others), including challenges to farming communities' primary sense of identity as food producers rather than land conservationists. Peatland restoration requires a long-term vision for land use change and the ability to give farmers some stability around these decisions; RABI's (2021) survey highlighted that fluctuating agricultural policies around environmental protections are a source of stress for nearly a third of farmers.

Lastly, the Seventh Carbon Budget stated that increasing the take-up of low-carbon farming practices and technologies is a key action to reduce non-CO_2 greenhouse gas emissions from livestock (Climate Change Committee, 2025a: 192). Aside from the costs of implementing changes, barriers to the take-up of these low-carbon farming practices include digital skills gaps and a cultural reluctance to adopt new techniques, as described by our workshop participants. These barriers may be particularly apparent in agriculture where the concentration of older workers is higher than in many other sectors, but we are cautious to suggest that old farmers can't learn new tricks. On the other hand, while young people are often assumed to be proficient 'digital natives', farmers of all ages may lack the essential digital skills needed to take up new low-carbon farming technologies, especially in areas lacking sufficient internet connectivity. As a result of these pressures, support and incentives will be needed to enable the implementation of farming practices advocated by the Climate Change Committee (2025a).

3.9 Conclusion

Part One of this report has set out the UK and devolved policy frameworks shaping agriculture and land use in the context of legally binding Net Zero targets, alongside the Climate Change Committee's recommendations for emissions reduction. There is clear alignment across all four nations in recognising that agriculture - particularly livestock systems - has a critical role to play in delivering climate mitigation, alongside wider objectives for soil health, biodiversity, animal welfare and rural vitality.

At a strategic level, many measures identified by the Climate Change Committee, such as improving nutrient efficiency, soil management, livestock health and manure management, align with established principles of good farming practice and with statutory agricultural objectives in Scotland and Wales, and the payment purposes set out in England and Northern Ireland. Policy frameworks increasingly emphasise multifunctional land use, reflecting an understanding that carbon reduction cannot be pursued independently of food production, ecosystem resilience and viable rural communities.

However, significant tensions remain in how these ambitions translate into practice. Agriculture is expected to deliver faster and deeper emissions reductions at a time when many farmers face acute financial, regulatory and wellbeing pressures. Assumptions embedded in Climate Change Committee pathways - such as changes to livestock numbers or land use - can conflict with farmers' business models, cultural identities and the constraints of landscapes, particularly in regions where agriculture accounts for a high share of emissions. Differences in policy design and enforcement across the devolved nations, alongside ongoing reform and uncertainty, further complicate long-term decision-making and investment.

The central challenge, therefore, lies not in the direction of travel but in delivery: aligning ambitious Net Zero policy with the lived realities of farmers and land managers. Addressing this gap requires policies and pathways that are not only technically effective, but also socially acceptable, economically viable and sensitive to place-based contexts. In Part Two, the report will explore the findings from the LUNZ Grasslands series of workshops involving farmers and land managers in which a priority set of farming practices were identified and perceived by workshop participants as being both likely to help the industry achieve Net Zero targets and largely acceptable to UK farmers.

1. Part Two

4.1 Introduction to the LUNZ Grasslands workshops

The purpose of each workshop was to convene members of the agricultural sector who graze livestock on UK grasslands, or whose work supports or engages with grassland farmers, to develop pathways (i.e. a set of activities that lead toward a goal) for achieving the UK Government's land use policy and net-zero objectives. As policies to address net zero targets for agriculture are determined at a devolved national level, we sought to engage farmers and others in the farming community across the UK by holding three workshops: the first in Newcastle for farmers in England and Scotland; the second in Birmingham for farmers in England and Wales, and the third in Cookstown in central Northern Ireland. The locations were chosen due to the availability of suitable workshop venues and good transport links by road and rail.

53 participants attended a regional workshop in Newcastle (12 participants), Birmingham (14 participants) or Cookstown (27 participants). To supplement the workshop input and increase the involvement of farmers who may experience barriers to participation, we distributed a condensed version of the workshops in the form of an online survey in February-March 2026 which received 85 responses. Further demographic, occupation, and farm system data for workshop and survey participants is available in Appendix C. A limitation of the workshop data is that twice as many participants attended the Northern Ireland workshop than the other regional workshops, such that the data presented here is significantly skewed towards their perspectives.

The workshops facilitated conversations with farmers and others about their experiences and knowledge of livestock and grassland management practices (hereafter 'the practices') that could reduce greenhouse gas emissions from UK agriculture by reducing waste, increasing farm efficiency and sequestering carbon. Workshop participants also discussed the value and limitations of these practices in terms of their potential impacts on other important aspects of agricultural sustainability, such as farmers' livelihoods, biodiversity, and wider food systems. We were also interested in workshop participants' *perceptions* of which livestock and grassland management practices had the potential to make the biggest impact on reducing net emissions. We asked workshop participants whether any practices could be 'easy wins' – those that were regarded as generally easy to implement *and* had high potential to reduce net emissions.

Lastly, we live in uncertain times. Global geopolitics, technological developments and a changing climate will shape the coming decades with yet unknown implications for UK society. The Shared Socioeconomic Pathways (SSPs) are a set of five future scenarios that have been developed at different scales to help governments plan actions to assist with climate change mitigation, adaptation, and impact. Scenarios are commonly used by researchers to explore potential future outcomes under conditions of uncertainty (Pedde *et al.,* 2020). In 2025, the TRADE project, in co-production with stakeholders from the livestock sector, developed the 'UK-Livestock-SSPs' and their narratives (Blair *et al.,* 2025). Asking our workshop participants to reflect upon the opportunities or constraints presented by these future scenarios prompted them to identify priority farming practices that would be viable under these varied circumstances, therefore helping UK farming to become more resilient against a range of possible future conditions. More information about the SSPs, including the visual summaries used in the LUNZ Grasslands workshops, is available in Appendix D.

4.2 Overview of workshop activities

A full explanation of workshop activities is available in Appendix E.

Activity 1 asked participants to review a list of over 60 practices for livestock and grassland management that could reduce net emissions (see Appendix F) and invited to suggest additional practices that had not been listed. In each workshop, participants generated 15-20 further ideas for emissions-reducing livestock and grassland management practices (see Appendix G). Participants voted for the three practices they believed had the most potential to reduce net emissions, generating a shortlist of priority practices that were advanced to Activity 2 (see Appendix H).

Activity 2 distributed the shortlisted practices between break-out groups and asked participants to complete a SWOT analysis of each practice, exploring the internal strengths and weaknesses of each practice, as well as the external opportunities and threats that might affect their implementation. For full details of all 32 SWOT analyses, see Appendix I; summary points are given in Appendix J. When each SWOT analysis was complete, participants were asked to assess whether they expected the practice to be 'easy', 'medium', or 'hard' to implement at the farm level (see Appendix K).

Activity 3 invited participants to consider all shortlisted practices in terms of the *scale* of their potential to reduce net emissions (see Appendix L). Participants scored practices based on their perceived potential to reduce net emissions: one point to those with low potential, two points for medium potential, and three points for high potential. Participants then ranked the shortlisted practices from the highest to lowest potential to reduce net emissions and made notes explaining their reasoning (see Appendix M). 'Easy wins' were practices that workshop participants perceived as both easy to implement and having high potential to reduce net emissions (see Appendix N). At the end of Activity 3, each group calculated the combined total of its scores (the 'total score', with a minimum possible overall score of 15 and a maximum possible score of 45) and fed their results back to the whole group.

Activity 4 explored the suites of practices that participants would choose in response to possible future scenarios. Participants were invited to choose practices that a) would contribute towards reaching emissions reduction targets given the challenges imposed by a future scenario, and b) were acceptable to their group as a result of the priorities and compromises they had identified and agreed upon. Groups were assigned one of three UK-Livestock-SSP scenarios which described the implications of a given future scenario upon farm businesses, the environment, agricultural policy, and public health. To begin the activity, each group calculated their 'target score': an arbitrary limit set at one-third of their 'total score' from Activity 3. This arbitrary target was devised to demonstrate the *principle* of choosing a limited set of the most valuable and acceptable practices in light of the need to identify priorities and make trade-offs when constrained by challenging future circumstances. When time allowed, breakout groups were asked questions around perceived biodiversity impacts and differences across the devolved nations of the UK. See Appendix O for the findings derived from Activity 4.

The **Priority Practices Postcard** was implemented in the Northern Ireland workshop and it invited participants to list the top five practices which, in their opinion, were "most likely to reduce emissions, support biodiversity, and sustain profitable farming in Northern Ireland" following Activity 2 (see Appendix P).

4.3 Research methods

In Newcastle and Birmingham, notetakers were used to keep a record of breakout group discussions. In Cookstown, the discussions were audio-recorded so that we could record group discussions in greater detail. All breakout groups made written notes on activity worksheets which were later transcribed and used in our analysis.

A **Supplementary Survey** was distributed among our network of LUNZ project partners in early February 2026 to compensate for the high workshop drop-out rate and enable more members of the farming community to participate in the research. Ethical approval was obtained from UWE Bristol for the collection and storage of this data using Qualtrics survey software. The survey was offered in English and Welsh versions for seven weeks and was open to all farmers, farm workers, land managers and staff from organisations supporting UK farming as long as they were aged 18 years or over and resident in the UK. In recognition of their time, survey respondents were offered to choose one of eight UK farming support charities to receive a £2 donation on their behalf from the LUNZ Grasslands project (see Appendix Q). The survey received 85 completed responses. Demographic data about the survey respondents is summarised in Appendix C, Table C2. Details of survey respondents' farms, including grassland type and livestock numbers, is summarised in Appendix C, Table C3.

4.4 Workshop findings

A summary of the results of the LUNZ Grasslands workshops and preliminary results from the supplementary survey are presented in Table 5. The table presents the 38 practices that were shortlisted either in Newcastle, Birmingham or Cookstown as priority livestock and grassland management practices with the most potential to reduce net emissions, or were most frequently shortlisted by survey respondents (see Appendix H). As participant numbers varied between the workshops and survey, relying on voting frequency alone as an indicator of a practice's popularity would be insufficient as perspectives from workshops with lower attendance may be lost. As such, Table 5 tests each practice against ten criteria that indicate their level of support they received from participants. The criteria include including popularity within the survey or a given workshop, cross-workshop popularity, being perceived as an 'easy win', being selected as a priority practice in response to a given UK-Livestock-SSP future scenario, and whether a practice has been recommended by the Seventh Carbon Budget's Balanced Pathway as a key climate change mitigation measure for the agricultural sector in at least one devolved nation or for the UK overall.

The practices are presented in descending order from those meeting the most criteria to the least. For clarity, where a practice is similar to one recommended by the Seventh Carbon Budget but is not directly equivalent, it is labelled 'Related'. For example, the key mitigation measure *[ensure] optimal soil pH* (Eory *et al.,* 2025) reported in the Seventh Carbon Budget is similar to *better soil health practices* but represents just one of many possible practices that could be used to improve soil health. It is *related* to a key mitigation measure, but it is not exactly the same. For the purpose of ranking the practices to identify those with the greatest overall support from our research participants, the 'Related' label can be thought of as a half-point which, if ascribed to a practice, would elevate it above another practice that otherwise met the same number of criteria in Table 5 but had no relation to key measures in the Seventh Carbon Budget.

The most criteria (9/10) were met by *grass-legume mixtures and multispecies swards,* also known as herbal leys, which fix nitrogen, increase forage production and biodiversity, and improve soil health by adding clovers, herbs and grasses to pasture seed mixes. This practice did not meet the criteria of being perceived as an 'easy win' as only 2 of 6 breakout groups thought it has high potential to reduce net emissions, and none of the workshops agreed upon its level of ease of implementation (see Appendix K).

Better soil health practices met the second most criteria (6.5/10). Measures to improve soil health, such as optimising pH levels to support healthy plant growth, would increase sub-surface carbon sequestration and support farm efficiency by improving the volume and quality of forage available to livestock. In the Birmingham workshops, participants shortlisted a similar practice of *increasing soil organic matter*; combining these two practices may have met more criteria as the latter was regarded as an 'easy win'. *Better soil health* was not identified as an 'easy win', as the Newcastle and Cookstown workshops described it as 'medium difficulty' and 'hard' to implement. Further details are given in the SWOT analysis in Appendix I.

Improved animal health met the third most criteria (6/10). Producing healthier, fitter, and more fertile livestock would increase farm efficiency and decrease greenhouse gas emissions from livestock systems per unit of output. This practice did not appear within the top five most popular practices by voting frequency in any of the workshops, but was applied to the SSP future scenarios by at least two breakout groups, and was selected for suites of practice to address multiple kinds of future scenario, namely '*SSP1: Sustainable Transformation*' and *'SSP4: Inequality.'*

Each of these three practices were shortlisted within two or more workshops, indicating they were supported by a broader consensus than other practices. They are also supported by the survey data, as they were shortlisted within the top 15 practices by voting frequency among survey respondents. If, however, we discount the survey data*, genetic improvement in female productivity* would occupy joint-second place in Table 5 alongside *better soil health practices*. The fourth and fifth practices to meet the most criteria in Table 5 were *genetic improvement in female productivity* (5.5/10) and *nutrient management planning* (5/10) respectively.

All of the top five practices in Table 5 directly matched or were closely related to key mitigation measures outlined in the Seventh Carbon Budget's Balanced Pathway. Given a number of recent high-profile conflicts between government policy and UK farmers, it is noteworthy that we can identify a strong alignment between these five practices which received the most support from our research participants *and* are recommended as key climate change mitigation measures by the Climate Change Committee. It is useful here to return to Table 3 in Section 3.5, which identified the following key mitigation measures for the devolved nations:

- In **England and the UK overall,** measures to improve soil health while reducing nitrous oxide emissions, such as more efficient application of nitrogen and planting crops that reduce the need for fertiliser inputs, are anticipated to reduce emissions from grassland agriculture.
- In **Northern Ireland**, feed additives, waste and manure management measures (including anaerobic digestion) are anticipated to achieve 60% of GHG abatement from agriculture, and soil enhancement measures, such as cover crops and reducing excess nitrogen, would achieve a further 19% GHG abatement by 2040.
- In **Scotland**, it is anticipated that the largest share of GHG emissions savings will be delivered by waste and manure management measures, as well as reduced use of fertiliser.
- In **Wales**, the largest share of emissions savings will be delivered by measures for livestock feed and reduced use of fertiliser.

Of the twelve practices that were ranked highest in Table 5, six would directly help to improve soil health *(grass-legume mixtures and multispecies swards; better soil health practices; nutrient management planning; increased soil organic matter; regenerative farming practices*, and *winter cover crops*). Two of the highest-ranked practices are livestock management practices (*improved animal health* and *genetic improvement in female productivity*). Two of the practices directly relate to livestock diet *(improved forage quality* and *specialised feed ingredients and additives*). The remaining highest-ranked practices relate to training and planning *(improved training for farmers and advisors in GHG mitigation*) and carbon-capture planting (*agroforestry and woodland grazing*).

However, though the Climate Change Committee anticipates that better waste and manure management practices will deliver a significant share of emissions savings, there are none within the overall top twelve practices and only three appear in Table 5 at all: *methane-powered farm vehicles* (when paired with on-farm anaerobic digestion), *slurry acidification*, and *manure separation (separating solids and liquids)*. This is unsurprising given that several participants of the Newcastle and Birmingham workshops ran sheep livestock systems which do not produce large quantities of animal manure in concentrated storage compared with housed dairy systems. As such, *slurry acidification* and *methane-powered farm vehicles* were shortlisted in the Birmingham workshop on the basis of one vote each, and no manure-related practices were shortlisted in Newcastle at all. *Manure separation (separating solids and liquids)* was shortlisted in Cookstown in both Activity 1 and in the Priority Practices Postcards, though both appeared in the lower 50% of these rankings by vote frequency. Nevertheless, while there are some encouraging overlaps between the practices supported by farmers and those highlighted in the Seventh Carbon Budget's Balanced Pathway, it appears that the *scale* of their potential to reduce emissions from UK grassland agriculture has been overestimated by workshop participants. It is important to recognise that livestock and grassland management practices (or *'soil and livestock measures'* as they are termed in the Balanced Pathway) are anticipated to achieve only 14% of the emissions reductions needed from agriculture by 2040. 21% of emissions reductions from this sector are expected to come from decarbonising machinery. Though the practice of introducing *methane-powered farm vehicles* was shortlisted, other ways of decarbonising farm machinery, such as the renewable electrification of heating and cooling systems for livestock housing, hydrogen-powered vehicles and electric vehicles, were not shortlisted.

Significantly, neither was the practice of reducing livestock numbers raised by workshop participants. The Balanced Pathway anticipates that reducing livestock numbers would achieve 32% of the emissions reductions needed from UK agriculture by 2040 and provide 68% of the land that would be made available for woodland creation, peatland restoration and other means of sequestering carbon. Reducing the number of livestock would involve the provision of government support to diversify farm businesses, consumer-driven reductions in red meat consumption, and a shift to lower-carbon foods. The Balanced Pathway also anticipates the following contributors to reduce emissions by 2040: other land-release measures e.g. reducing food waste or improving crop yields (2%), peatland restoration and management (17%), woodland creation and management (4%), energy crops such as miscanthus, short rotation coppice and short rotation forestry (7%), and agroforestry and hedgerows (2%). The only shortlisted practices from the workshops and survey that align with these remaining practices were *agroforestry/woodland grazing* and *increased hedgerow planting*. It should be noted, however, that the majority of UK peatlands are located in Scotland (nearly 2 million ha) with smaller amounts in England and Northern Ireland, and less than 100,000 ha in Wales (IUCN, 2026). Few farmers or land managers from Scotland attended the Newcastle workshop, so this perceived gap between farmers' preferred practices and those proposed in the Balanced Pathway could be partly attributed to the underrepresentation of farmers from Scotland. Of the survey respondents, 11% lived in Scotland.

Comparing the practices favoured by farmers with those prioritised in the Balanced Pathway for their calculated capacity to reduce net emissions from UK agriculture is important because it demonstrates that there is a significant gap between the actions that have been recommended to UK Government and those that farming people believe are viable, appealing, and capable of moving the needle on reducing sector emissions. Bridging this gap between the perspective offered by the Climate Change Committee as policy advisers and those of our workshop participants as farmers and land managers is the goal of the LUNZ Grasslands project. The analysis of workshop and survey data presented here and in the Appendix provides an insight into farmers' experiences with and perceptions of different low-carbon farming practices, not least within the detailed SWOT analyses, with the intention of giving policy makers an overview of the strengths, weaknesses, opportunities and threats associated with each practice as perceived by farming people. The next stage of the LUNZ Grasslands project will take the priority set of practices identified by workshop participants and use digital modelling to test them upon a series of typical farms to determine whether they are likely to be as effective in reducing emissions as expected. By sharing the findings of these digital farm models with farmers and others, we will determine whether the priority practices identified in the workshops will be sufficient to reduce typical farms' emissions to Net Zero and, if not, develop alternative sets of practices that could enable a typical farm to achieve Net Zero. Whether the shortlisted practices will be enough to reach Net Zero targets or different practices are needed, farmers and land managers will be invited to further workshops to discuss how barriers to adopting low-carbon farming practices can be overcome in ways that work for farmers, their businesses, biodiversity, and the climate.

Table 5. Summary of results from the LUNZ Grasslands workshops.

Practice	Shortlisted in more than one workshop (Activity 1)	Top 5 practices by voting frequency in Scotland/ England workshop (Activity 1)	Top 5 practices by voting frequency in Wales/ England workshop (Activity 1)	Top 5 practices by voting frequency in Northern Ireland workshop (Activity 1)	Perceived by two or more breakout groups as having high potential to reduce net emissions by more (Activity 2)	Perceived as 'easy wins', i.e. being both easy to implement and having high potential to reduce net emissions (Activity 3)	Most frequently chosen by breakout groups for their suites of practices (Activity 4)	Applied to two or more different SSP future scenarios (Activity 4)	Top 15 practices by voting frequency in the supplementary survey	Recommended within the Seventh Carbon Budget's key mitigation measures for the UK or a devolved nation
Grass-legume mixtures and multispecies swards	✓	✓	✓	✓	✓	×	✓	✓	✓	✓
Better soil health practices	✓	✓*	×	✓	×	×	✓	✓	✓	Related
Improved animal health	✓	×	×	×	✓	×	✓	✓	✓	✓
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early calf and lamb growth/survival, milk production, replacement rate)*	✓	✓	✓	×	✓	×	×	✓	×	Related
Nutrient management planning	×	✓	×	×	✓	✓	×	✓	×	✓
Improving training for farmers and advisors in GHG mitigation	✓	✓*	×	×	✓	×	×	✓	×	×
Increasing soil organic matter	×	×	×	×	✓	✓	×	×	✓	Related
Improved forage quality	✓	×	×	✓	×	×	×	×	✓	Related
Regenerative farming practices	×	×	✓	×	✓	✓	×	×	×	×
Specialised feed ingredients and additives	×	×	×	×	×	×	✓	✓	×	✓

Practice	Shortlisted in more than one workshop (Activity 1)	Top 5 practices by voting frequency in Scotland/ England workshop (Activity 1)	Top 5 practices by voting frequency in Wales/ England workshop (Activity 1)	Top 5 practices by voting frequency in Northern Ireland workshop (Activity 1)	Perceived by two or more breakout groups as having high potential to reduce net emissions by more (Activity 2)	Perceived as 'easy wins', i.e. being both easy to implement and having high potential to reduce net emissions (Activity 3)	Most frequently chosen by breakout groups for their suites of practices (Activity 4)	Applied to two or more different SSP future scenarios (Activity 4)	Top 15 practices by voting frequency in the supplementary survey	Recommended within the Seventh Carbon Budget's key mitigation measures for the UK or a devolved nation
Agroforestry/woodland grazing	✓	×	×	×	✓	×	×	×	×	✓
Winter cover crops / reduction in bare soil over the winter	×	×	✓	×	×	×	×	×	✓	✓
Rotational grazing	×	✓	×	×	✓	×	×	×	×	Related
Improved fertility performance *(e.g. sensors to measure tail-raising)*	×	×	×	×	✓	✓	×	×	×	Related
Farm specific system assessment and advice / Good on-the-ground independent advice *(merged category due to similarity)*	×	×	×	✓	×	×	×	×	✓	×
Improved animal health through enhanced disease and pest monitoring *(e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease)*	×	×	×	×	×	×	×	×	✓	✓
Capturing emissions from livestock buildings	×	×	×	×	✓	×	×	×	×	✓

Practice	Shortlisted in more than one workshop (Activity 1)	Top 5 practices by voting frequency in Scotland/ England workshop (Activity 1)	Top 5 practices by voting frequency in Wales/ England workshop (Activity 1)	Top 5 practices by voting frequency in Northern Ireland workshop (Activity 1)	Perceived by two or more breakout groups as having high potential to reduce net emissions by more (Activity 2)	Perceived as 'easy wins', i.e. being both easy to implement and having high potential to reduce net emissions (Activity 3)	Most frequently chosen by breakout groups for their suites of practices (Activity 4)	Applied to two or more different SSP future scenarios (Activity 4)	Top 15 practices by voting frequency in the supplementary survey	Recommended within the Seventh Carbon Budget's key mitigation measures for the UK or a devolved nation
Methane-powered farm vehicles	×	×	×	×	✓	×	×	×	×	✓
Integrating specific forages for the environment	×	×	×	×	×	✓	×	×	×	Related
Genetic improvement *(for sheep)*	×	×	×	×	✓	×	×	×	×	Related
Reducing maximum fertiliser use	×	×	×	×	×	×	×	×	✓	Related
Nutrient dense produce	×	×	✓	×	×	×	×	×	×	×
Genetic improvement in direct feed efficiency *(for beef)*	×	×	×	✓	×	×	×	×	×	×
Slurry acidification	×	×	×	×	×	×	×	×	×	✓
Increased hedgerow planting	×	×	×	×	×	×	×	×	×	✓
Feed CH_4 inhibitors *(e.g. 3NOP, nitrate, seaweed compounds)*	×	×	×	×	×	×	×	×	×	✓
Locally sourced livestock feed to reduce air miles	×	×	×	×	×	×	×	×	✓	×
Extended grazing	×	×	×	×	×	×	×	×	✓	×
Growing grass for carbon storage	×	×	×	×	×	×	×	×	✓	×
Reduced age at first calving *(for dairy)*	×	×	×	×	×	×	×	×	✓	×

Practice	Shortlisted in more than one workshop (Activity 1)	Top 5 practices by voting frequency in Scotland/ England workshop (Activity 1)	Top 5 practices by voting frequency in Wales/ England workshop (Activity 1)	Top 5 practices by voting frequency in Northern Ireland workshop (Activity 1)	Perceived by two or more breakout groups as having high potential to reduce net emissions by more (Activity 2)	Perceived as 'easy wins', i.e. being both easy to implement and having high potential to reduce net emissions (Activity 3)	Most frequently chosen by breakout groups for their suites of practices (Activity 4)	Applied to two or more different SSP future scenarios (Activity 4)	Top 15 practices by voting frequency in the supplementary survey	Recommended within the Seventh Carbon Budget's key mitigation measures for the UK or a devolved nation
Selecting livestock types/breeds suited to the farm's environmental conditions	×	×	×	×	×	×	×	×	✓	×
Precision feeding and feed intake analysis *(e.g. with animal-mounted sensors)*	×	×	×	×	×	×	×	×	✓	×
Greater awareness of genetic improvements and greater uptake of higher-performance breeds	×	×	×	×	×	×	×	×	×	×
Manure separation *(separating solids and liquids)*	×	×	×	×	×	×	×	×	×	×
Increase liveweight efficiency *(e.g. not overdeveloping animals for market)*	×	×	×	×	×	×	×	×	×	×
First mating of ewes as lambs rather than yearlings	×	×	×	×	×	×	×	×	×	×
Improved decision-making support *(e.g. distributed ledgers, weather tracking, low-cost infrastructure, digital twinning)*	×	×	×	×	×	×	×	×	×	×
Site-specific GHG mitigation planning	×	×	×	×	×	×	×	×	×	×

5. Next steps

The circulation of this draft report marks the mid-point of the LUNZ Grasslands project. The following outlines the estimated timeline for the work that remains to be done to share our current findings with workshop participants and farming communities, conduct further research into the efficacy of the priority practices in reducing net emissions, and engage with policymakers:

Table 6: Outline of next steps for delivery of the LUNZ Grasslands project (Work Package 1) from May 2026-February 2027.

