UKRI-BBSRC SAF-SAP MEETING – A NET ZERO AND BIODIVERSE AGRI-FOOD SYSTEM: HOW CAN RESEARCH AND INNOVATION HELP ACHIEVE NET ZERO?

MEETING: 18 November 2020

MEETING MINUTES: The minutes enclosed are a summary of the proceedings of the UKRI BBSRC Bioscience for Sustainable Agriculture and Food Strategic Advisory Panel (SAF-SAP) meeting to discuss and provide advice on the concept note for a research and innovation programme on a clean, sustainable, biodiverse and low carbon UK agri-food system. External experts and UKRI partner representatives were invited to join the SAF-SAP members at this meeting. The full list of attendees is provided in Annex 1.

AIMS OF MEETING
• To explore pathways that enable systemic step changes in the agri-food sector for achieving Net Zero emissions by 2050;
• To determine how UKRI might support this transition through Research and Innovation.
Executive Summary

The report describes the findings of a meeting to determine the research and innovation (R&I) needs and opportunities for ‘a sustainable, resilient, and biodiverse Net Zero UK agri-food system’. The meeting was held by UKRI-BBSRC and participants included the BBSRC Sustainable Agriculture and Food Strategic Advisory Panel (SAF-SAP), other UKRI partners, government departments and devolved administrations (Annex 1).

Participants were asked to discuss (1) the knowledge gaps and the R&I needs for making a step change in Green House Gas (GHG) reduction, mitigation, and adaptation; (2) the vision and scope for a potential programme; and (3) What a UKRI interdisciplinary Net zero Agri-food System Programme should look like? (Annex 2).

Participants reviewed the UK R&I landscape (Question 1, Annex 2) and identified some gaps that should be addressed, building on UK’s strengths and on the existing UKRI programmes:

i. Gaps in system thinking and systems level of working, both at the level of a wide systems perspective, and at the level of agri-food systems within the UK and globally. For example, linkages between crop, soil, landscape and biodiversity are not well established and there is a disconnect between in-lab and on-farm/field activities.

ii. Scientifically robust measurement and monitoring of GHG emissions and environmental performance across the whole supply-chain is still challenging.

iii. Insufficient knowledge of where soil-sequestered carbon is stored and how this can be accurately measured.

iv. Need for modelling that is properly adapted to changing situations, and that allows decision-making and prediction of the future impact for key sustainability targets.

v. Challenges with access to big and complete high-quality data sets required for unlocking a system thinking and the transition to a decarbonised agri-food system.

vi. Gaps in the understanding of emerging agricultural practices that integrate biological, environmental and social sciences to achieve sustainable production

vii. Gaps in knowledge of the cultural dynamics and in public understanding of food systems for proper management of changes in UK food production and consumption.

viii. Gaps in knowledge on information sharing mechanisms among farmers, to connect and scaleup piloted innovative solutions and maximise their impact.

ix. Need for a connected and sustained long-term significant investment to ensure critical data sets and knowledge are maintained and continued.

x. Missing link between research, policy and industry, to translate research output to tangible products and services, including decision support.

In discussing the Programme’s vision (Question 2, Annex 2), participants raised the need for sustainable strategies that go beyond Net Zero, and beyond 2050, with a focus on delivering a transformed and sustainable agri-food system through three broad strategic approaches:

i. A Systems approach that looks at the entire agri-food system and ecosystem services, as well consumer and producer behaviour changes; and requiring large and reliable data sets to develop digital technologies for effective monitoring.

ii. Placing Sustainability at the Centre with focus on reversing biodiversity decline, improving resilience, and achieving Net Zero alongside increased food production.

iii. Interdisciplinary approaches embedding co-design, bringing together all UKRI disciplines and other key actors covering the breadth of the programme’s vision.
In addition to the above strategic approaches, participants suggested that the programme could distinguish itself from other programmes in this area (Question 3, Annex 2) through:

i. **Impact–Driven Research** with translation of knowledge into measurable impacts, focusing on developing evidence-based strategies for delivering tangible outputs.

ii. **High risk investment for high reward** in the form of a new generation of system thinkers for transformative interventions requiring novel multifactorial combinations.

iii. **A mixed funding model** combining large grants that target long-term goals, with pump priming for short-term objectives; and involving multi-stakeholder funding.

iv. **A multi-Actor Community** built through networks and partnerships among researchers and users of research outputs, including international partnerships.

Participants at the meeting also identified three key areas for assessing the success of the programme in the short- medium- and long-term:

i. **Clean Growth** – achieving sustainable production alongside biodiversity recovery and reduced net carbon emissions

ii. **Knowledge Gaps** – acquiring more knowledge and understanding of UK agri-food systems

iii. **Impact** – uptake and translation of research outputs into tangible products, and community response through behaviour changes.
1. Opening and Introductions

The meeting opened with a brief introduction by the Chair, followed by a presentation from the BBSRC Bioscience for Sustainable Agriculture and Food team (SAF) to set the scene, share their strategic interests and introduce the agenda.

BBSRC gave a brief background on the development of this activity linking it to BBSRC’s strategic context and presented the questions to be discussed in the meeting (Annex 2). The proposed programme responds to BBSRC’s 2020/21 Delivery Plan Near Term Action to “Catalyse a coordinated approach to support research and innovation that delivers Net Zero emissions agriculture and future farming for climate change”; and it aligns with the strategic priorities of the other UKRI partners.

