A Net Zero Food System

Insight Report

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EIT Food – Europe's leading food innovation initiative, working to make the food system more sustainable, healthy and trusted

Knowledge & Innovation Center on Food, part of the European Institute of Innovation and Technology (EIT)

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Foreword

Some issues are so big they can only be solved if we work together. That's the thinking behind EIT Food – a community that has come together to respond to problems in the food system that affect us all. And while those problems are complex, our mission is clear and focussed – to improve outcomes for people and planet alike.

Healthier Lives Though Food

We'll give consumers access to healthier, more affordable, products which balance nutrition with environmental footprint and use a more diverse range of proteins. We will support this change with better access to practical, useful information. With better advice, we can all make better choices and improve our quality of life.

A Net Zero Food System

Our three-point plan will smooth the path to a Net Zero food system by:

- Enabling farmers and producers to lead the transition to regenerative agriculture.
- Creating new markets and opportunities to reduce our food waste and food loss in production.
- Empowering consumers, making their food purchasing choices count and play a crucial role in the circular food economy.

Reducing Risk for a Fair and Resilient Food System

We'll improve food security and safety for consumers everywhere by enabling and establishing resilient and dependable digitally enabled food supply chains.

We co-invest public funds alongside resources from our community partners to drive innovation, develop new business, build skills, and engage the public while we move towards system-wide change in how the food system works for all of us.

This is both a privilege and a challenge. We know we have to prioritise our investments, funding, advocacy and interventions to make a real difference.

Taking stock of the great progress we've made in the first 3-4 years of operations, we put together three teams of experts from the EIT Food community to look at how we can best implement our strategy.

Each team ran an open programme of research, consultation and systems thinking co-design workshops to produce detailed reports, including key mission insights and recommendations.

These reports stretch beyond the boundaries of what we, the EIT Food community, can do on our own. That's why we're publishing them as a public call to action on behalf of our community. If these reports inspire you, please get in touch – tell us how we can help you make change happen.

On behalf of the leadership team and wider EIT Food community, I would like to extend our gratitude to the teams involved, and to the many experts and members of the public who volunteered their valuable time and insights. The passion for change behind these reports is a constant inspiration for us at EIT Food as we reach for a more trusted, fair, sustainable and healthier food system for all.

Andrew Carlin
Director of Missions & Strategic Programmes,
EIT Food

https://www.eitfood.eu/missions

2. Introduction

EIT Food's overarching purpose is to create a world where everyone can access and enjoy sustainable, safe and healthy food with trust and fairness from farm to fork. To achieve this overarching vision and purpose, EIT Food has defined Missions that form the basis of their strategic drive. As part of its Missions, EIT Food, its community and beyond, are co-designing roadmaps to identify areas of impact and to provide solutions and opportunities for the agrifood system to step change and evolve, providing consumers with more sustainable, healthy and trusted food. These roadmaps are a recognition that it is time to change and refine areas for investment, forge new funding relationships and identify areas which can have a distinctive and significant impact on the food system. Within this report, we are focusing on EIT Food's Mission "A Net Zero Food System", which connects with a key priority across the globe. The European Union (EU) aims to be climate-neutral by 2050, that is, an economy with Net Zero greenhouse gas (GHG) emissions. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement.

The Net Zero GHG emissions target stems from the United Nations (UN) 2015 Paris Agreement where more than 190 countries committed to keep global temperatures rise well below 2 °C above preindustrial levels, and ideally, 1.5 ° C to avoid the worst impacts from more extreme weather and rising seas – which is also a threat to globally food security. GHG emissions from anthropogenic activity are the predominant cause of global warming. Thus, in order to ensure temperatures remain below the 1.5 °C target an annual reduction of 30 gigatonnes of GHG emissions across the globe is necessary (UNEP, 2020). Worryingly, atmospheric concentrations of carbon dioxide (CO_2) have been increasing since 1800 from 278 ppm to 417 ppm in 2021 (Met Office, 2021). This is an increase of 50% compared to pre-industrial levels. In order to prevent catastrophic levels of CO_2 in our atmosphere and return atmospheric concentrations of CO_2 to the 'magic number' of 350ppm, all sectors must reach net zero (Toensmeier, 2016). The UN defines 'net zero' as "cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests for instance" (UN, 2022). The UN Environment Programme (UNEP) has identified six sectors that can cumulatively reduce emissions by more than 30 gigatonnes each year, to limit temperatures to 1.5 °C. These include energy (8.2 Gt), agriculture, food, and waste (6.7 Gt), buildings and cities (5.9 Gt), nature-based solutions (5.9 Gt), industry (5.4 Gt) and transport (4.7 Gt) (UNEP, 2020).

As recognised by the UN Environment Programme, the food sector is a significant emitter of GHG emissions globally accounting for 35% of emissions from all sectors. It is therefore vital to transform our food system towards a net zero system, particularly as emissions are expected to rise given the expected increases in population growth and food demands if no action is taken (Jordon et al., 2022). There is large uncertainty in calculating and estimating GHG emissions from the food system, particularly as some GHG emissions are traditionally allocated to other sectors, as opposed to the food and agriculture sector e.g. transport of inputs from factories to farms, production of plastics for packaging, power in grocery stores and for food preparation (Mbow et al., 2019). The IPCC suggests that 21–37% of total GHG emissions caused by human activities globally are from the food system (Mbow et al., 2019). Other sources state that the global food system is responsible for approximately half of all global emissions with 11–15% attributed directly to agricultural production, 15–20% from processing, transport, packing, and retail, 15–18% from land-use change and deforestation and 2% associated with waste (Toensmeier, 2016). Within the sector 57% of emissions are generated from the production of animal-based food compared to the 29% associated with plant-based commodities (Xu et al., 2021). Agriculture produces approximately 50% of all anthropogenic methane (CH_4) emissions and 75% of anthropogenic nitrous oxide (N_2O) (Mbow et al., 2019). In comparison, CO_2 emissions from agricultural activity are relatively smaller, with use of urea and lime emitting CO_2 (Lynch et al., 2021). The global food system is the primary source of land-use change CO_2 emissions, as a result of land use change associated with crop production or pasture (Lynch et al., 2021). 14% of annual anthropogenic CO_2 emissions are linked with land-use change with agriculture responsible for 10% of this figure (Le Quéré et al., 2018; Mbow et al., 2019). Finally, as much as 70% of the total GHG emissions from cropping are associated with nitrogen (N) fertiliser, a combination of CO_2 and N_2O from manufacture and distribution and N_2O from its use on crops (Antille et al., 2015).

Notably, the world's energy consumption which is dependent on fossil fuels is also a significant root cause of unsustainability and GHG emissions across the globe (Babin et al., 2021; US State Department, 2021; International Energy Agency, 2022, Pyrka et al., 2021). Whilst the dependence on traditional biomass fuels has led to an overexploitation of forests and woodland resources, leading to the acceleration of deforestation and forest degradation in Eastern Africa (Wassie and Adaramola, 2019; Cameron et al., 2021; República Portuguesa et al., 2019), in addition to a depletion of natural resources (Yousefpour et al., 2020; Bayrak and Marafa, 2016; Oxfam, 2021; Boussemaere et al., 2015). In the food system, food production, manufacturing, packaging, transport and storage are all dependent on energy and fossil fuels, which is a key cause of greenhouse gas emissions (Sovacool et al., 2021; El-Sayed, 2020; Zingale et al., 2022; National Food Strategy, 2021; Hjorth et al., 2022; New Zealand Minister of Climate Change, 2022; US State Department, 2021; Piloto-Rodríguez et al., 2017). The CO_2 generated from energy use within the food system is uncertain and it is contained within energy and transport emissions with the IPCC framework for accounting (Lynch et al., 2021).

Finally, in addition to the release of GHG emissions, contribution to global warming and role in climate change, the global food system is also a worrying cause of environmental degradation and biodiversity loss which should be considered when evaluating and improving the sustainability of the food system (Toensmeier, 2016). It will therefore be important to understand, define and improve environmental indicators in a pathway to A Net Zero Food System.

It is clear the food system is one of the main drivers of GHG emissions and will therefore play a key role. This was reiterated at the past two United Nations Conference of Parties summits (COP26 in Scotland and COP27 in Egypt) where food systems were at the centre of discussions. However, to achieve a net zero food system, a radical rethink of the whole agrifood system is needed: from production and consumption to policy and legislation. We first need to define the root cause of the problems and learn from the activities, operations and programmes taking place around the world at country level as well as pan-European and global initiatives to deal with driving Net Zero. This needs to be followed up by an evaluation and prioritisation of opportunities and solutions to develop a pathway to Net Zero. This report outlines a roadmapping methodology and subsequent results for a Net Zero food system.

At the outset, the intended impact of producing the roadmap is to identify the most relevant and impactful options available to EIT Food to pave the way towards a Net Zero food system, reducing carbon dioxide equivalent (CO_2-eq) emissions by tackling GHG hotspots, reducing the footprint of proteins through diversification, and creating new markets for food loss and waste. The overarching goal for the roadmap is to achieve ambitious outcomes and measures, including, but not limited to:

- Improving impact on ecosystems due to factors identified as EU Green Deal and/or Common Agricultural Policy (CAP) targets (such as CO_2 reduction, water quality and use, use of chemical pesticides, antimicrobial use, nutrient loss and biodiversity protection (multiannual impact indicator)
- Volume reduction in CO_2-eq tonnes from areas, business segments or practices of the agrifood system identified as major contributory sources by Life Cycle Analysis methodology (annual impact indicator)
- Increasing the number of products on the market derived from alternative sources (e.g. alternative proteins, new plant varieties, alternative production techniques) (annual impact indicator)
- Increasing the number of products or processes launched using revalorised and reintegrated food system side-streams and waste streams (annual impact indicator)

3. Executive Summary

EIT Food is seeking to shape Europe's priorities for action over the next 3–5 years via the Mission: A Net Zero Food System. A roadmapping activity was commissioned to explore this Mission, where the outputs formed part of EIT Food's strategic initiatives actions and will shape the business planning and decision-making priorities for 2023–2025 and beyond.

This report summarises the work undertaken between September and December 2022 with EIT Food partners (Queen's University Belfast, Pepsico, Kerry, IfM Engage, University of Reading) and documents the process and outcomes that led to the creation of roadmap opportunities for a Net Zero food system. It identifies priority opportunity areas and evaluates their potential impacts. An extensive literature review followed by an extensive on-line survey and in-depth interviews provides the material to identify key drivers, trends, opportunities, capabilities and enablers as well as the overall vision for the mission. Conclusions and priorities outlined in the report have been informed by over 150 paper reviews, over 160 questionnaires completed by experts across 29 countries, 23 in-depth interviews, over 30 case studies and over 30 experts working together.

EIT Food's vision for A Net Zero Food System should prioritise the following themes:

1. Green infrastructure and sustainable integration with built environment
2. Sustainable Food production
3. Sustainable nutrition and meeting nutritional needs
4. Transparent, connected and circular food systems
5. Informing key players and stakeholders on Net Zero goals and empowering them to act

The vision statement will be finalised by EIT Food post review of this report.

Prioritised lists of 12 macro-level trends and drivers, and 15 market drivers/needs were identified to inform the roadmapping exercise. Based on these drivers and the overarching vision statement, delegates explored potential opportunities that might satisfy emerging priorities facing the food system on the path towards Net Zero. In total 70 opportunities were identified during the pre-workshop desk research, and a further 28 opportunities were ideated during a workshop held in Paris in December 2022. These were then prioritised based on their impact potential and feasibility for positive change towards a Net Zero food system, resulting in a short-list of 12 key opportunities. From this list, seven key topics were taken forward for detailed 'topic roadmapping' to explore the required capabilities and enablers, barriers and risks, feasibility and impact, and the potential roles for EIT Food to play in facilitating and driving change in the food system. The priority opportunities explored were:

A. Regenerative Agriculture
B. Data and value-chain integration, and measure, report, verify (MRV) methods
C. Food Loss and Waste Prevention and valorisation of side streams, recycling
D. Overcoming barriers to consumer behaviour change
E. Diversification of Protein Sources
F. Overcoming barriers to behaviour change within the farming community
G. Food and Beverage Packaging Never Becomes Waste

From this prioritisation process, four hotspots within the food system should be considered by EIT Food as its main focus areas for its Net Zero agenda. These are:

- Tackling GHG emissions in Agriculture with an emphasis on Regenerative Agriculture,
- Food Waste and Loss,
- Packaging Reduction, and
- Protein Diversification.

These four priority roadmaps to be considered by EIT Food should be supplemented by three overarching enabling impact pathways:

- Consumer behaviour change,
- Farming practices change, and
- Data and value-chain integration with MRV methods.

The required enablers for change to deliver the vision present significant potential roles for EIT Food spanning all four of the organisation's core pillars: innovation, entrepreneurship, education and public engagement. Namely they are:

1. Engaging with policymakers as key in shaping policy & legislation to support the Net Zero transition.

2. Forging collaboration & partnerships between government, academia, NGOs, and industry (from big brands down to individual farmers).

3. Developing knowledge & skills among the farming communities and among society and consumers, particularly young people. Technologies and methodologies do already exist for Net Zero but adoption will require a new generation of farmers willing and able to work differently.

4. Driving the Net Zero change through the development of resources and infrastructure. This will accelerate the technological innovation to scale up solutions and drive down costs to make solutions economically attractive and affordable for consumers.

5. Facilitating a supportive funding landscape for innovation and entrepreneurship to drive experimentation in new production methods, products, services, and innovative new business models. New models for use of food waste will be particularly important.

6. Engaging the public, particularly young people to inform on Net Zero and raise awareness and increase consumer acceptance of innovative new Net Zero solutions such as protein diversification.

Overall, this report details the four priority roadmaps and three impact enabling pathways as key areas that EIT Food should consider for intervention and facilitation towards a Net Zero food system.

4. Approach and methodology

4.1 Overview of the roadmapping process for A Net Zero Food System Mission Area

To identify and respond to the areas of greatest need and where EIT Food can have a significant and distinctive impact on the mission of A Net Zero Food System, the roadmapping exercise included three key phases which are described in more detail below.

Phase 1 – SCOPING PRIORITY AREAS: An impact scoping exercise included an extensive literature review (from both commercial/academic sources (grey) and peer-reviewed (published) literature), sector-level roadmaps and horizon scanning reports available in the public domain, the university and startup innovation ecosystem and the activities and funding opportunities already in place around the world related to a Net Zero food system. The aim was to identify: (1) sectors, products or processes; (2) LCA stages within those categories; and (3) environmental impact factors EIT Food should prioritise and why. This scoping exercise established the baseline and identified drivers, market needs, opportunities, capabilities and enablers for delivering impact for A Net Zero Food System. The results informed the survey instruments in phase two and fed into the draft roadmap.

Phase 2 – SHAPING PRIORITY AREAS: An online 15-minute questionnaire with 166 stakeholders, related to sustainability and a Net Zero food system, was conducted to identify, evaluate and rank the greatest market needs and priority opportunities from a stakeholder's perspective. In addition, 23 in-depth semi-structured interviews with industry players, thought leaders and experts were conducted to assess priorities and fill gaps related to A Net Zero Food System and validate the findings. Finally, a workshop was held with the EIT Food Community at the EIT Food Annual Event in Brussels for feedback and validation.

Phase 3 – ROADMAPPING PRIORITY AREAS & RECOMMENDATIONS: In a multi-stakeholder workshop In Paris in December 2022, 30 experts worked on (i) prioritisation of the roadmap drivers (ii) ideation of key opportunities; (iii) evaluation of the priority opportunities and (iv) deep diving into the top seven priority opportunities in cross-functional breakout groups of circa three to develop a Net Zero Roadmap for the food system, addressing each of the identified priority action areas and knowledge gaps.

The overarching objectives of this roadmapping exercise for A Net Zero Food System were to:

- Develop an understanding of the root cause of the problems around achieving a Net Zero food system
- Review the activities, operations and programmes occurring at country, European and global levels that are driving Net Zero food systems
- Evaluate, prioritise and validate the opportunities and solutions for a Net Zero food system
- Construct a report to document the overarching roadmapping process and Impact Priority Areas for a Net Zero food system

4.2 Phase 1: Scoping Priority Areas

In Phase 1, a desk-based literature review was conducted to investigate the scale and consequences of unmet societal and economic needs related to Mission 2: A Net Zero Food System. This phase helped in several ways:

- Developing an understanding of the root cause of the problems around achieving a Net Zero food system;
- Identifying and evaluating existing sector-level roadmaps and horizon scanning reports from across the world available in the public domain;
- Reviewing university and startup innovation to capture the 'technology push' dimension;
- Reviewing the activities, operations and programmes (case studies) occurring at country, European and global levels to deal with driving Net Zero food systems.