June 2026	Delivery of 2x online workshops to share our draft findings with attendees of the Newcastle, Birmingham and Cookstown workshops, to invite discussion and gather feedback on the report. This feedback will improve the quality of the final report so that it best reflects the input of the farmers and members of the farming community who engaged with the LUNZ Grasslands workshops.
August-September 2026	Sharing of the revised LUNZ Grasslands workshop report with policy makers and inviting their feedback and discussion.
May - October 2026	Digital modelling of prioritised farm practices by other LUNZ Grasslands researchers. The workshops asked participants to make judgements about the efficacy of different farm practices in reducing net emissions to the best of their knowledge. The model will use data from the scientific literature to test these practices on a series of typical farms to determine whether the priority practices are likely to be as effective in reducing emissions as anticipated by workshop participants. This work will explore whether there is a gap between the amount of emissions that can be reduced by these priority practices and the total amount of emissions that must be reduced in order to achieve net zero targets. If the priority practices identified by farmers will be insufficient to reach net zero targets, alternative pathways for reducing net emissions will be needed.
November 2026	Delivery of 3x in-person workshops to discuss the findings from the farm emissions model and discuss ways of bridging any gap to achieving net zero targets. The workshop will focus on the actions that would reduce barriers to adopting practices that could enable the UK agriculture sector to reach its net zero targets.
February 2027	Discussion of the results of the autumn in-person workshops with the policy advisory group and farming representatives. This will shape the recommendations that the LUNZ Grasslands project will give to policymakers.

6. Conclusion

This interim report was compiled to share our findings from the LUNZ Grasslands workshops and supplementary survey which identify a priority set of pasture-based farming practices which participants regarded as largely acceptable to members of the farming community and capable of reducing greenhouse gas emissions at scale. Some of these practices have also been identified by the Climate Change Committee's Seventh Carbon Budget as important components in their pathway to achieving the Net Zero target for UK agriculture. However, this research has identified that there are substantial gaps between farmers' perspectives on the potential of certain practices to reduce emissions and those which the CCC anticipate would make the biggest contribution to achieving Net Zero.

The key messages of this report are:

- The workshops underscored that farmers' capacity to adopt lower-emissions practices is shaped not only by farm size and landownership but also by the diverging agricultural policy frameworks across the four UK nations. These differences influence farmers' perceptions of feasibility, fairness and long-term stability, reinforcing the need for future Net Zero policy pathways to be sensitive to regional contexts, especially for small and medium-sized family farms that manage much of the UK's grassland.
- Peatland restoration and tree planting are central pillars of climate policy across all four nations. Workshop findings suggest that farmers' acceptance of tree-planting initiatives remains highly conditional. As a result, policies promoting peatland restoration and woodland expansion must account for local constraints, ensure fair compensation, and provide clear long-term guidance if they are to achieve meaningful uptake within pasture-based farming systems.
- Farmers face a range of economic, social and environmental pressures that can reduce their capacity to adopt new farming practices. Workshop participants' analyses of the strengths, weaknesses, opportunities and threats related to their shortlisted farming practices indicated that farmers identified a need for greater support in order to enact these changes, including financial incentives alongside trusted advice, training, and decision-making support. Several discussions also described the need for *"behaviour change"* and a *"mindset change"* among farmers to facilitate greater acceptance and uptake of some farming practices. Further, while farmers may be willing to adopt certain lower-carbon practices, especially those that increase farm efficiency, they need less policy churn and greater notification of the long-term direction of travel for farming policy in order to enable the long-term planning and adaptation of their businesses.
- Farmers want greater access to independent, impartial farm advisory services and have concerns about seeking advice from commercial bodies. Though several public and private bodies have created tools and guidance to support farmers' uptake of more efficient or lower-emissions farming practices, workshop findings suggest that further action is needed to connect farming people with existing resources. Future agricultural and environmental policies should take the current state of the farming advice landscape into account as a lack of trust in the available guidance will hinder the uptake of preferred farming practices.
- Given that the financial benefits of some lower-carbon farming practices may be small, slow to materialise, or difficult to prove, policy incentives would need to reflect the scale of investment needed for farmers to change course and adopt policymakers' desired practices.
- The three pasture-based farming practices that fulfilled the most criteria indicative of popularity and perceived efficacy were *grass-legume mixtures and multispecies swards, better soil health practices*, and *improved animal health*. These practices are also recommended as key measures to reduce agricultural emissions in the Seventh Carbon Budget's Balanced Pathway (Climate Change Committee, 2025a). However, the Balanced Pathway anticipates that 26 soil and livestock measures combined will only account for 14% of the emissions reductions needed across the agriculture and land use sector. In contrast, other practices are expected to make more signification reductions in emissions by 2040, including decarbonising machinery (21%), reducing livestock numbers (32%) and peatland restoration and management (17%) (Climate Change

Committee, 2025a). Although some of these practices were mentioned in workshops, they did not receive broad support from participants. This suggests there is a gap between the most impactful practices advanced by the Climate Change Committee and the practices that UK farmers believe are feasible and acceptable ways of changing the way they farm with the climate in mind.

- There was no consensus between workshop participants regarding the expected ease of implementation of each practice.
- Practices perceived as having the most potential to reduce net emissions were *grass-legume mixtures and multispecies swards, improved training for farmers and advisors in greenhouse gas mitigation,* and *agroforestry and woodland grazing. There were differences identified in the acceptability of some practices however, with tree planting, for example being more acceptable under certain constraints in Norther Ireland, than other workshops*.
- Workshop participants identified five 'easy wins': practices that were perceived as easy to implement and having high potential to reduce net emissions. These were improving livestock fertility performance, nutrient management planning, increasing soil organic matter, regenerative farming practices, and integrating specific forages for the environment, several of which overlapped with practices promoted in the Balanced Pathway.

Overall, while there are some promising points of congruence between the farming practices favoured by our workshop and survey participants and those practices considered in the Balanced Pathway, there is a gap between these proposed pathways to achieving Net Zero. The remaining research activities for this branch of the LUNZ Grasslands project aim to test whether the perceived efficacy of farming practices in reducing net emissions will be reflected by digital models of farm systems. In addition, the project will engage with policy makers to identify the opportunity space in terms of the policy measures that could be conducive to achieving the Net Zero goal, while also being feasible, fair and sustainable for UK grassland farmers and their businesses.

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8. Appendices

Appendix A: Distribution of peatlands in the UK

Figure A1 presents the distribution of peatlands across Scotland, England, Wales and Northern Ireland. Figure A2 indicates the distribution of specific types of peatland, such as bogs, heather grasslands, swamps and acid grasslands. Unfortunately the scale of this map allows limited insight into the distribution of peatland types in Northern Ireland.

Where peatlands are present, actions such as carbon-capture planting, agroforestry, and hedgerow planting can be detrimental to the environmental conditions needed to maintain and enhance peatland habitats. As such, agricultural policies must take into account that some farming regions are limited in the farming practices available to them due to the presence of environmentally sensitive ecosystems.

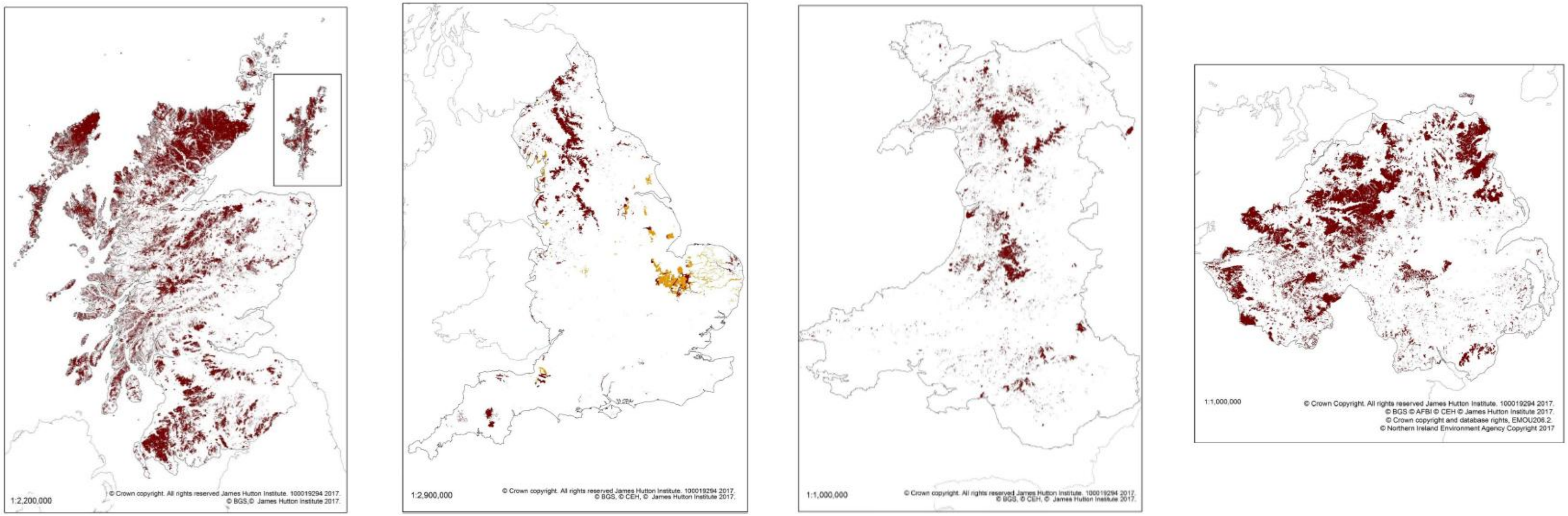


Figure A1: Peatland maps of Scotland, England Wales and Northern Ireland. Peat extent as shown is based on various survey and model-based data sources, with both known and unknown limitations in terms of local accuracy. Source Evans et al. (2017).

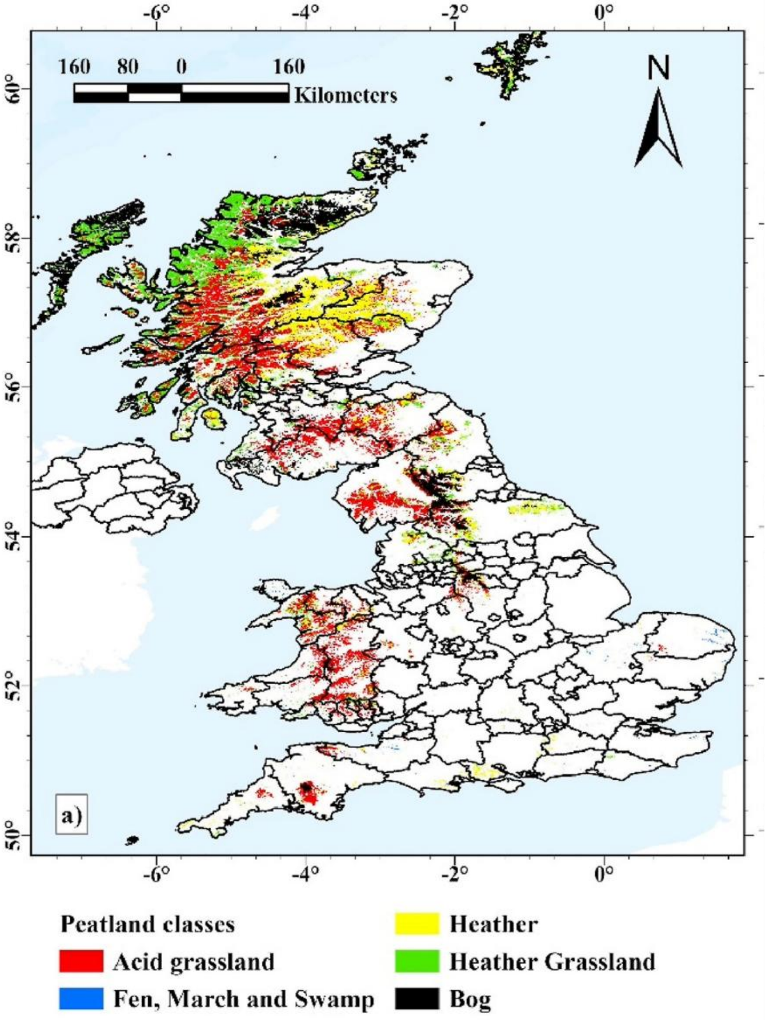


Figure A2: Spatial overview of peatland extent and classification in the UK in 2023 based on the UKCEH Land Cover Map at 25 m resolution. Source: Agarwal & Lim (2026).

Appendix B: Pressures on farmers and farming communities

While the agricultural sector will need to take urgent action to achieve the UK Government's commitment of net-zero emissions by 2050, it must be recognised that farmers and farming communities face a wide array of pressures and challenges that can limit their capacity to make these changes. At the same time, UK agriculture is highly heterogeneous: farms vary significantly by size, livestock system, income, terrain, and tenancy, among other factors. Further, the 452,900 agricultural sector workers in the UK (DEFRA, 2025) are not a monolithic group and will have varied experiences of these pressures. This is not intended as a definitive list of the pressures faced by farmers and the farming community, but rather to contextualise the workshop findings and in recognition that further policy will need to take these challenges into account in order to develop a just pathway forward for the agricultural sector, wider society, and the environment.

People involved in farming face pressures related to physical and mental health and wellbeing:

- Agricultural workers experience high numbers of injuries and fatalities on the job, 20 times higher than the all-industry rate (HSE, 2023).
- Agricultural workers report higher levels of physical pain and discomfort at all ages compared to the UK average (RABI, 2021), with implications for quality of life and farm productivity.
- Mental health problems are very common in farming communities. A survey of over 15,000 members of the farming community in England and Wales found that over one-third are possibly or probably depressed, almost half report some level of anxiety, and young people report high rates of loneliness (RABI, 2021). Farming people working in specialist pig, upland grazing, dairy, and lowland grazing livestock systems are more likely to report moderate or severe anxiety than those involved in other farm types (RABI, 2021).

The UK agricultural workforce is getting older, with nearly a third of farmers aged 65 years or older (ONS, 2023):

- The agricultural sector today is characterised by an ageing and shrinking workforce (RABI, 2021). Increased rates of ill-health and disability in older age have potential implications for farm productivity and skills, as older farming people retire or can no longer undertake farm work.
- 62% of farming people reported retirement and succession as minor or major challenges to their businesses (RABI, 2021).

Many farming people experience stressful working conditions:

- Farming workloads are often time-consuming, physically demanding, and increasingly divided between fewer people due to mechanisation (Rose *et al.,* 2024).
- Farming people report having insufficient leisure time, such that 29% never or hardly ever leave the farm for leisure purposes (RABI, 2021).
- Animal and crop diseases, livestock deaths and crop failures are factors affecting farmers' mental health (Rose *et al.,* 2024).
- Financial costs and time pressures leave little margin for error or experimentation, with implications for work performance (Rose *et al.,* 2024).
- Women in farming have reported sexism and misogyny in their homes and workplaces, including issues around stereotypes, succession and the ability to influence farm decisions (Farmers Weekly, 2024; Rose *et al.,* 2024).

Many farmers are under financial pressures related to costs, subsidies and market forces:

- When adjusted for inflation, farming incomes in the UK have barely improved over the past 50 years despite increasing productivity (FFCC, 2025).
- Many farmers receive low incomes or make losses, with 21% of farm businesses in England running at a loss, and 22% recording annual incomes of less than £25,000 (DEFRA, 2026a). Upland and lowland cattle and sheep farmers have traditionally recorded the lowest farm returns (DEFRA, 2026b)
- 69% of farming people surveyed by RABI (2021) said that changes to farming subsidies was a challenge for their businesses. Almost half of people in farming households derive 75%-100% of their income from agriculture, including from subsidies.
- Over two thirds of farming people surveyed by RABI (2021) said that changing food preferences in the UK and abroad was a challenge for their businesses.
- The cost of farm inputs including fuel, fertiliser and feed increased significantly after Russia invaded Ukraine in 2022. This highlighted the vulnerability of many UK farms to geopolitical changes, including trade deals and the threat of tariffs (FFCC, 2025).
- Changes to agricultural property relief (inheritance tax) from April 2026.

Policy and regulations were frequently cited as causes of stress in RABI's Big Farming Survey (2021):

- 45% of farming people felt stressed by the pressures or regulations, compliance and inspection.
- 35% of farming people felt stressed by public access issues.
- 31% of farming people felt stressed by pressure from the public or policymakers regarding the environment, and 50% were concerned that future environmental schemes would pose a minor or major challenge to their farm businesses.

Extreme and unpredictable weather conditions place significant pressure on farming people:

- Bad or unpredictable weather was cited as a source of stress by 43% of farming people (RABI, 2021).
- 85% of farming people reported that extreme weather and a changing climate was a minor or major challenge to their businesses (RABI, 2021).
- The UK has experienced record-breaking weather conditions in recent years. In England, the 18-month period leading up to December 2024 was the wettest on record, followed by drought in 2025 (FFCC, 2025).

Appendix C: Summary of workshop participant demographics

53 participants attended a regional workshop in Newcastle (12 participants), Birmingham (14 participants) or Cookstown (27 participants). The limited availability of participants is a challenge for research involving farmers as on-farm issues often arise at short notice, making attendance at scheduled events difficult. As such, around a quarter (26%) of those who registered to join a workshop were not able to attend. To supplement the workshop input and increase the involvement of farmers who may experience barriers to participation, we distributed a condensed version of the workshops in the form of an online survey in February-March 2026.

In the Birmingham workshop, 57% of participants described themselves as farmers, farm workers, owners, partners or managers. By contrast, only 33% of participants in the Newcastle workshop described themselves as farmers or farm workers. Unfortunately, the job titles of over a quarter of the workshop participants in Northern Ireland is unknown due to a technical problem with the online booking form which was used to manage registration.

Table C1. Workshop participants' self-declared job titles by percentage. *Job title data missing due to a technical issue with the online workshop registration form.

	Job title			
Regional Workshop	**Farmer/Farm worker**	**Farm Owner/Partner/Manager**	**Related fields, e.g. agricultural researchers, advisors, and technologists**	**Unknown**
England/Scotland	33%	0%	58%	8%
England/Wales	36%	21%	43%	0%
Northern Ireland	26%	18%	30%	26%*

As twice as many participants attended the Northern Ireland workshop than the other regional workshops, the data presented from Activities 1 and 2 are skewed towards the voices of Northern Irish agricultural sector workers. The reasons for the much higher attendance in this region may include:

- **A more attractive 'offer' for farmers** – The afternoon workshop in Northern Ireland included a soil health demonstration on a nearby farm, which provided an opportunity for knowledge exchange, networking and conversation.
- **Workshop location** – The workshop was held in a rural hotel in a central location in Northern Ireland, rather than a city centre conference venue as chosen in Birmingham and Newcastle. Although we had prioritised venues with convenient public transport links, most participants travelled by car, such that access to adequate car parking facilities was an important factor.
- **A condensed workshop** – The Northern Ireland workshop was shortened to a half-day, following feedback that the workshop ought to be timed so as to accommodate dairy farmers' afternoon milking schedules.

The supplementary survey attracted a much higher percentage of farmers than the workshops. Of 85 respondents, 81% were full-time farmers and 15% were part-time farmers. Only 4% of respondents described themselves as non-farmers, but worked in the agricultural sector in administrative, research, or advisory roles.

Table C2. Summary of survey respondents' demographic data.

What is your occupation?		
Occupation	Frequency	Percentage of respondents
Full-time farmer	69	81%
Part-time farmer	13	15%
Not a farmer	3	4%

What is your gender?		
Gender	Frequency	Percentage of respondents
Male	59	69%
Female	24	28%
Prefer not to say	2	2%

How old are you?		
Age category	Frequency	Percentage of respondents
18-24	1	1%
25-34	5	6%
35-44	19	22%
45-54	23	27%
55-64	22	26%
65-74	11	13%
75+	4	5%

Where do you live?		
Devolved nation	Frequency	Percentage of respondents
England	62	73%
Wales	12	14%
Scotland	9	11%
Northern Ireland	2	2%

Who owns the land you farm?		
Ownership	Frequency	Percentage of respondents
Owner all or most of the farm	52	63%
Tenant of all or most of the farm	26	32%
Other	4	5%

Table C3. Summary of survey respondents' farm data.

How would you describe the majority of your grazing land?

Grass type	Frequency	Percentage of respondents
Improved permanent pasture	42	51%
Improved temporary pasture	29	35%
Unimproved grassland	9	11%
Other	2	2%

How would you describe your farm?

Farm type	Frequency	Percentage of respondents
Mostly lowland	66	78%
Mostly upland	14	16%
Mostly hill	2	2%
Not applicable	3	4%

Which enterprises do you have on your farm? Tick all that apply.

Enterprise	Frequency	Percentage of respondents
Beef	40	47%
Dairy	55	65%
Sheep	30	35%
Arable	25	29%
Other livestock	3	4%
Not applicable to me	1	1%

What is the approximate size of your farm in hectares (ha)?

Farm size	Frequency	Percentage of respondents
Less than 25 ha	3	4%
25-50 ha	9	11%
101-150 ha	10	12%
151-200 ha	15	18%
201-250 ha	15	18%
Over 250 ha	16	19%

What is the size of your dairy herd (if applicable)?

Head of cattle	Frequency	Percentage of respondents
Less than 100 head	3	4%
101-150	8	10%
151-200	6	7%
201-250	7	8%
251-300	11	13%
Over 300	20	24%

What is the size of your beef herd (if applicable)?

Head of cattle	Frequency	Percentage of respondents
Less than 100 head	29	35%
101-150	8	10%
151-200	3	4%
201-250	1	1%
251-300	0	0%
Over 300	2	2%

What is the size of your sheep flock (if applicable)?

Head of sheep	Frequency	Percentage of respondents
Less than 100 head	12	14%
101-200	6	7%
201-300	4	5%
301-400	1	1%
401-500	1	1%
501-600	2	2%
601-700	2	2%
Over 700	3	4%

How many hectares (ha) of arable land do you have?