Responding to the UK legislation on Net Zero in June 2019, and UKRI’s recognition of the importance and urgency of achieving Net Zero in the agri-food sector, BBSRC and NERC drafted a think piece on Net Zero UK agriculture and consulted across UKRI and with external partners (academia, government departments, devolved administrations). This was followed by further engagement with other UKRI partners (EPSRC, ESRC, Innovate UK, STFC) to understand their strategic interest, and this led to a cross-UKRI group on Net Zero and agri-food. Many partners have contributed to the programme concept shared with meeting attendees as the main meeting paper.

This was followed by a presentation of four scenarios of the impact of climate change on future food systems by the Global Food Security Programme. Then UKRI partners were invited to present their perspectives in relation to the proposed programme followed by a plenary discussion where the following points were raised:

- There should be emphasis on adaptive regulations and guidance for users, for example on biocontrol solutions. A good regulatory framework needs to be embedded in the research.
- Other UKRI-funded research can make a big contribution to the Net Zero agri-food agenda and these need to be aligned for maximum benefits.
- Industry needs to shift from traditional corporate social responsibility, to real commitment / engagement in addressing real challenges.
- There should be a broader view of the pathway for combatting climate change, including a focus on policy instruments as a whole.
- The vision should not be limited to "sustainable agriculture solutions" but should cover sustainable food solutions as well.
- Issues of supply chain and clear transmission of appropriate market signals should be sufficiently integrated into the programme, with focus on high quality food and the end consumer. Integrating the supply chain and finance will broaden the scope beyond ‘farmer behaviour’ to include the whole system that enables change. Changes in supply chains can take several years so actions for change need to be communicated to supply chain actors in clear and tailored messages to enable effective transition.
- The role of UKRI national capabilities in supporting this programme should be considered, e.g. the NC-funded Crop Map of Great Britain produced using Sentinel satellite data every year since 2015 could provide useful context for the programme.
- It is difficult to separate adaptation and mitigation, and one should not be compromised in favour of the other.
- Productivity should be improved through more efficient use of resources, e.g. producing more food on the same or smaller amount, less water and energy consumption, and with reduced chemical (fertilizer and pesticide) inputs.
2. Breakout Session 1

The meeting participants were split into five breakout groups that met in two sessions, with each breakout group facilitated by a member of the SAF team. In the first breakout session two questions were discussed and the main points emerging from the discussions are summarised below:

Question 1: What are the knowledge gaps and the R&I needs for making a step change in GHG reduction, mitigation, and adaptation in agri-food?

a) The current UK R&I landscape

Participants mapped out the UK Research and Innovation landscape under 4 themes (Fig 1): (1) UKRI national programmes, (2) independent national initiatives, (3) government led and (4) international programmes with UK component, giving examples of types of programmes within these themes and recommending that any future programme should build on and connect to these if possible.

b) UK R&I gaps/challenges and opportunities

Participants discussed in five breakout groups, several research and innovation gaps and challenges that stand in the way of achieving a clean, sustainable and biodiverse UK agri-food system that would contribute to Net Zero carbon emissions by 2050, as listed below. Some of these may not necessarily be within the remit of UKRI.

1. Agri-food Systems Understanding

There are gaps in system thinking and systems level of working, both at the level of a wide systems perspective, and at the level of agri-food systems within the UK and globally. For example, there is limited food system understanding of crop improvement or of land use. Changes in land use are not linked to the life cycle analysis and sustainability models and impacts of individual interventions at a system scale are not well understood. Linkages between crop, soil, landscape and biodiversity are not well established and there is a disconnect between in-lab and on-farm/field activities.

There is a gap in the understanding of the link between biodiversity and Net Zero, and how to balance productive agriculture with biodiverse agriculture. There is no clarity on what other impacts may result from land management interventions that are intended to improve or maintain biodiversity. The trade-offs, synergies, and complementarities need to be better understood in order to be properly managed. Some interventions may have unintended consequences (e.g. wine lakes, butter mountains, removing hedgerows), so it is important to identify them early enough to inform and adapt policy change in-flight and avoid dramatic changes to systems.

GHG mitigation and adaptation tend to be handled separately and this comes with the risk of being locked-in on one objective to the detriment of the other. The two need to be addressed together. There is need for a coherent research framework for jointly delivering mitigation and adaptation, building on the synergies and complementarities, and balancing the trade-offs.

Emission reduction measures need to also look at the impacts from different perspectives and there should be more coherence and integration. For example, managing carbon emission from farmed animals is a huge challenge that affects sustainability of the sector if taken in isolation. Ruminants cannot be net-zero unless if they are part of a broader C cycle. We need to integrate and connect research and innovation capabilities from across disciplines and sectors to bring into agriculture.
Figure 1: UK’s Current Research and Innovation Landscape

**UKRI led National Programmes**
- Research Infrastructure: BBSRC Institutes; NERC Centres, STFC Facilities
- Core Programmes: Future of UK Treescapes; Landscape Decisions; GHG Removal; Valuing Nature; Biodiversity and Ecosystem Service Sustainability; Green Recovery Theme in COVID Programme.
- SPF – Transforming the food system
- ISCF - Transforming Food Production
- Global Food Security Programme
- Strength in Places