The first stage in the desk-based literature review involved finding and selecting relevant published and grey literature from:

1. scientific journals;
2. government webpages and reports;
3. non-governmental organisations (NGOs) and industry, corporate or charity reports related to the food system; and
4. activities, programmes and funding opportunities related to Net Zero and the food system.

Only articles published between 2015–2022 were considered eligible. This timeframe was selected as it is in line with the adoption of the Sustainable Development Goals (SDGs) by the 193 United Nations member states in 2015. The search strategy used a combination of key words related to a Net Zero food system and interventions, reviews, horizon scanning or roadmapping reports to retrieve relevant articles from scientific databases and the grey literature. The total hits from 2015–2022 on Web of Science was 1,329. The full list of keywords, combinations and search hit details are available to view in the appendix. Due to the large number of articles retrieved, the review of the published literature used the Horizon scanning methodology outlined by Glaros et al, (2022) which is as follows:

- Focus on (1) most relevant and (2) highly cited, peer-reviewed literature. The scoping exercise analysed the top 50 papers listed in order with these two filters applied separately i.e. the top 50 relevant papers and the top 50 highly cited papers.
- This was followed up with research gap identification and further literature searches as required.

The grey literature was retrieved using Google. Relevant published information which met the eligibility criteria was included. In total 100 published scientific papers, 76 roadmaps and 55 case studies and industry reports were reviewed. This literature was critically analysed to identify the most powerful areas of intervention in the next 3–5 years that will allow Net Zero emissions in the food system by 2050; and to explore which: (1) sectors, products or processes; (2) LCA stages within those categories; and (3) environmental impact factors EIT Food should prioritise and why. The data extracted from the literature review was also tabulated based on drivers, market trends, opportunities, capabilities, and enablers to a Net Zero food system. The results from the literature review were used to inform the survey instruments and the draft roadmap landscape for prioritisation by key stakeholders within the food system. The full literature review protocol used for the scoping priority areas can be found in the Appendix.

4.3 Phase 2: Shaping Priority Areas

Phase 2 investigated, assessed and ranked the greatest market needs and priority opportunities for a Net Zero food system from a stakeholder's perspective; identified any gaps from the literature review; and shaped the draft roadmap landscape for the roadmapping workshop. An interactive workshop, online questionnaire and in-depth interviews were held with stakeholders in the food system to collect this data and inform the draft roadmap landscape.

EIT Food Partner Assembly Workshop on A Net Zero Food System

A one-hour interactive workshop was held with the EIT Food Community at the EIT Food Annual Event in Brussels, Belgium, on Monday 17th – Tuesday 18th October 2022. The purpose of this workshop was to gather feedback and validation on the results from the initial scoping exercise (Phase 1) and to gather further insights from the EIT Food community to shape the priority areas. More than 30 experts from the EIT Food community actively engaged in the workshop, sharing the greatest challenges in delivering a Net Zero food system and what opportunities they felt would help to overcome these challenges. The participants were also asked to share examples of any initiatives, activities or work in progress which they knew were delivering real impact to the Net Zero agenda.

Survey

A 15-minute online questionnaire collected the views, knowledge and inputs from stakeholders related to a sustainable and Net Zero food system. The aim was to rank, shape and prioritise the current barriers, drivers, market needs, opportunities and enablers for a Net Zero food system. It was also designed to identify any gaps and highlight activities and programmes taking place at local, European and Global levels that are having a significant impact on the Net Zero agenda. The questionnaire was informed by the results from the literature review combined with expert input, piloted, and refined prior to implementation (Appendix). The survey was created on the online platform *LimeSurvey* and was available from 31st October–31st December 2022. Convenience and snowball sampling through the university, consortium and EIT Food's strong regional, European and global agrifood innovation ecosystems was used to reach all relevant stakeholders in the food system (farmers, industry, entrepreneurs, startups, government, university and research institutions, investors and funders, thought leaders and subject matter experts and society (NGOs, environmental groups and citizens)). The partners and EIT Food's social media channels (Twitter, Facebook, LinkedIn, Instagram, Food Hive and Food Unfolded) were also used to disseminate the questionnaire. Descriptive statistics was carried out on the quantitative data (closed questions) to rank and prioritise the greatest market needs and opportunities for A Net Zero Food System. Content analysis was performed on the qualitative data (open questions) to develop a vision for the mission and add additional insights on the potential opportunities and areas where EIT Food can make a powerful difference and transform the food system in the next 3–5 years.

Interviews

Finally, in-depth semi-structured interviews were conducted with 23 thought leaders and subject matter experts from relevant perspectives across the food system (regulatory, policy, industry, society, startup community and science and technology base) to assess priorities and fill gaps related to a Net Zero food system. Interview questions were informed by the results from Phase 1: Scoping priority areas. They explored:

- The current drivers, market needs, opportunities, capabilities and enablers for A Net Zero Food System
- The current activities taking place across the globe
- A final reflection on the vision and goal of A Net Zero Food System

Interviewees were recruited by directly reaching out and targeting experts and corporates to participate in a 45-minute interview, and also by following up with questionnaire respondents who had indicated their willingness to participate. Content analysis was used to analyse the qualitative interview data; exploring the perceptions of thought leaders and subject matter experts from all relevant perspectives to assess priorities and fill gaps; and to validate, rank and shape the short list of impact priority areas for a Net Zero food system. The results fed into the road mapping workshop.

The full protocol and survey instruments for shaping the priority areas can be found in the Appendix.

4.4 Phase 3: Roadmapping Priority Areas & Recommendations for Collaborative Action

In Phase 3, a facilitated roadmap development process was undertaken to co-create a roadmap to A Net Zero Food System. During the multi-stakeholder workshop, participants followed these steps:

- Prioritised drivers
- Developed the roadmap landscape
- Scored the opportunities
- Prioritised and refined the impact pathways to A Net Zero Food System
- Identified the role(s) EIT Food could take

The results from the workshop were synthesised and the priority areas where EIT Food can lead change were elaborated on. The data collected from all sources (literature review, workshop, questionnaires and interviews) were then analysed to provide key recommendations on how EIT Food can make a distinctive and significant impact on A Net Zero Food System and how EIT Food's impact indicators can be consistently met in the next 3–5 years. Finally, a search was completed to identify the current and future stakeholders and collaborators including funding sources which might be available to fund development or scaling of solutions in these areas; and might be accessible by EIT Food and partner organisations working together as consortia.

Roadmapping

The roadmap to A Net Zero Food System sought to explore and validate initial desk research and data gathering and build a detailed understanding of specific priority opportunities for a Net Zero food system. To achieve the project goals, the specific objectives of the roadmapping workshop were to:

- Share perspectives on the vision of the future Net Zero food system and the key value creation opportunities.
- Review and prioritise vision statements and the key trends and drivers.
- Ideate value creation opportunities and identify the priority value creation opportunities.
- Develop impact pathways for the selected key value creation opportunities including identifying the enablers and resources required as well as any potential risks, and to discuss the potential roles of EIT Food in the Net Zero transition.
- Review and feedback on the key value creation opportunities from from EIT Food's other two Missions.

Underpinning this work are tools and methodologies for strategic roadmapping. Roadmaps provide a structured visualisation of information for specific strategic aspects. They are used to support strategic planning across a broad spectrum of applications. A common roadmap layout, or architecture, will contain two axes, as shown below in Figure 1. There is a horizontal, time-based axis; often encompassing the past, short-, medium- and long-term, as well as the vision. The vertical axis usually pertains to perspectives, or dimensions, relevant to the focal point of the roadmap; often represented as horizontal layers, forming a matrix across the time dimension (Figure 2).

To achieve the objectives of the roadmapping workshop, the fast-start approach for strategic roadmapping ('S-Plan') developed by the Institute for Manufacturing (IfM) at the University of Cambridge was deployed. It is appropriate for a sector-level strategy, examining strategic challenges and exploring innovation opportunities. Generally, it is particularly suitable for understanding and addressing issues at the 'front-end' of innovation, where decisions have considerable strategic implications.

Figure 1 shows the customised roadmap structure for the Mission 2 objectives. The vision and subsequent goals for the Net Zero Food System are on the right-hand side of the roadmap showing the direction of change. The top layer 'Why?' captures the relevant trends, drivers and market needs that influence and drive the change. To address these drivers, the value creation opportunities are typically shown in the middle layer 'What?' of the roadmap. And finally, the bottom 'How?' layer contains capabilities, technologies, and enablers required to realise the opportunities.

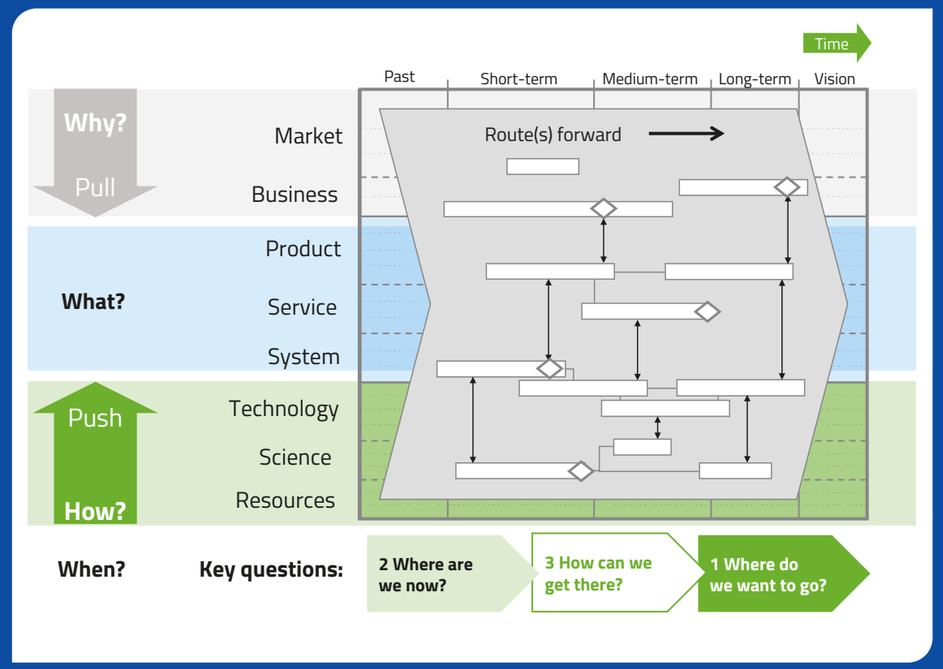


Figure 1: Roadmap structure (from IfM Engage)

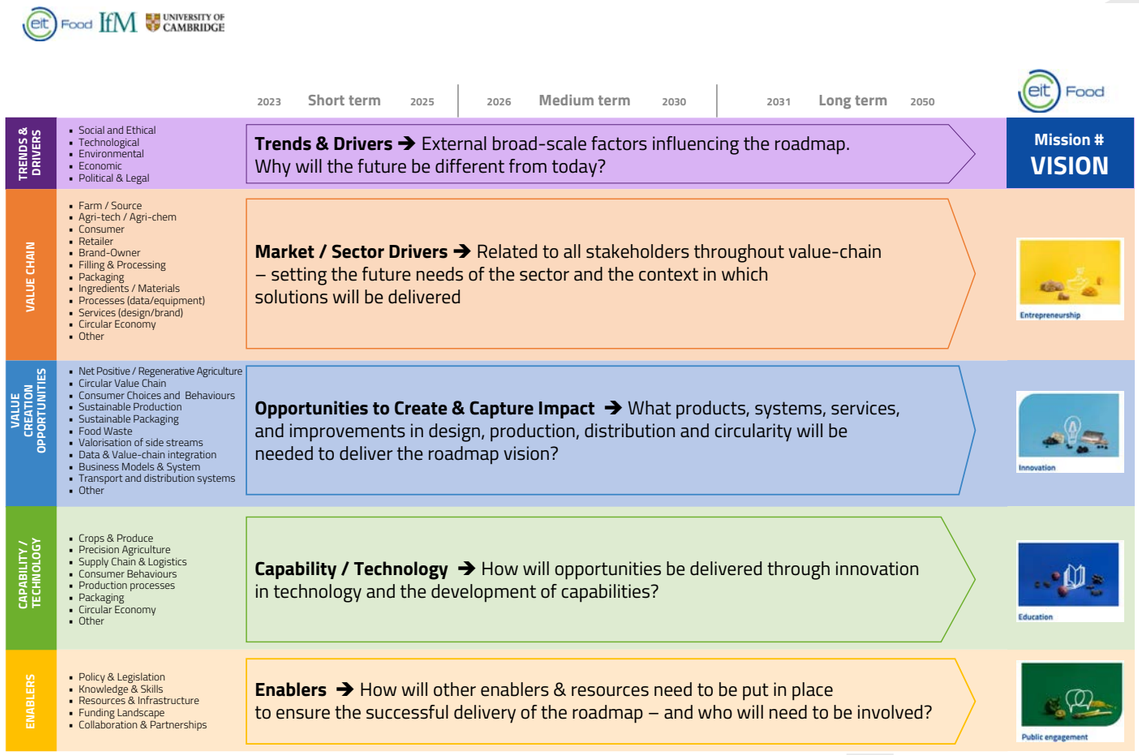


Figure 2: Roadmap landscape for Mission 2

Ideally, to prioritise different value creation opportunities a full business plan would be created and those that would make the best contribution to the bottom line are selected. But often, and especially for value creation opportunities in their early stages, there may simply not be enough valid information to do this, and time and resources are limited. IfM's portfolio prioritisation method provides a scoring and selection process for early-stage innovation ideas. It helps to evaluate those ideas using multiple impact and feasibility factors and not just financial criteria to reduce the uncertainty in decision making. Both dimensions were defined and are outlined in Table 1.

Table 1: Impact and Feasibility Factors for the roadmap to A Net Zero Food System

Impact Factors	Feasibility Factors
What is the contribution of the opportunities towards the vision for the Net Zero food system? **Impact factors:** ▪ Overall impact of this opportunity space across whole food/drink sector ▪ Potential to scale – Deliverable improvement of roadmap vision by 2030 ▪ Positive impact related to for example SDGs and other Missions ▪ Negative impact related to for example SDGs and other Missions	How likely are these opportunities to happen from the technical, market and regulatory point of view? **Feasibility factors:** ▪ Likelihood of Adoption across value chain Farm => Brand => Retail => Consumer => Circular ▪ Technical probability of success: Feasibility of key technologies and capabilities required ▪ Relevance of role for EIT Food in enabling pathway to impact through innovation, education, entrepreneurship, and public engagement ▪ Regulatory, legal, safety and governance

The portfolio prioritisation was done based on an individual assessment of all opportunity ideas and a group review of the scoring results and the selection of the priority opportunities. Figure 3. shows schematically how the results are presented. For mapping and evaluating the priority value creation opportunities, the topic roadmaps were utilised to describe the desired outcome including contribution to the Mission's vision, main implementation milestones, capabilities, technologies and enablers required as well as likely barriers, risk aspects and potential knowledge gaps.

The overall design process of the roadmap for the Net Zero System is shown in Figure 4. The comprehensive data collection took place through:

- Review of >150 academic and industry publications,
- Conduction of 20+ expert interviews,
- Collection of >160 survey responses,
- Identifying of ~50 case studies.

This data was used as an input to the roadmapping workshops. Workshops are a core element of the roadmapping process, bringing together key stakeholders to identify and explore exploitation routes for new/different ideas or research, support strategy formation, enable communication and formation of new networks, and build consensus for decision-making and action. The roadmapping workshop was delivered in December 2022 via two days in Paris, France with 30 participants from the international community consisting of academia, industry, and policy makers. This Mission 2 workshop took place in parallel to the workshops of EIT Food's other two missions "Healthier Lives through Food" and A Fully Transparent, Resilient & Fair Food System". The final stage of the process was a review of the opportunities across all missions, where delegates were able to comment, add information as well as indicate any cross-linkages between the missions.