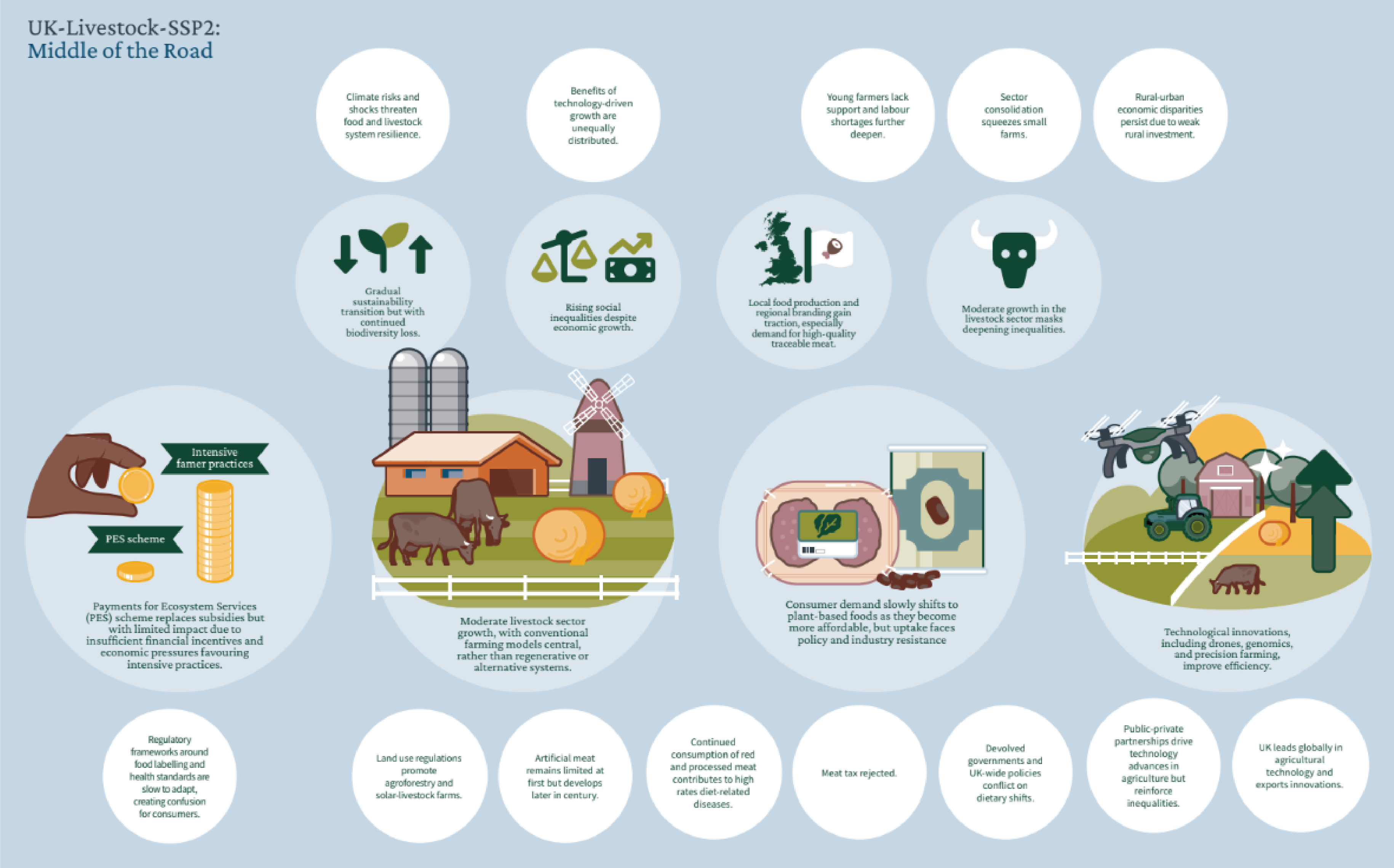
Area of arable land	Frequency	Percentage of respondents
Less than 25 ha	16	19%
25-50 ha	10	12%
51-100 ha	6	7%
101-150 ha	4	5%
151-200 ha	1	1%
201-250 ha	2	2%
Over 250 ha	2	2%

Appendix D: SSP information and visual summaries

The Shared Socioeconomic Pathways (SSPs) are a future scenario analysis tool that have been developed at different scales to help governments plan actions to assist with climate change mitigation, adaptation, and impact. Scenarios are commonly used by researchers to explore potential future outcomes under conditions of uncertainty (Pedde *et al.,* 2020). SSP development involves the co-production of exploratory scenarios with stakeholders to help understand what could occur in the future for a particular region, considering adaptable trajectories of various influencing factors (Rohat *et al.*, 2018). The five SSP narratives thus far are SSP1 'Sustainability: Taking the green road' (low challenges); SSP2 'Middle of the road' (intermediate challenges); SSP3 'Regional Rivalry: a rocky road' (high challenges); SSP4 'Inequality: a road divided' (adapt, challenges dominate), and SSP5 'Fossil Fuel Development: taking the highway' (mitigation, challenges dominate) (O'Neill *et al.,* 2017). Following this, the SSPs have been developed for specific geographic regions, countries, and sectors, for example, for Europe and European agriculture (Mitter *et al.,* 2019), and for various UK sectors (Harmáčková *et al.,* 2022; Pedde *et al.,* 2020). In 2025, the TRADE project, in co-production with stakeholders from the livestock sector, developed the 'UK-Livestock-SSPs' and their narratives (Blair *et al.,* 2025).

Workshop participants explored several plausible future scenarios (the UK Livestock Shared Socioeconomic Pathways or UK-Livestock-SSPs (Blair *et al.,* 2025) and proposed high-priority groups or 'suites' of practices which they believed could help the farming sector to reach net zero goals *despite* an array of possible future pressures. These pressures included plausible (but not guaranteed) changes in natural resource availability, international relations, government policy and governance, public attitudes, and pests and diseases. In other words, this aspect of the workshop identified a priority list of practices that participants believed would make UK farming more robust and resilient across a range of potential future scenarios.

The workshops used three of the five UK-Livestock-SSPs and are presented in Appendix O to provide context to the findings from Activity 4. The two SSPs that were not discussed in the workshops are presented here for completeness.



This research is part of the TRAnsforming the DEbate about livestock systems transformation (TRADE) project, funded under UKRI grant number BB/W018152/1.

Figure D1: UK-Livestock-SSP2, the 'Middle of the Road' scenario (Blair et al., 2025).

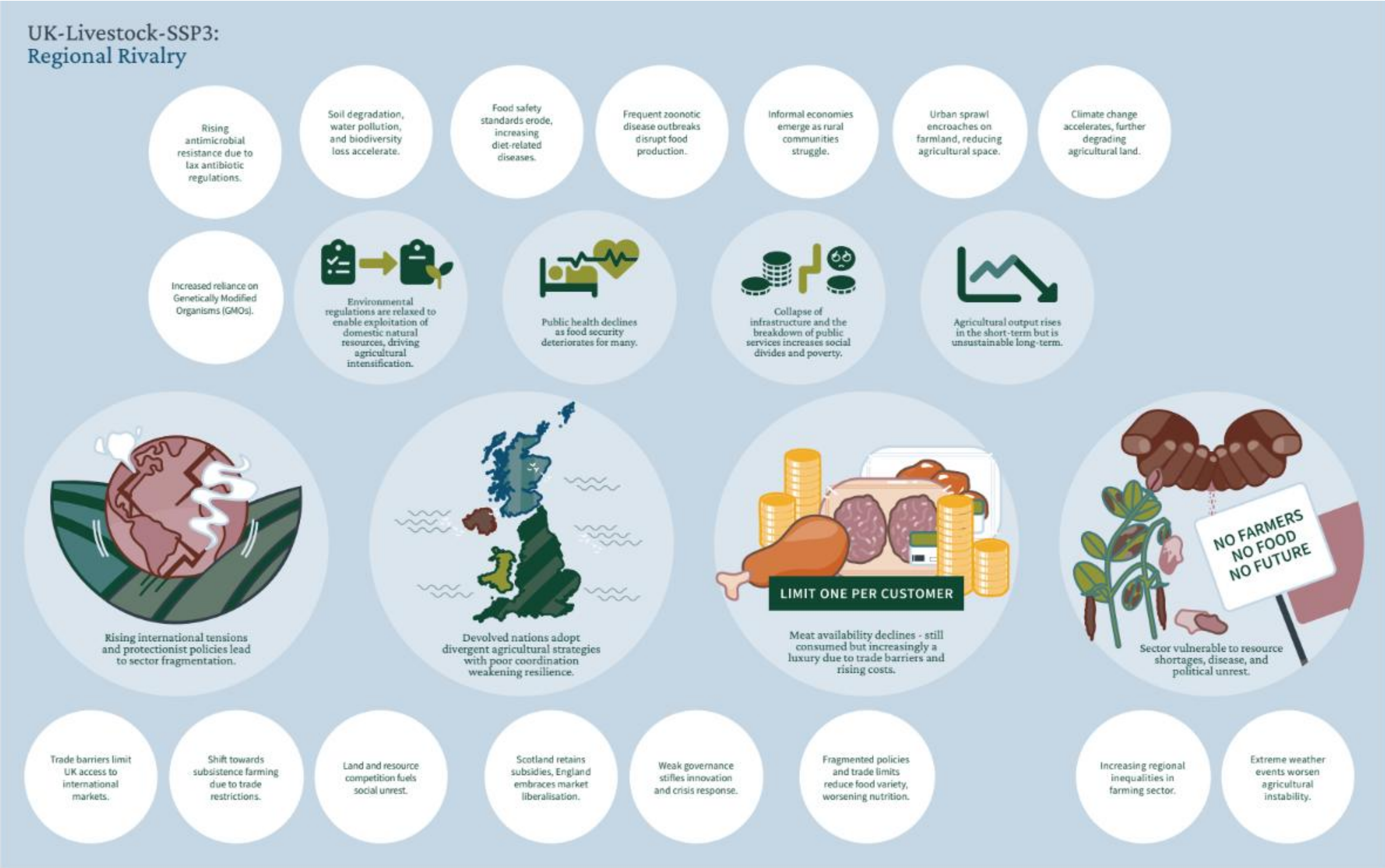


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Figure D2: UK-Livestock-SSP3, the 'Regional Rivalry' scenario (Blair et al., 2025).

Appendix E: Full explanation of workshop activities

The workshops were designed to include four key activities detailed below. Due to time constraints in the Northern Ireland workshop, a modified approach was taken with the omission of Activity 4 and the introduction of a 'priority practices postcard' activity (see Appendix P).

Activity 1 invited all participants to review a list of over 60 practices for livestock and grassland management (Appendix F). The list of practices was compiled from several reports (including CIEL, 2022; Department for Energy Security and Net Zero, 2023; Eory, *et al.,* 2015; Eory, *et al.,* 2025; McNicol, *et al.,* 2024; Nature Friendly Farming Network, 2019). Further practices were derived from feedback from LUNZ Grasslands farming cluster groups and an unpublished literature review compiled by a project partner. Participants were provided with a brief written explanation of how each practice could reduce net emissions, for example, by reducing reliance on imports, sequestering carbon, or increasing efficiency to reduce emissions from livestock systems per unit of product output. It was emphasised by the research team that inclusion on the list did not indicate the LUNZ project's promotion of any practice, only acknowledgement of its potential to reduce net emissions according to the literature.

Participants were invited to discuss their experiences of implementing any of the practices in small groups and to write any additional practices on sticky notes. In both workshops, participants generated 15-20 additional practices which were added to the initial list of practices.

Participants identified a shortlist of 15 practices for more detailed discussion in subsequent workshop activities. Participants were each given three stickers and asked to vote for the three practices they thought had the most potential to reduce net emissions. Where votes were tied, researchers made the final decision on which practices would advance to Activity 2.

Activity 2 developed our understanding of participants' experiences and perceptions of shortlisted practices. The shortlisted practices were shared among the break-out groups for further discussion, so that each group received 4-5 practices to discuss. To structure these discussions, participants were invited to conduct a SWOT analysis, in which they explored the internal strengths and weaknesses of each practice, as well as the external opportunities and threats that might shape their implementation. To prompt discussions around various social, environmental and economic aspects of farm systems, groups were given a copy of the Global Farm Metric Framework (Sustainable Food Trust, 2025) (Appendix R), though time pressures and the abundance of participants' ideas and contributions meant the Framework was used less than anticipated. Volunteer scribes recorded key points on SWOT analysis templates and notetakers made detailed notes of their group's conversations, recording quotations, areas of agreement and disagreement, and group dynamics. When each SWOT analysis was complete, participants were asked to assess whether they expected the practice to be 'easy', 'medium', or 'hard' to implement at the farm level.

Activity 3 invited participants to consider all shortlisted practices in terms of the *scale* of their potential to reduce net emissions. Participants reviewed their set of labelled sticky notes in small groups and decided on the expected net emissions reduction potential of each practice and a corresponding 'score': those with low potential were given a score of one, practices with medium potential scored two, and those with high potential to reduce net emissions were given a score of three. After deciding, scores were written on each sticky note. At this point, each sticky note held three values: the name of a livestock or grassland management practice, a colour representing its expected ease of implementation, and a numerical score between one and three indicating the expected level of its potential to reduce net emissions.

Participants then ranked the shortlisted practices from the highest to lowest potential to reduce net emissions and made notes explaining their decisions on the activity's worksheets. At the end of Activity 3, each group calculated the sum total of its scores (with a minimum possible overall score of 15 and a maximum possible score of 45) and fed their results back to the whole group.

Activity 4 explored the suites of practices that participants would choose given the different possible future scenarios. Participants were invited to choose practices that a) would contribute towards reaching emissions reduction targets despite the challenges imposed by a future scenario, and b) were acceptable to their group as a result of the priorities and compromises they had identified and agreed upon.

Groups were provided with one of three co-designed Shared Socio-economic Pathways for UK livestock systems (UK-Livestock-SSPs) created by the TRADE project. The TRADE project produced adapted versions which imagine how those possible changes might shape livestock systems in the UK with implications for business, the environment, policy, and public health. Each group was provided with brief information about one of three UK-Livestock-SSPs: Sustainable Transformation (SSP1), Inequality (SSP4) and Fossil-Fuelled Development (SSP5).

To begin the activity, each group calculated their target score: an arbitrary limit set at one-third of their total score from Activity 3. Given that limited data on the reduction of net emissions are available for several practices, this activity instead set participants an arbitrary target to demonstrate the *concept* of choosing a set of practices in light of the necessity of identifying priorities and making trade-offs when constrained by challenging future possibilities.

Using the sticky notes from Activity 3, participants discussed and selected several practices which, when their individual scores were added together, met their group's target score. Surprisingly, many groups arrived at a final decision about their suite of practices very quickly. As such, additional discussion prompts were introduced after the first workshop, posing questions around biodiversity impacts, differences across the devolved nations of the UK, and reintroducing practices from the longlist which may be particularly helpful in a specific future scenario.

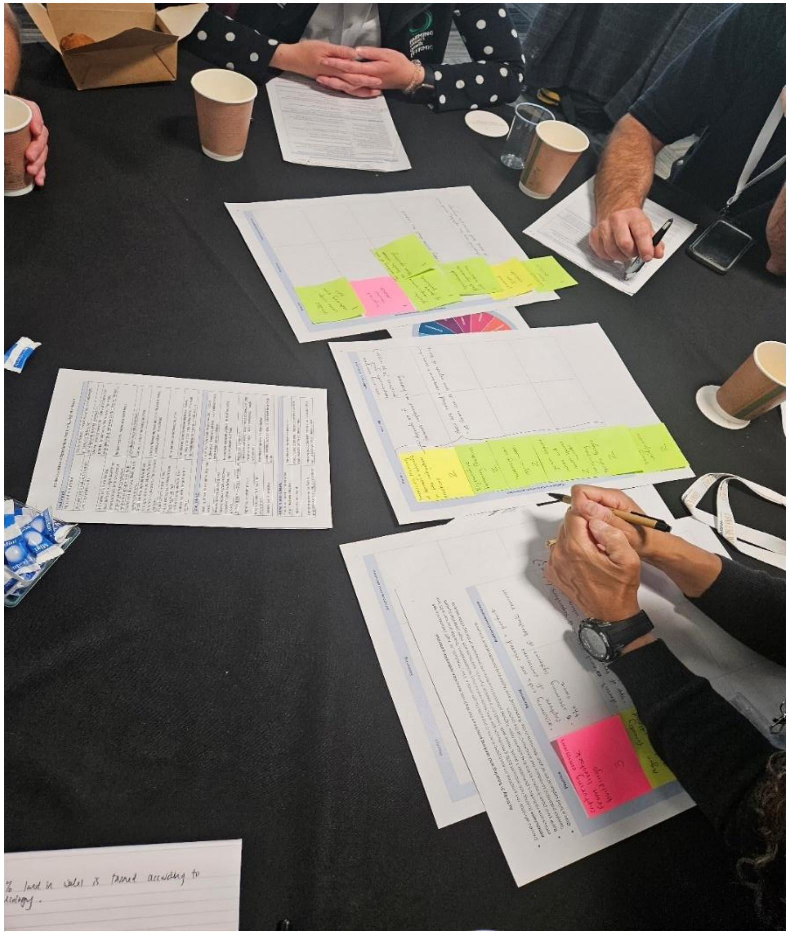

Figure E1. Workshop participants working on Activity 4.

Appendix F: List of livestock and grassland management practices

The following is the list of livestock and grassland management practices that was first presented for discussion in the Newcastle workshop. This was the shortest list used in the workshops, as the list was updated each time to include participants' ideas for additional practices. For clarity, we confirmed to workshop participants that inclusion on the list was based on the availability of evidence for their efficacy in the academic literature, that every practice has its strengths, limitations and important contextual considerations, and that inclusion on the list did not indicate endorsement by the LUNZ Grasslands project.

In your opinion, which <u>three</u> practices in this list have the most potential to reduce net emissions? Cast your votes using the stickers provided

Feed related:		
High starch content diet	Greater efficiency: increases milk production and weight gain; reduces finishing time	
Increasing dietary oil and fat content	Can reduce enteric methane production	
Low crude protein diets	Can reduce nitrogen excretion in dairy cattle; lower their potential for ammonia and nitrous oxide formation; potentially reduce methane and carbon dioxide emissions	
Alternative protein sources *(e.g. microbial proteins, algae-based feeds, fermented feeds, bacteria-extracted feeds, on-farm insect production)*	Reduce need for imported soya-based feeds	
Feed tannin and saponin-rich feeds	Can reduce enteric methane production	
Feed CH_4 inhibitors *(e.g. 3NOP, nitrate, seaweed compounds)*	Can reduce enteric methane production	
Specialised feed ingredients/additives *(e.g. Agolin Ruminant, Mootral, SarStart, Rumalator, Digestarom, LChance, various plant oils)*	Greater efficiency: improves animal health, feed efficiency, digestibility and/or milk production	
Probiotics/Fermentation in feed substances *(e.g. Locus Fermentation Solutions, Kowbucha)*	Can reduce enteric methane production	
Precision feeding and feed intake analysis (e.g. with animal-mounted sensors)	Can reduce emissions by maximising feed utilisation, stabilising enteric fermentation, improving animal health, and minimising nutrient excretion in the manure	

Forage related:		
Grass-legume mixtures and multispecies swards	Fixes nitrogen, increases forage production, increases biodiversity and improves soil health, e.g. by adding clovers, herbs and grasses to seed mixes	
Improve forage quality *(e.g. early harvest, increased grazing frequency, decreased regrowth interval, mob grazing)*	Increasing forage quality reduces the need for feeding imported concentrated feeds	
Increasing maize silage proportion in diet	Increases milk production	
Higher sugar content grasses	Can increase livestock's nitrogen usage efficiency, reducing the emission of nitrogen into the environment through livestock urine	
Integrating specific forages for environment	Maximises forage health and production	
Reduced use of herbicides	Can improve biodiversity and reduces the need for artificial inputs	

Animal related – GENERAL		
Genetic selection for inherently low enteric methane emissions	Can reduce enteric methane production	
Improved animal health	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb growth/survival, milk production, replacement rate, early calf growth/survival)*	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Genetic improvement in terminal sire productive traits *(e.g. growth rate)*	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Wider uptake of current genetic improvement practices	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Improved fertility performance (e.g. sensors to measure tail-rising)	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Alternative strategies for worm control to reduce anthelmintic use	Reducing time and cost of worming procedures while maintaining animal health can decrease GHGs from livestock systems per unit of output	

Animal related – LAMB		
Finish lambs at a younger age	Greater efficiency - reduced feed requirements mean fewer emissions are produced during shorter finishing times	
First mating of ewe as lambs rather than yearlings	Longer productive life therefore reduced GHG emissions per unit output	

Animal related – DAIRY		
Reducing age at first calving	Longer productive life therefore reduced GHG emissions per unit output	
Improved animal health through enhanced disease and pest monitoring – e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease	Improving production and fitness traits can decrease GHGs from livestock systems per unit of output	
Increased milking frequency *(with robots)*	Increases efficiency with lower GHG emissions per unit of output	
Dual-purpose cows *(milk, calves and meat)*	Efficient production of multiple outputs - reduced GHG emissions per unit output	
Methane vaccine *(Fonterra)*	Would reduce enteric methane production	

Animal related – BEEF		
Genetic improvement in direct feed efficiency	Increases efficiency with lower GHG emissions per unit of output	
Increased liveweight gain by optimising diet and grazing strategies	Increases efficiency with lower GHG emissions per unit of output	
Reducing age at first calving	Longer productive life therefore reduced GHG emissions per unit output	
Reducing age at slaughter	Greater efficiency – reducing slaughter age by three months reduces feed requirements with no impact on deadweight	
Dual-purpose cows *(milk, calves and meat)*	Efficient production of multiple outputs - reduced GHG emissions per unit output	

Training/decision support		
Improving training for farmers and advisors in GHG mitigation practices	Speeds up and refines the implementation of practices to reduce GHG emissions	
Site-specific GHG mitigation planning	Refines the implementation of practices to reduce GHG emissions	
Identifying less productive areas and targeting for ecosystem services *(in beef and sheep systems)*	Enables carbon sequestration opportunities without adversely affecting food productivity	
Improved decision-making support *(e.g. distributed ledgers, weather tracking, low-cost infrastructure, digital twinning)*	Greater efficiency	
Manure/fertiliser related		
Nitrification and urease inhibitors	Inhibit or delay the biochemical processes that release GHGs when fertiliser breaks down	
Combined application of urea with nitrification inhibitors plus deep placement in soil	Deep placement of urea with nitrification inhibitors reduces ammonia emissions in comparison with the more common practice of surface broadcasting urea	
Fluoride and tannin additives to manure	Reduces the release of various GHGs and odours	
Covering slurry stores	Reduces the release of various GHGs and odours, particularly ammonia	
Anaerobic digestion	Reduces the release of various GHGs and odours, particularly methane	
Slurry acidification	Reduces the release of various GHGs and odours, particularly ammonia	
Low emission slurry spreading	Reduces the release of nitrogen	
Housing		
Low-emission housing systems: Wider uptake of 'best available techniques' *(BATs)*	Increases efficiency with lower GHG emissions per unit of output	
Capturing emissions from livestock buildings *(e.g. directing gases from barns into underground pipes for the oxidation of methane by soil microbes)*	Increases efficiency with lower GHG emissions per unit of output	
Energy-efficient smart cattle sheds	Increases efficiency with lower GHG emissions per unit of output	
Agri-tech		
Methane-powered farm vehicles	Increases efficiency with lower GHG emissions per unit of output, using locally-produced fuel	
Biorefinery as nutrient recovery	Reduces the need for imported artificial fertilisers	
Agrovoltaics	Combining agriculture with solar energy production to produce renewable energy and increase land use productivity	
Engineered soil microbes to reduce nitrogen emissions	Would identity biological traits in soil microbes which target nitrogen fixation and would thereby reduce nitrogen emissions	
Soil management		
Taking livestock off wet ground to reduce compaction and soil degradation	Reduce emissions of nitrogen associated with compacted soils	
Restoring organic soils and paludiculture/wetlands/peatlands	Increases carbon sequestration in various soil types	
Soil-monitoring sensors to detect soil moisture changes	Efficient methods to monitor and improve soil health to increase carbon sequestration	
Better soil health practices *(e.g. maintaining optimal pH for plant growth)*	Increase carbon sequestration	
Increasing soil organic matter	Increase carbon sequestration	
Winter cover crops / reduction in bare soil over winter	Reduce soil erosion to increase carbon sequestration	
Minimal or no till	Reduce soil erosion to increase carbon sequestration	

Carbon capture planting		
Agro-forestry	Increases above and below-ground carbon sequestration	
Increased hedgerow planting	Increases above and below-ground carbon sequestration	
Perennial energy crops *(e.g. miscanthus)*	Increases above and below-ground carbon sequestration	
Increased tree cover	Increases above and below-ground carbon sequestration	

Any more?		

Sources:

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LUNZ Grassland Project Cluster farm activity.

Appendix G: Additional livestock and grassland management practices suggested by workshop participants

After reviewing the list of livestock and grassland management practices provided by the LUNZ team, workshop participants suggested new practices that they thought had potential to reduce greenhouse gas emissions. Some were similar to the listed practices but differed in key details or added specific contextual information which merits their inclusion in Table G1. To review the original list of practices compiled by the LUNZ team, see Appendix F.

Table G1. Additional livestock and grassland management practices suggested by workshop participants.