**Independent National Initiatives**
- UK Energy Research Centre
- Supergen Energy Hub
- Innovative Farmers Network
- Industry / Agritech (Coop Farm Networks)
- NFU Net Zero Target 2040
- CIEL
- Lancet report (Healthy diets …)

**International Programmes**
- GCRF
- Signals in the Soil (UK/US)
- EU Framework
- Germany’s International Climate Initiative
- Lighthouse Farm Network

**Governemnt Led programmes**
- BEIS Investments
- Defra R&D Programmes
- Welsh Government Programmes: Soil mapping; Agricultural Land Classification predictive map.
- Scottish Gov Programmes: Scottish Finance for Nature Accelerator; Good Food Nation policy; SEPA and Scottish Wildlife Trust’s Challenge Route map; Local Investment in Natural Capital, Agriculture Bill (Scotland)
2. **Measurement of GHG emissions**
   There are gaps in the understanding of how to measure and monitor GHG emissions and environmental performance across the whole supply-chain in a scientifically robust manner that enables economic and social costs to be properly estimated. An efficient carbon credit system relies on the ability to measure and manage emissions.

3. **Understanding Carbon sequestration in the soil and soil health**
   Soil carbon sequestration is not well understood. Soil is regarded as a carbon sink, but we don’t know where the carbon goes and we can’t measure it, so we can’t account for it in the Carbon (C) credits. We need a good understanding of how soil health influences sustainable production as well as soil carbon dynamics. For example, healthy soil means healthy crops and healthy ecosystem services (biodiversity). We still don’t fully understand the interactions between soil, microbes, crop, farmed animals and biodiversity and how these can be measured. We do not fully understand how to determine the amount of carbon a soil can sequester and how soil health is affected by different land use types and land management practices, in order to provide meaningful advice to farmers and other land users. Nitrogen flows in the agri-food system are also not well understood.

4. **Modelling**
   There is great work on different modelling systems across the UK, but the physical modelling needs to link better with the economic and market changes. We need integrated models that allow forward modelling of decision-making and prediction of the future impact for key sustainability targets. Modelling needs to be taken a step further and aim at delivering practical solutions. Life Cycle Assessment (LCA) tends to be excluded when modelling forward. The LCA tool sold short of what it can be used for. It should be used to identify hot spots of inefficiency. Existing models and approaches also need to be updated to adapt to changing situations. For example, stronger integration is needed between modelling and environmental (biodiversity) and agricultural outcomes (sustainable productivity).

5. **Data availability and access**
   Access to big and complete data sets of high quality is required for unlocking system thinking and the transition to a decarbonised agri-food system. Good data is necessary for understanding what is happening on the farm, but we need regulation on how to collect and share the data (legal and ethical issues).

   Data is needed for understanding the relationships between systems in order to develop a framework with well accepted metrics that are understood. Existing metrics are currently isolated in disconnected pockets. We need to understand where we want to be with metrics that have been accepted e.g. planetary boundaries.

   Access to private data can sometimes constrain public-private partnerships as it is often difficult to access due to lack of trust.

   Good quality (reliable) data at multiple layers needs to be transmitted to users to enable making informed policy and consumer choices. This programme can provide an opportunity to use GHG measurement as a pilot for transparent data collection, sharing and usage but research is needed to understand the data generated from scope 3 emissions (indirect emissions that occur in a company’s value chain) and what the next stage would be.

   There are opportunities to explore existing datasets for integrating robotics, autonomous systems, Artificial Intelligence, etc. with other disciplines to maximise value. There are also opportunities for synthesis of existing knowledge and tools.

6. **Understanding innovative sustainable production practices**
   There are major gaps in the knowledge and understanding of emerging agricultural practices that integrate biological, environmental and social sciences to achieve sustainable production. There are new agricultural production techniques such as agroforestry, agroecology, permaculture, mixed farming, commodity diversification, vertical farming, etc.;
but not enough knowledge on how these practices play out to ensure sustainable production, nor of the economic incentives that may be driving their adoption.

A better understanding of the energy fluxes in livestock nutrition is crucial for designing low carbon ruminant farming that is sustainably productive and economically profitable.

There is also insufficient knowledge on how to link modelling with a sustainable systems approach to influence policy. We need a strong flow from component science to models for evaluating policy interventions.

7. Embedding social science
There is a need to understand the cultural dynamics of food and the public understanding of food systems, as well as the impact of post-Brexit regulatory changes. This will be useful for determining how to influence change in the food system portfolio both in terms of what is produced and what is consumed, and what the impact of any such change may be. For example, what would be the impact on UK farm income, how will this affect the incentive for local food production, and what would be the implication for food sovereignty and international food trade?

8. Research & Innovation landscape
There are great foundations of investments and knowledge in the UK R&I agri-food landscape but achieving a clean biodiverse system will require significant investment possibly through a national capability funding model. The investments will need to be connected and sustained in the long term to ensure critical data sets and knowledge are maintained and continued. The UK has a strong research base across biological, environmental, technological, social and economic and disciplines. The formation of UKRI presents the opportunity to connect and integrate the research and innovation landscape to accelerate the transformation to a clean, biodiverse and sustainable low carbon agri-food system.

Although quick wins through applied research are desired for making short-term impacts, R&I funding should also target fundamental research to deliver longer term sustainable benefits which cannot be achieved in the short-term. The programme will therefore require a mixed model of funding to support both fundamental and applied research.