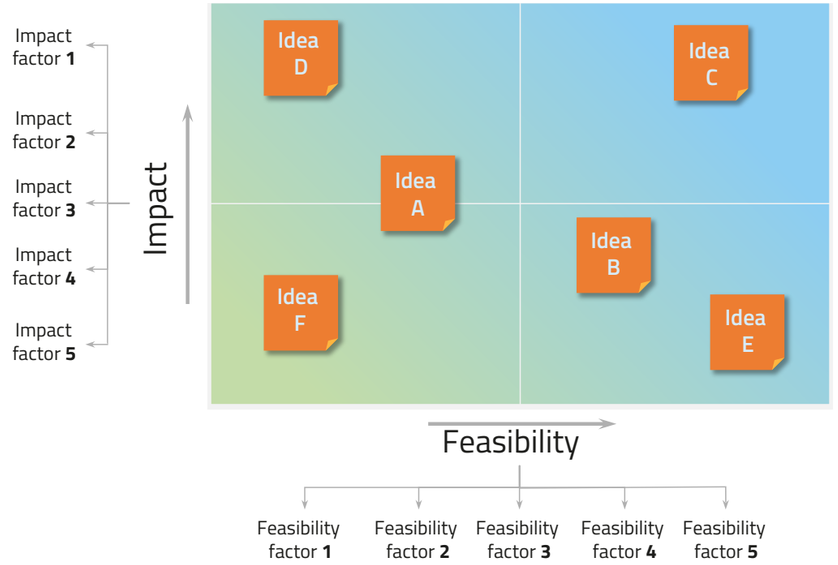


Figure 3: Prioritisation of the value creation opportunities

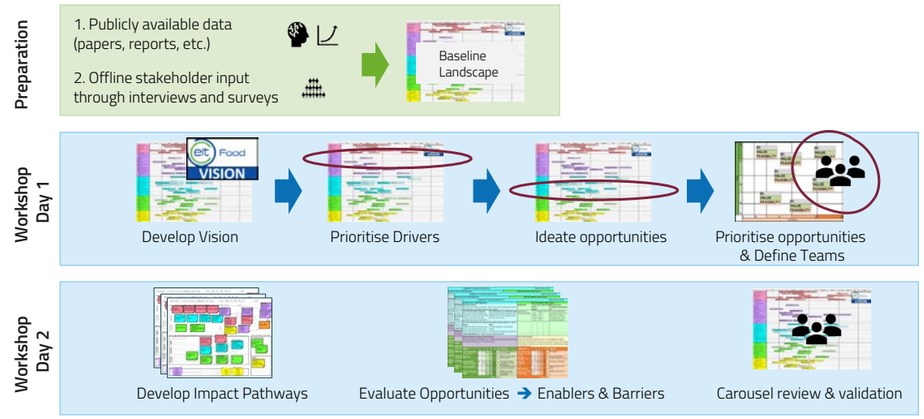


Figure 4: Overview of the roadmapping process

5.
Results

The findings of the roadmapping exercise for A Net Zero Food System provided the baseline and targets in the form of priority areas and KPIs regarding the scale and consequences of unmet societal and economic needs, answering the following key A Net Zero Food System mission area questions:

- Which sectors, products or processes should EIT Food prioritise and why?
- Which life cycle assessment (LCA) stages within those categories should EIT Food prioritise and why?
- Which environmental impact factors should EIT Food prioritise and why?

5.1 Scoping Priority Areas

The root cause of Greenhouse Gas Emissions in the Food System

Based on the review of the literature (full literature review in the appendix), the following sectors, products and processes have emerged as the key priority areas of action and transformation of the global food system to one that is Net Zero:

1. Agriculture, Livestock and Rice Production (produced globally and transported to Europe and specifically produced in Europe)
2. Food Loss and Food Waste
3. Food Packaging
4. Diversification of protein sources
5. Changing farmer and consumer behaviour
6. Life cycle analysis and monitoring of key environmental impact factors.

Agriculture, Ruminant Livestock and Rice Production

Agriculture is responsible for farm-level degradation of land (Sovacool et al., 2021; Ng'ang'a et al., 2019; Zingale et al., 2022; UK Government, 2020; Government of Ireland, 2022; Lwin et al., 2018; Modernel et al., 2016; Dressler et al., 2017) and relies heavily on natural resources such as soils, minerals, biomass and water. In particular, nitrogen inputs to agricultural soils and fertiliser application are of increasing concern and are cited as a major source of nitrous oxide (N_2O) emissions (Sovacool et al., 2021; Ng'ang'a et al., 2019; Lynch, 2019; Bhuiyan et al., 2021; Calabi-Floody et al., 2018; Antille et al., 2015; de Sousa et al., 2021; Abubaker 2021 Rajendran et al., 2021). Whilst land-use change, tillage and other agricultural practices which disturb the soil and release GHG's from the soil into the atmosphere.

Within the agricultural sector, **ruminant livestock production** is a significant contributor to methane (CH_4) emissions as a consequence of enteric fermentation, as well as additional methane and nitrous oxide (N_2O) emissions from animal excreta (Sovacool et al., 2021; Ng'ang'a et al., 2019; Pakseresht et al., 2022; de Sousa et al., 2021; Lynch, 2019; NFU, 2019; McNicholl, 2020; Janoskuti et al., 2022; KPMG, 2021; Khoshnevisan et al., 2021). Whilst feed production and processing is also a source of land-use change and GHG emissions. In particular, **beef** is the greatest contributor of GHG emissions within the animal-based food categories, accounting for 25% of emissions from the food sector. **Paddy rice cultivation** is the next greatest contributor to greenhouse gas emissions responsible for 12% of emissions from the global food sector (Xu et al., 2021;

Lynch, 2019) and the leading agricultural source of methane (Mboyerwa et al., 2022; Smartt et al., 2016). However, within Europe, paddy rice cultivation is not a significant source of GHG emissions as it is not widely grown within the region due to unsuitable climatic conditions and consumption is low in comparison to other regions. Of the 500 million tonnes of milled equivalent rice production across the globe, the EU produces 1.8 million tonnes, exports 0.2 million tonnes, imports 1.2 million tonnes and consumes 2.8 million tonnes (EC, 2019). Nevertheless, the European Union can play a role in supporting the global rice production system to reduce the associated GHG emissions by advocating for the adoption of climate smart cultivation and rice management practices. The greenhouse gas emissions associated with rice cultivation are mainly methane (CH_4), nitrous oxide (N_20) and carbon dioxide (CO_2) as a result of crop management practices, such as irrigation water management, crop variety selection and fertiliser management (Mboyerwa et al., 2022). Rice is grown under continuous flooded-soil conditions which creates an anoxic environment. As a result, methane from anaerobic decomposition is released into the atmosphere along with other GHGs. Rice production is cited as a key priority area within the literature (Bhuiyan et al., 2021; Arenas-Calle et al., 2019).

Following the literature review, the themes for addressing the GHG emissions and sustainability issues from the animal and plant-based farming could be categorised into three key areas (1) Low emission, carbon sequestration and sustainable farming practices to regenerate soils, boost productivity, reduce emissions and capture carbon; (2) Technology innovations to regenerate soils, boost productivity, reduce emissions and capture carbon (3) Source of biomass for energy with carbon capture and storage.

(1) Low Emission, Carbon sequestration and Sustainable Farming Practices

Within the agricultural sector, low emission, carbon sequestration and sustainable farming practices represents an effective solution to regenerate soils, increase productivity, increase the environmental performance of farms and tackle emissions generated from the agricultural and food system (Toensmeier, 2016). Roe et al., (2021) reveal that combining carbon sequestration with low-emission agricultural practices could reduce CO_2 equivalents by 10.5Gt every year. Low emission, carbon sequestration and sustainable farming practices in agriculture typically combine sustainable land management practices (e.g., silver pasture, agroforestry and the use of perennial crops) (Toensmeier, 2016), with strategies to reduce emissions (e.g. fertiliser strategies, reduced fuel usage and the use of green renewable sources of energy) (Baaken, 2022; Hjorth et al., 2022; Zingale et al., 2022; Abubaker, 2021; Bhuiyan et al., 2021;). In particular, Roe et al., (2021) estimate that agroforesty has the technical potential to sequester approximately 11.2 $GtCO_2$ every year. However, only 20% of this potential is considered cost effective today (Jr et al., 2022). In ruminant livestock production, the low emissions, carbon sequestration and sustainable farming practices cited within the literature extended to manure and nutrient management; animal feed management; animal health and husbandry management; and animal breeding and farm level genetics to improve fertility, increase longevity, age of first calving and animal health. The low emission, carbon sequestration and sustainable farming practices cited throughout the literature are displayed in Figure 5.

A necessary part of the change towards reducing GHG emissions and carbon sequestration strategies will be the pricing of carbon (Burke et al., 2019). Additional revenue from carbon farming could help farmers fund the negative emissions technology required to achieve Net Zero (Burke et al., 2019). Regarding agriculture and land use, the literature indicates that carbon prices could be levied on sources of emissions, such as red meat and fertiliser usage (Burke et al., 2019). Notably, carbon leakage, whereby countries reduce carbon CO_2 at the national level but import goods from countries with poorer environmental and welfare standards without a measurement of GHG emissions, was highlighted as a significant concern (BCG Nordic Net Zero project, 2022; Zubairu et al., 2022; FACT Dialogue, 2022).

(2) Technology innovations to regenerate soils, boost productivity, reduce emissions and capture carbon

The literature also outlined opportunities related to the use of new innovative technologies to help reduce GHG emissions and land-use change, contribute to carbon sequestration and increase productivity and yield. Examples included:

- Methane capture
- Novel feed additives
- Anaerobic digestors to better recycle nutrients
- Robots to help reduce labour and increase productivity
- New breeds and gene editing
- Novel plants
- Vertical farms
- Precision livestock farming
- Plant and soil microbiome technology
- Plant growth promoting bacteria (PGPB)
- Sensors and photovoltaic panels in irrigation
- Supercritical fluid extraction (SFE) for recovery of phenolic antioxidants
- Extraction of thermally necessary functional bioactive components for food
- Biofertilisers, adjusting fertilisation to crop needs, controlled release fertiliser, fertiliser with urease inhibitors, organic soil amendments application, deep placement of fertiliser, fertiliser mixed with amendment, nitrification inhibitors and non-urea-based fertilisers
- Phytoremediation, tannery effluent treatment using plants and products

(3) Source of biomass for energy with carbon capture and storage

Studies also referred to agricultural, forestry, and municipal residues as sources of biomass for bioenergy with carbon capture and storage (BECCS), but there are limitations on the scale of bioenergy production using these sources (Babin, 2021; Mirana et al., 2021; Kumari and Singh, 2018; Wang et al., 2018; Filoso et al., 2017; Cao et al., 2019). There are also additional limitations to BECCS, such as competition with other land uses, e.g., food growth and water consumption (Babin, 2021; Costa et al., 2022; Ren et al., 2019; Panigrahi and Dubey, 2019) and the potential impact on food security.

Figure 5: Low emission, carbon sequestration and sustainable farming practices from the literature

Low Emission, Carbon Sequestration and Sustainable Farming Practices

Land Sharing | Land Sparing: Several land use and agricultural policies exists to help the sector reduce GHG emissions and reach sustainability goals. Land sharing and land sparing have been proposed as two different strategies to reconcile agricultural and conservation agendas, in which agriculture is often a cause of biodiversity loss (Grau et al., 2013). Land sharing refers to the co-existence of land for agricultural production and land used for conservation, which land sparing encapsulates land separation of intensive agriculture and areas using the conservation of biodiversity (Grau et al., 2013). Parts of agricultural land under a land sparing policy should be taken out of production and used to promote biodiversity (Grau et al., 2013). Critics of these policies have identified that these policies, while they consider production and land scarcity, they do not consider food security (Fischer et al., 2013).

Sustainable Intensification: Sustainable Intensification (SI) is also proposed as a strategy to achieve food security and prevent additional loses of biodiversity (Struik and Kuyper, 2017; Gassman and Grassini, 2020). Sustainable intensification is described as "a process or system where agricultural yields are increased without adverse environmental impact and without the conversion of additional non-agricultural land" (Pretty and Bharucha, 2014). However, alternative variations of SI have also been put forward, these include de-intensification within high-input systems and another encompassing and increasing in inputs where both yield and inefficiencies' are high (Stuik and Kuyper, 2017).

Agroforestry / Integrated systems: Agroforestry offers a viable solution to mitigate GHG emissions through carbon sequestration, while maintaining agricultural productivity (Yousefpour et al., 2020; Yeboah et al., 2021). Integrated crop-livestock-forest systems especially eucalyptus plantations produce less N20 emissions (de Sousa et al., 2021).

Crop diversification: Crop diversification, whereby one crop is substituted for another and changing crop rotation is a cost-effective strategy of diversifying the system (Aryal et al., 2020), while also reducing GHG emissions (Baaken, 2022).

Perennials: The planting of perennial crops, which help to protect the soil from erosion and improve the soil structure. They can also support nutrient retention, carbon sequestration and water infiltration. Use of perennials found to have a consistently positive impact on reducing emissions (Baaken, 2022).

Cover crops: Cover crops increase the carbon sequestration potential of soils (Abdalla et al., 2019; Jordon et al., 2022), reduce nitrogen leaching, reduce N20 emissions (Abdalla et al., 2019), while also improving soil health (Baaken, 2022). Cover cropping can increase soil organic carbon stocks by 10 tonnes per ha within 30 years of adoption, sequestrating 6.5 and 2.1-10.6 megatonnes of CO2 per year (Jordan et al., 2022).

Crop rotation: Crop rotation, such as those incorporating grass-based leys into arable rotations can also increase soil carbon stocks (Ng'ang'a et al., 2019; Jordan et al., 2022).

Tillage Systems: Minimum conservation and zero-tillage were highlighted as asoil carbon enhancing strategy whilst reducing GHG emissions (Yeboah et al., 2021; Aryal et al., 2020; Ng'ang'a et al., 2019; Baaken, 2022; de Sousa et al., 2021; Vazquez-Roew et al., 2019).

Biochar Application: The use and application of biochar for animal feeding, manure treatment, as a fertiliser component or direct soil application (Schmidt et al., 2022; Baaken et al., 2022; Terlouw et al., 2021; Kumar et al., 2021; Zabaniotou and Kameterou, 2019).

Water Management and Irrigation Optimization: Water management, particularly in rice paddies (Jr et al., 2022). Optimal irrigation brings water and nutrients to crops in the right quantity and ensures consistent yield whilst reducing GHG emissions.

Manure and Nutrient Management: Managing, storing and applying manure and nutrients in a responsible and sustainable manner. There are also opportunities in regard to the use of, and technologies related to, fertilisers to reduce GHG emissions – precision fertiliser application techniques. Strategies include adjusting fertilization to crop needs, controlled release fertilizer, fertilizer with urease inhibitors, organic soil amendments application, deep placement of fertilizer, fertilizer mixed with amendment, nitrification inhibitors and non-urea-based fertilisers (Baaken, 2022; Bhuiyan et al., 2021; Abubakar, 2021; Zingale et al., 2022; Vázquez-Rowe et al., 2019).

Animal Management: Animal feed management, animal health and husbandry and animal breeding and farm level genetics to improve fertility, increase longevity, age of first calving and animal health.

Food Supply Chain

Across the food supply chain, 18% of GHG emissions occur as a result of food processing (4%), transport (6%), packaging (5%) and retail (3%) (Poore and Nemecek, 2018). Interestingly, many assume eating local is the key to a low-carbon diet. However, whilst transport emissions are important and efforts should be in place to reduce emissions related to food transportation, they are often only a small percentage of the overall emissions, with food loss and waste responsible for a large proportion of emissions across the supply chain, a priority area for action (Poore and Nemecek, 2018).

In addition to food waste and food loss in the supply chain, the packaging sector has emerged as playing a key role in the sustainability of the food system. A study by Crippa et al., (2021), used the EDGAR-Food emissions inventory to break down the emissions from each stage of the food chain from 1990 to 2015. The results revealed that food packaging contributed approximately 5.4% of food emissions which was more than "food miles" responsible for 4.8% of GHG emissions. Therefore, it is important that packaging moves from a linear model towards a circular system where value can be captured in the system and out of the environment (WRAP, 2022). Active packaging can help to reduce plastic, cardboard, and glass, while innovations such as edible coatings are also important and smart labels can identify to the consumer when food is contaminated or spoiled (Sovacool et al., 2021); and biodegradable packaging is another opportunity area (Miranda et al., 2021).

Food Loss and Waste

In 2011, the Food and Agriculture Organization (FAO) estimated that one-third of the annual food produced for human consumption was either wasted or lost (FAO, 2011). This accounted for 24% of freshwater use, 28% of total global cropland area, 23% of global fertiliser use and approximately 8% of total GHG emissions (Do et al., 2021). It is a notable and worrying cause of GHG emissions, environmental degradation and food insecurity. Worryingly, data from a more recent report from WWF and Tesco (2021), Driven to Waste, indicates that in fact over 40% of food produce is lost or wasted, 1 billion more tonnes than originally thought, with a contribution of approximately 10% of all GHG emissions. This *Driven to Waste* report estimates that over 2.5 billion tonnes of food is lost or wasted, with 1.2 billion tonnes of food lost at the farm (WWF, 2021), 436 million for post-harvest up to but not including retail (based on calculations from FAO, 2019) and 931 million tonnes lost in retail, food service and consumer homes (UNEP, 2021) every year.