Newcastle	
Practice	**Practice sub-category**
Robotic feed pushers	Feed management
Mob grazing	Forage management
Rotational grazing - increased forage quality and productivity	Forage management
Field margins (as part of arable-livestock integrated systems)	Forage management
Improving grasslands – growing grass for carbon storage	Forage management
Selecting appropriate livestock type/breed for land	Livestock management
High-welfare systems (stocking density, health, housing)	Livestock management
Genetic improvement for efficiency – sheep	Livestock management
Nitrification inhibitors (as a separate category from urease inhibitors)	Manure/fertiliser management
Urease inhibitors (as a separate category from nitrification inhibitors)	Manure/fertiliser management
Slurry health/Slurry aeration	Manure/fertiliser management
Manure separation - solids and liquids	Manure/fertiliser management
Nutrient management planning	Manure/fertiliser management
Context-specific farming- outcomes rather than practices	Other
Mixed arable farming systems (integrating livestock to arable)	Other

Birmingham	
Practice	**Practice sub-category**
Improving targeted feeding in sheep/lamb	Feed management
Grazing lambs on standing arable crops such as wheat, oilseed rape, oats	Forage management
Plant species selection and biodiversity - context specific mixes	Forage management
Winter cover crops - more 'sheep friendly' options for mixes	Forage management
Improving grazing systems management, mob, rotational, etc.	Forage management
Grazing sheep and cattle at different times on the same field to manage parasite load	Forage management
Breed for CH4nge - genetic improvement in lamb to improve their gut microbiome, produce lower methane, and increase lamb survival rate	Livestock management
Increase twinning rate (and twin survival) in sheep and cattle	Livestock management
Not overdeveloping animals, i.e. not overfat/overweight for market	Livestock management
Ewe efficiency (a 70kg ewe rearing 2x 35kg lambs (i.e. 100% her bodyweight) is better than a 95kg ewe rearing 2x 35kg lambs (i.e. <70% her bodyweight)	Livestock management
Higher uptake of higher-performance breeds and greater awareness of genetic improvements	Livestock management
Genetic improvement of lamb to enable faster finishing	Livestock management
Genetic research flocks as in other countries - measuring genomics over longer timescales and reducing the use of short-term project cycles	Livestock management
Valuing the nutrient density of end product (not just the kg output)	Other
Fossil fuel reduction - fertilisers, fuel	Other
Regenerative farming practices	Other

Cookstown	
Practice	**Practice sub-category**
Locally-sourced livestock feed to reduce air miles	Feed management
Reduce/eliminate concentrate feeding*	Feed management
Alternative protein sources - less bought in so reducing emissions*	Feed management
Alternative forage crops (whole crop and protein)	Forage management
Extended grazing	Forage management
Apps for grass monitoring and nutrient management planning	Forage management
Limit use of synthetic fertilisers - use has to be justified according to recent soil analysis*	Forage management
More breeds for liveweight efficiency	Livestock management
Genetic breeding of animals to finish better off grass*	Livestock management
Taking animals with poor performance due to disease (like BVD) out of the system*	Livestock management
Reducing maximum fertiliser use	Manure/fertiliser management
Low-input farming	Manure/fertiliser management
Biodynamic Aerobic Systems (using worms to remove contaminants from wastewater and compost farm manure)	Manure/fertiliser management
A better understanding of ways to utilise slurry in Northern Ireland*	Manure/fertiliser management
Good on-the-ground independent advice	Training/decision-making support
Farm-specific system assessment and advice	Training/decision-making support
Increased development of on-farm data capture	Training/decision-making support
Farm efficiency - monitoring and putting figures*	Training/decision-making support
Improving soil structure - using available data to do so and to make decisions*	Soil management
Improved management of existing hedgerows*	Carbon capture planting
No livestock housing	Livestock housing
Sustainable building materials in housing (e.g. hempcrete)	Livestock housing
Better care management taken on small areas of biodiversity that are already on farms i.e. hedges, wet spots, forestry*	Other
Base subsidy payments on farm biodiversity i.e. number of plant species, birds, pollinators, etc.*	Other

**Practice suggested via the 'Top 5 Practices Postcard' activity rather than from break-out group discussions (Northern Ireland workshop only)*

Summary of additional practices

In the Newcastle workshop, the ‘manure/fertiliser management’ sub-category contained the most newly suggested practices, followed by the ‘forage management’ sub-category. In the Birmingham workshop, the ‘livestock management’ sub-category contained the most newly suggested practices, followed by ‘forage management’. Compared with Newcastle, there were no new suggestions for manure- or fertiliser-related practices in the Birmingham workshop, and many more suggestions were made for practices suitable for sheep systems. The Northern Ireland workshop was the only one of the three in which new suggestions were advances for training and decision-making support. Suggestions for new practices were almost evenly split between the sub-categories for training and decision-making support, and the feed, forage, livestock, manure/fertiliser management practices. Of the 24 new practices identified in the Northern Ireland workshop, 11 of them were suggested via the ‘Top 5 Practices Postcard’ activity, in which participants were invited to indicate their ideas for priority practices independently, rather than through group discussion. Possible reasons why so many new practices were suggested during this task (the final activity of the day) include farmers having had more time to ‘warm up’ through in-depth discussions with peers and thereby generating more ideas, or a reluctance to suggest contentious practices in a group setting. This activity also highlighted workshop participants’ extensive knowledge of where efficiencies could be made within farming systems, including an awareness of relevant research projects and new technologies. Further, the vast majority of suggested practices were means of reducing net emissions through farming efficiencies which would reduce emissions per kilogram of product output. Very few related to carbon sequestration measures, though those that did referred to improving soils and grasslands as carbon stores, as well as better maintenance of existing vegetation (specifically hedgerows). Overall, of the 55 new practices suggested by workshop participants, the majority belonged to the sub-categories related to forage management (24%), livestock management (24%) and manure or fertiliser management (16%).

Appendix H: Shortlisting practices for further discussion

The longlist of practices was updated after each workshop to include participants' suggestions for additional practices. This iterative process culminated in the creation of a longlist containing 90 livestock and grassland management practices which formed the basis of the farmer survey in February 2026.

Workshop participants were each given three voting stickers and invited to vote for the practices they believed would be most effective in reducing net emissions from UK agriculture. These 'priority practices' were carried forward into subsequent workshop activities. Table H1 provides these shortlisted practices in descending order, from practices receiving the highest number of votes to those receiving the lowest. A limitation of this activity is that a practice could be advanced to the shortlist with just one or two votes. As there was a minimum of 60 practices on the longlist, votes were spread particularly thinly in Birmingham and Newcastle where the numbers of participants in attendance were lower. Because of this limitation, a supplementary online survey was released in February 2026.

Voting frequencies are useful here only in terms of indicating a practice's relative popularity – totalling the voting frequencies across the workshops as a whole would be misleading as the Northern Ireland workshop was attended by twice as many participants as the other workshops. Table H1 nonetheless highlights the widespread acceptability of grass-legume mixtures and multispecies swards, which received the most votes in all three workshops. Improving the performance of livestock via genetic advancements appeared in the top five practices of each workshop by voting frequency, with the focus upon female productivity in Newcastle and Birmingham. In Cookstown, emphasis was placed upon making genetic improvements in direct feed efficiency in the beef sector. Practices that were directly or indirectly related to soil health (e.g. better soil health practices (Cookstown and Newcastle), winter cover crops and regenerative farming practices (Birmingham)) were voted highly across all three workshops.

Participants in Northern Ireland were asked two slightly different questions when voting for their preferred practices. They were first asked in Activity 1 to vote for the practices they regarded as having the most potential to reduce net emissions. At the end of the session, they were asked to vote via the Top 5 Priority Practices Postcard for the practices they believed would be the most likely to reduce net emissions, support biodiversity *and* sustain profitable farming in Northern Ireland. Although the practices receiving the most votes were *mostly* consistent across these activities, 35% of them differed, and the practices of making genetic improvements in female productivity and direct feed efficiency, nutrient management planning and reducing the age at first calving for beef and dairy cows were shortlisted when participants were asked the latter, more holistic question.

Table H1. Livestock and grassland management practices shortlisted for further discussion. Voting frequencies are indicated in round brackets. In Northern Ireland, only ten practices were shortlisted due to shorter time slot. In the survey, respondents were asked to select the five practices they believed had the most potential to reduce net emissions. The fifteen practices that received the most votes from survey respondents are given in this table.
Workshop location
Newcastle
Grass-legume mixtures and multispecies swards *(5)*
Rotational grazing *(5)*
Nutrient management planning *(4)*
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate) (3)*
Improving training for farmers and advisors in GHG mitigation practices *(3)*
Better soil health practices *(3)*
Precision feeding and feed intake analysis *(e.g. with animal-mounted sensors) (2)*
Improved forage quality *(2)*
Improved animal health *(2)*
Increased hedgerow planting *(1)*
Genetic improvement - sheep *(1)*
Improved decision-making support *(e.g. distributed ledgers, weather tracking, low-cost infrastructure, digital twinning) (1)*
Improved fertility performance *(e.g. sensors to measure tail-raising) (1)*
Site-specific GHG mitigation planning *(1)*
Agro-forestry / woodland grazing *(1)*
Birmingham
Grass-legume mixtures and multispecies swards *(8)*
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate) (5)*
Increasing soil organic matter *(4)*
Regenerative farming practices *(4)*
Nutrient dense produce *(4)*
Winter cover crops / reduction in bare soil over the winter *(3)*
Improved animal health *(2)*
First mating of ewes as lambs rather than yearlings *(2)*
Improving training for farmers and advisors in GHG mitigation practices *(2)*
Capturing emissions from livestock buildings *(e.g. directing gases from barns into underground pipes for the oxidation of methane by soil microbes) (2)*
Specialised feed ingredients/additives *(e.g. Agolin Ruminant, Mootral, SarStart, Rumalator, Digestarom, LChance, various plant oils) (1)*
Integrating specific forages for environment *(1)*
Slurry acidification *(1)*
Methane-powered farm vehicles *(1)*
Agro-forestry / woodland grazing *(1)*

Cookstown
Grass-legume mixtures and multispecies swards *(12)*
Farm specific system assessment and advice / Good on-the-ground independent advice (merged category due to similarity) *(9)*
Better soil health practices *(e.g. maintaining optimal pH for plant growth) (6)*
Improve forage quality *(e.g. early harvest, increased grazing frequency, decreased regrowth interval, mob grazing, rotational grazing) (5)*
Genetic improvement in direct feed efficiency *(for beef) (5)*
Feed CH4 inhibitors *(e.g. 3NOP, nitrate, seaweed compounds) (4)*
Greater awareness of genetic improvements and greater uptake of higher-performance breeds *(4)*
Improved animal health through enhanced disease and pest monitoring *(e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease) (4)*
Manure separation (separating solids and liquids) *(4)*
Increase liveweight efficiency *(e.g. not overdeveloping animals for market) (3)*
Cookstown Top 5 Priority Practices Postcard activity (n.b. These practices were not carried forward for further discussion)
Grass-legume mixtures and multispecies swards *(13)*
Improve forage quality *(e.g. early harvest, increased grazing frequency, decreased regrowth interval, mob grazing, rotational grazing) (11)*
Improved animal health *(9)*
Better soil health practices *(e.g. maintaining optimal pH for plant growth) (7)*
Nutrient management planning *(6)*
Reducing age at first calving (for beef) *(5)*
Manure separation (separating solids and liquids) *(4)*
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate) (4)*
Reducing age at first calving (for dairy) *(4)*
Wider uptake of current genetic improvement practices *(3)*
Genetic improvement in direct feed efficiency (for beef) *(3)*
Supplementary Survey
Improve forage quality *(e.g. early harvest, increased grazing frequency, decreased regrowth interval, mob grazing, rotational grazing) (30)*
Grass-legume mixtures and multispecies swards *(24)*
Reduced age at first calving (for dairy) (17)
Better soil health practices *(e.g. maintaining optimal pH for plant growth) (17)*
Selecting livestock types/breeds suited to the farm's environmental conditions *(16)*
Reducing maximum fertiliser use *(16)*
Increasing soil organic matter *(15)*
Improved animal health *(15)*
Locally sourced livestock feed to reduce air miles *(13)*
Improved animal health through enhanced disease and pest monitoring *(e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease) (13)*
Winter cover crops / reduction in bare soil over the winter *(12)*

Extended grazing *(12)*	
Growing grass for carbon storage *(11)*	
Precision feeding and feed intake analysis *(10)*	
Farm specific system assessment and advice *(10)*	

However, there was relatively little consistency between workshops as to which practices were shortlisted. Seven practices were shortlisted in two or more workshops, as shown in Table H2:

Table H2. Livestock and grassland management practices that were shortlisted in more than one workshop ('✓' indicates that a practice was shortlisted in the corresponding workshop; '×' indicates that the practice was not.)

	Workshop		
Practice	**Newcastle**	**Birmingham**	**Cookstown**
Grass-legume mixtures and multispecies swards	✓	✓	✓
Improving training for farmers and advisors in GHG mitigation	✓	✓	×
Improved animal health	✓	✓	×*
Genetic improvement in female productivity (e.g. fertility, lower mature weight, health, longevity, early calf and lamb growth/survival, milk production, replacement rate)	✓	✓	×
Agroforestry/woodland grazing	✓	✓	×
Better soil health practices	✓	×	✓
Improve forage quality	✓	×	✓

**In Cookstown, the practice shortlisted for further discussion was very similar:* 'improved animal health through enhanced disease and pest monitoring – e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease'.

Of the 32 practices that were shortlisted across the workshops, only seven (22%) were shortlisted within two or more workshops. As mentioned previously, *grass-legume mixtures and multispecies swards* was the only practice to be shortlisted in all three workshops. It could be argued that *improved animal health* was also shortlisted in all three workshops, as *improved animal health through enhanced disease and pest monitoring* was selected by participants in Cookstown. However, where the former was given as a general livestock management practice applicable across livestock systems, the latter practice referred to the use of technologies including *automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease* specifically within the dairy sector. Although this is seemingly equivalent to the practice of *improved animal health,* we maintain that they are distinct categories on the basis that the printed materials available to workshop participants specified that 'improved animal health through enhanced disease and pest monitoring' was grouped within the category of livestock-related practices the specifically dealt with dairy systems, rather than in livestock systems more generally. In general, the practices shortlisted by participants varied substantially between workshops, reflecting the different farming systems and priorities, which further highlights the challenge of identifying farming practices that are acceptable to a wide range of farmers and farming communities.

Table H3 indicates that, when the votes cast for the practices across the three workshops are totalled and ranked, the five practices with the most votes mostly reflect those that were prioritised within the survey. Although the workshop vote frequencies were relatively small due to lower attendance in Newcastle and Birmingham, it is notable that these results were also supported by the larger survey dataset. Grass-legume mixtures and multispecies swards, better soil health practices and improved forage quality were each ranked highly (see Table H3).

Table H3. Comparison of the top five practices in the workshops and the survey by vote frequency. 'Workshop vote frequency (total)' denotes the number of votes cast for a given practice in the Birmingham, Newcastle and Cookstown workshops combined. The practices that received the most votes from across the three workshops *and* the most votes in the survey are highlighted in bold font.

Practice	Workshop vote frequency (total)	Position in the workshop rankings	Practice	Survey vote frequency	Position in the survey rankings
Grass-legume mixtures and multispecies swards	**25**	**1st**	**Improved forage quality**	**30**	**1st**
Genetic improvement in female productivity (e.g. fertility, lower mature weight, health, longevity, early lamb growth/survival, milk production, replacement rate, early calf growth/survival)	10	2nd	**Grass-legume mixtures and multispecies swards**	**24**	**2nd**
Better soil health practices (e.g. maintaining optimal pH for plant growth)	**9**	**Joint 3rd**	Reducing age at first calving (for dairy)	17	Joint 3rd
Farm specific system assessment and advice/Good on-the-ground independent advice	9	Joint 3rd	**Better soil health practices (e.g. maintaining optimal pH for plant growth)**	**17**	**Joint 3rd**
Improved forage quality	**8**	**5th**	Selecting livestock types/breeds suited to the farm's environmental conditions	16	Joint 5th
			Reducing maximum fertiliser use	16	Joint 5th

Appendix I: SWOT analyses of shortlisted livestock and grassland management practices

The purpose of this activity was to deepen our understanding of the viability of the shortlisted practices through a detailed discussion of participants' experiences, perceptions, and concerns regarding each practice. We asked workshop participants to discuss their understanding of the shortlisted practices and probed for details about their own experiences, as well as the experiences of their friends, peers or neighbours. Each breakout group received 2-5 practices to discuss in detail using the structure of a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. This activity asked participants to reflect on the strengths and weaknesses of a practice which would generally be within a farmer's control, as well as the opportunities and threats that were largely due to external factors.

The practices selected for SWOT analysis are presented in this report in the following order:

- **Carbon capture planting**
    - Agroforestry and woodland grazing
    - Increased hedgerow planting
- **General dairy systems**
    - Improved animal health through enhanced disease and pest monitoring (e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease)
- **Housed dairy systems**
    - Manure separation (separating solids and liquids)
    - Capturing emissions from livestock buildings
    - Precision feeding and feed intake analysis
    - Methane-powered farm vehicles
    - Slurry acidification
- **Beef systems**
    - Genetic improvement in direct feed efficiency
- **Sheep systems**
    - First mating of ewes as lambs rather than as yearlings
    - Genetic improvement of sheep

The data collected from participants' SWOT analyses is summarised in the following infographics. Direct quotations taken from transcribed audio files and notetakers' notes are given in italics. The infographics also indicate the perceived ease of implementation of each practice, including where this differed between breakout groups. Lastly, the infographics provide additional information in the boxes labelled 'Other considerations' which does not fit easily within the SWOT analysis structure, but provides important further detail about the practices, including regional variations in attitudes or suggestions for more effective implementation of practices.

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BEEF SYSTEMS

SHEEP SYSTEMS

Grass-legume mixtures and multispecies swards

All pasture-grazing systems:
Forage management

Strengths

- Supports biodiversity *"above and below ground"*.
- Provides sheep and beef with a different nutrient profile that supports their performance, speeds up finishing time, and increases yields. One farmer found that *"herbs [in the mix] don't last"* but he values them as *"[his] cattle do well on it"*. Another said that red clover compared favourably with *"putting [an annual] brassica in"* as the clover lasted for three years without re-sowing.
- Reduces ruminant methane production *"in the first few years [...] when you've got high levels of herbs in the mix."*
- Increases drought tolerance by increasing soil organic matter and reduces flood risk as plants with different rooting depths improve soil structure.
- Improves soil quality and carbon sequestration in the longer term.
- Supports animal health and may reduce medicine bills due to naturally anthelmintic properties and a more varied diet.
- Possible public health benefits due to *"more vitamins and minerals in livestock and grown food."* Some farmers reported *"increased butterfat, protein, and milk quality"* from grazing livestock on multispecies swards.
- Reduces the need for nitrogen fertilisers: *"No nitrogen needed [is] a massive strength [...] the clover does need phosphorus and potassium but we got away without it for years."*
- Can *"extend your grazing season [...] in spring and autumn."*

Weaknesses

- Increased costs due to difficulty maintaining a balanced mixture of species over time: *"Persistence is a big weakness [...] We're reseeding more often."*
- One group stressed the need for grazing control to prevent damage, which requires time and labour.
- High levels of phytoestrogens that can affect livestock ovulation - effective management requires further planning.
- Problems with weed control and *"getting different [unwanted] species in silage."*
- Difficulties with *"different growth rates [and] diverse seed size"* when sowing, though one experienced farmer argued that any difference in growth rate could be *"offset with [the] application of additives."*
- Challenges of getting silage dried within silage weather windows.

Perceived ease of implementation:
Easy (England/Wales workshop)
Medium (England/Scotland workshop)
Medium to Hard (Northern Ireland workshop)

Other considerations:

Some groups expressed a desire for further research into the efficacy of this practice. One workshop participant posited that "*[the] baseline in terms of legume [efficacy] is advanced - not so much for multispecies swards*".

Without convincing evidence, some participants were concerned that overestimating the benefits of multispecies swards could lead to the implementation of this practice at the expense of current permanent pasture ecosystems and existing carbon capture.

Grass-legume mixtures and multispecies swards (Continued)

Opportunities

- Fixes soil nitrogen, increasing independence from imported feeds and fertilisers and reducing emissions from supply chain logistics.
- Can provide farmers with additional income through grants and schemes (by generating natural capital and biodiversity net gain): *"The seed cost is twice the price, which is why we've been writing to the ministers to subsidise it."*
- Generates branding opportunities and added value as 'regeneratively farmed milk': *"It's a better story for the public to hear about cows out in the fields eating a wide variety of things."*
- Potential to diversify income streams, e.g. honey production on diverse swards.
- Provides farmers with an opportunity to develop skills that may be lost when relying too much on a limited set of farming practices: *"[Needing more management] isn't a weakness, it needs to come back into farming." "It's an opportunity to learn more."*
- Potential to create more demand for agronomist jobs to *"work with farmers to get better grass."*

Threats

- Adverse weather increases costs: *"if the weather turns once you've put them in, you can lose a set of seeds."*
- A lack of tailored support and expertise to support effective management of multispecies swards, which risks *"spending time and money on the wrong mix"* or losing growth by *"cut[ting] too low"*.
- Supply chain issues affecting the availability of seed.
- Entrenched views against this practice: *"It needs a mindset change for people to do it."*
- Overreliance on subsidies for seed may make farmers vulnerable to changes in future funding systems.
- Management may require additional skills and training that agricultural contractors may not have: *"You're relying on [contractors] so there's more pressure on you to get them to do it right."*
- Concerns among some farmers that multispecies swards cannot support a competitive stocking rate: *"Can you stock 3.6 cows to the hectare? […] I'm just a bit afraid of it, that's all."*
- Concerns about the quality of the advice given by advisors affiliated with livestock feed companies: *"Nutritionists shouldn't be tied to the feed firms, I don't have much time for them."*
- Perceptions of untidiness and poor grassland management from peers, neighbours and the public: *"You get abuse from the neighbour, saying 'what the hell are you doing?'"*

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Rotational grazing

Strengths

- Benefits soil health by increasing organic matter and allowing the land time to rest before grazing resumes.
- Supports carbon sequestration: "*Rotational grazing helps the land recover and healthier pastures mean more carbon in the ground.*"
- Increases the nutritional value of forage.
- Benefits animal welfare.
- Generates opportunities to increase stocking densities as more efficient grazing practices can support more livestock.

Weaknesses

- Risk of sheep that *"don't respect the fence"* getting trapped and injured: *"sheep with horns do not mix with electric fencing".*
- Reduced efficiency in multi-cell grazing systems, e.g. needing multiple water sources, supervised movement of livestock at tupping time.
- Risk of soil compaction if stocking density is too high.
- Potentially detrimental to biodiversity e.g. where fences restrict movement or electric fences kill ground-nesting birds.
- Logistical challenges when farming pedigree livestock alongside other breeds, such that many fields would be needed to prevent accidental cross-breeding.

Opportunities

- Uptake could be increased if establishing the infrastructure for rotational grazing (e.g. electric fences, water sources) was supported by grants and schemes.
- A farmer suggested that rotational grazing *"feed[s] the soil",* creating *"better quality food"* for a *"healthier [human] population",* potentially benefitting public health.

Threats

- Aesthetic considerations where conserving the landscape value of *"historical [...] field systems"* is particularly important and new field divisions are controlled, e.g. in National Parks.
- A lack of current funding schemes to support the establishment of rotational grazing systems.

All pasture-grazing systems:
Forage management

Perceived ease of implementation:
Medium (England/Scotland workshop)

Other considerations:

Workshop participants said that rotational grazing had limited benefits when implemented in isolation. They stated that rotational grazing is *"a piece of the improved forage quality puzzle"* but has limited impact *"on its own".*

Participants regarded rotational grazing as impactful *"when it's done well",* but noted that *"animal welfare needs to be considered"* for effective implementation.

In Northern Ireland, workshop participants believed rotational grazing was a better option *"for animal health and any other metric"* than the vast majority of grassland management practices available.

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Improving forage quality

All pasture-grazing systems: Forage management

Strengths

- Reduces the need for imported feed and fertilisers, reducing costs.
- Increases biodiversity.
- Improves animal health and fertility *"if done well"*.
- Further potential benefits from improving grassland as it is *"the foundation of the system [and] we need to get it right"*.
- Broadly popular with workshop attendees due to combined benefits and ease of implementation: *"It's one of the easiest wins in terms of getting carbon footprint down and animals doing better and finishing quicker."*
- Enables farmers to optimise stocking rates.
- Relatively low cost of implementation.
- Increases feed efficiency.

Weaknesses

- Increases need for grazing management, labour inputs, and the hiring of contractors which increase financial and time costs.
- Needs additional infrastructure such as fencing and water when establishing rotational grazing cells.
- Difficulty overcoming reluctance among farmers – a *"change of mindset"* would be needed.
- Increased management is needed to address weed burden.
- Risks of environmental degradation and animal health issues *"if done badly"* and subsequent damage to public perception.
- Lack of understanding among farmers who prioritise lower quality but higher volume silage: *"[A farmer] thinks he's getting better value, but then he has to feed extra meal because his silage isn't strong."*

Perceived ease of implementation:
Medium (England/Scotland and Northern Ireland workshops), *"Because change is hard."*

Other considerations:

When assessing the overall contribution of this practice towards agriculture's net zero goals, workshop participants noted that its impact *"depends on how much feed was going to be brought in"* and could be replaced by better quality forage on-farm.

Some participants were frustrated at the lack of high quality economic data that would help convince farmers to adopt different practices: *"If I'm trying to convince someone to do something on their farm, I don't often have the economic data to support it. Having the economic data is needed, because money talks."*

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Improving forage quality (Continued)

Opportunities

- Increases climate resilience.
- Potential product marketing opportunities due to the perceived quality of meat from grass-fed livestock.
- Farmer-to-farmer learning and cooperation opportunities.
- Decreases reliance on external or imported inputs and increases resilience against supply chain issues.
- Enhances public perception of *"animals on grass"* rather than in housed systems.
- Financial support to incentivise the testing of forage quality would increase uptake of this practice.
- Opportunities for collaboration between scientists and farmers to develop *"local scenarios for different practices [...] unique to the uplands of Northern Ireland or whatever so the farmer knows the best he or she can that if I do this, here's the likely outcome."*

Threats

- Increases vulnerability to adverse weather conditions when growing forage as *"timing [is] crucial"* to sowing and cutting.
- Poor alignment between subsidy payers' administrative timescales and farmers' seasonal calendars. In Northern Ireland, farmers had not been informed in good time of the outcome of their subsidy payment applications: *"There's no hope of getting a cover crop in at this late stage, given the weather."*
- Insufficient advisory systems to support increased uptake.
- Difficulty encouraging farmers to invest resources into alternative ways of improving forage quality: *"Good grass management is a hard thing to sell when concentrates are so cheap."*
- Without financial support for testing forage quality, farmers struggle to see the economic benefit.
- Lack of forage quality testing facilities in Northern Ireland.
- Lack of time which affects forward planning and good practice: *"Farmers want to make improvements but they're just trying to get through the day."*
- A lack of contractors with relevant skills, knowledge and experience.