9. Knowledge Exchange
Innovative solutions have been developed, e.g. through demonstrator/pilot Net Zero farms, and there are situations where farmers are already adopting piloted alternative solutions, but these have remained isolated. These innovations need to be connected and scaled up but there is lack of knowledge on how information is formally or informally shared among farmers, and how this can be used for scaling up.

The UK’s strength in science communication can be used to harness interdisciplinary research and facilitate knowledge transfer from research to field application at farm scale, as well as share best practices among farmers.

10. Partnerships for impact
There is often a missing link between policy and practice to provide feedback on changes, as well as between academia and industry in producing research and translating the outputs into tangible products. Co-design and co-implementation involving private and public partners centred around the challenge is needed to create the transformation required in agri-food systems.

The UK impact agenda presents an opportunity to bring relevant actors into research, with far more integration of industry research needs than before. There is more collaborative research & development (R&D) as a result of the interface between academia and industry and there are opportunities for improving connectivity between the research base and users of research outputs. For example, through the courtauld 2025 commitment organisations across the food system and agri-food industry have undertaken to improve resource use
efficiency in the agri-food sector by reducing food waste, cutting carbon and protecting critical water resources. The courtauld platform provides a unique environment for building participatory research and innovation programmes through co-design. This is further strengthened by the incentive provided through the new system introduced in the Agriculture bill for payment of subsidies. This encourages farmers and land managers to adopt innovative practices for more sustainable production systems.

Stronger stakeholder engagement is required at all levels, including devolved administrations and local governments. UKRI has a role in ensuring inclusiveness and appropriate consultation in joining up activities of the various players in the UK R&I landscape. Interdisciplinary research is required on how to work across the systems. At the same time there is a need to break down interdisciplinary partnership barriers arising from differences in the meaning of some terminology, e.g. the meaning of sustainability, resilience, etc. We need to have a common understanding of the challenge and the solution and avoid jargon/discipline-specific terminology that may be confusing among stakeholders.

Research and innovation needs to go beyond what works for the UK and include learning from what has worked in other countries. At the same time, the UK needs to continue showing global leadership by working with other countries to influence change at a global scale. International collaboration in research and innovation in sustainable agriculture and food has been increasing and this needs to continue (e.g. GCRF, NEWTON, FIC etc).

Question 2: What is the vision for this programme?

a) Vision of the Programme

A draft vision was shared with the participants to aid discussions:

*For the UK agri-food system to transition and achieve Net Zero emissions by 2050 through sustainable agriculture solutions that are environmentally, economically and socially beneficial for future generations*

Several suggestions were made in terms of what should be reflected in the vision statement, leading to the following rewording:

*For research and innovation to support transformation of the agri-food system through sustainable strategies / trajectories that are environmentally, economically and socially beneficial for future generations, and lead to a decarbonised agri-food system by 2050*

b) Scope of programme and key themes to deliver the vision.

There was consensus to keep the scope of the programme broad enough to cover the entire agri-food system. Three broad strategic approaches were recommended for implementation of the programme:

1. **Systems approach**
   The vision needs to be expanded to cover the entire agri-food system and a wider range of ecosystem services, as well as behavioural change (of both producers and consumers). Waste reduction and the needs of manufacturing and processing systems need to be incorporated into the upstream thinking at the farm and agriculture side. Aquaculture and fisheries need to be more explicitly mentioned rather than simply assumed to be covered. Food processing should be explicitly included in the systems thinking as it plays an important role in food security and in emission dynamics.

   The programme needs to take a holistic approach embedding equity and connecting across the UK nations, all GHGs and environmental measures, and across supply-chains and businesses, to meet both economic and societal needs. An understanding of the UK system in terms of local production and consumption, and of imports and exports is needed.
There is need for a balance between protecting the environment, setting land aside for recreation and other ecosystem services, and ensuring local food production within the UK. Systems analysis should include evaluating the negative impacts of solutions as a differentiator for assessing trade-offs and the risk of undesired outcomes, e.g. the risk of land abandonment in pursuit of Net Zero, that is, stopping agriculture in order to decarbonise; and the risk of compromising national food and nutrition security and dietary health, in pursuit of biodiversity and ecosystem services. This will avoid wasting efforts on solutions that are technologically perfect but cannot be implemented due to their negative impacts on other parts of the system. For example, the healthy school lunches project in the Netherlands resulted in better nutrition of the children but the project failed because these school lunches came at a higher cost than home-made lunch boxes and parents were not willing to pay for the more nutritious school lunches.

Barriers to impact can be reduced by enabling the right disciplines and actors to work in true partnership. The programme needs to consider parameters for addressing restraints in technology and production systems (what to produce on the farm and how); consumer demand and changes in commodities (food and other products from the land); and patterns of land-use and spatial constraints. How do these overlap and what are the futures we could have and live within in these constraints?

Agri-food system thinking should include behavioural perspectives, to eliminate the risk of community rejection of top-down changes. The ecological economics perspective needs to be expanded to include qualitative social sciences and humanities to enable closer working with communities, with a more appropriate power balance that makes farmers feel more equitable.

Confidence building is also required in terms of the accuracy in estimation / measurement of GHGs from across UK systems; and understanding the effect of interventions on the environment.