Food loss at the farm level is driven by a multitude of factors (biological and environmental factors; agronomy, animal husbandry and fishing practices; technology and infrastructure; human factors; and market structure, governance, investment and fair trade) (WWF, 2021). At present, the current food system separates farmers from the end market which can lead to mismatches in supply and demand and timing of harvesting (WWF, 2021). To date, interventions to tackle food waste have concentrated on the consumers, but this new data from the *Driven by Waste* report provides clear evidence and a strong case for a focus on farm-stage food loss, which should not be overlooked. A number of publications indicate that in developing countries food loss or food waste is more likely to occur at post-harvest, while among industrialised countries

behaviour and associated household waste is responsible for the majority of food loss or waste (Sovacool et al., 2021; Do et al., 2021; Kafa and Jaegler, 2021; Redlingshöfer et al., 2020; National Food Strategy, 2021; Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) Germany, 2016; Federal Ministry Republic of Austria, 2019). However, the latest per capita farm loss data from the WWF (2021) report argues that high- and middle-income countries of Europe, North America and industrialised Asia contribute 58% of global harvest losses and low-income countries contribute 54% of global post-harvest farm stage loss. Regardless, food loss in the supply chain, particularly on farms, remains neglected in comparison to efforts at retail and consumers, mainly due to the difficulty in measuring loss and progress, presenting an opportunity for reducing GHG emissions in our food system. The WWF (2021) reveals the volume of waste on farms is largest for fruit and vegetables (449 million tonnes), followed by roots, tubers and oil crops (261 tonnes), meat and animal products (153 tonnes) and cereals and pulses (196 tonnes).

The UN Environment Programme's (UNEP, 2021) Food Waste Index takes a closer look at food waste in retail, food service and consumer homes. This report revealed that within Europe, the largest amount of food waste occurs in France and Germany, both with 5–6 million tonnes per year; whilst the largest food waste per capita in Europe occurs in the United Kingdom and Spain, at 77kg per capita. Overall, household per capita food waste generation is found to be broadly similar across country income groups, suggesting that action on food waste income is equally relevant in high, upper middle- and lower-income countries. It is important to note that methodologies and confidence level across countries varies when making comparisons on food waste across Europe and beyond. A key recommendation from the report was the need to improve the food waste evidence base and methodologies and disaggregate estimates of food waste into edible and inedible parts when undertaking food waste measurements as this would support policymakers in terms of the balance of policies focusing on food waste prevention and on circular uses of less commonly eaten and inedible food parts (UNEP, 2021). In terms of food waste, a study carried out by the European Commission in 2018, estimates that up to 10% of food waste generated annually in the EU is linked to date marking. The Farm to Fork Strategy has called for the revision of EU rules on date marking, as consumers commonly misinterpret "use by" and "best before" dates. The European Commission (2018) also reveals that how date marking is utilised by food business operators and regulatory authorities in managing the supply chain also impacts on food waste. This includes: the decision to use use-by or best before date marking when setting the products' shelf-life; market practices re the amount of shelf life demanded by retailers on product delivery; and national legislation on the distribution and use of foods beyond their best before date (EC, 2022). Tackling waste at the retailer, food service and consumer level is important because the further along the supply chain the loss or waste occurs, the more carbon intensive the loss and waste (EUFIC, 2022).

In 2015, the FAO reviewed the contribution of different food commodities to food loss or wastage and the associated carbon footprint. The FAO (2015) estimated that cereals contribute over 30% to the carbon footprint of total food loss and food waste; while vegetables and meat both contribute just over 20% each. Milk, fruit, starchy roots, and fish and seafood add an additional 5% each to the carbon footprint of total food waste and loss (FAO, 2015).

Together, food loss and waste prevention are a root cause of GHG emissions and sustainability issues in our food system. A reduction of food loss and food waste at primary production and by consumers; and valorisation of side streams as well as recycling are key priority areas within the food system. End-of-use and waste should also be addressed by recovery, e.g. recycling and anaerobic digestion of food waste and waste-to-energy technologies.

Food Specialisation

There are three systems that produce most of our food, using about 40% of the world's land. These are: cropland to produce grains (primarily rice, wheat and corn); rangelands, pastures and feedlots (to produce meat and meat products); and fisheries and aquaculture (to provide fish products). These three systems rely on a small number of plant and animal species. For example, of the estimated 30,000 edible plant species, just 14 supply about 90% of the world's calories (Miller an Spoolman, 2018). In particular, over half of the global population is estimated to survive primarily on eating three crops: rice, wheat and corn. This is worrying as such food specialisation violates the biodiversity principle of sustainability whilst intensive agricultural food production and the associated land use, dependence on natural resource, heavy equipment and application of fertilisers and pesticides, among other factors within agriculture and primary food production, are a significant cause of GHG emissions in the food system. Meanwhile, the over exploitation and depleting fish stocks are of concern (McKenzie et al., 2004; Black et al., 2021; Prata et al., 2019). As a result, a priority area for reducing GHG emissions is diversified protein production and consumption to complement and support the agricultural sector in feeding a growing population and meeting increasing demands for protein. A number of different solutions and technologies were identified including: plant diversification, aquaculture and algae biotechnology (El-Sayed, 2021), and cellular agriculture (Sovacool et al., 2021).

Enablers for a Net Zero Food System

To tackle the root cause of GHG emissions and sustainability issues within our food system a range of environmental, social, technical, economic and policy aspects need to be addressed to facilitate the shift towards a Net Zero food system. Of course, it will also need to be accompanied by progress in other sectors, such as the energy sector. In terms of the food system, the key enablers that emerged from the scoping exercise included:

Behaviour Change

Underpinning the key priority opportunities for a Net Zero food system is behaviour change. The farmer needs to adopt the low emission, carbon sequestration and sustainable farming practises for the reduction of GHG emissions and increased environmental performance of the food system to be realised. On the other hand, consumers are responsible for a large amount of food waste in the system and will be a key player in the acceptance and consumption of diversified protein products in order for them to complement the agricultural sector to feed a growing population.

Farmer: Understanding farmer adaptation behaviour is key to realising the economic benefits of strategies, changing gender roles and social norms, raising education, and increasing climate change awareness (Aryal et al., 2020). More research is also required to explore the yield aspects and profitability of mitigation measures to promote behavioural change amongst farmers (Kumar et al., 2021).

Consumer: Among industrialised countries consumer behaviour is responsible for a significant amount of food loss/waste (Sovacool et al., 2021; Do et al., 2021; Kafa and Jaegler, 2021; Redlingshöfer et al., 2020; National Food Strategy, 2021; Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) Germany, 2016; Federal Ministry Republic of Austria, 2019). Furthermore, at the consumption level, carbon-intensive diets are also cited as a contributor of GHG emissions (Sovacool et al., 2021; Chai et al., 2019; Payne et al., 2016; Ridoutt et al., 2017). Therefore, diversification of protein is a key strategy. This may involve consumer diets that have smaller carbon footprints, as well as alternatives to meat produced from cellular agriculture, such as products from 'Beyond Burger' or 'Impossible Burger' (Sovacool et al., 2021). In terms of energy production, red meat, poultry, breads, and biscuits are the most intensive while soft drinks, fish, oil, and fats are the lowest energy intensity (Sovacool et al., 2021). Red meat, such as beef and pork have a carbon intensity of 2.58 kg CO_2eq per dollar, while fruit and vegetables have carbon intensities of 0.54 and 0.73 kg CO_2eq per dollar (Sovacool et al., 2021).

Data and Measure, Report and Verify Processes

An overarching limitation across all studies was a lack of a consistent and standardised approach for measuring, reporting and verifying data on GHG emissions, environmental performance and life cycle analysis. For example, in relation to the carbon footprint process, there is no standardisation to address double counting and finances; or ability to robustly and reliably compare data generated from different institutions (Robinson et al., 2018). Presently, there is insufficient data to assess the impact of agricultural practices on CO_2 emissions (Baaken, 2022), as well as understanding the environmental impact of carbon dioxide removal technologies (Terlouw et al., 2021). Current life cycle assessment methodologies often do not account for the nutritional composition of foods (Zingale et al., 2022). Ultimately, there is insufficient robust data available to fully address important questions regarding the climate impacts of agricultural production and there are calls for researchers to include separate GHG emissions and environmental performance indicators in addition to aggregated CO_2 footprints (Lynch, 2019).

Strong Leadership

Strong leadership by local government (Dawkins et al., 2019; Cameron et al., 2021; International Energy Agency, 2021; Ibn-Mohammed et al., 2021) as well as strong policy support are needed for new technologies in the agrifood sector (Babin, 2021; McKinsey Sustainability, 2020; International Energy Agency, 2021; Boussemaere et al., 2015). There also needs to be an increase in guidance, political will, and reduction of political barriers to generate the needed changes (Dawkins et al., 2019; Wassie & Adaramola, 2019; Ministry of Economic Affairs and Climate Policy, The Netherlands, 2019). Good stakeholder engagement is also a critical requirement (Dawkins et al., 2019; Mendes and de Souza, 2020; Zhang et al., 2017).

Policy Instruments

In terms of the policy instruments that can be utilised to achieve a Net Zero food system financial subsidises for innovation, tax incentives to encourage sustainable practices, carbon prices, as well as environmental and pollution taxes emerged as important (Miranda et al., 2021).

Decarbonisation of the energy sector

Decarbonisation of the energy sector including green energy and energy reduction will be important. The energy sector has already made strides towards reaching Net Zero and it will be important for the food system to utilise these green and renewable energy sources (Ghadge et al., 2019; Gruda et al., 2019; International Energy Agency, 2022; Kwon et al., 2022). Renewable energy includes solar and hydro-powered energy and energy generated from recycled material as well as the use geothermal, biomass fuels, biogas energies for heating and photovoltaics and wind for electricity generation). The energy sector should also make better use of roofs and car parks for solar panels and other waste-to-energy technologies, rather than using agricultural land.

In addition, agricultural, forestry, and municipal residues were cited as sources of biomass for bioenergy with carbon capture and storage (BECCS), but there are limitations on the scale of bioenergy production using these sources (Babin, 2021; Kumari and Singh, 2018; Wang et al., 2018; Filoso et al., 2017; Cao et al., 2019). There are also additional limitations to BECCS, such as competition with other land uses, e.g., food growth and water consumption (Babin, 2021; Costa et al., 2022; Ren et al., 2019; Panigrahi and Dubey, 2019).

There are a range of key points in the food value chain where decarbonisation can occur. In regards, to farm level decarbonisation, the focal points relate to fertiliser and livestock emissions, while for food manufacturing and processing, the energy and water consumption are a key concern. At the retail and distribution level efforts to decarbonise should focus on reducing food and packaging waste, onsite energy consumption, as well as the transportation of foods by reducing food miles and considering the method of shipping. Regarding user practices and consumption, the priority is again reducing food and packaging waste, promoting diets that are less carbon intensive, as well as addressing energy usage associated with food preparation (Sovacool et al., 2021).

Funding

Strategies also need to be economically viable and profitable to be adopted and implemented (Gruda et al., 2019; Kumar et al., 2021; El-Sayed, 2021; Jordan et al., 2022). Attention should also be paid to the generation of investment funds and improvements in funding to remove the financial barriers preventing the adoption of adaptation and mitigation measures (Aryal et al., 2019; Dawkins et al., 2019; Wassie and Adaramola, 2019).

Environmental Impact Indicators

From the literature review, GHG emissions emerged as a key indicator of the environmental impact of sectors, products, and processes. Emissions of the following GHG's emerged as the most concern: carbon dioxide, nitrous oxide and methane (Gruda et al., 2019; University College London and HSBC, 2021; Nestlé, 2021; Kaaret et al., 2021; Hellenic Republic Ministry of the Environment and Energy, 2019; ŞAHİN et al., 2021). Studies focused predominately on climate change and GHG emissions when quantifying the environmental impacts of diets with many studies not considering changes to carbon stocks, land or water usage (Ridoutt et al., 2017). While GHG emissions are an important metric to assess for some areas of the food system, they do not offer a complete picture of the entire food system (Ridoutt et al., 2017). Soil, water, and biodiversity are critical components of environmental sustainability and should also be used to assess environmental impact as the food sector, especially agriculture, has ramifications for each of these indicators (Baaken et al., 2022; Zingale et al., 2022; Zabaniotou & Kamaterou, 2019). Furthermore, conservation of biodiversity, especially in regions with tropical rainforests, as well as the conservation of carbon stocks in soils are listed as mitigation measures to climate change (Abubakar et al., 2021). This study therefore proposes that to fully assess the environmental impact of food production, GHG emissions, water scarcity, biodiversity loss, and climate change should all be prioritised. The full list of priority impact factors emerging from the literature are presented in Table 2.

Table 2: Summary of priority environmental impact factors emerging from the literature

Biodiversity:
Throughout the literature, agriculture and the rest of the food system are cited as the cause of land degradation, natural habitat destruction and biodiversity losses (Zingale et al., 2022). Therefore, improvements in biodiversity will be a key metric in which to measure the environmental impact of strategies. This is supported by findings of the literature review.

Soil health and soil carbon sequestration:
Concentrations of soil macronutrients; nitrogen, phosphorus, potassium, pH, and soil compaction are indicators of soil health (McGuire et al., 2022). Soil organic carbon (SOC) is also a predictor of the carbon sequestration potential of soils – a vital component to measuring a carbon net balance for food production.

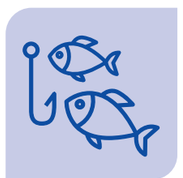
Energy:
Use of renewables, such as wind and solar, biomethane, electricity from anaerobic digestion were cited as essential in ensuring the energy used by the food system isn't contributing to the sector's emissions. Consequently, the proportion of energy used by companies, businesses, and countries coming from non-renewables sources should an indicator of environmental impact.

Water scarcity and use:
Poor water management is listed as a significant cause of GHG emissions and sustainability issues in the food system by survey respondents and literature review (Filoso et al., 2017; Ridoutt et al., 2017). Survey respondents also felt having water management was an urgent need for a Net Zero food system and is cited in the top 10 market needs.

Air Pollution:
Air pollution which can also impact the health of people, animal, and the overall quality of food (White et al., 2013). A main cause of air pollution is the burning of fossil fuels for energy use and production (Mackenzie and Turrentine, 2021), therefore, declines in air pollution will reflect whether GHG emissions are decreasing to Net Zero.

Water pollution and acidification:
Acidification of oceans can be used as an indicator of atmospheric concentrations of CO_2 (Sunda and Cai, 2012; Hurd et al., 2018). Eutrophication of water, caused by inputs of nutrients from fertilisers, animal manure and human waste, as well as CO_2 from the burning of fossil fuels have led to algal blooms in coastal waterways (Sunda and Cai, 2012). Thus, a decrease in water pollution will coincide with declines in GHG emissions.

Land use:
Land use change which can lead to deforestation, habitat loss, ground pollution and have an adverse effect on food production and distribution. To achieve the UK's 2050 emissions reductions target, 20% of existing land use for agricultural land should be converted to forestry, used for bioenergy, peatland, and for the diversification of land use (CCC, 2019). Thus, land use change can be used as an indicator to identify whether mitigation strategies have taken effect.



Monitoring fish stocks:
Overfishing and overharvesting reduces the availability of wild-caught fish, leading to food insecurity and disruption of the ocean's ecosystems. Therefore, fish stocks should be monitored to identify depletion and sustainable consumption (Boyd and Charles, 2006). In addition, the Marine Stewardship Council (MSC) requires fisheries to evidence that fish stocks are recovering where stocks have become depleted as part of their sustainable fish stocks strategy (MSC, 2023).

Ozone depletion:
Gases causing ozone depletion are potent GHGs. Therefore, reducing emissions associated with substances causing ozone depletion will protect the ozone layer and reduce further warming (European Environment Agency, 2022).

Ammonia emissions:
In addition to its carbon footprint, nearly 90% of global ammonia emissions are emitted from agricultural sources, including ammonia-based fertilisers and animal manure (Ma et al., 2021). At a European level, livestock farms are the principal emitters of ammonia – accounting for 90% of ammonia emissions of the agricultural sector (EEA, 2018).