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Integrating specific forages for the environment

All pasture-grazing systems: Forage management

Strengths

- Maximises forage health and production relatively quickly, increasing stock health, livestock production and profitability.
- Provides ecosystem services such as increased biodiversity, soil health, root system variability, water retention and drought resistance.
- Scalable, so the practice is accessible across a range of farm systems.
- Can be implemented quickly and is *"relatively easy"* compared with other livestock and grassland management practices.

Weaknesses

- Without adequate planning or knowledge, farmers may choose species that are poorly matched to the terrain or soil conditions.

Opportunities

- Healthier livestock could gain higher prices at market, increasing profitability.

Threats

- Adverse weather conditions and climate change can cause plant loss.
- Farmers will only enact this practice if they are subsidised to do so.
- Acting upon incorrect information means forages *"won't grow if not matched to [the] soil context."*
- Variability between brands selling herbal leys.

Perceived ease of implementation:
Easy (Wales/England workshop)

Other considerations:

Workshop participants posited that integrating specific forages for the environment would require some coordination between the farms in a given geographical area. Without coordination, farmers could unintentionally create a monocrop in some areas if *"everyone plants the same forage"* and therefore undermine potential biodiversity gains.

Better soil health practices (e.g. maintaining optimal pH for plant growth)

All pasture-grazing systems:
Soil and nutrient management

Strengths

- Caring for a foundational aspect of farm livelihoods: *"it's the key driver for everything […] good soil is fundamental […] to all food systems".*
- Improves the on-farm production of winter feed: *"[you] can't get a good silage cut if pH isn't right - Rule 101 of farming is to get your pH right."*
- Improves nutrient and mineral availability, reducing the need for additives: *"you end up using less fertiliser, which is a win all around".*
- Reduces soil erosion and improves air quality (i.e. by reducing wind-blown soil movement).
- Improving soil biology, structure, and capacity to hold water can improve yields, increase weather tolerance, reduce flood risk and lengthen the growing season.
- Healthy soils are more able to sequester carbon.

Weaknesses

- Improving soil health is a *"long-term journey"*. One farmer said improving soil health on his farm had *"taken seven years with still a little bit to go"*.
- Difficulty striking the right balance of soil management practices, monitoring the process, and working with the right soil advisor for the farm's needs.
- Conflicting advice and a lack of consensus around approaches to soil management, such as minimum tillage.
- Difficulty taking on new practices without knowing if or when they will pay off.
- Lack of understanding of appropriate soil management could result in over-application of slurry.

Opportunities

- Availability of resources, advice and support, including peer-to-peer learning opportunities.
- Strong alignment between soil health practices and regenerative agriculture approaches (e.g. rotational grazing) and policy goals.

Threats

- Exploitation of some farmers' lack of specialist knowledge by *"snake oil salesmen"* or bad science, placing costs on the farmer without getting results.
- Vulnerable to external, landscape-level factors (e.g. the deposition of pollutants by floodwater) and a lack of knowledge or power to mitigate these external threats.
- Overreliance on synthetic inputs, causing issues with run-off.

Perceived ease of implementation:
Medium (England/Scotland workshop)
Hard (Northern Ireland workshop)

Other considerations:

Different processes are needed to improve different soil types: *"On the mainland you can have ten fields of different soil types, in Northern Ireland you can have ten soil types in one field!"*

When considering the scale of potential net emissions reductions, participants stressed that *"other [practices] won't work as well without getting [soil management] right."* Improving soil health was a logical starting point as *"you feed the soil first, then everything else follows."*

Northern Irish farmers said that the majority of farmers lack the specialist knowledge to improve their soils and would require farm-specific, tailored guidance.

Increasing soil organic matter

All pasture-grazing systems:
Soil and nutrient management

Strengths

- Increases soil biodiversity and structure.
- Increases water retention in the landscape to enhance farm resilience.
- Perceived as a win-win as it both reduces greenhouse gas emissions and benefits soil health: *"it helps the climate but the farmer's better off too."*
- Requires smaller system changes than other practices: *"All farms can do [this] […] it is scalable (from one field to the whole farm) so farmers can dip their toes in"*

Weaknesses

- Costs to establish a baseline on a farm.
- Geographic variation in soil characteristics such that farms may not have an equal opportunity to attract payments for ecosystem services: *"Some soils can't increase soil organic matter significantly." "I'm not sure how much room there is for carbon sequestration in Northern Ireland, our organic matter is around 20% anyway."*
- Improving rates of soil organic matter is *"a slow process"*.
- Uncertain economic benefits of improving soil organic matter: *"[it] has to be financially worth it].*

Perceived ease of implementation:
Easy (Wales/England workshop): *"But slow!"*

Opportunities

- Farmers could procure financial support for increasing soil organic matter if a grant funding scheme using *"government funded baseline [soil sampling] data"* was established.

Threats

- A lack of clarity on definitions and a consistent methodology for establishing baselines, given that the percentage of organic matter in soils varies with soil depth.

Other considerations:

Some argued this practice would be appropriate only *"on arable/rotational land, NOT [on] existing pasture".*

Increasing soil organic matter was perceived as strongly connected with other practices such as grass-legume mixtures and multispecies swards, integrating specific forages for the environment, regenerative farming practices, and planting winter cover crops.

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Regenerative farming practices

Strengths

- Benefits the environment by improving soil biology, soil health, biodiversity, water quality, and infiltration rates, and decreasing nitrate emissions.
- Increases animal health and rates of production, reducing veterinary costs.
- Increases carbon sequestration and improves climate resilience.

Weaknesses

- Difficulty grazing sheep on herbal leys - *"sheep are selective".*
- Increased labour demands where livestock need to be moved more frequently.

Opportunities

- Could enhance public relations due to a *"huge amount of interest"* in these practices.
- There is already *"lots of knowledge out there"*, but greater evidence of benefits would attract more farmers.
- Potentially generate farm income from government subsidies and carbon markets.
- Reduces need for synthetic inputs, saving costs and increasing resilience: *"We have all the nutrients, I shouldn't be buying fertiliser, I have nutrients on the farm. We should be able to close that loop."*

Threats

- A lack of clear definitions, which risks "greenwashing" (the making of exaggerated or false claims about the sustainability of products or processes).
- Insufficient mindset or behaviour change in the sector.
- Reliance on government subsidies and carbon markets.
- Perceptions of farming peers and the wider sector.
- Pushback from the agrochemical industry.

All pasture-grazing systems:
Soil and nutrient management

Perceived ease of implementation:
Easy (Wales/England workshop)

Other considerations:

Workshop participants described regenerative farming practices as part of a group of practices (e.g. increasing soil organic matter and integrating specific forages for the environment) that are accessible to many farmers due to the ease of implementing changes in one field, then scaling up across a larger area over time.

However, they emphasised that evaluation is depends upon clear definitions, thorough understanding, and the consistent implementation of the '7 principles' of regenerative practice.

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Nutrient management planning

All pasture-grazing systems: Soil and nutrient management

Strengths

- Reduced reliance on fertiliser, saving costs for the farmer.
- Ease of implementation as plans can be updated each year: *"it's not time-consuming once a plan is in place".*
- Improves soil health and microbiology, as well as water and air quality.
- Addresses common slurry spreading practices that can disrupt soil chemistry.
- A low barrier to entry as nutrient management planning helps the farmer with better *"using what [they've] already got".*

Weaknesses

- The initial levels of time and specialist technical knowledge required to begin nutrient management planning: *"[it's] a pain!"*
- That the impact of this practice is contingent on both quality planning and quality implementation: *"A plan is only as good as the actions it leads to".*

Opportunities

- Access to support if living in a Nitrate Vulnerable Zone (NVZ).
- Long-term cost savings and opportunities to link nutrient management planning to farm subsidies.
- Opportunities to use a growing number of digital tools to perform this work and potential to *"integrate nutrient management planning with broader carbon or sustainability metrics".*

Threats

- Uncertainty around whether available support was sufficient: *"Support tools and advisors do exist, but access to tailored advice is still patchy".*
- Weather-related disruption.
- The longer-term *"potential for regulatory changes to complicate things".*

Perceived ease of implementation:
Easy (England/Scotland workshop)

Other considerations:

Participants noted that its potential to mitigate emissions as *"a standalone measure"* was moderate, but it would be more effective when implemented in conjunction with other soil- and feed-related strategies.

Winter cover crops (reducing bare soil)

All pasture-grazing systems:
Soil and nutrient management

Strengths

- Increases biodiversity.
- Protects soil from runoff and wind erosion.
- Improves water quality by reducing the transportation of sediment and other pollutants into watercourses: *"Growing winter rye will reduce effluent run-off and support biodiversity."*
- Winter grazing opportunities, potentially reducing the costs of feed, livestock housing, and slurry management.
- Above- and below-ground carbon capture.
- Generally non-economic benefits, so there are few financial implications if cover crops do not thrive.

Weaknesses

- Poor establishment, particularly if the weather is too dry.
- Uncertainty around efficient stocking densities.
- Difficulty quantifying the benefits to assess whether the return outweighs the costs.
- The cost of buying seeds, if not supported by a grant.
- Abiding by regulations to prevent the spread of tuberculosis when moving cattle onto outdoor winter grazing areas.

Opportunities

- Grants to cover seed costs.
- Greater incorporation of cover crops into sheep and cattle grazing systems so that livestock are also *"getting something"* from the cover crop.

Threats

- Vulnerable to climate volatility affecting patterns of seasonal rainfall.
- Uncertainty around the availability of grant funding.

Perceived ease of implementation:
Easy (Wales/England workshop) if funded *"with grants and incentives"*.

Other considerations:

One group argued that the practice offered *"minor […] efficiency gains, but [it] won't save the world."*

Another group suggested that keeping soil covered in winter had more obvious benefits than reducing net emissions, such as improving soil quality, increasing biodiversity, and reducing the transportation of nitrates to watercourses.

Northern Irish farmers broadly agreed that there *is "room for improvement"* in the use of cover crops in the region, including grazing livestock on cover crops.

Genetic improvement in female productivity (e.g. fertility, lower mature weight, health, longevity, early lamb or calf growth/survival, milk production and replacement rate)

Strengths

- Better outputs, profits, and more efficient production by breeding for improved health, longevity, parasite resilience and feed efficiency.
- Already familiar to farmers who are *"doing it every year - picking the best [animals] in the system".*
- Generates efficiencies by producing higher body scores for the same or lower net emissions. With widespread uptake, Participants felt genetic improvement had *"very big potential to make gains"* in increasing farm efficiency.
- Makes progress over time with *"iterative improvement [and] cumulative gains"* - this could also be a weakness if rapid change is desired.
- Increases farmer satisfaction and pride in their work, and creates opportunities for more *"social benefits"* by developing farmer communities through *"breed societies".*
- Generally accessible: buying stock with desirable traits to improve herds is *"open to everyone"* and *"a decision ram-buyers make every year".*
- Potential for more closed flocks to protect genetic gains, contributing to *"less disease transfer across the country [by] breeding own replacements on-farm".*

Opportunities

- *[Collaborating] with peer groups or consultants - community is key to everything."* One farmer said it *"really helps to have that kind of network to avoid feeling isolated or stuck in your own bubble."*
- Bringing different products to the market: *"Supermarkets want a uniform product, but providing variety could be an opportunity."*
- Opportunities to create a *"national genetic resource flock"*, as in Australia.
- Opportunities to benefit from enhanced data analysis to *"develop a model for sheep and cattle [...] so better genetics are used"*, with farmers making comparisons with the pig farming industry's use of genetic models.
- Resilience against external factors: *"Genetic improvements are less dependent on wider environmental factors"*

All pasture-grazing systems:
Livestock management

Perceived ease of implementation:
Easy (Wales/England workshop)
Medium to Hard
(England/Scotland workshop)

Other considerations:
They noted that access to good data and decision-support tools would be helpful, as well as farmer-friendly resources and better incentives.

One group argued that the adoption of better breeding systems for female productivity was held back by cultural resistance (centred on pride in the UK's heritage breeds) and a lack of practical knowledge: *"tradition can be a threat".*
One questioned the parameters of the practice, asking whether genetic improvement was assessed *"per individual or per hectare".*
The potential for making economic gains was more appealing than the argument for reducing emissions.

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Genetic improvement in female productivity (Continued)

Weaknesses

- Improving female productivity through better breeding is a long-term endeavour which requires that farmers define and stick to their goals and selection criteria though they may not see the pay-off from those decisions until several years later.
- Keeping a closed herd requires setting aside separate fields for them.
- Breeding for more productive traits at the expense of other qualities may have unintended and detrimental impacts: *"push too hard for growth or meat and you might lose mothering ability or fertility."* Participants cautioned against breeding to extremes and noted that hybrid benefits and genetic diversity could be lost. One farmer noted, *"it's 'line breeding' when it works, and 'inbreeding' when it doesn't."*
- Difficulty identifying *"hard to measure yet highly valuable traits"* - for example, difficulty in assessing whether good health is due to good animal care or inherent healthy genetics.
- Due to the range of environmental and climatic conditions in the UK, *"you can't just pick one 'perfect' breed for everything"* without having trade-offs. As most farmer-participants raised sheep (i.e. in predominantly outdoor systems), they stressed the importance of selecting animals suited to the specific conditions of each farm.
- Some believed this practice is *"held back by cultural resistance and a lack of practical knowledge",* including difficulty *"getting farmers to choose animals based on good genes, not good looks".*
- Participants warned that efficiency gains *"could be lost in the long term"* and that genetic improvement of the terminal line *"should also be capitalised upon".*

Threats

- The delay between initial action and seeing the results contrasts with the shorter timescales of food trends and consumer demand: *"You'll never get it right - the goalposts change"*. One group noted that supermarkets' demand for *"a uniform product"* might ease the path to market, but also reduce genetic diversity and resilience: *"you need hybrid vigour."*
- Years' worth of progress made on improving a herd's genetics is vulnerable to shocks, such as the outbreak of disease, if the herd is wiped out. Farmers warned it is *"no quick fix [and] needs many years' records to make it work effectively."*
- Risk of growing inequalities in the farm sector if *"some take up, others left behind"*, though others saw this as an advantage - *"natural selection [removing] farmers who are not commercially aware."*
- Concerns about a lack of training and specialist knowledge, such that some farmers would *"get lost in the data [risking] short-sighted, unintended consequences.*
- Concerns about the ownership of genetic data if *"owned externally"* by companies, while suggesting the *"need to keep [a] genetic bank"* for security purposes.
- Participants queried *"the incentive to head in any particular direction"* in developing different aspects of female productivity, and whether the market would respond positively to the direction of travel.

Improved animal health

All pasture-grazing systems: Livestock management

Strengths

- Benefit farm businesses by improving productivity and reducing vet bills if farmers took advantage of advancements in livestock genetics research to identify healthier and hardier breeds or individuals.
- Benefits farmers' mental health and sense of identity as good stockpeople: *"[caring for their herds is] what stockpeople do [...] it's the basis of everything"*.
- Increases biodiversity by reducing the need for anthelmintics or other chemical treatments used to improve livestock health.

Weaknesses

- Additional costs incurred from more frequent veterinary treatment, technical solutions, and extra time taken to monitor livestock health.
- Detrimental traits can also be inherited among the herd, and traits generated by good livestock management are not necessarily heritable.
- Potential loss, over-specialisation or *"dumbing down"* of stock keeping skills when this labour is outsourced to technological alternatives.

Opportunities

- Improves the public image of farming.
- Take advantage of technological advancements such as movement monitors and heat-detection collars to detect health issues early and at the individual level so that treatment costs are lower and the spread of disease is prevented.

Threats

- Changes to agricultural or environmental policies and regulations which would affect the range of treatments permitted (e.g. antibiotics).
- Limited access to treatments and supplies where global and domestic supply chains are disrupted.
- Increasing risks associated with climate change, including heat stress and the extended geographical range of some pests and diseases, in addition to antibiotic resistance and livestock diseases and ailments including Johne's disease, tuberculosis, blue tongue, lameness, cystitis and infertility.
- Participants asked whether, with a *"changing climate - are we future-proofed?"*

Perceived ease of implementation:
Easy (England/Scotland workshop)
Hard (Wales/England workshop)

Other considerations:

When considering the scale of the impact that improved animal health could make in reducing net emissions, one group argued that *"health is already pretty good, so [potential] gains [...] are quite small."* Another warned that *"supplementing with other things to patch up [animal] health could have impacts"* on other aspects of the farm system, such as soil pollution and veterinary fees.

A focus on environmental conditions is also important to make gains in this area: *"focusing on the environment they live in [will] improve the benefits."*

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Nutrient-dense produce

Strengths

- Greater pride in farmers' product and enhanced sense of identity as a producer of quality food.
- Identifies a selling point for competitiveness over other producers and generating increased profits.

Weaknesses

- Unclear whether the costs of changing farm processes to produce more nutrient-dense food would be recouped by a higher market value: *"[is it] worth the change and cost?"*
- Challenges of repeatability and consistency of product.
- Uncertainty around the eating experience of different or 'improved' beef, lamb, mutton and dairy products.

Opportunities

- Better public perceptions of UK farming.
- Could improve the standard of public health.
- Could address the cost of living crisis by improving availability of nutritious but less popular products, e.g. offal.

Threats

- Competition from cultured meat technologies.
- Lack of interest or awareness of *"cooking methods, e.g. for offal or unusual cuts of meat"*.
- Concerns that the demand to produce a new or different product will require *"changes to the livestock grading system"*.

All pasture-grazing systems:
Livestock management

Perceived ease of implementation:
Easy (Wales/England workshop)

Other considerations:

The key issue with this practice was a lack of clarity around definitions of nutrient-dense produce. This was suggested by a workshop participant, but other group members were unsure of its meaning and questioned whether it constituted a *practice* for reaching net zero, or simply a product or outcome. As such, the SWOT analysis for this practice was based on some degree of guesswork rather than drawing upon farmers' expertise.

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Greater awareness of genetic improvements and greater uptake of higher-performance breeds

All pasture-grazing systems:
Livestock management

Strengths

- Paying greater attention to genetic traits (*"the numbers, the figures"*) rather than outward appearance can reduce calf and lamb loss.
- Potential for increased efficiency and financial returns: *"[There is] lots of potential to get it right!"*

Weaknesses

- Lack of agreement and subjectivity around what constitutes a 'high-performance' breed given the needs of different farming contexts: *"What do they consider high performance? [...] Out all year, lighter on the land [...] Is it taste?"*
- Social and cultural values can make it difficult to change priorities for breeding: *"For some old boys it's been their life, breeding for shows and being rewarded for aesthetics."*
- Lack of education among farmers as well as consumers: *"They look at the price, they don't care, as long as it's on the shelf and it doesn't run out."*
- Requires long-term planning; slow gains.
- Lack of available figures for Northern Ireland limits buyers' ability to make informed decisions.

Opportunities

- Potential to change the grading system to reward low emissions livestock.
- Potential for more education and *"behavioural change"* among farmers to engage with animal genetics: *"Education is #1 – teach and help farmers."*
- Potential to reward farmers financially to buy and produce livestock with better genetics, as in the Republic of Ireland: *"Financial help was needed to get people convinced."*
- Potential to shape *"consumer preference"* for less carbon-intensive meat.

Threats

- Conflicting priorities in meat grading systems which reward meat by quality indicators rather than carbon efficiency: *"It takes longer to get [an animal] to 'E' ['Excellent' standard], it's on the farm longer."*
- Lack of governmental support and resources: *"Incentives and education are the big ones."*

Perceived ease of implementation:
Easy (Northern Ireland workshop), given appropriate support, incentives, and user-friendly software to assist decision-making.

Other considerations:
In Northern Ireland, one break-out group expressed a more sceptical view of genetic improvements than another.

One group warned of the trade-offs and unintended consequences when breeding for selected traits. They supported genetic variation in livestock and were more critical of pursuing a more narrow *"genetic route"*.

On the other hand, a second group were frustrated with what they perceived as other farmers' *"obsession"* with the aesthetic performance of favoured breeds and a subsequent lack of engagement with genetic research and statistics.

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Feed CH_4 inhibitors (e.g. 3NOP, nitrate, seaweed compounds)

Strengths

- Reduces greenhouse gas emissions: *"If it reduces methane, it's a good thing."*
- Quick and easy for the farmer to use: *"All you have to do is put a different bag of vitamins and minerals in the feed."*

Weaknesses

- Farmers' uncertainty around side-effects: *"I wonder what else it's doing."*
- Less useful in outdoor grazing systems where the CH_4 inhibitor may *"only be taken once or twice a day."*
- Unattractive to farmers without clear productivity gains: *"Why would a farmer do it?"*
- Requires the ongoing purchase of CH_4 inhibitors at a cost to the farmer: *"If you stop feeding [it], the effects stop."*
- Addresses the immediate problem of methane emissions but does not address the root cause as other practices seek to (e.g. breeding livestock that produce less methane)

Opportunities

- Society may be more willing to support methane reductions to reduce the warming effect more quickly.
- Water-administered CH_4 inhibitors are being trialled, which would better suit grazing systems.

Threats

- Negative public perceptions of feed additives.
- Uncertainty around *"long-term side-effects."*

All pasture-grazing systems:
Livestock management

Perceived ease of implementation:
Easy (Northern Ireland workshop)

Other considerations:

CH_4 inhibitors require extensive safety assessments and testing before being approved for use. The uptake of this practice is partly out of the hands of UK farmers as they cannot control which products will be approved and made available to them.

Increase liveweight efficiency (e.g. not overdeveloping animals for market)

All pasture-grazing systems: Livestock management

Strengths

- Better food conversion rates and lower inputs, producing a *"more carbon efficient animal".*
- Saves money and labour.

Weaknesses

- Requires education and *"changing mindset".* Some farmers raise livestock in excess of target weights because they *"enjoy feeding them"* and *"getting the big weights"* though this is less efficient.
- Animals can be hard to finish to some specifications.
- Close monitoring of liveweight has associated equipment and labour costs: *"You need liveweight tagging and weighing – the system is quite expensive."*
- Some farmers choose livestock on the basis of appearances rather than efficiency: *"Everyone's buying with their eyes, it's crazy."*
- Suppliers of breeding stock affect what is available to the farmer.

Opportunities

- Financial incentives for meeting target weights at market.

Threats

- Only a small proportion of farmers can benefit from target weight incentives: *"You can't have that for every single farm in Northern Ireland."*
- Consumers' expectations of product size, shape and weight can change quickly: *"The requirements will change and they don't tell us, and then it's too late, you can't make a fat cow skinny or a skinny cow fat overnight."*

Perceived ease of implementation:
None given (Northern Ireland) because it's *"farm specific"*

Other considerations:

Workshop participants in Northern Ireland expressed a need for better communication between farmers, breeders, markets, and consumers to ensure that farmers are sufficiently informed of changes in consumers' buying habits so they can produce meat and dairy products that meet those specifications: *"We're really out of touch with the consumer".*

Others highlighted that *"sometimes the breeders are a bit out of touch with the farmer and what they need."*

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Improved fertility performance (e.g. sensors to measure tail-raising)

Strengths

- Removing *"animals with poor performance due to diseases (like BVD) [from] the system"* increases farm efficiency, reducing net emissions per kilo of output. BVD (Bovine Viral Diarrhoea) reduces the fertility of cattle, causing early embryonic death.
- Reducing age at first calving can increase farm efficiency: *"Getting cows in calf quicker means less waste across the whole system."*
- Financial benefits for the farmer which *"motivates change"*.
- Reduces labour time for farm employees.
- There is an existing baseline of understanding in the industry, supported by good advisory support and guidance documents, so that farmers would not be *"starting from scratch"* with a new concept or process.

Weaknesses

- Difficulty *"increas[ing] uptake of [the] practice"* and the need for *"mindset [and] behaviour change"* in the sheep and beef sectors.
- *"Reluctance"* among farmers *"to engage and supply data"* which would support better breeding. The data collected in the dairy sector was seen as *"streets ahead"* in helping improve fertility.
- The slow rate of progress, having *"only one chance per year"* to breed better livestock.
- The challenge of addressing livestock fertility issues as it is a *"complex [...] multi-factor issue"*.
- The practice is *"not straightforward"* and requires long-term, consistent improvement in order to make long-term efficiencies.

Opportunities

- Enhanced data collection using available and emerging technologies.