2. Placing Sustainability at the Centre

Biodiversity, sustainability, adaptation and mitigation should be given more prominence than Net Zero. Net zero is one of the challenges but the focus should be on sustainability for generations to come past 2050. There should be alignment with the trend in global policy to join climate change and biodiversity agreements, with consideration of associated system issues, e.g. do we go for intensification and spare biodiversity in smaller areas or should we integrate biodiversity with production systems?

The programme should seek to improve resilience to future shocks (pandemics like the COVID outbreak, and other abiotic shocks) through diversification of systems and commodities. In this context, the notion of diversification needs to be defined, e.g. in terms of inclusion/exclusion of energy landscapes; and the type of ecosystems that need to be produced.

3. Interdisciplinary approaches embedding co-design

The programme will require co-design and co-production of research and innovation bringing together all UKRI disciplines and other key actors covering the breadth of the programme’s vision. The programme should be co-designed through transparent engagement of multiple stakeholders e.g. academia (including ECRs), citizens, farmers, industry, charities, private businesses and the public sector, to ensure the needs of all stakeholders are addressed. This will also facilitate impact assessment through direct stakeholder feedback. We need key framing principles that would promote innovation, e.g. unpacking relations, traversing sectors, and knowing who to involve.
3. Breakout Session 2

Question 3: What would a UKRI interdisciplinary Net-zero Agri-food System Programme look like?

a) What would make this programme unique, and why

Several qualities were identified, that would make the programme unique:

1. **Holistic approach to agri-food research and innovation with sustainability and resilience at the core**
   This programme is a UKRI-wide interdisciplinary initiative that should take a holistic or systems approach, to address sustainability of our food system; thereby distinguishing itself from discipline/council-specific programmes. The programme needs to look at the entire agri-food system and a wider range of ecosystem services and consumer and producer behaviour changes. This will need to be supported by collection of large and reliable data sets to develop digital technologies (e.g. Artificial Intelligence and Machine Learning) for effective monitoring that would enable providing appropriate and accurate incentives.

The programme should focus on providing the knowledge, data, tools, and technologies for reversing biodiversity decline; improving resilience; achieving Net Zero alongside increased food production; and on leaving a legacy of embedding the Clean Growth agenda in the agri-food sector. The agri-food perspective should take central stage rather than Net Zero which is already a crowded space. The flow should be from agri-food to Net Zero, and not the reverse. Emphasis should be on seeking to achieve Clean Growth in agricultural production within a system framing.

The programme should embed equity and connect across the UK nations, all GHGs and environmental measures, and across supply-chains and businesses to meet both economic and societal needs.

2. **Integrated Multi-Actor Approach**
   Delivery of the programme should be through a multi-actor approach bringing in multiple stakeholders from land managers/farmers to membership organisations, academia, Early Career Researchers, policy and civil society.

   The programme should focus on challenge-led solutions combining new technologies with nature-based solutions through co-design and co-delivery involving industry, landowners and farmers from start to finish. It will require economic assessment of solution scenarios, and analyses should include delivery of synergies, not just trade-offs and co-benefits. It will also require effective communications to establish links between the different components.

   Research should seek to understand the practitioner-based, bottom-up approach and how to address the challenges associated with this approach, namely, how to engage disciplines that are not traditionally engaged in agriculture; and how to reduce barriers to entry. This may require a decentralised network structure, as networks do not need a track record, and so can attract new early career researchers.

3. **Impact – Driven Research**
   The programme should aim at translating knowledge into measurable impacts, with a focus on developing evidence-based strategies for delivering tangible outputs. Research outputs should be extended to include other impacts, rather than focusing only on publications as the standard measure of output.

   Research should also target shortening the time taken between developing new technologies and applying them on-farm. Such fast-tracking on new technologies will require appropriate enabling conditions.
4. **High Risk for High Reward**

This programme needs to create the next generation of disciplines/paradigms/lexicons for developing transformative interventions that will require novel multifactorial combinations. This will require open networks to enable creation of ‘crazy new’ connections; identifying and understanding the current forums that attract and incentivise collaborations; and networks that enable the community to respond rapidly, flexibly, and non-linearly to challenges and opportunities.

**b) Stakeholders required for delivery of the programme**

Participants identified many stakeholders who it was felt would be important to engage with in any future programme and who would be useful in developing UKRI’s strategic thinking. These are summarised in Figure 2.

![Stakeholders Required for Programme Delivey](image)

Fig. 2: Suggested Stakeholders to engage with any future UKRI programme in clean biodiverse agriculture and food.

**c) What success would look like in the short-, medium-, and long-term**

Success indicators for the programme were grouped into three inter-related areas: clean growth, better understanding of the agri-food system and delivering impact.

1. **Clean growth – sustainability, biodiversity recovery and reduced net emissions**
The suggested indicators of success for the programme in terms of achieving sustainable production alongside biodiversity recovery and reduced net carbon emissions are summarised in Table 1.