Summary of scoped priority opportunities for a Net Zero Food System

Deforestation, depleting natural resources, over exploitation of the wild fisheries, dependence on fossil fuels, intensive agriculture production, GHG emissions, changing weather patterns and extreme weather events are some of the key drivers of the need for a Net Zero food system. Unsurprisingly, the published and grey literature retrieved during the scoping exercise were heavily related to the agricultural and primary production sector. This correlates with the fact that 80% of the carbon footprint and the opportunity to sequester carbon is at the farm gate, presenting a key opportunity for the transformation of the food system. Additional opportunities scoped from the literature for a Net Zero food system also included: food loss and food waste; food packaging; and moving away from food specialisation to diversified protein sources. The strategies and technologies needed to transform the food system already exist, but the pace of emissions reduction and addressing sustainability issues in the food system remains slow. The agriculture and the food sector are in danger of being left behind as many sectors, such as the energy sector, have identified the key technologies and a pathway that will ensure emission reduction (Ahmed et al., 2020). Education, behavioural change, and robust measures, report and verification processes; enabled by strong leadership, funding and fit-for-purpose policy will be vital to drive the transformation and ensure the agricultural sector and the food system can achieve Net Zero by 2050.

Overall, the most impactful areas to prioritise in the food system, which emerged from the scoping exercise, included:

1. Improving sustainable agriculture and fishing practices: adopting low emission, carbon sequestration and environmentally sustainable agriculture practises such as regenerative farming which can reduce the use of fossil-based inputs (fertilisers, diesel…) and increase or sequester carbon in soil. The health of our soil is fundamental to the delivery of essential ecosystems services, agricultural productivity, food security and environmental welfare (e.g. ecological integrity and conservation, crop nutrition, carbon sequestration (balancing) and animal welfare etc.). Moreover, soils should be an integral part of new agricultural policies at the national and pan-European level. Increasing SOC is beneficial for food productivity as well as many important ecosystem services, such as soil carbon storage, water holding and biodiversity. Globally, increasing SOC by 1 mgC/ha may result in a potential increase of 30 to 50 million tonnes of food per year in developing countries (McGuire et al., 2022). The opportunities for sustainable agriculture and fishing which emerged from the scoping exercise included:

- Robust research into the impact of different farming practices which reduce emissions, sequester carbon and improve environmental performance as there is limited scientific studies which clearly demonstrate the ability of the strategy to reduce GHG emissions and improve sustainability
- Understand, educate and drive behaviour change towards low-emission, carbon sequestration and environmentally sustainable farming practices (e.g. agroforestry, silver pasture, no-tillage, biochar application, fertiliser strategies, nutrient management and regeneration of degraded and nutrient depleted soils etc.)
- Improved farm management practices in livestock production, including grazing and animal feeding management, animal health and husbandry, breeding and manure management
- Supporting regions which produce rice for European consumers to adopt climate smart rice cultivation and rice management practices (including nitrogen fertilisation and improved water management in rice paddy fields) and the scaling of new technologies which reduce emissions for rice paddy fields (e.g. plant and soil microbiome technology)
- Scale new technologies to reduce and/or capture enteric methane and nitrous oxide emissions (e.g. inhibitors, feed additives, methane capture)
- Scale solutions for precise fertiliser use and reduced chemical inputs onto agricultural soils
- Reduce energy usage, increase energy efficiency and use renewable energy sources

2. Further to point 2, carbon credit markets are being developed around the world and will help drive the sequestration of carbon by farmers through monetary incentives. It is, however, imperative that the right market regulations and standards are in place to ensure awards and retention of credits where credit is produced.

3. Promoting sustainable food systems: encouraging the development of local, regional, and short food systems which can reduce the distance for food and raw materials to travel and hence reduce the overall GHG emissions due to transportation of food.

4. Reduce the usage of fossil-based material in the production of food along each stage of the food systems: packaging in all stages of the food system uses fossil-based materials and the removal or use of fossil-free materials will contribute towards a Net Zero food system.

5. Creating a circular food packaging value chain – reduce, reuse, refill, recycle

6. Reduction and valorisation of food loss and waste along the food supply chains, including the consumer. Up to 40% of food produced globally is lost or wasted which contributes to significant GHG emissions from production, transportation, and food disposal. The opportunities which emerged included: tools and interventions to reduce the level of food loss and waste from farm-to-fork, packaging innovations to improve shelf-life; accelerate and scale waste to energy technologies; and consumer education and behaviour change to reduce food waste.

7. Data and value-chain integration, and robust and standardised measures. Also, reporting, verifying MRV methods for life cycle analysis, greenhouse gas emissions and environmental impact indicators.

8. Changing dietary patterns: shifting towards a more diverse plant-based diet and reducing consumption of meat and dairy products, both actions will have the highest impact on the environment and in the Net Zero agenda (IPCC, 2022). Opportunities that emerged included interventions to encourage behaviour change; the need to conduct robust research into the GHG emissions environmental performance of new technologies for diversified protein production (e.g. vertical farming, cultured meat, recirculating aquaculture systems, algae biotechnology); accelerate and scale diversified protein production; and understand how to drive consumers to diversify their food choices towards less carbon intensive diets and diversified protein sources, particularly in Western Europe. It is important that recommendations for consumer diets should be informed by robust scientific evidence and consider not only the environmental footprint of the food, but also consider the nutrient density of foods. This recommendation has a clear link with EIT Food Mission 1: Healthier Lives Through Food.

9. Investing in renewable energy along the supply chain: transitioning towards renewable energy use along production, processing, transportation, and distribution can greatly reduce the overall carbon footprint for each food product.

Notably, while agriculture is a contributor of GHGs and associated environmental degradation, it is also a sector that can sequester carbon in both the soil and above ground biomass (Toensmeier, 2016). Thereby, not only being part of the problem, but simultaneously being part of the solution (Lynch et al., 2021). It is vital to establish a roadmap for a Net Zero food system and that the sector is supported to move together to achieve Net Zero targets. Social movements are also incentivising individuals, governments, countries and global entities to transform the current system (Costa et al., 2022; Benton and Harwatt, 2022; EU Commission, 2020).

5.2 Shaping Priority Areas

The online questionnaire and in-depth interviews on A Net Zero Food System, collected views, knowledge and inputs from different stakeholders across the food system in order to help rank, assess and shape the priority areas of opportunity. The results are summarised below. Full survey results are available in the appendix.

Survey results

A total of 305 individuals opened and started the questionnaire on *LimeSurvey,* of which 166 completed the questionnaire and were eligible for data analysis. Full demographic information on the participants is available in the appendix. Over 40% of respondents identified the following factors as a very significant root cause of GHG emissions and sustainability issues within the food system: deforestation for food production; policy and governance; food waste; conversion of land for food production; intensive industrialised food production systems; and international food supply chains. In particular, deforestation for food production stood out as a significant root cause of GHG emissions and sustainability issues within the food system with over 70% of respondents highlighting it as very significant.

Figure 6: The root causes of greenhouse gas emissions and sustainability issues in the food system

The Top 5 greatest trends and drivers influencing a Net Zero food system, in the short term (2023–2025) include: social media and influencers; war and conflict; rampant inflation and increases in non-food expenditure; labour and skills availability; and the cost and availability of cheap fossil fuel energy. In the medium term (2025–2030), the greatest trends and drivers influencing a Net Zero food system included: the use of crops for energy and non-food materials; a movement towards locally sourced goods; growing middle-class populations; rapid urbanisation and growth of megacities; migration of people to other regions; and increasing social innovations. Whilst in the longer term (2030–2050): a growing population; the use of crops for non-food materials; availability of water and land; climate change; and new technologies are projected to be the top 5 trends and drivers influencing a Net Zero food system (Figure 7).

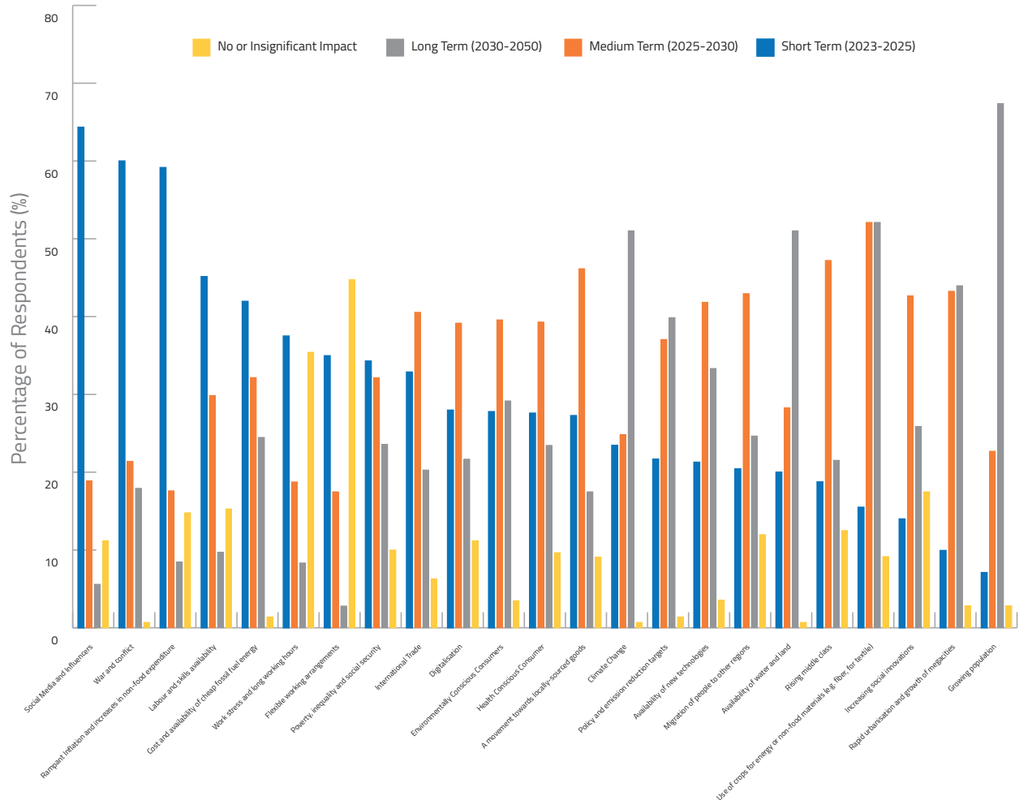


Figure 7: Trends and drivers influencing a Net Zero food system in the short (2023–2025), medium (2025–2030) and long term (2030–2050)

The participants also ranked the urgency of the market needs in relation to a Net Zero food system. Over 60% of the respondents ranked the following market needs as urgent (2023–2025): food waste reduction; sustainable farming techniques; evidence-based policy and governance; water management; consumer education, environmentally friendly alternatives; and resource efficiency. The full list of market needs, and the urgency of the need are illustrated in Figure 8.

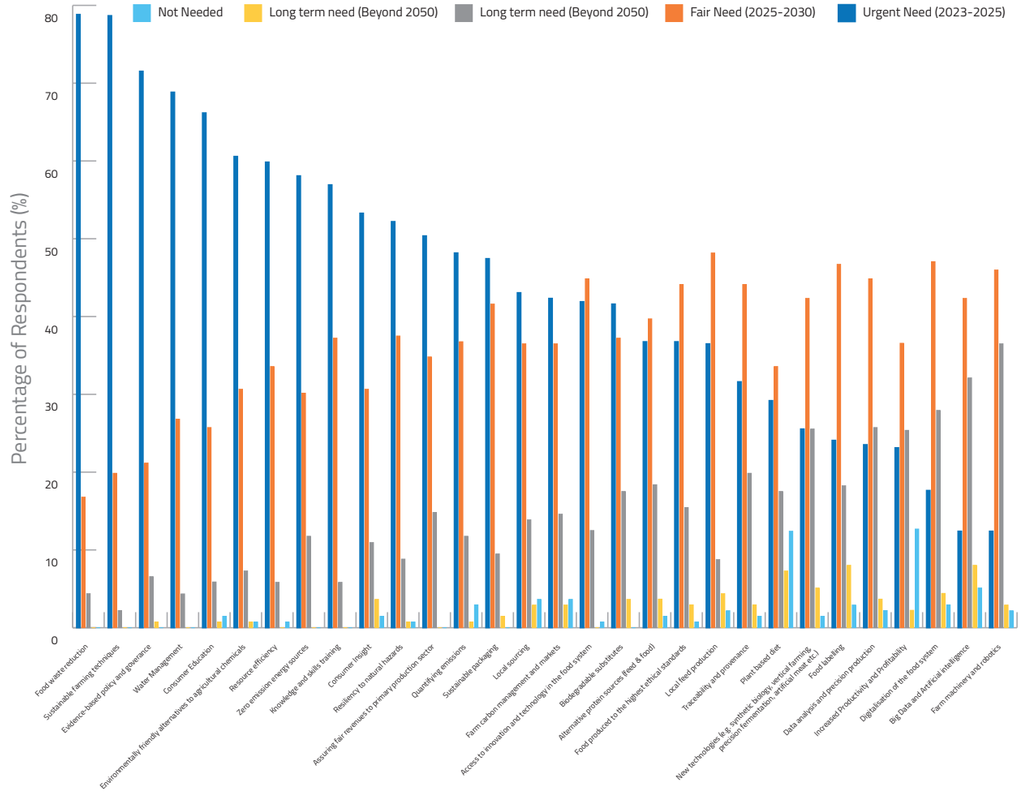


Figure 8: The urgency of market needs related to a Net Zero food system

In line with the market needs, the key opportunities respondents identified for a Net Zero food system from 2023–2025 included: waste management and a circular economy; evidence-based policy; regenerative agriculture; optimising local supply chains; optimising global supply chains; land sparing; consumer insights, behaviour and diets; food preservation and smart food packaging; supply chain disruption and management; and precision agriculture (Figure 9). The full detail and urgency of opportunities for a Net Zero food system are available in the Appendix.

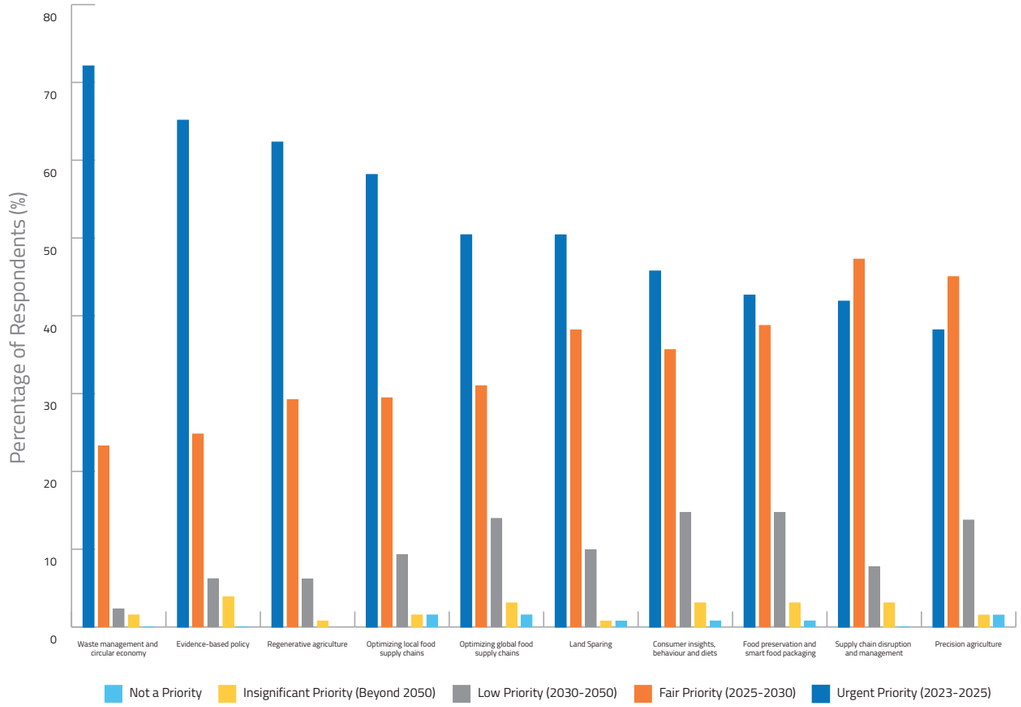


Figure 9: The Top 10 immediate (2023–2025) opportunities for a Net Zero food system

Finally, seven key enablers for a Net Zero food system were considered by the respondents. It was clear that a combination of policy and legislation; research and innovation; knowledge and skills; resources and infrastructure; collaboration and partnerships; and funding are urgent and critical to enable a Net Zero food system (Figure 10).

To conclude, the respondents reflected on the capability of our food system to become Net Zero by 2050. Interestingly, the perceptions of respondents were split with 59% believing we could not achieve Net Zero by 2050, whilst 41% were optimistic we could become Net Zero by 2050 (Figure 11). Perhaps this reflects the challenge that lies ahead and the fact that we are at a critical point whereby the decisions that industry, government, funders, investors and society make today will determine if we can achieve a Net Zero food system by 2050.