Threats

- The challenge of *"keep[ing] less productive livestock"* on the ground to maintain viable stocking numbers while *"need[ing] to be more ruthless to get genetic gain"* through selective culling of less fertile animals. Participants referenced negative public perceptions of *"culling healthy animals [to make] genetic progress"*.

All pasture-grazing systems:
Livestock management

Perceived ease of implementation:
Easy (England/Scotland workshop), *"but [it's] not straightforward"*.

Other considerations:
None given.

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Specialised feed ingredients/additives (e.g. Agolin Ruminant, Mootral, SarStart, Rumalator, Digestarom, LChance, various plant oils)

Strengths

- Potential to make efficiency gains when feeding livestock.
- Can reduce direct livestock emissions.

Weaknesses

- A lack of specialist knowledge among farmers to ensure the specialised feeds are used efficiently.
- Possibility of unintended consequences, such as negative impacts on product quality.

Opportunities

- Potential to improve product quality for greater profitability at market.

Threats

- The cost of buying branded feed products produced by a small number of companies. Participants posited that the ownership of the intellectual property among a small number of specialists and businesses could create investment opportunities for some, but farmers who purchase these products would be hindered by high costs of specialised feed.
- Possible negative public perceptions of *“the industrialisation of natural processes [...] [feeding] additives to an animal not designed for this [e.g.] oils.”*

All pasture-grazing systems:
Livestock management

Perceived ease of implementation:
Easy (Wales/England workshop)

Other considerations:

Participants noted that only marginal efficiency gains may be possible in some livestock systems.

All three break-out groups in the Birmingham workshop placed specialised feed ingredients and additives low in their rankings of practices for reducing net emissions on the basis that their use was *“controversial”* and they were *“very unsure of the impact”* of their use.

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Farm specific system assessment and advice

All pasture-grazing systems:
Planning and training

Strengths

- Tailored advice would be more useful to a farmer than generic advice, as farm systems can be so different.

Weaknesses

- Farmers often lack the capacity to engage with in-depth farm assessments due to a lack of time or the *"mindset"* to pursue improvements.
- Lack of knowledge and skills among trainers to deliver and facilitate system assessments of individual farms: *"[There's a] difference between book education and farm education."*

Opportunities

- Potential for farm clusters to do this work collaboratively in farming clusters, networks and cooperatives.
- Potential to employ more advisors and facilitators of peer-to-peer advice.
- Potential to increase social support and engagement for farmers, *"tackling isolation."*

Threats

- Vulnerable to political pressure to encourage some farm practices over others due to changing priorities at the policy level: *"Constant change is not good."*
- Delivery would be vulnerable to government budget cuts if state funded.
- Lack of incentives to implement this practice.

Perceived ease of implementation:
Hard (Northern Ireland workshop)

Other considerations:

As with similar training-based approaches, participants posited that peer-to-peer and on-farm learning would be more valuable that top-down training delivered by 'outsiders'.

Northern Irish farmers agreed that enforcement (*"a stick"*) would be required to get farmers to engage with farm assessments.

Northern Irish farmers said that getting one-to-one advice to assess and improve farm systems would be beneficial but would be unlikely to happen due to budget constraints at the government level.

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Improved training for farmers and advisors in greenhouse gas mitigation

All pasture-grazing systems:
Planning and training

Perceived ease of implementation:
Medium (Wales/England)
Hard (England/Scotland workshop)

Strengths

- Benefits farmers' and advisors' personal development and supports a *"mindset change"* around reducing on-farm emissions.
- Generally *"good for business"* as increasing efficiencies would reduce emissions per kilo of output and increase profits.
- Speeds up the implementation of practices known to reduce GHG emissions by training advisors who can reach more farmers.

Opportunities

- Participants identified peer-to-peer learning and shared learning within cluster groups as key strategies for building the confidence necessary to engage with training and take up new farming practices.

Weaknesses

- Depends upon having trust in the trainer as external training can feel forced upon some learners.
- Training alone is *"useless unless well implemented"*.

Threats

- Focusing on one metric due to the current policy direction rather than considering the whole farm system is *"not good for the farm."*

Participants said that effective training would have the following qualities:

- Provide flexible and tailored advice (rather than generic content) with multiple delivery methods as *"all farms are different"*.
- Target people on the farm with direct responsibility for implementing new practices. However, one group argued that *"everyone on [the] farm"* should receive training in reducing emissions, including those with the authority to make important decisions.
- Recognise the challenges of *"getting [farmers] in the room"* and pitch training sessions so as to engage learners without lecturing, pressuring or threatening them.
- Consider how particular language and a *"singular focus"* on emissions might alienate some farmers and find ways to engage them.
- Ideally provide social and networking opportunities - and a good lunch!

Other considerations:
Some thought training had the most potential to reduce net emissions as *"knowledge is power [...] you can't implement what you don't know"*.
Others mentioned that *"critical thinking"*, *"acknowledging complexity"* and training in *"holistic management"* were important. However, others thought training was less effective as it *"doesn't necessarily result in behaviour change"*.
Another group argued that although they *"all [had] carbon literacy training"*, farm workers had *"not much say"* in choosing more sustainable practices if their bosses were not in agreement.
In sum, participants felt that *"getting farmers to a meeting and changing [their minds] is hellish hard!"*

Site specific greenhouse gas mitigation planning

Strengths

- Makes farms more efficient by being tailored specifically to the conditions of individual farms. This would support farmers to better understand the process and capture baseline data.

Weaknesses

- A lack of specialist knowledge.
- Questionable returns for the farmer, and trade-offs with other farm practices and priorities.
- Reduced productivity, depending on the plan.

Opportunities

- Allows farmers to tap into new or existing accreditations that promote good farming, opening up markets and branding opportunities for meat and dairy products, e.g. with a low-carbon label.
- Highlights high trade standards for domestic products in order to compete favourably with trade from other countries.
- Opens up opportunities in the carbon sequestration market.

Threats

- A lack of a viable market, particularly where foreign trade deals may introduce cheaper products with a lower standard of welfare and/or quality to UK markets.

All pasture-grazing systems:
Planning and training

Perceived ease of implementation:
Easy (England/Scotland workshop)

Other considerations:

When considering the scale of the impact that site specific greenhouse gas mitigation planning could make in reducing net emissions, one group said that its efficacy depended on the sound implementation of these plans and *"legal obligations or [...] contracts"* to ensure implementation.

Another group thought this practice had the least potential to reduce net emissions due to *"distrust [of] models [and] advice - it's subjective"*. They questioned the rate of voluntary uptake *"unless [informed via] word of mouth"* by other trusted farmers.

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Improved decision-making support (e.g. distributed ledgers, weather tracking, low-cost infrastructure, digital twinning)

Strengths

- The convenience of using digital models to plan and test out different scenarios, giving farmers *"a great starter if you know where you want to be but don't know how to get there".*
- Increases farm resilience by supporting a proactive approach to problem-solving.
- An opportunity to *"translate science to [the] farm level"*, allowing farmers to access evidence-based research.
- Drawing upon advice from around the world was seen as *"important in [a] changing climate."*

Weaknesses

- The level of information can be overwhelming and difficult to navigate, requiring pre-existing knowledge: *"[It] doesn't suit everyone"*.
- Requires digital literacy, which may be more limited among the older farming population, thus reducing uptake of technological solutions.
- Those who prefer to learn from peers in farmer-led networks and are possibly less likely to trust or engage with digital tools.
- Decision-making support *"doesn't necessarily result in behaviour change."*
- Marginal gains for those already "operating efficiently."

Opportunities

- The uptake and troubleshooting of digital tools for improved decision-making could be supported by farmer-led networks.

Threats

- Costs (which could increase) to access services and software packages. One farmer had a monthly subscription to a digital twinning product *"but didn't get much out of it".*
- Decision support advice is *"only as good as the information that goes in",* and poor, inaccurate, or outdated models would be unhelpful.
- Some farming consultants were perceived as reactive rather than proactive.

All pasture-grazing systems:
Planning and training

Perceived ease of implementation:
Hard (England/Scotland workshop): *"It's easy to get started but the full results take time."*

Other considerations:

Participants noted that different systems have different advisory needs, with dairy systems *"bring[ing] consultants in"* more often than farmers in sheep and beef systems.

Several participants warned that *"good tools are only helpful if they're used and understood"* and regarded decision-making support as *"a stepping stone to other practices"* with *"lower potential"* to reduce greenhouse gas emissions by itself.

Agroforestry and woodland grazing

All pasture-grazing systems:
Carbon capture planting

Strengths

- Could diversity farm incomes by producing products such as nuts, fruit, cider, willow poles, timber or firewood.
- Support grazing livestock by providing shade, shelter from wind and rain, act as *"a safe place for sheep if [fields] flood"* and potentially offer anthelmintic properties. These could help improve animal welfare and reduce livestock loss, offsetting the reduction of productivity per acre.
- Field trees can be used for animal fodder: "the browse from the willow is fantastic".
- Continue the use of pastures for food production rather than turning the land over entirely into forestry - *"[it's] still agriculture"*.
- Improves soils in winter with inputs of fallen leaves.
- Planting field trees can help increase soil carbon in the centre of fields where it is most needed, rather than at the edges near hedgerows.
- Tree planting could make more efficient use of fields by filling areas unsuitable for grazing: *"We all have a wet corner of a field, if we all planted a corner..."*
- Potentially less work for the farmer in managing existing trees and hedges: *"going from [annual] hedge-cutting to cutting once every three years, and allowing it to flower, and getting the biodiversity in."*

Weaknesses

- Planning required to match machinery width to the amount of land available, a lack of knowledge for effective planning, reduced efficiency when using large vehicles for harrowing and cropping between avenues of trees. Farmers said it is *"not suited to all landscapes"*.
- Grazing animals around dense undergrowth can increase the risk of livestock getting stuck, injured or killed, where *"sheep [strangle] themselves on brambles"*. Retrieving trapped animals requires time and effort, while others warned of animals escaping if fences became damaged by falling trees during storms
- Converting pastures systems is time-intensive with uncertain returns: *"Takes a long time to get there with lower production."*
- Cannot easily be reversed: *"You can't change your mind in two years' time, once [a field's] in agroforestry, it's in agroforestry."*
- Costs of planning, planting and protection of trees in pastureland.
- Inconvenient for machinery: *"Do you want to drive around trees?"*
- Planting trees in hedge gaps and wet spots *"will offset a small amount, but it won't offset the emissions of a dairy farm, it's no panacea."*
- Potentially attracts more flies as animal waste is concentrated in a smaller area when livestock shelter together under trees.
- Unpalatable or lower quality grass under shaded areas, as well as labour involved in keeping livestock away from potentially dangerous species (e.g. acorn toxicity from oaks and thorn injuries from hawthorn). This reduces the amount of grazing land available.
- *"Saplings [had] no chance"* of survival unless protected from livestock or other animals, increasing time, labour, and material costs.

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Agroforestry and woodland grazing (Continued)

Perceived ease of implementation:
Medium (Wales/England workshop)
Hard (England/Scotland workshop)

Opportunities

- Provides ecosystem services such as water conservation, soil stabilisation, flood mitigation and carbon sequestration, particularly if funding schemes were available to support management costs and offset the loss of productive land.
- Boosts public perceptions of farming as it *"looks nice"* and tree planting is popular with the public.
- Can remediate damaged hedges without losing much growing space: *"where there's gaps in hedges [...] can we get trees established in the hedges where you won't have to drive around them?"*
- Opportunities for better outreach and guidance to improve farmers' hedge management skills: *"Nobody's come out and told me how I should be managing my hedge [...] come and tell me 'this is the best way'."*

Threats

- Widespread uptake of agroforestry would require *"a mindset change"* among farmers and *"the confidence"* to change systems when immediate returns are uncertain.
- Tree planting is a long-term investment vulnerable to current and future tree diseases (e.g. Dutch elm disease, ash dieback), storm damage, drought, and changes in definition, land ownership, funding schemes, tenancy and government policy. The long-term legacy of tree planting could be threatened if *"the next generation"* is not involved.
- Conflicts and confusion around various funding schemes make agroforestry less viable or appealing.
- Vulnerable to forest fires.

Agroforestry and woodland grazing (Continued)

Wales/England workshop:
When considering the scale of the impact that agroforestry could make in sequestering carbon, one group said the *"potential is huge"*. Others argued that the potential for carbon sequestration varied depending on tree species, climate and topography, such that the *"potential in some areas is high [but in] others not."* A third group posited that planting *"the right tree in the right place"* was essential to the success of this practice in reducing greenhouse gas emissions. Farmers in this workshop also mentioned that farmers do not have equal opportunity to implement this practice as tenant farmers are restricted by their *"landlord[s'] views"* and may be refused permission to plant trees. This affects a significant number of farmers as roughly a third of farmland in England and Wales is rented.

England/Scotland workshop:
Though some participants agreed that agroforestry and woodland grazing could be beneficial to biodiversity, animal welfare, and diversifying farm incomes, they explicitly stated that recognising possible benefits in the context of the LUNZ workshop did not mean they supported tree planting policies wholesale. One group posited that although there were some benefits to livestock in providing forage and shelter, there *were "lots of practical challenges"* and questioned whether agroforestry was *"a trend"* that would have long-term implications. On the other hand, a second group said agroforestry had potential for *"massive sequestration",* though they acknowledged *"cultural resistance",* fly infestations, and the possible displacement of food production as additional considerations. Some participants gave anecdotal support for agroforestry (*"[there's] a lot of it around me and they say it's working")* but others pointed to examples *"overseas that hadn't worked"*. Current arguments in favour of agroforestry were said to lack *"enough evidence to convince people"*, especially around the effects on productivity when attempted on different kinds of grassland, and participants expressed interest in hearing about case study examples.

Northern Ireland workshop:
Farmers in Northern Ireland were more supportive of agroforestry than other groups, mentioning the value of trees for fodder, soil carbon, and making the most of land with low grazing value. There were concerns, however, that the initial barriers to implementing agroforestry were off-putting: *"It has huge potential to make a difference [to net zero targets], but it's taking that first step..."* They also supported pragmatic planting of trees where they would not disrupt existing land use, e.g. *"on small areas of biodiversity that are already on farms"*, such as wet patches and gaps in hedges. One participant said that *"[f]armers want better hedges and [are] open to woodland in small amounts in the right place – policy and funding to support small but frequent planning would add up to a lot."*

Overall:
A lack of consensus around the value of agroforestry in reducing net emissions was apparent in the ranking task. Two groups placed agroforestry among the top five practices with the most potential to reduce net emissions, while three groups ranked it among their bottom five practices. Farmers in Northern Ireland did not shortlist agroforestry for further discussion though it was mentioned in relation to better hedgerow management.

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Increased hedgerow planting

Strengths

- Increases biodiversity.
- Improves soil health.
- Helps retain traditional rural skills, providing employment opportunities and holding cultural value.
- Enhances the landscape.
- Supports animal welfare by providing shelter and can reduce husbandry costs in the long term.
- Provides additional fodder for livestock.
- Sequesters carbon above and below the ground.
- Act as extra fencing when moving livestock.
- Supports natural pest control by providing habitat for insects, birds, and other animals that predate upon agricultural pests.
- Provide flood management benefits by absorbing rainfall and slowing the movement of runoff.

Weaknesses

- It takes time to establish healthy hedgerows.
- Time, labour and materials costs to install fencing and lay hedgerows, as well as the carbon cost of fencing materials.
- Ongoing hedge maintenance costs.
- Risks of damage by deer and rabbits, particularly when newly established.
- Loss of grazing land

Opportunities

- Generates opportunities to diversify farm incomes, e.g. with fruit or nuts.
- Generate opportunities for public engagement and better public relations by supporting education and training for fencing, hedge planting, hedge laying, and maintenance.
- Potential for financial support for farmers via government grants or supply chain incentives due to benefits to biodiversity and carbon sequestration.

Threats

- Difficulty balancing hedge laying with *"other environmental and landscape objectives"* in National Parks.
- Difficulty employing skilled hedge layers due to general decline in traditional rural skills.
- A lack of support schemes and uncertainty around applicability and eligibility.
- Difficulty making informed and resilient decisions when choosing tree species to plant, given the risks of climate change, drought, and current and future tree diseases.
- Difficulty navigating regulations and responsibilities around hedgerows, e.g. maintenance.

All pasture-grazing systems:
Carbon capture planting

Perceived ease of implementation:
Medium (England/Scotland workshop) due to the need to make *"physical changes"* to the farm, rather than requiring *"a mindset or cultural change."*

Other considerations:
One group thought this practice would have *"less impact than agroforestry"* on reducing net emissions, while others identified benefits including biodiversity, carbon sequestration and animal welfare.
As with agro-forestry, they were concerned about losing productive land to carbon capture but viewed hedgerow planting as more acceptable: *"You can't cover a whole field with hedgerows, but what you can plant still makes a difference"*.
In comparison with discussions around agro-forestry and woodland grazing, planting more hedgerows appeared to be a much less contentious form of carbon capture planting.

Improved animal health through enhanced disease and pest monitoring (e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease)

Strengths

- Reduces time, labour and stress from using technology (e.g. boluses measuring inner body temperature) for faster health monitoring and treatment: *"the calving alerts have been fantastic."*
- Financial benefits from *"reducing calf loss […] reducing mastitis."*
- Allows on-farm tasks to be delegated, reducing pressure on the farmer: *"I get notifications now, and I can text the person milking [to say] 'cow number such-and-such, check her out [for mastitis]."*
- Increased animal longevity and fertility.
- Reduces use of antibiotics.

Opportunities

- Reduces use of antibiotics, which benefits wider society and is *"a better story"* for the public.
- There is a range of products on the market to suit farmers' needs: *"There are external [health monitors] that can be swapped to a different animal."*
- Potential for reduced labour costs.

Weaknesses

- High costs and uncertainty around the return on investment.
- Costs to the farmer and the environment from single-use technological devices: *"Once the animal's gone, the bolus goes with it."*

Threats

- Additional costs in the event of culling: *"If you get a case of TB, you lose thirty cows [and] their boluses."*
- Reduces the incentive to breed healthier animals: *"it's managing a problem rather than addressing it at the source."*
- Potential *"threat from cybercriminals"* hacking technological systems.
- Public perceptions of some technological systems, e.g. internal boluses.
- Uncertainty around potential radiation risk from internal digital devices: *"How does that affect the dairy, or lifespan? Will the radiation affect her health? I don't know if that's an issue or not."*

Dairy systems:
General

Perceived ease of implementation:
Easy (Northern Ireland workshop)

Other considerations:

A few participants had direct experience of using health monitoring boluses in their livestock. The retrievability and reusability of the boluses after culling was a key point of discussion.
On the one hand, retrieving the devices to use again in other animals would prevent tech waste and reduce costs on the farmer.
On the other, some companies offered lengthy guarantees on their products and thus retrieving boluses from culled livestock was discouraged: *"They don't like you getting it back [and] putting it in another animal."*

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Manure separation *(separating solids and liquids)*

Dairy systems:
Housed dairy systems

Strengths

- Reduces ammonia emissions.
- Reduces burden on manure storage infrastructure.
- Enables *"precise allocation"* of separated waste to fields with farm equipment, e.g. a dribble bar.
- Reduces transport costs when managed on-farm.

Weaknesses

- Lack of understanding among some farmers: *"What do you do with the separate portions? Do you compost the solids? How do you manage the liquids? Can you use it in the sprinkler system?"*
- Uncertainty around costs, cost effectiveness, and storage: *"I think a lot of people would be open to try it but they don't have anywhere for it to go."*
- Time- and fuel-intensive: *"I know someone who had to run [the separator] all night to have enough to spread it the next morning."*
- Lack of consistency across types of equipment
- Possibly less applicable to smaller producers: *"We're a 30 suckler herd – do we need it?"*
- Uncertain impact on carbon emissions: *"The main argument for separation is to manage nutrients."*

Opportunities

- Potential for farming cluster groups to collaborate on slurry management, with additional social benefits: *"Anything that socially connects farmers is an opportunity, to me."*
- Potential to produce and sell phosphorus pellets from slurry in future, though workshop participants were uncertain of the logistics and viability of this.
- Potential to combine manure separation with anaerobic digestion to produce energy from waste.
- Potential for more training and skills development to manage slurry wizard tools.
- Potential to remove slurry from areas of risk to watercourses.
- More research and training is needed.

Threats

- Concerns around future policy directions: *"Would we be forced to use it?"*
- Poor *"optics"* if badly implemented and people other than the farmers are seen to profit: *"Will it be 'jobs for the boys'?"*
- Unsure whether the technology will resolve its limitations (of time, expense, consistency) by 2035.

Perceived ease of implementation:
Medium (Northern Ireland workshop)

Other considerations:

Workshop participants questioned whether manure separation was suitable for small scale farms which produce less slurry than industrial beef and dairy farms. Participants voiced concerns that small farms could be *"forced to do it"* despite having fewer resources than large operations.

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Capturing emissions from livestock buildings

Strengths

- Directly addresses the release of greenhouse gases and is already being implemented in pig and poultry systems.

Weaknesses

- High initial costs to set up systems (both financially and in terms of fossil fuel emissions), as well as ongoing maintenance costs, which would impact on profitability.
- Equipment and system failures.
- A lack of applicability to outdoor grazing systems, e.g. in sheep farming.

Opportunities

- Avoids the need for wide-scale behaviour change by targeting more intensive systems and making them more compliant.

Threats

- Public (and some farmers') perceptions of reduced animal welfare in housed systems: *"it's not natural, cows are meant to be outside bloody well grazing!"*
- Risk of livestock death in the event of equipment failure.

Dairy systems:
Housed dairy systems

Perceived ease of implementation:
Hard (Wales/England workshop)

Other considerations:

One break-out group ranked capturing emissions from livestock buildings as the practice with the biggest potential to reduce net emissions on the conditions that a) *"costs are covered"*, presumably through grants and schemes, b) there is *"perfect capture of emissions"*, and c) housed livestock systems remain the same, e.g. in the timing and duration of housing. Others queried the feasibility of *"adapt[ing] existing animal housing"*.

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Precision feeding and feed intake analysis

Strengths

- Reduces livestock feed costs, feed waste, and greenhouse gas emissions released by food production and importation.
- Improves animal welfare by avoiding under- and over-feeding.
- Increases the efficiency and productivity of housed systems.
- Contributes to more efficient land utilisation by reducing waste in systems.
- Can increase farmers' knowledge of their livestock's health and specific needs (as individuals and as a breed), and improve animal welfare by supporting health monitoring.
- Gives farmers greater control over farm outputs: *"If you know exactly what's going in, you can control what's coming out."*
- Reduces the amount of labour hours needed on the farm.

Weaknesses

- Initial and ongoing costs of new technology.
- Time is needed to teach animals to use new feed delivery systems and to interpret and act upon the data generated.
- A potential loss of husbandry skills from becoming overly reliant on technology.
- Technical issues.
- A lack of applicability in outdoor grazing systems.
- Some farmers' refusal of tools such as feed pushers: *"as soon as you mention a machine [...] it puts me off."*

Opportunities

- Generates better data about livestock's feed and energy needs, which could influence genetic improvements by selecting the most efficient feeders for breeding.

Threats

- A lack of farm connectivity, disadvantaging farms with poor internet or mobile signal.
- Dependence upon *"having access to feed analytics and formulation tools"* which may be inaccessible or unaffordable.

Dairy systems:
Housed dairy systems

Perceived ease of implementation:
Medium (England/Scotland workshop)

Other considerations:

Emissions reductions from this practice are *"high impact only if you are reliant on concentrate [i.e.] dairy [systems]."*

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Methane-powered farm vehicles

Strengths

- On-farm access to free or low-cost fuel in slurry-generating systems.
- Increases sustainability by using an agricultural by-product.
- Improves public perceptions of the management of agricultural methane emissions.
- Reduces on-farm use of fossil fuels.

Weaknesses

- The costs and availability of infrastructure for methane storage.
- Environmental and safety concerns: *"sounds more explosive than diesel"*.
- Concerns around land use change, if anaerobic digestion systems would *"take away from pasture"*.
- A lack of suitability for outdoor grazing and/or sheep systems: *"sheep farmers don't produce huge amounts of slurry!"*.
- *"Farm workers' attitudes [and] reluctance to change"*.

Opportunities

- Increased resilience against fuel/energy price rises.
- Opportunities for grant support, subsidies, and selling excess methane from larger farms.
- Solar panels can be adapted to produce methane if there are on-farm shortages of slurry for anaerobic digestion systems.

Threats

- The availability of other forms of renewable energy that are easier to install at a small farm scale, e.g. solar-powered electricity.
- Regulatory challenges, such as planning permission or high taxation.
- The possibility of long-term running costs if tech suppliers run a *"subscription service model"*.

Sub category:
Housed dairy systems

Perceived ease of implementation:
Hard (Wales/England workshop)

Other considerations:

Participants' perceptions of the feasibility and uptake of methane-powered farm vehicles differed between break-out groups. One group anticipated that there would be *"very low uptake"* which would mitigate a *"small amount of overall farm emissions anyway,"* but others thought this practice would be "*more accessible than capturing emissions from [livestock] buildings"* within slurry-producing livestock systems.