**Table 1: Success Indicators – Outcome 1: Sustainable, biodiverse and low-carbon food production**

<table>
<thead>
<tr>
<th>Success Indicator</th>
<th>Time Frame</th>
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<tbody>
<tr>
<td>Farm-level reduction of GHG and other gaseous emissions (NH3 and P). The programme should deliver short-term quick wins, e.g. significant reductions in methane emissions from ruminants; while also looking at longer term targets.</td>
<td>Short Term</td>
</tr>
<tr>
<td>Reduced offshore emissions footprint, e.g. by targeting alternative protein sources for livestock and human diets.</td>
<td>Medium Term</td>
</tr>
<tr>
<td>Sustained local production in parallel with reduced net emissions. Local production should not be compromised in the quest for achieving Net Zero. Emphasis should be on green growth. Maintaining the quantity, quality, and diversity of food produced in the UK should be a necessary boundary.</td>
<td>Medium Term</td>
</tr>
<tr>
<td>Improved water resource management (water quality, pollution, runoff, etc) and better resilience of agri-food systems to water-related hazards and disasters (droughts and floods).</td>
<td>Medium to Long Term</td>
</tr>
<tr>
<td>Recovery of biodiversity.</td>
<td>Medium to Long Term</td>
</tr>
<tr>
<td>Steady trend of decline in net emissions (declining emission and increasing sequestration) over the years.</td>
<td>Long Term</td>
</tr>
<tr>
<td>A shift from UKRI-to broader long-term government buy in and eventually beyond governments, to include cross-party national agreements/commitments e.g. selected communities for a low carbon future</td>
<td>Long Term</td>
</tr>
<tr>
<td>Emergence of a trajectory to continue change beyond 2050 and beyond Net Zero</td>
<td>Long Term</td>
</tr>
</tbody>
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2. **Better knowledge and Understanding of Agri-food systems**

   Table 2 summarises the suggested success indicators of the programme in addressing Knowledge gaps

**Table 2: Success Indicators – Outcome 2: Better Knowledge and Understanding of Agri-food systems**

<table>
<thead>
<tr>
<th>Success Indicator</th>
<th>Time Frame</th>
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<tbody>
<tr>
<td>A balanced research portfolio for ruminants, with top-down structures that reflect the needs of the entire sector and all farming communities</td>
<td>Short Term</td>
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<tr>
<td>Metrics of the economics – working out the cost of developing and implementing solution options, compared to the cost of taking no action</td>
<td>Short Term</td>
</tr>
<tr>
<td>Understanding of the social factors in the agri-food system and safeguarding the interest of UK local production/ producers (e.g. the import metrics for fisheries).</td>
<td>Short Term</td>
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<tr>
<td>Clarity on interventions that would work on an individual farm system – robust prediction of how complex changes will result in positive payment over the long term (business sustainability and resilience)</td>
<td>Short Term</td>
</tr>
<tr>
<td>Creation of a highly integrated UK agri-food research community that is challenge-focused to support the generation of scientifically excellent knowledge, working in partnership with industry and policy makers in the UK and Internationally.</td>
<td>Short to Medium Term</td>
</tr>
</tbody>
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2
Established a mixed model of funding, ranging from supporting Early Career Researchers (ECR) to larger scale, long term interdisciplinary programmes.

Increased engagement with industry on carbon planning – the nature of research outputs will help industry make choices and de-risk the pathway to Net Zero.

Mechanisms available to ensure measures are applied consistently through the system.

Tools are developed for accurate measurement of success, including quantifying soil carbon build up over time.

Trends and habits on demand are understood – e.g. ESRC’s Centre for Climate Change and Social Transformation (CAST) is already working on developing “the social transformations needed to produce a low-carbon and sustainable society”.

Food production systems respond to changes in consumer behaviour and food consumption patterns.

Consumer understanding of, and preference for greener products. Low carbon products are not always taken up compared to free-range. Consumers see free-range as being environmentally friendly, but they are not necessarily low carbon.

### 3. Impact – Translating Research into Products, decision support tools and changing Behaviours

The impact of the programme in terms of the community response (behaviour changes) and the uptake and translation of research outputs by business and industry will be assessed at different time scales against the indicators summarised in Table 3.

**Table 3. Success Indicators – Impact – Research translation and behavioural change**

<table>
<thead>
<tr>
<th>Success Indicator</th>
<th>Time frame</th>
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<tbody>
<tr>
<td>Private investment in Net Zero targets, including insurance companies – there is a large amount of private capital available but not readily used.</td>
<td>Short Term</td>
</tr>
<tr>
<td>Quick learning and application of new technologies and innovations.</td>
<td></td>
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<tr>
<td>Adoption of disruptive innovations and creation of green jobs</td>
<td>Short to Medium Term</td>
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<tr>
<td>Faster participatory pipeline of projects with different timelines and impacts in relation to the changing situation and involving consumer and citizen assemblies, with dialogue that moves away from polarised discussions.</td>
<td>Medium Term</td>
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<td>Accurate staging on where the biggest impact can be made in the shortest time</td>
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<td>Relevant SDG targets and indicators where applicable</td>
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<tr>
<td>Partnerships and reporting in industry with more frequent reporting of targets, e.g. training of farmers</td>
<td>Medium to Long Term</td>
</tr>
<tr>
<td>More companies, estates and landowners reporting on metrics, defining a baseline of their current situation and setting targets and milestones</td>
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<tr>
<td>Direct economic returns in terms of the assets that will come out of different phases of the programme</td>
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<td>Changes in habits, from both the demand and supply sides</td>
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<tr>
<td>Evidence-based policies and decisions that regulate UK agri-food systems</td>
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</table>
Research translation – bringing research onto the farm to discover the unforeseeable aspects of the industrial environment | On-going (continuous)

Engaged farming community with improved farming livelihoods; equitable distribution of nutritious food to all; broader societal impacts including economic, health, and wellbeing; and broader environmental sustainability going beyond reduction of carbon emissions, e.g. including water quality, air quality, soil quality, etc.