See the appendix for full analysis and results from the questionnaires, including qualitative data.

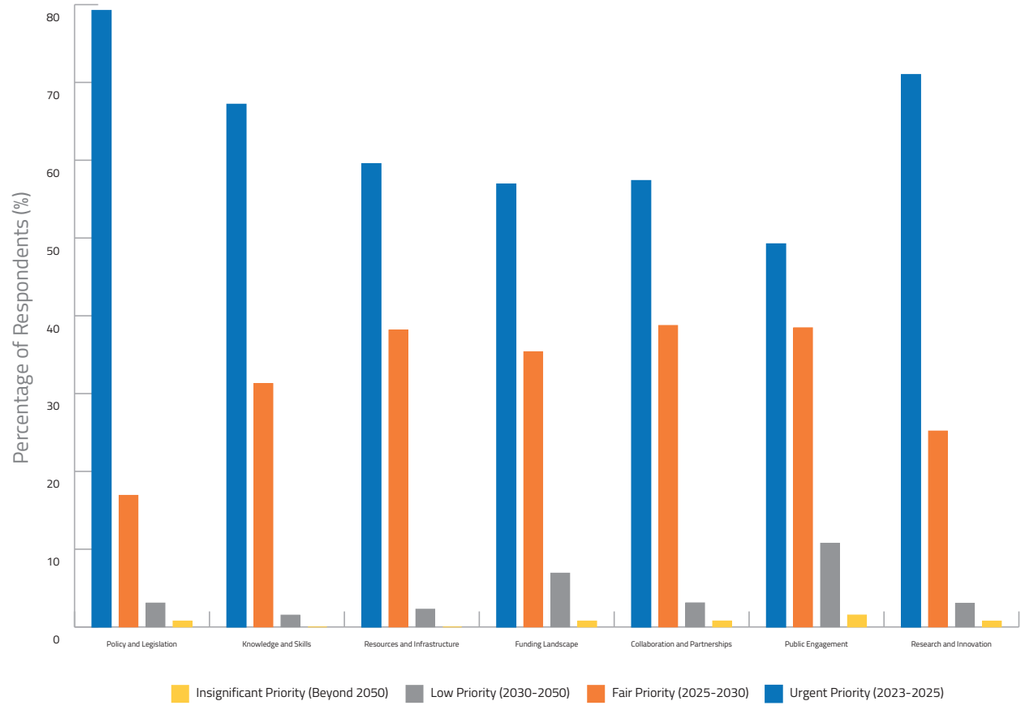


Figure 10: Enablers for a Net Zero food system

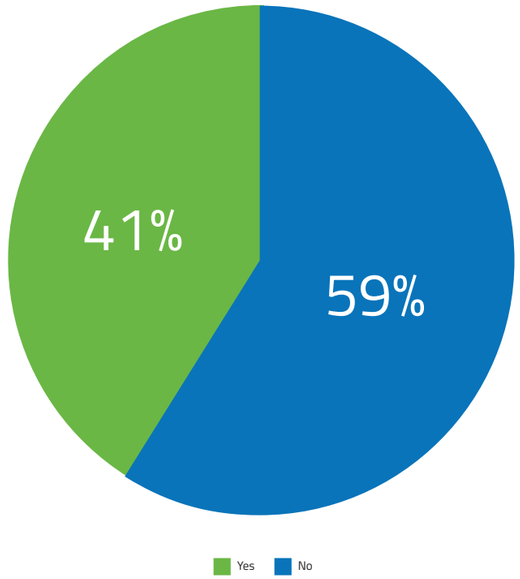


Figure 11: Respondents' reflection on : 'Can the food system become Net Zero by 2050?'

Interview results

A total of 23 interviews were conducted with thought leaders and subject matter experts from various sectors and countries across Europe to explore their views on a Net Zero food system and to shape the priority opportunities. Full interview data and demographic information on the interviewees can be found in the appendix.

The market needs and drivers for a Net Zero food system identified by the stakeholder interviews related to: adjusting the food system to combat the effects of climate change; driving the transition towards sustainable farming practices; reducing food loss and waste; supporting sustainable food packaging solutions (reduce, reuse and refill); tackling the overconsumption of our planet's resources, especially energy and other natural resources; and addressing society's disconnection from the food system and their reliance on cheap food. In terms of the key opportunities to deliver a Net Zero food system, the interviewees focused on: regenerative agriculture; reduce and valorise food loss and waste; better use of plastics and a circular packaging system; and diversification of protein sources. It was highlighted that robust, consistent and agreed approaches to measuring, reporting and verifying data related to the different targets (e.g., life cycle assessment, GHG emissions; carbon accounting; food loss and food waste) was critical to establish baseline measurements; support informed decision making; drive the change in behaviour required to reduce GHG emissions and improve environmental performance; and ultimately, demonstrate the positive impact the food system and related interventions are having on the environment. Central to this will be clear and standardised definitions; education; enabling policy and incentives for behaviour change. Connecting consumers to the food system, whereby they understand where their food originates; value food production; and have the knowledge to make informed decisions and manage food waste is also an important opportunity. The results of the interviews were combined with drivers, market trends, opportunities, capabilities and enablers identified from the questionnaires and literature review and refined for use in the road mapping workshop.

Understanding of a Net Zero food system

The interviewees reflected on their understanding of a Net Zero food system and the challenge that lies ahead. A core theme that emerged was that a Net Zero food system was a balance between carbon storage and emissions. However, there were different perspectives in relation to emissions, some interviewees focused on carbon, whilst others discussed balancing energy inputs and outputs, energy independent farming, circular economy, regenerative agriculture and other environmental indicators. As recognised by the interviewees, these differing perspectives are also reflected at national, European and global levels were there is no agreed and consistent definition or vision for a Net Zero food system. In particular, the interviewees highlighted that greenwashing by brand owners and ambitious commitments on Net Zero were a cause for concern. The targets and commitments being set out by both government and industry will need to be delivered. However, the majority of emissions from within the food system occur within the agricultural sector. Thus, the responsibility to achieve these targets are directed to the farmers who are not involved in the conversations or target setting; and have no guidance, support and/or knowledge on how to achieve Net Zero food production. This has highlighted the need for (1) a clear definition on a Net Zero food system and (2) engaging and educating farmers on how to achieve Net Zero food production. There was also significant concern raised that it is a big challenge to feed the world without maintaining a high level of inputs; that a lot of damage is already done; and whether Net Zero is achievable by 2050. Therefore, it is also important to consider adaptation.

Root causes of greenhouse gas emissions in the food system

The root cause of GHG emissions within the food system was discussed at length during the interviews and animal production was identified as one of the major root causes. However, it was noted that we have been driven to believe that we cannot achieve a Net Zero food system without the reduction in livestock numbers. Whilst there was unquestionable agreement that livestock production needs to change, it was highlighted that we may not need to cull numbers but instead adopt sustainable farming practices to reduce the impact of livestock production. This is particularly important when you consider the role of agriculture and livestock production in feeding a growing population with nutrient-dense foods and ensuring food security. In particular, alternatives to fossil fuels for energy in the food system will be critical. Manure and methane produced by the digestive process of ruminants through enteric fermentation was also discussed along with chemical inputs (e.g., reliance on fertiliser and pesticides) and depletion of soil and water quality. Whilst livestock were seen as the main source of greenhouse gas emissions, it was also noted that industrial crop production also has negative environmental impacts. Again, the use of chemical inputs including pesticides, fungicides, insecticides; and tilling and reduced soil quality were a key concern. Other concerns related to agriculture included: industrial feed; pollution and eutrophication and the impact on water quality; associated deforestation for farming and biodiversity loses; peat oxidation from land conversion for farming; nitrous oxide emissions from agricultural soils; and machinery and energy use. Outside of the agriculture sector, key root causes of GHG emissions included consumer diets and the intense desire for meat, harvest losses, food waste, food packaging, transport and refrigeration. In terms of the greatest source of emissions and sustainability issues in the food system: beef, rice, cocoa and palm oil farming were repeatedly mentioned.

Current activity around A Net Zero Food System

The interviewees were asked to share some examples of the work their organisations are doing to help contribute towards a Net Zero food system. This activity fell under 9 different categories:

1. Policy and strategies
2. Research
3. Innovation and business creation
4. Sustainable food production
5. Food packaging and labelling
6. Food waste and circular economy
7. Measuring, verifying and reporting (MRV) methods
8. Engaging, educating and upskilling different stakeholders in the food system
9. Lobbying and advocacy to industry and policy.

The details are illustrated in Figure 12.

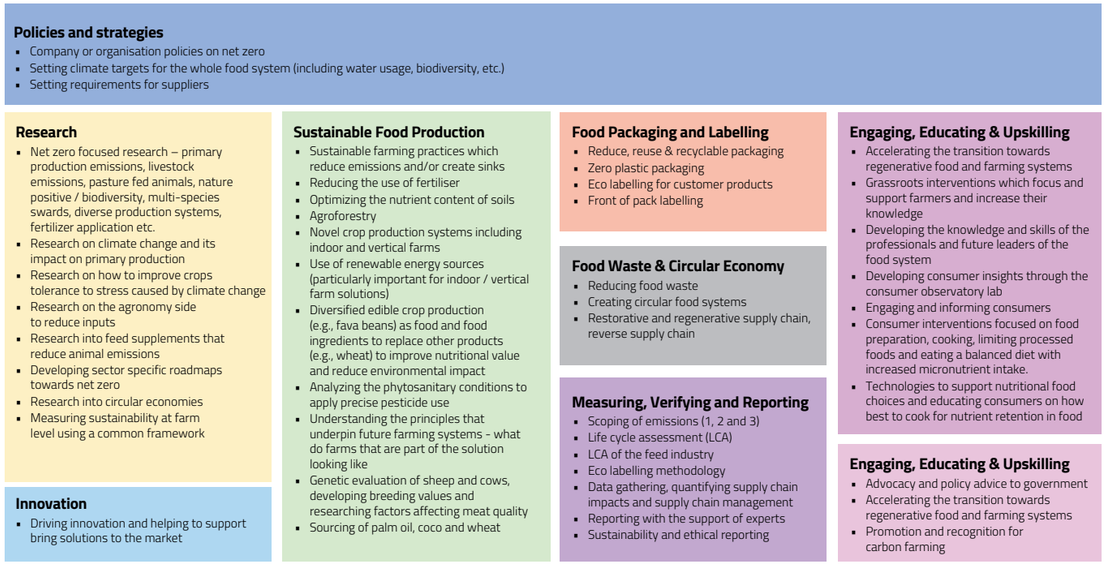


Figure 12: Summary for interviews on current activities taking place for driving a Net Zero food system

Trends and Drivers Influencing A Net Zero Food System

In relation to the trends and drivers influencing a Net Zero food system, these five key areas emerged during the interviews: social and ethical; technological; environmental; economic; and political and legal.

Social and ethical trends and drivers predominately centred around a cultural resistance to change and the fact that society has got used to cheap food that has been subsidised below the real value. The food supply chain is international, relying on imports. As a result, society has become disconnected from the food system and there is a lack of transparency. Moreover, there has been a trend for convenient, ultra-processed, low nutrient and discretionary foods. However, there is a rising number of environmentally and health-conscious consumers, particularly from younger generations, who are beginning to positively influence our food system. This includes increasing public awareness and concerns around single-use packaging and waste in oceans and landfills.

Economic trends and drivers focused on the current economic environment which is proving increasingly difficult for the food sector to operate in. In particular, inflation and the very high and continuous rise in the cost of inputs (e.g. energy, fertiliser and feed) is proving difficult. Simultaneously, there is a lack of financial incentives related to improving the environmental footprint of food production. Funding is low for research and development and hard to attain by small- and medium-sized enterprises. Whilst many of the technologies which could drive a Net Zero food system are not financially feasible for many in the industry.

Environmental trends and drivers had a central focus around the food systems dependence on fossil fuels for energy. Other environmental trends and drivers included climate change and its impact on primary production and food safety; the reduced availability and quality of natural resources (soil, land and water); and increased or change in pests and parasites. Furthermore, there is a drive for improved environmental performance from corporates and retailers on their suppliers and actors in their value chain as they seek to achieve strong commitments and targets on scope 3 emissions, focus on ethical sourcing and ensuring zero-deforestation certified with full traceability (driven by due diligence zero deforestation within EU by 2050).

Technological trends and drivers primarily had a core theme across discussions that there is increasing availability of new and innovative technologies that can support a Net Zero food system. However, there is a digital gap in the food system and access and affordability of technology is an issue. Moreover, more work needs to be done in the translation of science to technologies in the marketplace.

Political and Legal factors were the overarching cause of concern for the interviewees. There is insufficient government leadership, guidance and support; unclear policy and legislation; a continued delay in policy making; and a gap between policy making, the industry and the consumer. Trade agreements and geo-political issues are also playing a role. In Europe, we tend to have a Eurocentric outlook rather than a global outlook. However, the Food System is global and must therefore relate to all parts produced or not in Europe.

Market needs for A Net Zero Food System

The market needs for a Net Zero food system fell along the food value chain including: primary production, manufacturing and brand owners; consumers; along with the need for the food system to be supported with sustainable energy sources; and enabling through policy and governance.

Primary Production: At primary production, the critical market need is engaging and educating farmers. Farmers are key to a Net Zero food system. However, they do not have the knowledge and tools to deliver Net Zero food production or an understanding of the cost-benefit of sustainable farming practices. Moreover, farmers are price takers, not price makers. Farming is marginal, many do not get a sufficient living wage and cannot afford to adapt, innovate and invest in change. Equity for farmers is critical. In particular, more knowledge and investment are needed in the following areas:

- Consensus on the exact direction of travel in food and agriculture (e.g. land sharing vs. land sparing vs. sustainable intensification)
- Farmers need guidance and support on the most effective farming practices tailored to their farm to increase productivity, reduce emissions, support carbon sequestration, allow more efficient use of resources, reduce reliance on chemical inputs and produce better quality products
- Animal health management
- Soil management strategies
- Water management strategies
- Adapting to changing weather patterns e.g. floods and droughts
- A robust and agreed approach on how to measure, report and verify carbon and environmental impact of production
- Strategies to reduce harvest loss and increase yield which in turn will reduce carbon emissions
- Affordable and accessible technologies which contribute to more sustainable production, less emissions and increased profits
- A business case for farming with positive externalities (increased soil carbon, biodiversity, nutrition etc.)
- Better land tenancy agreements

Manufacturers or Brand owners: For manufacturers and brand owners, many corporates have already made many positive steps to increase productivity and efficiencies. However, corporates agree that more work must be done to reduce scope 3 emissions, such as rethinking their packaging materials and design; and reducing waste and creating a circular bioeconomy, in order to meet their bold commitments to improve the sustainability and environmental footprint of their products. In relation to scope 3 emissions, particular attention is related to how they robustly and reliably measure, report and verify these emissions. Importantly, how do they support their suppliers, particularly farmers, to reduce their emissions? There are already some good case studies and success stories with corporates supporting their farmers to deliver improved environmental performance (see appendix). For sustainable packaging, many corporates have needs around: investment in sustainable infrastructure; securing a supply of sustainable packaging materials; and the price of raw materials from sustainable and responsible sources which the consumer is not prepared to pay for. In particular, there is a focus on phasing out virgin packaging, eco-design thinking, recycling systems and smart packaging solutions which reduce packaging and food waste; and creating a circular economy (I.e. other uses for waste such as animal feed and energy instead of sending it to landfill). Another aspect to emerge in relation to manufacturers and brand owners, was the fact that large corporates are working under the logic of maximising profits and squeezing as much as possible from their suppliers. Therefore, there is a need for equity across the food system to support the change and technology adoption needed to achieve a Net Zero food system.

Energy: The food system is powered by energy from fossil fuels. However, the energy sector is the least analysed sector when thinking of food and the future of food. The food system needs decarbonisation of the energy grid to become sustainable, and for certain technologies and innovations to become a sustainable option to support food security (e.g. indoor farming and energy consumption). The energy sector has been proactive in moving towards reducing its greenhouse gas emissions. It will be important for the food sector to consider renewable and green sources of energy.

Consumers: Consumers have a key role in driving the transition to a Net Zero food system. However, they need to be engaged to re-connect them with the food system; increase the value they place on food; and help them make sustainable food choices, reduce food waste and recycle food packaging appropriately. Consumer education coupled with clear communication on the environmental impact of food, food quality and nutrition and food cooking and waste management is vital to drive behaviour change and allow consumers to make informed decisions.