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Slurry acidification

Strengths

- Reduces ammonia odours and emissions of methane and indirect nitrous oxide with easy-to-use additives.
- Producing a higher nitrogen by-product.

Weaknesses

- Suitable only for intensive indoor cattle systems.
- Disrupts soil biology when high-nitrogen slurry is spread.
- Concerns around whether there is *"robust evidence"* of its benefits.

Opportunities

- Reducing agricultural odours would be *"easy win [for] public and community perception"*.

Threats

- Cost and availability of slurry acidification additives.
- Concerns around the potential side-effects of slurry additives: *"the management of slurry need to be better understood. As soon as I see 'inhibitor', I think 'what else is it inhibiting?'"*

Dairy systems:
Housed dairy systems

Perceived ease of implementation:
Easy (England/Wales workshop)

Other considerations:

The group noted that as they were not dairy farmers, they did not produce large quantities of slurry in their farm systems and therefore had a limited understanding of the advantages and disadvantages of slurry acidification.

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Genetic improvement in direct feed efficiency *(for beef)*

Beef systems

Strengths

- Making efficiencies by selecting from high-performance breeds: *"Some can grow faster, be better convertors."*
- Better able to assess feed efficiency in systems that feed concentrated meal and silage.
- Lower carbon footprint.
- More profitable.

Weaknesses

- Making genetic improvements is a slow and complicated process: *"There can be more variation within the breed than between breeds, it's not always straightforward."*
- Less accessible to the average farmer due to costs and technical challenges.
- Limited ability to measure feed efficiency in pasture grazing systems.
- Progress would be too slow: *"Really small gains every year."*

Opportunities

- Feed efficiency is less important in upland grazing systems *"but does play a piece at the end with [livestock] finishing."*
- Potential to improve perceptions of farming: *"Low carbon beef."*
- Potential to benefit the average farmer *"if it can be tested through the year."*

Threats

- Uncertainty around the applicability of US-based science to the UK context: *"[The experiments are] based on maize silage, but when we bring it over to the UK, is it still going to have the same effects?"*
- Potential to widen the gap between small and large businesses, increasing inequalities in the agricultural sector: *"It's only going to be the top elite companies, not even the top breeders, that benefit."*
- Risk of losing other desirable traits through selective breeding: *"When you go in one direction, you take away from another trait."*

Perceived ease of implementation:
Hard (Northern Ireland workshop)

Other considerations:

Workshop participants stressed that this practice is out of reach for most farmers due to due to costs and specialist expertise: *"It's for the top dogs."* They stated that *"good leadership"* from government departments for agriculture would be needed if they were to benefit from these gains.

First mating of ewes as lambs rather than as yearlings

Sheep systems

Strengths

- Produce earlier returns, increasing productivity per unit of GHG emissions.
- Naturally improve flocks by selecting ewes that become fertile at a younger age.

Weaknesses

- A loss of other important traits due to a focus on fertility.
- Losing any efficiency gains in the long term due to the impact of other factors (e.g. increased management, feed and labour).
- Reduced longevity in breeding ewes.

Opportunities

- Potential to increase profitability.

Threats

- Younger ewes are less resilient to adverse weather conditions if lambing outdoors.

Perceived ease of implementation:
Easy (England/Wales workshop)

Other considerations:

When considering the scale of the impact that earlier mating could have upon reducing net emissions, all groups placed this practice among the lowest in their ranking on the grounds of being *"very context specific"*. Participants questioned whether it is *"appropriate for both upland and lowland environments"*.

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Genetic improvement of sheep

Sheep systems

Strengths

- Increases production and higher returns, reducing emissions per unit of output.
- Improves fertility and health, reducing veterinary costs.
- Develops a more consistent flock which simplifies management systems.
- Allows for improving specific traits depending on farm conditions, thus developing *"the right animal for the farm"*.
- More rapid improvement of breeding lines than in cattle systems.
- Lower emissions in sheep systems than in beef and dairy systems

Weaknesses

- Farm size and terrain can limit possibilities.
- Potentially negative implications of poor breeding: *"if it goes wrong, [the effects] can be far reaching quite quickly".*
- Making genetic advances is a *"long-term process"* so progress is relatively slow.

Perceived ease of implementation:
Hard (England/Scotland workshop)

Opportunities

- Better marketing of livestock due to the availability of supporting data about their characteristics.
- Increased reputation of breeding stock.
- *"[Getting] ahead of the game"*, for example, by breeding for shorter tails where tail docking legislation poses challenges to farmers.
- Opportunities to introduce *"mindset training courses"* that address concerns, raise awareness and generate support for better sheep breeding efforts.

Threats

- A lack of training to understand the technology used and the genetic data produced.
- Difficulty changing mindsets that are sceptical of reducing stock numbers in order to breed more productive herds.
- Limited availability of data.
- A lack of advisory support to improve the marketing of breeding stock.
- Adverse weather conditions, which reduce the number of lambs surviving to breeding age.

Other considerations:

None given.

Appendix J: Summary of SWOT analyses

In all, 32 livestock and grassland management practices were discussed involving ten breakout groups across three workshops. Though workshop participants had a limited amount of time to complete their SWOT analyses, they nevertheless generated a wide range of ideas about the advantages, disadvantages, and important contextual factors that shaped the viability and acceptability of these practices.

Biodiversity

The impact on biodiversity was raised in just under a third of the SWOT analyses, generally in terms of improving subsoil and above ground biodiversity. It was suggested that rotational grazing could negatively affect the movements of ground-nesting birds by enclosing them in grazing cells and integrating specific forages for the environment could inadvertently create a monocrop without coordination with neighbouring farms. Overall, however, discussions of biodiversity impacts focused upon anticipated gains rather than losses. Several discussions also linked improving farm biodiversity to economic gains, such as the ability to draw on grants and schemes, or as an added benefit of reduced expenditure on de-worming treatments, fertilisers and pesticides.

Adequate support

The need for adequate support in order to implement new practices was frequently raised within SWOT analyses. In 44% of SWOT analyses, financial support and incentives were mentioned as opportunities for farmers; lack of funding was given as a threat. However adequate support involves more than the allocation of funds: 59% of analyses described support in terms of access to expertise, advice, and education. Workshop participants described the *“patchy”* availability of expert advice, the importance of impartial advisors, and the vulnerability of available information to political pressures and policy changes, with which they struggle to keep up. They highlighted that educating and upskilling the broad range of farmers and agricultural workers was necessary due to difficulties finding contractors with specific knowledge of the practices discussed. Others noted a *“cultural resistance”* among some farmers who pursued traditional markers of success, such as high livestock weights, over the efficiencies needed to reduce wasted resources in farming systems. SWOT analyses repeatedly mentioned the significance of farmer-to-farmer peer support which, as well as increasing knowledge and application of more sustainable farming practices, also generates important opportunities to socialise and overcome some of the known health-related challenges of farming, such as loneliness and poor mental health.

Role of public perceptions

44% of SWOT analyses referred to the potential impact of a practice on public perceptions of farming. Farmers foresaw practices including agroforestry, increased hedgerow planting, grass-legume mixtures and multispecies swards, slurry acidification and methane-powered farm vehicles as potentially beneficial to the public image of UK agriculture by enhancing biodiversity, improving animal welfare, or reducing pollution and emissions. Other practices were expected to face public opposition, such as the use of CH_4 inhibitors, specialised feed ingredients and additives, and improving fertility performance through selective culling of infertile livestock to rapidly improve the genetic pool. The anticipated public relations impact of improving animal health through enhanced monitoring was more complex, as farmers believed the public would generally support reduced use of antibiotics but baulk at internal health monitoring devices such as cattle boluses.

Limitations

It is evident that some practices, particularly those that were popular or controversial, generated more detailed SWOT analyses than others. Although efforts were made to match the practices with breakout groups with relevant knowledge and experience of specific livestock systems, this was not always possible, resulting in SWOT analyses with limited detail. Some breakout groups contained fewer farmers than others and may have had less understanding of the practicalities of these practices. Further, there was a lack of clarity around the definitions of some participant-suggested practices and their anticipated contributions towards achieving net-zero targets, which posed a challenge for some breakout groups.

Appendix K: Perceived ease of implementation of shortlisted livestock and grassland management practices

Though a given livestock or grassland management practice may make a significant contribution to reaching net zero targets, pressures on farmers and farming communities (as discussed in Section 3.7) mean that the *ease* with which a practice can be implemented is an important consideration. 'Ease of implementation' was a subjective judgement made by workshop participants following discussion within their breakout groups but was based upon their knowledge and perception of the costs of implementing a new practice, its suitability for different farming contexts, the need for specialist knowledge, equipment or labour, or the need for significant alterations of farm systems. Although researchers largely distributed the practices between groups according to participants' specialisms, the stipulation of assessing the implementation of practices 'at the farm level' was challenging in some instances where participants' own farming systems were not compatible with a practice assigned to them, e.g. where sheep farmers were tasked with assess the ease of implementing slurry acidification. As such, there was no clear consensus about the perceived level of ease of implementation of the shortlisted practices (see Table K1).

Table K1. Summary of perceived ease of implementation of shortlisted livestock and grassland management practices. Breakout groups were asked to determine whether they believed shortlisted practices were likely to be 'easy', 'medium' or 'hard' to implement at the farm level. '-' indicates that a practice was not shortlisted in the corresponding workshop.

Practice	Newcastle	Birmingham	Cookstown
Grass-legume mixtures and multispecies swards	Medium	Easy	Medium/Hard
Rotational grazing	Medium	-	-
Improve forage quality	Medium	-	Medium
Integrating specific forages for the environment	-	-	-
Better soil health practices *(e.g. maintaining optimal pH for plant growth)*	Medium	-	No response given
Increasing soil organic matter	-	Easy	-
Regenerative farming practices	-	Easy	-
Nutrient management planning	Easy	-	-
Winter cover crops / reduction in bare soil over the winter	-	Easy	-
Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early calf and lamb growth/survival, milk production, replacement rate)*	Hard	Easy	-
Improved animal health	Easy	Hard	-
Nutrient dense produce	-	Easy	-

Greater awareness of genetic improvements and greater uptake of higher-performance breeds	-	-	Easy
Feed CH_4 inhibitors *(e.g. 3NOP, nitrate, seaweed compounds)*	-	-	Easy
Increase liveweight efficiency *(e.g. not overdeveloping animals for market)*	-	-	No response given
Improved fertility performance *(e.g. sensors to measure tail-raising)*	Easy	-	-
Specialised feed ingredients and additives *(e.g. Agolin Ruminant, Mootral, SarStart, Rumalator, Digestarom, LChance, various plant oils)*	-	-	-
Farm specific system assessment and advice / Good on-the-ground independent advice (merged category due to similarity)	-	-	No response given
Improving training for farmers and advisors in GHG mitigation	Hard	Medium	-
Site-specific GHG mitigation planning	Easy	-	-
Improved decision-making support (e.g. distributed ledgers, weather tracking, low-cost infrastructure, digital twinning)	Hard	-	-
Agroforestry/woodland grazing	Hard	Medium	-
Increased hedgerow planting	Medium	-	-
Improved animal health through enhanced disease and pest monitoring *(e.g. including automated heat detection systems, animal-mounted biometric sensors for recording feeding behaviours and mapping movement, digital pathology to predict incidence of disease)*	-	-	Easy
Manure separation (separating solids and liquids)	-	-	Medium
Capturing emissions from livestock buildings	-	Hard	-
Precision feeding and feed intake analysis *(e.g. with animal-mounted sensors)*	Medium	-	-
Methane-powered farm vehicles	-	Medium	-
Slurry acidification	-	-	-
Genetic improvement in direct feed efficiency (for beef)	-	-	Hard
First mating of ewes as lambs rather than yearlings	-	Easy	-
Genetic improvement (sheep)	Hard	-	-

Appendix L: Perceived potential of shortlisted grassland and livestock practices to reduce net emissions

After conducting a SWOT analysis, breakout groups were asked to state whether they perceived their practice as having low, medium, or high potential to reduce net emissions from UK agriculture. This was a subjective judgement made on the basis of their group discussion, and taking into account both the efficacy of a practice in reducing net emissions *and* the likelihood of widespread uptake. The practices that were perceived as having high potential to reduce net emissions are given in Table L1 below.

Table L1. Practices perceived by workshop participants as having high potential to reduce net emissions from UK agriculture, by breakout group. (n.b. This activity was not included in the Northern Ireland workshop).

Workshop			
England/Scotland	Group A	• Genetic improvement (sheep) • Improved fertility performance *(e.g. sensors to measure tail-raising)* • Improved animal health • Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate)*
	Group B	• Better soil health practices *(e.g. maintaining optimal pH for plant growth)* • Rotational grazing • Grass-legume mixes and multispecies swards • Increased hedgerow planting • Improved fertility performance *(e.g. sensors to measure tail-raising)* • Nutrient management planning • Precision feeding and feed intake analysis
	Group C	• Agroforestry/woodland grazing • Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate)* • Nutrient management planning • Rotational grazing • Improved forage quality • Site specific GHG mitigation and planning • Genetic improvement (sheep)

England/Wales	**Group A**	• Capturing emissions from livestock buildings • Agroforestry and woodland grazing
	Group B	• Improving training of farmers and advisors in GHG mitigation practices • Regenerative farming practices • Grass-legume mixes and multispecies swards • Increasing soil organic matter • Integrating specific forages for the environment • Winter cover crops/reduction in bare soil over the winter • Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate)* • Improved animal health • Methane-powered farm vehicles • Capturing emissions from livestock buildings
	Group C	• Methane powered farm vehicles • Increasing soil organic matter • Regenerative farming practices • Improving training for farmers and advisors in GHG mitigation practices • Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate)*

Table L1 presents the 20 practices that were regarded by at least one breakout group as having high potential to reduce net emissions (hereafter 'high-potential practices'). However, identifying consensus between the breakout groups was more challenging. Genetic improvement in female productivity was perceived as a high-potential practice by four breakout groups, indicating a broader consensus around its potential for reducing net emissions than any other practice considered in this activity. In comparison, seven of the 20 practices did not appear in the list more than once, having been regarded as high-potential practices by only one breakout group each. This indicates that there was less consensus between workshop participants as to the potential of these practices to reduce net emissions. The seven practices were better soil health practices (e.g. maintaining optimal pH for plant growth), increased hedgerow planting, precision feeding and feed intake analysis, improved forage quality, site-specific greenhouse gas mitigation and planning, integrating specific forages for the environment, and planting winter cover crops/reducing bare soil over the winter. In contrast, 13 of the 20 practices were perceived by two or more breakout groups as having high potential to reduce net emissions from UK agriculture, as indicated in Table L2.

Table L2. Practices perceived by two or more breakout groups as having high potential to reduce net emissions from UK agriculture.

Practices	**Forage related**	• Rotational grazing • Grass-legume mixes and multispecies swards
	Livestock related	• Genetic improvement (sheep) • Improved fertility performance *(e.g. sensors to measure tail-raising)* • Improved animal health • Genetic improvement in female productivity *(e.g. fertility, lower mature weight, health, longevity, early lamb and calf growth/survival, milk production, replacement rate)*
	Manure/Fertiliser related	• Nutrient management planning
	Training and decision-making support	• Improving training of farmers and advisors in GHG mitigation practices
	Soil management	• Increasing soil organic matter • Regenerative farming practices
	Livestock housing	• Capturing emissions from livestock buildings
	Agri-tech	• Methane-powered farm vehicles
	Carbon capture planting	• Agroforestry/woodland grazing

Appendix M: Ranking livestock and grassland management practices

Table M1. Top three practices perceived by workshop breakout groups as having the most potential to reduce net emissions. Practices given in bold were ranked in the top 3 by two or more breakout groups.

	Newcastle			Birmingham		
Ranked position	Group A	Group B	Group C	Group A	Group B	Group C
1st	Genetic improvement (sheep)	Better soil health practices	**Agroforestry/ woodland grazing**	Capturing emissions from livestock buildings	**Improving training of farmers and advisors in GHG mitigation practices**	Did not complete ranking activity
2nd	Improved fertility performance *(e.g. sensors to measure tail-raising)*	Rotational grazing	Genetic improvement in female productivity	**Agroforestry and woodland grazing**	Regenerative farming practices	
3rd	Improved animal health	**Grass-legume mixtures and multispecies swards**	Nutrient management planning	**Improving training of farmers and advisors in GHG mitigation practices**	**Grass-legume mixtures and multispecies swards**	

In this activity, breakout groups in Newcastle and Birmingham ranked their shortlist of 15 practices from those with the highest potential to reduce net emissions to those with the lowest. None of the breakout groups agreed on the practice with the most potential to reduce net emissions. **Genetic improvement of sheep, better soil health practices, agroforestry and woodland grazing, training for farmers and advisors in GHG emissions** and **capturing emissions from livestock buildings** were all ranked highest by their respective breakout groups. One breakout group in the Birmingham workshop ran out of time and did not complete the ranking task. This activity was not offered in the Cookstown workshop. To determine whether there was any consensus between breakout groups, the top three practices from each breakout group are presented in Table L1. It indicates that three practices – improving training of farmers and advisors in GHG mitigation practices, agroforestry and woodland grazing, and grass-legume mixtures and multispecies swards – were ranked in the top three of most effective practices by more than one breakout group. While improving training of farmers and advisors in greenhouse gas mitigation practices received support from two breakout groups in Birmingham, the latter two practices were ranked highly in both workshops, suggesting that they were deemed applicable by workshop participants in several devolved UK nations.

Appendix N: Perceived 'easy wins'

Workshop participants identified five practices that they perceived as being both easy to implement at the farm level *and* having high potential to reduce net emissions. These practices, which we describe as potential 'easy wins' for farmers, were:

- Improved fertility performance *(e.g. sensors to measure tail-raising)*
- Nutrient management planning
- Increasing soil organic matter
- Regenerative farming practices
- Integrating specific forages for the environment

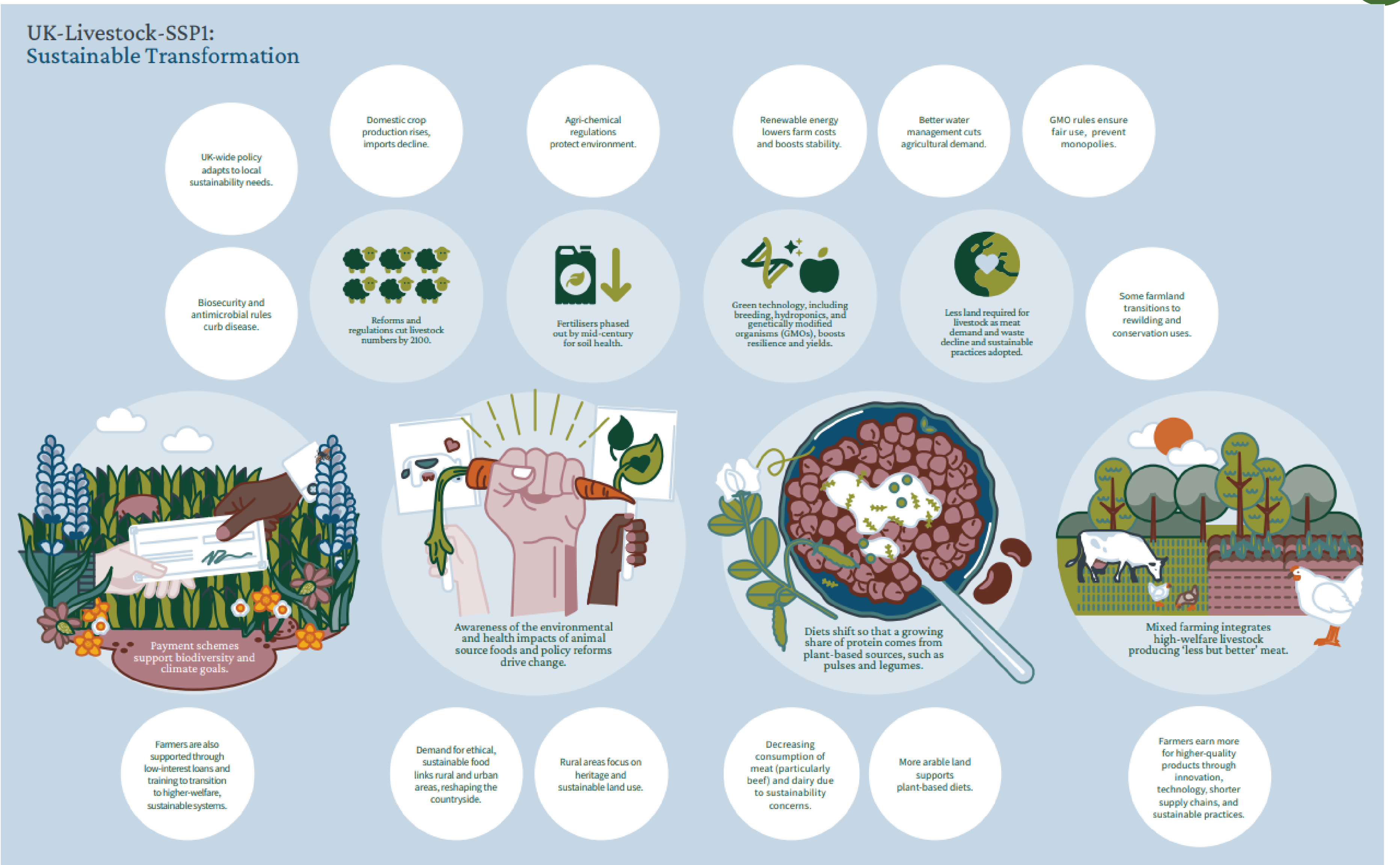
Of these 'easy win' practices, two (nutrient management planning and regenerative farming practices) were suggested by workshop participants during Activity 1. These practices were regarded as helping to reduce net emissions in a range of ways, including increasing efficiencies in livestock systems, reducing imports of soil additives, and increasing both the productivity of grasslands as a food source for livestock and their capacity to store carbon in soils and vegetation. 'Regenerative farming practices' presents some challenges to this analysis as it duplicates, or is an umbrella term encompassing, many practices that were shortlisted by workshop participants, including planting winter cover crops, agroforestry and woodland grazing, rotational grazing, better soil health practices and planting multispecies swards.

There was some overlap between these perceived 'easy wins' and the soil and livestock mitigation measures identified in the Seventh Carbon Budget (Climate Change Committee 2025a; Eory *et al.,* 2025). Nutrient management planning (or 'reducing excess nitrogen fertilisation' as it is described by Eory and colleagues) is a key measure recommended by the Seventh Carbon Budget. Increasing soil organic matter is not explicitly included as a key measure by Eory and colleagues but is related to their mitigation measure 'optimal soil pH' as pH generally influences soil carbon content. As mentioned, 'regenerative farming practices' encompasses a swathe of practices, including at least three key mitigation measures related to improving soil health, including reducing soil compaction, optimising soil pH and planting cover crops (Eory *et al.*, 2025a).

Appendix O: Assessing pathways to possible future scenarios through livestock and grassland practices

Activity four was undertaken in the Birmingham and Newcastle workshops only and built on the practices and considerations explored in the previous activities. This activity had several purposes. Participants were encouraged to consider possible futures for the livestock sector, reflecting on how different these futures might be and which practices shortlisted earlier in their workshop would be most appropriate in each context. Additionally, from a research perspective, we were interested in identifying whether any practices were regarded by farmers as useful across all Shared Socio-economic Pathway (SSP) futures.

Working in groups, participants drew on three of the Shared Socio-economic Pathways for UK livestock systems (UK-Livestock-SSPs): Sustainable Transformation (SSP1), Inequality (SSP4), and Fossil-Fuelled Development (SSP5). These scenarios provided contrasting examples of possible futures and were used to prompt discussion. Groups were asked to identify a suite of livestock and grassland practices that were acceptable through consensus building, and that could meet emissions reduction targets within the constraints of their assigned scenario. During the discussions, each group was also asked to consider whether any practices from the original list should be reintroduced, to reflect on biodiversity impacts, and to note any differences across the devolved nations. The findings are presented in the order of Sustainable Transformation (SSP1), Inequality (SSP4), and Fossil-Fuelled Development (SSP5), followed by a brief commentary.



This research is part of the TRAnsforming the DEbate about livestock systems transformation (TRADE) project, funded under UKRI grant number BB/W018152/1.

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Figure O1. Summary infographic of UK-Livestock-SSP1: the 'Sustainable Transformation' future scenario (Blair et al.*, 2025, pre-print).*

UK-Livestock-SSP1 - Sustainable Transformation: Summary and priority practices

Future Scenario Overview

"By 2100, the UK's agricultural and livestock systems have transformed into sustainable, resilient, and equitable models driven by societal and policy shifts. Increased awareness of the environmental and health impacts of meat consumption, alongside climate challenges, has reduced livestock numbers significantly and prioritised high-welfare mixed farming systems. Governance reforms and payment-for-public-good schemes incentivise biodiversity enhancement, soil health, and water conservation. Advances in green technologies and precision farming improve productivity and resilience while reducing reliance on artificial fertilisers and agrochemicals. Declining consumption of meat (particularly beef) and shifts towards plant-based alternatives and cultured meat in diets reduce land use, enabling rewilding, forestry, and horticulture to flourish, restoring ecosystems and enhancing food security. Localised supply chains, cooperative markets, and reduced supermarket dominance ensure fair pricing for farmers. Collaborative efforts across sectors establish a circular economy with minimal waste and efficient resource use. These changes contribute to healthier diets, reduced NHS pressures, and equitable access to food, achieving the UK's climate goals and securing a sustainable future." (Blair *et al.*, 2025 (pre-print))

England/Scotland workshop:

Table O1. Suite of practices selected by the breakout group in Newcastle as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlined in the Future Scenario Overview. These practices are arranged in columns based on their perceived potential to reduce net emissions.