4. Cross-cutting issues
   In addition to the indicators presented above, the following issues were raised in relation to the success of the programme:
   
i. There is no silver bullet, as the challenge is complex and will require a mixture of solutions that are complementary.
   
   ii. Measurement of success is not just about evaluating the milestones. It should include feeding down the changes to understand the public acceptance and then feeding back up on how the changes can be adjusted to achieve a negotiated public acceptance.
   
   iii. The programme needs a structure that shows the impact of the metrics. Measuring impact should not just be about evaluating papers but should factor in the time scale of the impact
   
   iv. Co-design needs to be practical and actionable by farm businesses and should be able to cater for the broadest group. However, the complexity of accounting, diversity, and the number of actors in the sector poses barriers to effective co-design and these need to be addressed

   d) Delivery Mechanisms

   The delivery mechanisms proposed at the meeting are summarised under the following main areas:

   1. Interdisciplinary research bringing together actors from many disciplines.
      The programme will need an interdisciplinary hub structure fully integrated in the existing landscape (filling the gaps) and learning from previous large-scale approaches including international approaches (e.g. EU, New Zealand, Australia, US, Latin America). Consortia should be constructed in a manner that all the pieces are tied to the outputs, even if the different pieces harbour different areas of expertise. This will enable cutting across all sectors of the economy. Synthesis work will be required to bring together different programmes currently operating in the UK research and innovation landscape.

   2. Multi-Actor Community
      Effective implementation of the programme through a multi-actor approach will require building networks and partnerships to bring larger communities of interdisciplinary researchers and users together, potentially through a network that brings together existing networks into one community.

      A decentralised network structure with scalable funding would help to secure more long-term funding commitments. This would require setting up networks with sandpits building for pump-priming; putting in place a strong scientific governance structure to encourage action and attract new researchers; and providing intermediate funding before large scale grants. The network structure would enable more efficient funding by allocating money to networks or programmes that can then provide funding for small grants. For example, the Network+ model will reduce demands on the research councils and will enable the widest possible engagement.
3. **Build a Community of Agri-food System Thinkers**
   The programme will require a mixed model of system thinking that combines discipline-specific expertise with interdisciplinary agri-food system thinkers (dot-joiners) with clear trajectories. There should be training opportunities for scientists to develop systems thinking and contextualise their work in the process, in order to understand where their work fits and how to pivot it.

   There should be incentives for skills development activities that aim for long-term gains, starting with short-term learning that keeps the momentum for working towards longer term outputs and impacts. There should be skills mobilisation within the system, through knowledge exchange fellowships and short secondment of experts, e.g. data scientists and physicists working on farms to build relationships between different silos. Training should also be more practical, e.g. incorporating on-farm modules in agriculture courses.

4. **A mixed funding model**
   The programme will require a mixed funding model combining large grants for long-term goals with pump priming to deliver short-term objectives. Long-term sustained funding will be required to ensure continuity and operation at scale; and address the challenge of disconnect often associated with short-term projects. However, Large projects tend to be limited in number and would not be able to cover the full range of areas that need investigating. Therefore, a mixed model of projects and programmes will be required to fill the gaps.

5. **Cross stakeholder buy in and commitment**
   The programme should seek co-funding where possible by securing protected funding commitments from different stakeholders - UKRI, industry, government departments, including devolved administrations, charities, etc. Funding by stakeholders can be enabled through co-design and co-implementation although this will require time for building the relationships. The industry club model (e.g. SARIC) is a good example of industry funding for R&I. Co-funding may also be achieved through shared ownership of solution-focused national capabilities.

6. **Governance and structure**
   A Programme Secretariat or Management / Coordination Unit will be required for pulling the various components of the programme together and stimulating joining up of related programmes/projects to make the most of the investments and of the science produced. The Secretariat may need to be supported by a Scientific committee that ensures a smooth blend in the interdisciplinary research landscape. An agri-food systems governance body may also be required to ensure a top-down approach influences and moves things forward, and to determine how to prioritise the available intervention options. Dedicated panels can be useful. Governance structures may also need to incorporate ‘out of the box’ thinking by involving the youth.

7. **International Collaboration**
   Sustainable low carbon agriculture and food is a global challenge which cannot be addressed by any single country in isolation. This programme should provide a new opportunity for UK to lead a collective international effort by offering its strong multi-disciplinary science base while also learning from other international players in the global research and innovation landscape. UKRI has several avenues for international research collaboration and partnerships, and these should be explored in the implementation of the programme.
Final Remarks

In the closing session the Chair summarised the main issues emerging from the breakout sessions, highlighting the following points:

i. A challenge for UKRI is on where/how to position this programme in the wider landscape among soil, food, and agriculture programmes.

ii. The concept of clean growth is more unique than Net Zero.

iii. System thinking is important, but this has to be complemented with breakthrough technologies at the discipline specific level.

iv. The key networkers need to be identified - where is the key knowledge and who will give their time to input into the programme?

v. In any programme created there is a need for the right balance between disciplines and for ‘dot-joiners’ between disciplines and sectors.

vi. There is emphasis on co-design with a mix of stakeholders to get their buy-in, with particular attention to farmers, young people and early career researchers.