Policy & Governance: The market needs consistent legislation and a regulatory framework across Europe (and beyond) which drives the change needed for a Net Zero food system. The targets need to be consistent, transparent and based on science; and reporting at different levels (farm, country and EU level) should be robust. Moreover, the role of agriculture as part of the solution and its capacity to sequester carbon should be recognised.

Opportunities emerging from interviews for a Net Zero food system

Following on from the market needs for a Net Zero food system, the interviewees shared their perspectives on the key opportunities to deliver the Net Zero agenda. These included strategies, innovations and interventions which supported sustainable food production; protein diversification and novel ingredients; food waste and a circular value chain; data and value chain integration and supporting behaviour change and responsible consumer choices and food management.

Sustainable Food Production: to support sustainable food production, many opportunities exist as discussed by interviewees. Examples discussed are: decision support for farmers on-line / on-time; suitable farm management systems; optimising use of natural resources (e.g., fields, soil, water); carbon sequestration and management of carbon stored in soils; adopting no till systems; integrated pest management and biological control agents; production and usage of carbon-neutral fertilisers; reduction of fertiliser in low yield area and focus use of fertiliser in high yield area – better targeted land management policies; integrating biodiversity; agroforestry; feed additives to reduce animal emissions (e.g. methane) such as seaweed extracts; manure management; use of anaerobic digesters to better recycle nutrients; modern technologies to make farming more sustainable and reduce emissions; crop diversity and mixed production; genetic selection research into plant and animal efficiency (most productive individuals with least amount of feed establish the most effective farm management practices (e.g. land sparing vs land sharing); develop communities or co-operatives of farmers working together.

Protein Diversification and Novel Ingredients: Protein diversification was also a key opportunity to help complement protein sourced from agriculture and to support achieving global food security for a growing population without jeopardising the environment for future generations. It was noted that there is a EIT Food task force and think tank working on the protein diversification which should be engaged with. There is a large opportunity to engage with stakeholders within the EIT Food network to identify and build expertise in this space. There are already existing solutions, initiatives and innovations within the EIT Food network that should be promoted and supported in terms of scaling and accelerating for impact.

Sustainable Packaging and Labelling: A key opportunity is supporting sustainable and smart food packaging solutions to reduce, refill, reuse and recycle food packaging, phase out virgin plastics; and reduce food waste; coupled with clear and reliable labelling based on sound scientific evidence to address misleading claims on food packaging; allow consumers to make informed and responsible food choices; reduce food waste; and ensure proper disposal or recycling of food packaging. In particular, scientifically robust and trusted eco-labelling and nutritional and healthy claims, were highlighted as key opportunities.

Food Waste and a Circular Value Chain: Several key opportunities for reducing food waste and creating a circular value chain were also discussed. These included processes, innovations and interventions which help to eliminate food waste, zero waste processes; recycling systems; better sorting of waste products, recycling waste stream for other processes; working with charities on food waste; better food preservation; accurate forecasting of food based on demand; side streams from farm biomass; and improving meat processing efficiency.

Consumer Choices: The role of consumers and the power they can play within the food system was discussed by the interviewees. There is a large opportunity to drive public engagement activities which re-connect consumers with the food system; leverage and grow the consumer observatory labs to improve consumer insights and understand their perception and misconception of sustainability; equipping consumers with the knowledge and information required to understand the environmental impact of products; nudging consumers to choose more sustainable and healthy ingredients and food choices; communicating with consumers to improve their trust and perception of new technologies; increasing consumers choice; improving limitations of novel food (e.g., taste, texture); promoting plant-based food; mixing meat-free options with other products to encourage consumer choice; interventions or solutions which help to support consumers with cooking, meal planning and nutrition; promote locally sourced and locally consumed; increase garden growers of food; revise concept of only animal protein consumption.

Data and value chain integration: Underpinning all of these opportunities was the need for robust and reliable data which can be translated into positive behaviour change. The opportunities included: improving the ability to trace back to farm; incorporating large scale data; digital interfacing to improve supply chain efficiency; incorporating artificial intelligence; collecting base line data; more and better data for decision making and verifying claims; data storage and accessibility; life cycle assessment; an integrated farm carbon model / clear means of carbon accounting; and robust supply chain sustainability checks.

Other: Reducing food system's reliance on energy from fossil fuels was identified as an area of opportunity to reduce greenhouse gas emissions and improve the environmental performance of the food system. The opportunities highlighted included: energy optimisation; decarbonising energy sources; shift of fuel transition to renewables or clean energy (e.g., hydrogen, biogas, wind and green energy sources); electrifying production stage; transport electrification; make better use of roofs, carparks for solar panels; better energy storage for consistent energy supply; reduce combustion engines; hydrogen and methane powered machinery (JCB and CAT making great strides in this area); solar power could be used to generate the electricity needed for electrolysis to produce hydrogen. Finally, other areas of opportunity included modelling the impacts of reducing measures and communicating the impacts to help support behaviour change; and a focus on fairness, which is interlinked with EIT Food's mission 3: Reducing Risk for a Fair & Resilient Food System.

Capabilities

The capabilities discussed during the interviews included: Biotechnology, Bioreactors, Precision farming; Regenerative agriculture; Insect farming; Agroecology; Seaweed extracts as feed additives to recue emissions; Inhibiting soil enzymes to reduce soil emissions; Digital solutions for food planning and reducing food waste; biodigester for energy; Hand-held spectrometer for consumers to inform on food nutritional value; animal breeding programmes; genetic manipulation to improve yield and reduce emissions; modern breeding methods such as CRISPR; gene editing to have more resistant plant to drought and speed the process of selection; and for livestock breeding to reduce methane emission; biogas, hydrogen and green energy; hydropower; utilising energy from microbes; lifecycle assessment; robotics, drones and automation; anaerobic digestion plants; forecasting models and predictive analytics; integrated pest management; carbon dioxide removal technologies; experimental farms where multiple partners and actors (e.g. farmers, researchers, spatial planners and citizens) come together to co-create innovations for a jointly agreed objective (living labs) and demonstration farms which showcase good practices and allow peer-to-peer learning (lighthouses) across Europe; microbiome technologies for crops and soil health; aquaculture; algae biotechnology; controlled environment agriculture and vertical farms; big data, machine learning and artificial intelligence; fermentation; and synthetic biology.

Enablers for a Net Zero food system

The following factors emerged as key enablers for a Net Zero food system:

Research: To develop a Net Zero food system it is important to generate high quality knowledge through data and measurement; developing new technologies; addressing research gaps and carrying out horizon scanning activities. In particular, it was noted that we need to understand the impact and potential risks climate change poses to food production and commodities in the future. Food systems are global and requires a global approach with local solutions. For example, palm oil is a global commodity and it is estimated that it is used in over 50% of all products found in supermarkets. This same palm oil is largely produced in South East Asia. When South East Asia is unable to produce palm oil in 20 years due to climate change, we need to consider alternative solutions to reduce reliance to world markets and develop alternative sustainable strategies. Moreover, open research and access to data will help to avoid wasting of research and repeating research and interventions that have failed elsewhere. Open-source global data and databases could be a key enabler to more transparency and support the transition to sustainable food systems.

Horizon Scanning and Foresight: As mentioned within the literature review, continued horizon scanning and foresight projections are key to ensure a sustainable food system. For example, we need foresight projections to anticipate the true impacts of the projected impacts of climate change on what we will be able or capable to grow (where and at what costs?) and with what natural resources? What energy will be needed? Similarly, with new technologies, what are the potential food safety risks? Are there potential negative food system impacts at another part of the food system?

Funding & Financial Incentives: Finance and financial incentives emerged in every interview as a key enabler to a Net Zero food system. Farmers need financial support, incentives or compensation schemes to support their transition to sustainable farming practices. The sources can be a combination of government support, subsidies for less emitting products; brands and corporates fairly paying farmers for cutting their emissions, cheap loans for farmers; and clear guarantees for positive environmental behaviour and performance. Moreover, more investment and feasible funding for research, development, innovation and commercialisation of new technologies with application in the agrifood sector is vital.

Farmer Engagement: Farmers are vital in the transition to a Net Zero food system. A key enabler will be engaging, mentoring and supporting farmers to build their own sustainability plans; and providing education and access to knowledge on sustainable farming practices. Moreover, community support and building farming cooperatives and collaboration between farmers will allow peer-to-peer learning and support them in having a collective voice to share their best-practices and ensure a bottom-up approach.

Policy & Governance: Policy and governing bodies need to provide leadership and enable the transition to a Net Zero food system. Governments need to engage in food systems resilience; support with investment and incentives or subsidies; and create enabling legislation. In particular, interviewees desire regulation that supports new technologies; punishes unsustainable practices (e.g., plastic tax and tax on discretionary foods); governs nutrition and eco-labels, ensuring they convey the science to the consumer; and better regulation of carbon markets were discussed. At present, policy and regulation can be slow and restrictive for the agrifood industry. One particular example to showcase this was legislative restrictions for robots to be used on tractors and the fact that driver-less tractors are not allowed due to safety risk. If we are to translate research into novel solutions for the agrifood industry, policy and government need to be proactive and support its application without posing a risk to the safety or integrity of the food system. Participatory policy approaches which listen to different perspectives, consider essential needs, embrace compassion, enable co-learning, help share ownership and promote innovation capacity are needed.

Infrastructure: Good connectivity in rural areas was identified as an enabler for a Net Zero food system.

Educating and upskilling: Education and upskilling is an enabler. The interviewees highlighted the immediate need to build capacity and knowledge on sustainable farming practices; and ensuring more skilled workers within organisations. This extends to government and support organisations. For example, EIT Food could play a role in showcasing how technology can help food security, minimise impact on biodiversity and reduce soil compaction. This knowledge is important to help governments make informed policy decisions; and the support services are a trusted source of information for farmers. Moreover, skills forecasting to develop insights and identify skills gaps in the agrifood sector and what will happen if we don't have them will be important. In particular, key initiatives that will drive EIT Food's education agenda will include: European Commission Pact for skills: upskill and reskill people in agrifood; and The Deep Tech Initiative which aims to upskill one million people in deep tech fields over the next three years. In particular, state-of-the-art deep tech education programmes will be necessary to build a skilled labour force which can leverage new technologies for the green and digital transition of the food system.

Innovation and Entrepreneurship Skills: Developing advanced entrepreneurial and innovation skills programmes will be key to educate and encourage STEM students and the future innovators of the food system to develop new and creative ideas and solutions. Structures are also needed to help the commercialisation of new technologies which could transform our food system – moving from the university and research sector to the market.

Collaboration and Partnerships: Stakeholders within the food system need to work together, share capacities and knowledge and encourage collaboration. At present, many stakeholders and organisations are working in silos. It is important to remove the barriers between stakeholders in the industry and scientific experts. A transdisciplinary approach will be critical, for example, with biologists and energy experts working together. EIT Food can play a key role in facilitating collaboration and partnerships and ensuring stakeholders reflect and communicate with each other. For example, EIT Food could support building a relationship with retailers and lobbying and supporting them to align their purpose, targets and measurement of sustainability and reward farmers who are cutting emissions; or help build a community of empowered farmers who can learn from each other, combine efforts and showcase to the world their best practices. Moreover, ensuring technology providers and support services are involved will help ensure the multiplication of knowledge.

Public Engagement: Public engagement is another key enabler in the transition to a Net Zero food system. It is important that society has a trusted source of reliable and robust information related to the food system. In particular, public engagement will help to re-connect society with the food system; address myths; and showcase good news stories. Activities which can shift citizens from passive recipients to informed and active change agents will be particularly important. The EIT Food Consumer Observatory was identified as a key tool to help identify trends across the food system and could act as a valuable resource for consumer research and market discovery for startups and entrepreneurs. There is also continued opportunity to leverage and extend EIT Food's social media and other digital platforms (e.g. Food Unfolded) to engage with citizens across the globe and disseminate information; whilst events with citizens will continue to help build awareness and trust. Key themes for public engagement centered around informing citizens about the attributes of different food; how to critically assess food labels; how to reduce food waste; and ways to reduce meat consumption and diversify their diets.

Engaging young people: Of particular note during the interviews was the need to attract and engage young people into the food system. This should be targeted at primary and secondary school children. The Youth Mission was identified as a good example of work that should continue to help enable a Net Zero food system. Moreover, showcasing agriculture, farming and aquaculture as an attractive and interesting occupation emerged as important to attract young talents into the industry. The interviewees highlighted that this is important to bring new ideas into the industry and to transform production practices as from their observations, most, but not all, senior farmers are more likely to be content with the current system.

Business creation: An enabling environment for innovation and startups to flourish will support the pathway to a Net Zero food system. This includes building an ecosystem which supports entrepreneurs and startups to launch, accelerate and scale. A particular focus on identifying and scouting innovations with underpinning IP, which can address the market needs for a Net Zero food system will be critical for success. To help de-risk these innovations and help startups navigate the valley of death, market discovery programmes; technical support; regulatory support; intellectual property support; access to facilities, pilot plants and farms to accelerate and move innovations from lab to commercial scale are vital. Finally, access to corporates, funders, and investors with the same vision and interest in innovations for the food system will also be a key enabler.

Intrapreneurship: Intrapreneurship and innovations from within companies within the supply chain was also identified as a key enabler.

Summary of Scoping Priority Areas

The key takeaway message from the interviews was that the majority of GHG emissions in the agrifood system are from the agriculture sector. However, agriculture is also one of the very few industries with the capability to store carbon, and the positive impact of livestock grazing on soils is often overlooked. There are ways to reduce the dependence on conventional agriculture, such as precision fermentation, vertical farming or insect farming, but these are not the silver bullets. Whilst these will be important to complement the agricultural sector, they will not replace conventional agriculture fully as agriculture offers a solution to the Net Zero agenda. Other sources of emissions in the food system include food packaging materials, food waste, consumer behaviour and food choices, logistics and productions systems linked to the use of fossil fuel and associated energy for power, heating and cooling.

Farmers are critical to achieving a Net Zero food system. However, they do not have the profits or the knowledge and tools to drive the change. They need to be adequately supported to deliver the change required. This change will be driven by legislation, industry and consumer pressure. The market needs and opportunities for delivering a Net Zero food system can be summarised as:

- A clear definition and harmonised language on a Net Zero food system and environmental impact indicators
- Farming cooperatives where farmers can have one powerful voice acting in union to have a stronger voice in the system
- The development of high-quality knowledge on a Net Zero food system and a consensus on sustainable farming practices
- Benchmarking in order to understand each farms' carbon footprint, address hotspots and show improvements over time
- Life cycle assessments (LCA) need to be robust. At present, the calculation of scope 3 emissions is commonly based on secondary data and there is no consistency in LCA, for instance the food and drink sectors each adopt different LCA standards. There needs to be a clear understanding of where the data is, how it can be collected, monitored, verified and reported on food labels
- Tailored advice and support to farmers for decision making and how to improve their environmental performance and reduce food loss at farm level
- Carbon farming schemes are the most talked about but the least thought about. Clarity and consistency on carbon accounting and how farmers will be compensated is necessary
- Focus on eliminating food waste and creating a circular bioeconomy
- Technologies which improve productivity, increases yields and reduces emissions
- Side steams for biomass

- An honest and fair price for food with profits shared across the food system
- Diversified protein sources
- Sustainable food packaging
- Clear and transparent labelling which allows consumers to make informed choices
- Engage and educate consumers so that they can be active change agents towards environmentally friendly food choices and ensure appropriate recycling, reuse or disposal of food packaging
- Financial investment in research and development
- Enabling policy and regulation
- Skilled people and attracting young people to the farming sector
- Decarbonising energy, focus on renewable, clean and green energy
- Transdisciplinary research
- Foresight projects to anticipate the true expected impact of climate change
- Support research translation and collaboration between stakeholders and scientific experts

Ultimately, to reach a Net Zero balance, farmers will be more important than ever. There is no silver bullet; instead, it will require a cumulative effect of many different initiatives. It may not necessarily require a revolution, but learning how to reuse, adapt and complement some of the things we already have. It will be important to consider and discuss the unintended consequences of new policies or demands placed on farmers. Indeed, if farmers are incentivised to become providers of environmental practices and services to become Net Zero it will present some interesting questions. If farmers are asked to manage energy, capture carbon in the soil, will they still be a farmer? Will they have time to be a farmer? Reflection and open discussions are key. To determine the agenda for Net Zero, we need to think, imagine and model solutions collectively.

5.3 Roadmapping Priority Areas

The final phase involved roadmapping the priority areas during a 2-day intensive workshop in Paris in December 2022 with 30 participants selected from a broad range of key stakeholder groups who provided diverse perspectives to the workshop processes, including: industry, research, government and non-governmental organisations and funders and investors.