Perceived potential to reduce net emissions		
Low potential	Medium potential	High potential
Winter cover crops/reduction in bare soil	Grass legume mixtures and multispecies swards	Improved training for farmers and advisors in GHG mitigation practices
Specialised feed ingredients/additives Improved decision-making support	Grass-legume mixes and multispecies swards Improved animal health	Improved animal health
	Better soil health practices	
	Nutrient management planning	

England/Wales workshop:

Table O2. Suite of practices selected by the breakout group in Birmingham as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlined in the Future Scenario Overview. These practices are arranged in columns based on their perceived potential to reduce net emissions.

Perceived potential to reduce net emissions		
Low potential	Medium potential	High potential
Winter cover crops/reduction in bare soil	Grass-legume mixtures and multispecies swards	Improved training for farmers and advisors in GHG mitigation practices
Specialised feed ingredients/additives	Improved animal health	

UK-Livestock-SSP1 - Sustainable Transformation: Supporting and explanatory comments

Breakout group comments, England/Scotland workshop

Regarding the group's choice of practices:

- Improving animal health is most important due to its implications for animal welfare and supply chains.
- In a future scenario where artificial fertilisers may be less available to farmers, practices that improve soil health – including planting more diverse swards – should be prioritised. The latter also supports biodiversity.
- We need practices that are best supported by the data.

Regarding the potential future scenario:

- Increasing the productivity and efficiency of upland sheep farming systems is challenging as sheep are harder to monitor outdoors.
- How can we bring about behaviour change? How can we incentivise people to come into farming when *"it is not an easy job"* and people *"need to have a work-life balance"*? How can we increase diversity in farming?
- The system which educates the next generation of farmers and connects them with the industry *"feels broken in the UK"* compared with those overseas, e.g. in Canada.

Breakout group comments, England/Wales workshop

Regarding the group's choice of practices:

- Participants believed that practices to improve soil health would best support farming under this scenario.
- The group was unsure whether these practices would be enough to reach net-zero.
- Participants did not want agroforestry included in this suite of practices due to concerns it would be *"jumped upon [by policymakers]"* to meet carbon capture and biodiversity goals. After discussion, the group selected 'improved animal health' instead.

Regarding the potential future scenario:

- Concern around where the increase in arable land for plant-based alternatives would come from – would it be *"taken from livestock",* or would arable and livestock systems become more integrated?
- Concern around farmers' autonomy and the level of government control within this scenario: *"is education a key factor, or will this be forced?"*
- Concern around public perceptions of reduced red meat production and potentially increased prices: *"When people have money, they eat livestock-based products."*
- This future scenario is provocative for farmers – *"[It is] not an enthusiastic view for our livelihoods."*
- Concern that farmers are not prepared for a potentially increased burden of insect pests (e.g. mosquitos) in the UK as a result of climate change.
- Training critical thinkers was identified as a key consideration in this scenario.

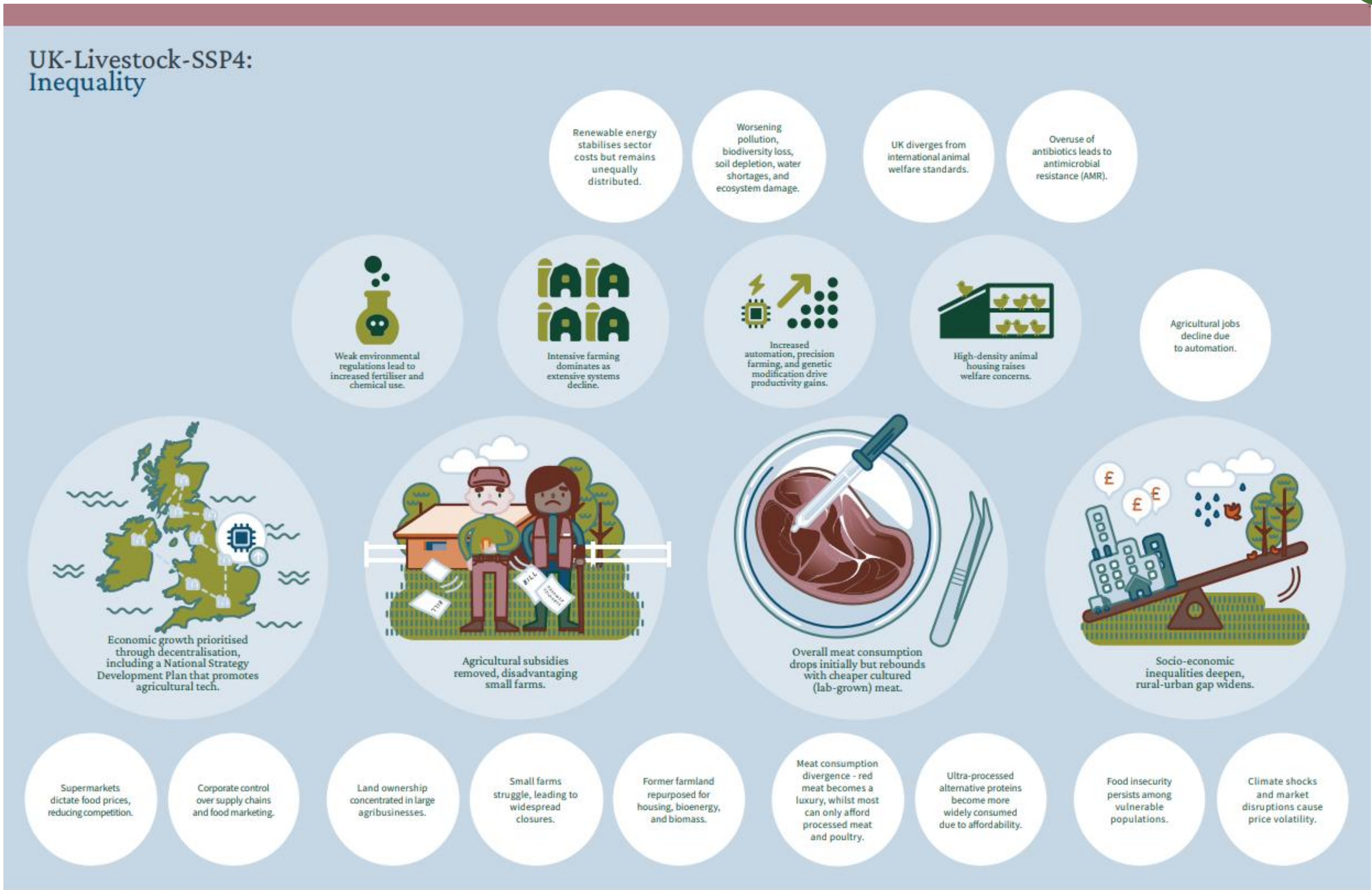

Figure O2. Summary infographic of UK-Livestock-SSP4: the 'Inequality' future scenario (Blair et al., *2025, pre-print).*

UK-Livestock-SSP4 - Inequality: Summary and priority practices

Future Scenario Overview

"The UK's focus on economic growth through decentralisation fosters technological innovation in agriculture and livestock but exacerbates inequality. The National Strategy Development Plan supports automation, genetic advancements, and green energy in farming, leading to greater economic growth but also concentrating land ownership in the hands of a few large agribusinesses. As industrialised farming expands, small, family-owned farms are displaced by larger operations that prioritise high-tech, high-efficiency systems such as precision farming and genetic modifications. While these advances initially boost productivity, they unintentionally lead to environmental degradation and animal welfare concerns. The removal of agricultural subsidies further pressures smaller farms, which struggle to compete. Meanwhile, intensified livestock production leads to soil depletion, water contamination, and biodiversity loss. Carbon emissions from large-scale livestock operations rise, undermining climate targets despite efficiency gains. High-density animal housing and overuse of antibiotics and growth hormones raise animal welfare and public health concerns, including antimicrobial resistance (AMR). The result is a growing divide between large agribusinesses and small farms, deepening social and economic inequalities, and exacerbating environmental degradation." (Blair *et al.*, 2025 (pre-print))

England/Scotland workshop:

Table O3. Suite of practices selected by the breakout group in Newcastle as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlined in the Future Scenario Overview. Only practices perceived as having medium and high potential to reduce net emissions were selected by this group.

Perceived potential to reduce net emissions	
Medium potential	High potential
Improved animal health	Nutrient management planning
Better soil health practices	Genetic improvement in female productivity
Precision feeding and feed intake analysis	
Genetic improvement in sheep	

England/Wales workshop:

Table O4. Suite of practices selected by the breakout group in Birmingham as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlines in the Future Scenario Overview. These practices are arranged in columns based on their perceived potential to reduce net emissions.

Perceived potential to reduce net emissions		
Low potential	Medium potential	High potential
Methane-powered farm vehicles	Slurry acidification	Capturing emissions from livestock buildings
Specialised feed ingredients/additives		
Improved animal health		

UK-Livestock-SSP4 - Inequality: Supporting and explanatory comments

Breakout group comments, England/Scotland workshop

Additional comments regarding the breakout group's choice of practices:

- Concern about what would happen to upland land management, on the basis that under-grazing would cause detrimental changes to grasslands.

Additional comments regarding the potential future scenario:

- Concern that this scenario would likely cause civil unrest: *"We're not currently far off this future already."*
- Farming in this future would need to be supported with large subsidies
- There would be shocks to the system and price increases, and food would be a market good rather than a public good.
- Participants felt strongly that a food system in any future should not just be about food, but about communities, landscapes, and maintaining livelihoods.

Breakout group comments, England/Wales workshop

Additional comments regarding the breakout group's choice of practices:

- Participants said they had to think about the wider UK national context when choosing practices, rather than focusing on their specific experience as upland farmers in Wales. They therefore felt they had to choose practices that would work for the scenario overall, rather than due to their personal preferences.

Additional comments regarding the potential future scenario:

- Participants suggested that subsistence farming would be best for them in this scenario.

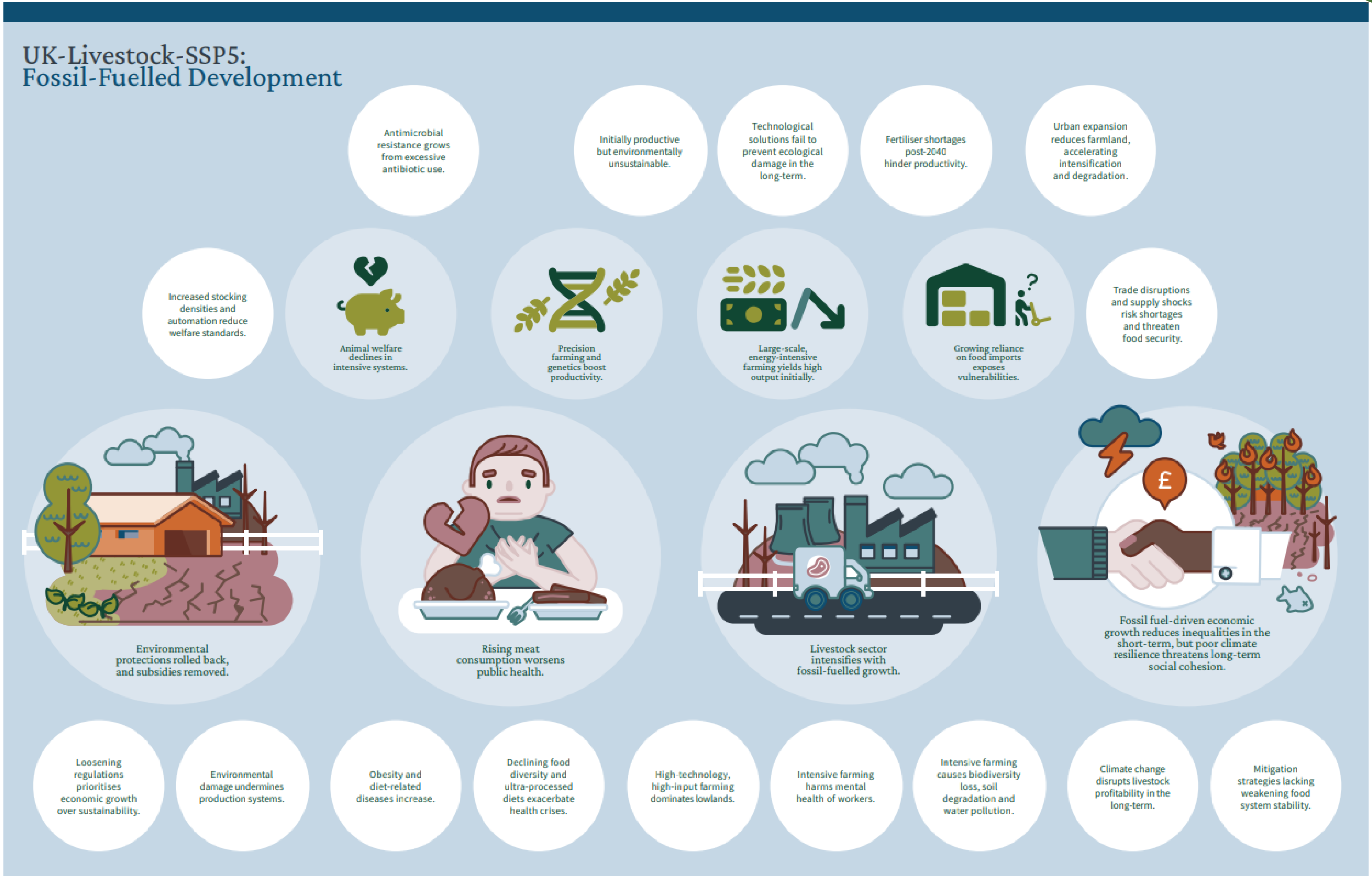

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Figure O3. Summary infographic of UK-Livestock-SSP5: the 'Fossil-Fuelled Development' future scenario (Blair et al.*, 2025, pre-print).*

UK-Livestock-SSP5 - Fossil-Fuelled Development: Summary and priority practices

Future Scenario Overview

"The UK's livestock sector undergoes rapid intensification, driven by fossil-fuelled economic growth based on cheap domestic energy, and technological advancements. High-input, technology-driven agriculture dominates, particularly in lowland areas, while environmental protections are rolled back, and agri-environmental schemes are removed. Initially, large-scale, energy-intensive livestock achieves high yields, but environmental degradation eventually causes production systems to fail, exacerbated by declining fertiliser availability post-2040. The intensive systems also come at significant environmental costs, including severe biodiversity loss, soil degradation, increased water demand, and worsening animal welfare standards. Although technological solutions attempt to mitigate environmental damage, they fall short in preventing widespread ecological decline, while poor climate resilience exacerbates vulnerabilities in the food system. Urban expansion results in the loss of agricultural land, pushing livestock production into restricted areas. The UK becomes increasingly reliant on food imports, leaving it vulnerable to global supply shocks. Rising meat consumption contributes to worsening public health outcomes, including diet-related diseases and the rapid spread of antimicrobial resistance (AMR) due to excessive antibiotic use." (Blair *et al.*, 2025 (pre-print))

England/Scotland workshop:

Table O5. Suite of practices selected by the breakout group in Newcastle as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlined in the Future Scenario Overview. Only practices perceived as having high potential to reduce net emissions were selected by this group.

Perceived potential to reduce net emissions
High potential
Grass-legume mixtures and multispecies swards
Rotational grazing
Better soil health practices (e.g. maintaining optimal pH for plant growth)
Increased hedgerow planting

England/Wales workshop:

Table O6. Suite of practices selected by the breakout group in Birmingham as the preferred pathway to meeting UK agriculture's net zero targets in light of the possible circumstances outlined in the Future Scenario Overview. Only practices perceived as having low and high potential to reduce net emissions were selected by this group.

Perceived potential to reduce net emissions	
Low potential	High potential
Specialised feed ingredients/additives	Improved training for farmers and advisors in GHG mitigation practices
	Regenerative farming practices
	Genetic improvement of female productivity
	Capturing emissions from livestock buildings

UK-Livestock-SSP5 - Fossil-Fuelled Development: Supporting and explanatory comments

Breakout group comments, England/Scotland workshop

Additional comments regarding the breakout group's choice of practices:

- Improved grazing practices have multiple benefits for soils, biodiversity, animal welfare and productivity. Rebuilding soil health was perceived as a foundation for resilience and recovery.
- Participants were concerned that practices like hedgerow planting may be technically easy to achieve, but may carry hidden long-term costs or depend upon landowners' consent.
- One participant suggested combining hedgerows with other forms of food production and carbon capture planting: *"I'd want to put a fruit tree [in the hedge] every 50 metres […] trees are what you give to the next generation."*

Additional comments regarding the potential future scenario:

- Some participants disagreed that high red meat consumption would be a public health issue and instead raised ultra-processed food as growing problem.
- Participants talked about reconnecting people with locally-produced food within future-focused food systems, eating seasonally and making informed choices about food.
- Participants described generational differences as a barrier, perceiving younger farmers are more open to change, but still influenced by older peers and their norms.
- The success of some practices is conditional upon establishing optimal soil health.

Breakout group comments, England/Wales workshop

Additional comments regarding the breakout group's choice of practices:

- The group had discussed methane-powered farm vehicles but questioned whether they would be adopted widely in a future where fossil fuels would be cheap.
- The group suggested that critical thinking should form part of improved training for farmers and advisors in GHG mitigation practices, and that farmers need training and tools to adopt the latest techniques. However, they added that it is hard to stay up to date in a rapidly changing world.
- Participants were not in agreement on the importance of animal health. One suggested that animal health problems can be addressed via genetics as you *"can't breed from unhealthy stock"*. However, another argued that animal health *"has a place but [is] not overly important"*.
- Improving livestock genetics cannot compensate for poor land or poor management, *"but will help a bit in all environments"*.
- Feed additives were selected on the basis of *"mak[ing] your farm more efficient"*.
- The group struggled to prioritise some practices over others as there were *"so many useful things"* available to them.
- Several practices could be amalgamated under the umbrella of 'regenerative farming practices'

Additional comments regarding the potential future scenario:

- Some participants did not agree that high meat consumption affects public health and instead pointed to ultra-processed foods. They also disagreed that animal welfare would be worsened within intensive systems.
- The group questioned whether the UK's climate targets are enforceable: *"Who will hold us to account if we don't meet net zero by 2050?"*
- Overall the group expressed horror at the prospect of this future scenario.

Activity 4 summary

This commentary focuses on the practices perceived as having high potential to reduce net emissions across different possible futures.
For the Sustainable Transformation scenario (SSP1), the practices seen as having high potential were *improved animal health* and *enhanced training for farmers and advisors in GHG mitigation practices*. Under the Inequality scenario (SSP4), the practices with high potential to reduce emissions included *nutrient management planning*, *genetic improvement in female productivity*, and *capturing emissions from livestock buildings*. In the Fossil-Fuelled Development scenario (SSP5), a broader set of practices was identified as having high potential to reduce net emissions: *grass-legume mixtures and multispecies swards*, *rotational grazing, better soil health practices (e.g., maintaining optimal pH for plant growth), increased hedgerow planting, improved training for farmers and advisors in GHG mitigation practices, regenerative farming practices, genetic improvement of female productivity,* and capturing emissions from livestock buildings.

Examining these practices across all scenarios, certain patterns emerge. Practices clustered around soil management - *including better soil health practices, rotational grazing*, *nutrient management planning* and *regenerative farming;* animal-related measures, such *as genetic improvement of female productivity* and *improved animal health*; and forage management, including *grass-legume mixtures and multispecies swards,* and *regenerative farming*. Other practice categories were represented as follows: housing (*capturing emissions from livestock buildings*), training/decision support (*improved training for farmers and advisors*), carbon capture planting (*increased hedgerow planting*).

When asked to consider biodiversity, participants' responses varied across the scenarios. In SSP1, practices that improve soil health, including planting more diverse swards, were seen as most supportive for farming under this scenario, while also benefiting biodiversity. Participants were uncertain whether these measures alone would be sufficient to achieve net-zero. Agroforestry was not included in this suite of practices due to concerns that it could be used by policymakers to meet carbon capture and biodiversity goals against farmers' wishes, following the Welsh Government's controversial (and since amended) plans to designate 10% of farmland for tree planting in 2024. Under SSP4, participants expressed concern about upland land management, noting that under-grazing could lead to detrimental changes in grasslands. They emphasized that a future food system should not focus solely on food production, but also support communities, landscapes, and livelihoods. In SSP5, improved grazing practices were recognized for their multiple benefits, including supporting soil health, biodiversity, animal welfare, and productivity, with rebuilding soil health seen as foundational for resilience and recovery. Participants noted that practices such as hedgerow planting, while technically feasible, may carry hidden long-term costs or depend on landowners' consent. The limited ability to take up farming practices that have long-term implications for land use (e.g. planting trees and hedges) affects a significant proportion of farmers: 32% of our survey respondents are tenant farmers (see Appendix C, Table C2). In England, 45% of farms and wholly or partly tenanted (DEFRA, 2025). They suggested combining hedgerows with other forms of food production and carbon capture planting. The success of some practices was considered conditional on establishing optimal soil health. Improving livestock genetics was seen as beneficial across environments but insufficient to compensate for poor land or management. Several practices could also be integrated under the broader concept of regenerative farming practices.

Regarding differences across the devolved nations, the variation in prioritised practices perceived as most effective for reducing emissions in each SSP during the workshops is striking. Interestingly, in the England-Wales workshop, participants considering SSP4 reported that they had to take the wider UK national context into account when choosing practices, rather than focusing solely on their personal experience as upland farmers in Wales. As a result, they felt compelled to select practices that would be suitable for the scenario overall, rather than based on personal preference. However, the practices chosen for SSP4 differed between the England-Wales and England-Scotland workshops, highlighting the diversity of farming practices that are necessary across different farming contexts in the UK.

None of the practices were selected across all three scenarios. However, three practices were considered applicable under two of the scenarios*: capturing emissions from livestock buildings* (SSP4 and SSP5), *genetic improvement in female productivity* (SSP4 and SSP5), and *improved training for farmers and advisors in GHG mitigation practices* (SSP1 and SSP5).

Appendix P: The Priority Practices Postcard

The **Priority Practices Postcard** was implemented in the Northern Ireland workshop only. It invited participants to list the top five practices which, in their opinion, were "most likely to reduce emissions, support biodiversity, and sustain profitable farming in Northern Ireland" following the completion of the SWOT analysis activity.

GRASSLANDS
LAND USE *for* NET ZERO

In your opinion, which **five** practices are most likely to reduce net emissions, support biodiversity and sustain profitable farming in Northern Ireland? Please make a few notes to explain your 'Top 5' using the space overleaf if needed.

1.

2.

3.

4.

5.

Which best describes your farm? (please circle): Hill Upland Lowland

Appendix Q: Charitable donations allocated on behalf of survey respondents

Supplementary Survey

We observed high drop-out rates in the Newcastle and Birmingham workshops, where registered participants later could not attend their workshop on the day due to conflicting responsibilities. To address this and include as many voices from farming communities as possible, a supplementary survey was distributed among our network of project partners in early February 2026. Ethical approval was obtained from UWE Bristol for the collection and storage of this data using Qualtrics survey software. The survey was open for seven weeks until late March. The survey was offered in English and in Welsh and was open to all farmers, farm workers, land managers and staff from organisations supporting UK farming as long as they were aged 18 years or over and resident in England, Scotland, Wales or Northern Ireland. In recognition of their time, survey respondents were offered to choose one of eight UK farming support charities to receive a £2 donation on their behalf from the LUNZ Grasslands project. Donations were paid to each charity in July 2026. Respondents voted to donate to the following charities:

Table Q1. Survey respondents' choice of charity to receive a £2 donation from the LUNZ Grasslands project.

Charity	Region covered	Frequency	Donation to be administered
Royal Agricultural Benevolent Institution (RABI)	England and Wales	36	£72
The Addington Fund	England and Wales	7	£14
The Royal Countryside Fund	UK wide	1	£2
Yellow Wellies (Farm Safety Foundation)	UK wide	18	£36
The DPJ Foundation	Wales	8	£16
Tir Dewi	Wales	3	£6
The Royal Scottish Agricultural Benevolent Fund (RSABI)	Scotland	9	£18
Rural Support	Northern Ireland	2	£4
Do not make a donation on my behalf	N/A	1	£2

Appendix R: Global Farm Metric Framework Wheel used in SWOT analysis discussions

Figure R1. Global Farm Metric Framework Wheel 2.0 (Sustainable Food Trust, 2025).

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