vii. Programme management and governance needs to be strong - not just the usual suspects. Need to involve young people with ‘out of the box’ thinking.
# Annex 1: Attendees

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Organisation</th>
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<tbody>
<tr>
<td>Maggie Gill (Chair)</td>
<td>University of Aberdeen</td>
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<tr>
<td>Mark Reed</td>
<td>Newcastle University / Fast Track Impact Ltd</td>
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<tr>
<td>Elizabeth Magowan</td>
<td>Agri-Food and Biosciences Institute</td>
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<tr>
<td>Simon Pearson</td>
<td>University of Lincoln</td>
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<tr>
<td>Matt Heard</td>
<td>The National Trust</td>
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<tr>
<td>Debbie Sparkes</td>
<td>University of Nottingham</td>
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<tr>
<td>Chris Brown</td>
<td>ASDA</td>
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<tr>
<td>Richard Harrison</td>
<td>NIAB</td>
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<tr>
<td>Colette Shortt</td>
<td>Johnson &amp; Johnson</td>
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<tr>
<td>Richard Pywell</td>
<td>CEH</td>
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<tr>
<td>Sarah Bridle</td>
<td>University of Manchester</td>
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<tr>
<td>Lindsay Stringer</td>
<td>University of York</td>
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<tr>
<td>Jessica Davies</td>
<td>Lancaster University</td>
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<tr>
<td>Ken Stebbings</td>
<td>Welsh Gov</td>
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<tr>
<td>Maia Elliot</td>
<td>GFS</td>
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<tr>
<td>Luke Spadavecchia</td>
<td>Defra</td>
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<tr>
<td>Alistair Carson</td>
<td>DAERA</td>
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<tr>
<td>Geoff McBride</td>
<td>STFC</td>
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<tr>
<td>Calum Murray</td>
<td>Innovate UK</td>
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<tr>
<td>Beth Adams</td>
<td>NERC</td>
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<tr>
<td>Lisa Bettington</td>
<td>NERC</td>
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<tr>
<td>Gerard Davies</td>
<td>EPSRC</td>
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<tr>
<td>Helen Rogers</td>
<td>ESRC</td>
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<tr>
<td>Colin Miles</td>
<td>BBSRC</td>
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<tr>
<td>Jef Grainger</td>
<td>BBSRC</td>
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<tr>
<td>James Phillips</td>
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<td>Harriet Trewin</td>
<td>BBSRC</td>
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<td>Jamie Stone</td>
<td>BBSRC</td>
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Annex 2: AGENDA

<table>
<thead>
<tr>
<th>Time</th>
<th>Item</th>
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<tbody>
<tr>
<td>13:00 – 13:15</td>
<td>Opening and Introduction: Summary of concept note, including the vision for Net Zero; and the questions for breakout sessions</td>
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<tr>
<td>13:15 – 13:30</td>
<td>GFS Future Scenarios of climate change impact on food systems</td>
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<td>13:30 – 13:55</td>
<td>UKRI Partner Perspectives: NERC, EPSRC, ESRC, IUK, STFC</td>
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<td>13:55 – 14:10</td>
<td>General discussion: Questions from the presentations; points for clarification; get a common understanding of what needs to be done</td>
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<td>14:10 – 14:15</td>
<td>Breakout Session Briefing: Instructions for breakout sessions</td>
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<td>14:15 – 15:00</td>
<td>Breakout session 1:&lt;br&gt;&lt;br&gt;<strong>Question 1:</strong> What are the knowledge gaps and the R&amp;I needs for making a step change in GHG reduction, mitigation, and adaptation?&lt;br&gt;1. What is the current UK’s R&amp;I landscape? &lt;br&gt;2. What are the research and innovation gaps/challenges?&lt;br&gt;3. What are the UK strengths for addressing these challenges?&lt;br&gt;&lt;br&gt;<strong>Question 2:</strong> What is the vision for this programme?&lt;br&gt;1. What would you like to see in the vision?&lt;br&gt;2. What should the scope be?&lt;br&gt;3. What key themes would we need to deliver the vision?</td>
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<td>15:00 – 15:15</td>
<td>Feedback from breakout session 1</td>
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<td>15:15 – 15:30</td>
<td>Break</td>
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<td>15:30 – 16:10</td>
<td>Breakout session 2&lt;br&gt;&lt;br&gt;<strong>Question 3:</strong> What would a UKRI interdisciplinary programme on Resilient and Biodiverse Net Zero Agri-food System Programme look like?&lt;br&gt;1. What would make this programme unique, and why?&lt;br&gt;2. What R&amp;I components do we need (interdisciplinary, top-down &amp; bottom-up components)?&lt;br&gt;3. What can we leverage and who should be the key stakeholders be?&lt;br&gt;4. What would success look like in the short-, medium-, and long-term?&lt;br&gt;• net emission targets (milestones) towards Net Zero by 2050&lt;br&gt;• other milestones to consider (e.g. biodiversity targets, etc)&lt;br&gt;• success indicators&lt;br&gt;5. What mechanisms / building blocks are needed?</td>
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<td>16:10 – 16:25</td>
<td>Feedback from breakout session 2</td>
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<td>16:25 – 16:55</td>
<td>Concluding Plenary Discussion</td>
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<td>16:55 – 17:00</td>
<td>Wrap up and close</td>
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