The desk-based research from Phase 1, along with the survey, interviews and engagement with thought leaders and subject matter experts from Phase 2, was used to develop a preliminary vision and draft roadmap landscape for a Roadmap to A Net Zero Food System. This draft roadmap for Mission 2 'A Net Zero Food System" incorporated: a consolidated list of 39 macro-level trends and drivers (based on PESTLE – Political/legal, Economic, Societal/ ethical, Technological, and Environmental); 48 market-level drivers and needs; and 70 opportunities (Figure 19). During the workshop, through a process of prioritisation and clustering, the participants prioritised **12 macro-level trends and drivers; 14 market drivers and needs; and 7 opportunities**. Delegates were then assigned to groups to develop detailed topic roadmaps on the 7 priority opportunities. Four of these opportunities were key topic areas: Regenerative Agriculture; Food loss and waste management; Diversification of protein sources; and Food and beverage packaging never becomes waste. Three were overarching enablers critical for these opportunities to be realised: Data and value-chain integration, standard LCA processes and measure, report and verify (MRV); Overcoming barriers to behaviour change of consumers; and Overcoming barriers to behaviour change within farming.

The full details of the topics and prioritised roadmap that emerged and was explored during the workshop is available in the appendix. Priority capabilities and enablers are identified as focal points for future strategy development of EIT Food.

Vision for A Net Zero Food System

The workshop participants discussed and voted on the vision for a Net Zero food system. As a result, six primary elements emerged for the vision for a Net Zero food system. Good stakeholder alignment was observed across the priorities, with particularly strong stakeholder alignment on zero waste resource sufficiency and regeneration; sustainable food production; and a Net Zero carbon food system. The detailed statements on the vision generated through workshop ideation and the pre-populated vision themes developed through the desk research and interviews are presented in the appendix. The six priority themes which emerged that should be included within a vision for a Net Zero food system, in order of priority were:

1. Zero waste, resource sufficiency and regeneration
2. Societal/behavioural change to support Net Zero
3. Sustainable food production
4. Economic system alignment to support Net Zero
5. Technological change to drive Net Zero
6. Net Zero carbon food system

Prioritisation of Trends & Drivers, Market Drivers & Needs and Opportunities

After a vote, the priority macro-level trends and drivers which emerged, in order of importance were:

1. Climate change adding pressure to the food system – extreme weather, rising temperatures, sea-level rise
2. Global food system contributes to climate change, environmental degradation and biodiversity loss
3. Waste and losses in the food system
4. Over-consumption and over-exploitation of resources
5. The world's food system and energy consumption is dependent on fossil fuels
6. Availability of new technologies transforming the food system
7. Growing and increasingly affluent global population demanding more and better food
8. Population growth in urban settlements changing food distribution requirements
9. Increase in industrial activity and intensive food production systems
10. Biodiversity loss and species extinction
11. Deforestation and depletion of natural resources for food and biofuels
12. Labour and skills availability.

The priority market drivers and needs for a Net Zero food system, in order of priority as voted by the workshop participants were:

1. Society has got used to cheap food that has been subsidised below the real value
2. Farmers are price takers not price makers
3. Cost of living, cost of inputs (fertiliser, grain, energy) are so high and farmers real living wage is so low, farmers can't afford to adapt and innovate as easily as other industries
4. Energy and natural resources used for food production and delivery e.g. fossil fuels, crops, soils, biomass, plastic, steel and minerals, water and land
5. Food and packaging waste at retail, distribution, consumption
6. Current agri-environmental policies and practices are insufficient in protecting the environment with law and regulations creating unsustainable practices
7. Malnutrition, nutrient deficiencies from junk food diets, high macro (carb, protein and fat) diets which are also carbon intensive and lacking in micronutrients
8. Social disengagement with food production and preparation, and lack of consumer awareness of the source of food, true costs and environmental impact of consumption
9. Agricultural intensification has led to degradation of soils and water pollution
10. Livestock production – methane from enteric fermentation, animal excreta (methane and nitrous oxide)
11. Land use and land use change (CO_2) as a result of agriculture activities
12. Consumption level – carbon intensive diets
13. Food manufacturing and processing level – energy and water consumption
14. Global and complex food systems.

Two additional market drivers or needs were suggested by participants that were not included in the voting but were deemed important to include in the roadmap: A need for market signals (e.g. policy and regulation) to drive industry; and lack of information and misinformation to consumers, i.e. a need to enable informed decision making.

In terms of the opportunities for A Net Zero Food System, the participants reviewed, voted and consolidated the prioritised list of opportunities for a Net Zero food system that were aligned with the agreed vision and addressing the priority trends/drivers. This voting exercise evaluated the opportunities most likely to deliver positive impact and change towards a Net Zero food system and the feasibility of implementation. Based on the impact, feasibility, and level of interest in the topic a list of 13 topics was developed (Figure 13).

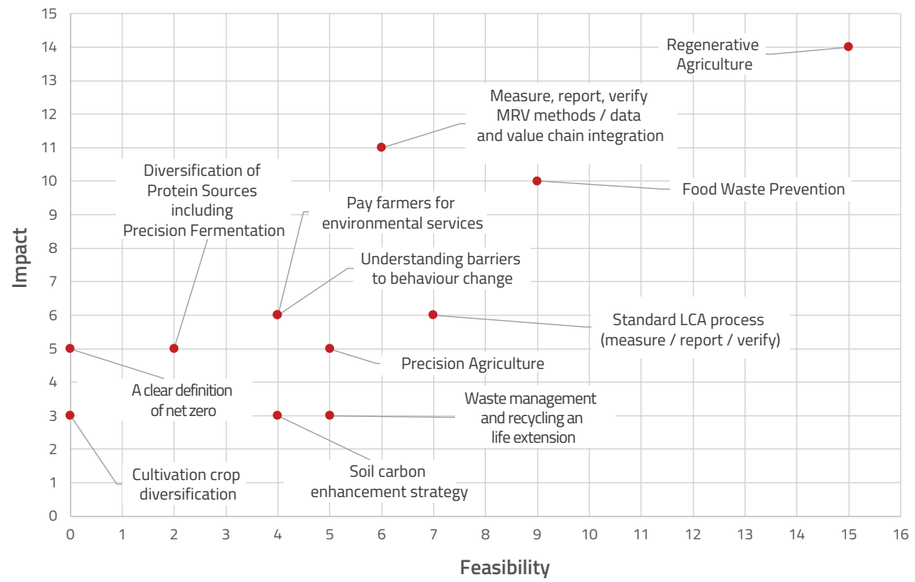


Figure 13 : Representation of Impact x Feasibility voting for priority opportunities

A final review and clustering of similar opportunities was conducted to establish and agree seven distinct priority opportunities for a Net Zero food system. Four of these opportunities were clear topic areas to be explored. These were:

A. Regenerative Agriculture
B. Food loss and waste management
C. Diversification of protein sources
D. Food and beverage packaging never becomes waste

Whilst three were overarching enablers critical for the topic area opportunities to be realised. These included:

E. Data and value-chain integration, standard LCA processes and measure, report and verify (MRV)
F. Overcoming barriers to behaviour change of consumers
G. Overcoming barriers to behaviour change within farming

Finally, the delegates were then split into seven groups during the second day of the workshop – developing detailed topic roadmaps. During this final stage, the seven priority impact pathways were explored to determine the opportunities where EIT Food can have a significant and distinctive impact in the next 3–5 years. A detailed view of the roadmapping landscape is available in the appendix.

Priority Area: Regenerative Agriculture workshop output

Overview: The workshop participants working on the Regenerative Agriculture priority area described how regenerative farming covers the scope of primary production on agricultural lands or in agriculture, up to the farm gate, but also considering the impact on the wider ecosystem and landscape; farm-to-farm landscape level; and socio-economic impacts on the farming/ rural community. The successful outcome would be all farming in Europe is under regenerative practices for environmental and socioeconomic indicators by 2050. It's about everybody doing better to regenerate resources that have been previously degraded and eroded. Regarding milestones, this may extend beyond the 2050 timeline, but many activities and early adopters should commence now.

First it is important to develop a clear definition of regenerative farming and outcome indicators – that is, what are we actually trying to achieve? – and building consensus around Europe so all actors come on board, support, and move collectively towards the same goals. The workshop working group highlighted that an important pillar of this priority opportunity area should be the development of rural areas, so we have more attractive and accessible rural living areas for people. This involves many things, including internet in villages to land and access for farming. Infrastructure needs to be established preferably in each region or country, so there is knowledge, guidance, finance and capital flows; technologies; and business and market development to support the transition. If that infrastructure is there, the scaling can start. It is envisaged that the drive to regenerative agriculture starts with some early adopters, with the aim to have 15% engaged by 2030. Then once everything is established and the proof is there that solutions can and do work, scale up can be undertaken so everybody can work to regenerate Europe by 2050.

In their summary, the workshop participants highlighted that the Regenerative Agriculture priority opportunity incorporates many things including: working on the definition for regenerative agriculture through public engagement processes; education and raising awareness of farmers and consumers; research and development of new technologies and methodologies; establishing new business models; and transition financing mechanisms...Initiatives also need to deliver rural developments by having for example Land Management programmes to address the abandonment for agricultural land; collaborative, local governments; and campaigns to promote rural life.

It was highlighted that the technologies and techniques required are already there, and have been proven to function, at least on a relatively small scale. The challenge is the scaling and enabling wide-spread adoption. It is critical to have the farm support infrastructure in place before we can scale, so that should be the primary focus. The main area where barriers exist is on the regulatory side because current regulations do not enable innovative farming practises. Systems change is required across the entire value chain, so it's going to be challenging, but achievable.

EIT Food can play a key role in encouraging entrepreneurship and innovation; promoting sustainable farming techniques; and demonstrating feasibility through education and public and farming community engagement. From 2023–2030, EIT Food should focus on these activities:

- Defining regenerative agriculture and engaging with key stakeholders across Europe for agreement and buy-in to regenerative agricultural practices (early-adopters);
- Establishing measure, report and verification processes which will robustly track outcomes;
- Supporting new technologies and business/ market models;
- Transitioning funding mechanisms;
- Educating students, farmers and consumers, particularly those under 30 years old, on regenerative agriculture and showcasing the opportunities within the agriculture sector.

From 2030–2050, EIT Food can shift its focus to these activities:

- Engaging, educating and mentoring farmers to scale the transition to regenerative farming in Europe by 2050;
- Reviewing and monitoring the activities and outcomes;
- Gathering proof of success;
- Representing the regenerative farming community in CAP reform to ensure regenerative agriculture is defined and there is payments for ecosystem services.

Over the longer term, important activities will include: establishing a land management programme to address abandonment of agriculture land or areas; collaborating with local government and organisations to establish rural infrastructure and services; and a campaign to promote rural life.

The overall impact of the Regenerative Agriculture opportunity across the whole food and drink sector was ranked as very high (18/20). It is tackling the basis of the agrifood value chain; has the potential to scale and deliver improvements to the vision of the roadmap from 2030; and delivers positive impacts on almost all the sustainable development goals. However, there could potentially be negative impacts to businesses during the transition. The Regenerative Agriculture opportunity will deliver impact to:

- Value from food waste or side-streams in production
- Reduction in CO_2 equivalent emissions in the food system
- Increase in products that use alternative ingredients which improve environmental outcomes
- Carbon sequestration; Enhanced biodiversity; human well-being and health; area of land use management

The overall feasibility of the Regenerative Agriculture opportunity is good (14/20). The likelihood of adoption across the food system is fair as change is required within a challenging system. The technical probability of success and feasibility of key technologies and capabilities required is very high as we already have reliable data available. However, it is only done on a small scale. EIT Food has a key role to play in enabling the pathway to impact as they are already experienced and network ready. However, the greatest barrier to this opportunity is the complexity of the regulatory system (regional, national and EU). Other potential risks and barriers include: knowledge gaps; lack of funding; lack of data or numbers; and low farmer motivation.

Mission Synergies: The Regenerative Agriculture opportunity also has strong synergies with Mission 1: Healthier lives through food; and Mission 3: A fully Transparent, Resilient and Fair food system.

The resultant roadmap for the Regenerative Agriculture Priority Opportunity, including the trends/drivers, market needs, opportunities, capabilities and enablers as determined by the workshop participants, is available in the appendix.

Table 3: Summary of Regenerative Agriculture Opportunity that emerged from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System (2023 – 2025 – 2030 – 2050)
Regenerative Agriculture	15% of all farms in Europe are early adopters of regenerative agriculture by 2030	Reduce food loss from farms in Europe (1.2 billion tonnes: WWF, 2021)	LEADERSHIP: Clear, agreed & adopted definition of Regenerative Agriculture & outcome indicators → Gather proof of success stories → EIT Food established as a thought leader in Regenerative Agriculture & MRV processes
	Regenerative agriculture and indicators are defined in CAP with payments for ecosystem services	Reduce CO2 equivalent emissions in the food system by 10.5Gt CO2 every year (when 100% of farms are using low emission, carbon sequestration & sustainable practices: Roe et al., 2021)	INNOVATION: Scientifically robust, agreed and adopted measure, report and verify processes to track impact of Reg Ag → Regenerative Agriculture Interventions which measure, report and verify impact
	100% of farming is under regenerative agriculture outcomes for environmental and socioeconomic indicators	Increase in products that use alternative ingredients which improve environmental outcomes	EDUCATION: GROW workshops with tailored knowledge, skills and mentoring to early adopters to support transition to regenerative farming practices
		Improvement in environmental indicators: carbon sequestration, enhanced biodiversity, human well-being and health; area of land use	PUBLIC ENGAGEMENT: Engage and educate the farming community acrosss Europe to establish early adopters of Regenerative Agriculture → A campaign to promote rural life and encourage young people into the agricultural sector → Disseminate impact and good news stories on Regenerative Agriculture
			BUSINESS CREATION: Scout and support the acceleration of the priority capabilities & innovative technologies which could deliver positive impact towards the regenerative agriculture indicators
			LOBBYING: Represent farmers at CAP reform to ensure Regenerative Agriculture is defined and payment for ecosystem services

Priority Area: Data and value-chain integration, and measure, report, verify MRV methods workshop output

Overview: "Data and value chain integration", and "Measure, report and verify methods (MRV)", is a key enabler that underpins a lot of the opportunities identified in the roadmapping workshop. The workshop participants working on this priority opportunity area explained how multiple systems already exist, but they are not standardised, they're not talking to each other, and depending on where you go within Europe, there is different measurements and different approaches to how they are interpreted.
This becomes even more problematic when talking about the global food industry, where measurements and standards differ across continents, which has huge implications for trade and managing impacts of the food system. So the challenge and the opportunity lies in harmonising global databases, bringing in big data, helping industry to understand impacts from Farm to Fork, standardising measurement and appraisal techniques, and delivering global agreement and alignment on objectives.

A key activity may involve bringing in and aligning with a body like the FAO to stamp their authority on it and define the set of rules to enable all to start collaborating. The successful outcome is standardised procedures for uniformity. A clear definition is key, maybe a global ISO standard for food products and production, joining metrics on land management, food production, processing, sequestration, etc. But not only defining, but accounting and reporting and presenting the outcomes. The participants stated that we've had the organic food movement; maybe we now need Net Zero food. In the short term, an appropriate body to manage and implement is required, possibly ISO or FAO, but that would include big data and its management. The EU needs to lead and globalise and harmonise the system and establish such things as a global database for carbon accounting and carbon accounting principles. Then it's all about training and education. It's about making sure everybody knows what is being dealt with and not just about talking down to farmers. Farmers probably know more about the land than anyone, so it's about giving them the language to communicate and transfer that knowledge.

Life cycle assessment (LCA) is a relatively common approach in this space. People and organisations are working on this all over the world, but the problem is that methods vary at different levels, and they are not aligned around a common vision. Alignment will help facilitate the digital transition, enable full supply chain collaboration and visibility, and enable a strong regulatory and legislative base to support and protect stakeholders.

In any transformation of this magnitude, there are always early adopters, and there will be others who, through economic, social, or other reasons, are going to be slow catching up, but they should not be penalising for that. They should be supported and brought along on the journey, so again, education and collaboration is key and hopefully a rising tide raises all boats. Big brands and retailers are already highly digitalised, but the opportunity is in bringing more of that digital technology to the broader farming community. A lot of the building blocks are already in place and the workshop participants highlighted that EIT Food can play a huge role in public engagement and education. Then finally, regulatory intervention will be hugely important, and the participants view was that regulatory, legal, safety, and governance are all lacking to date. Getting it all working together is where the biggest challenge is foreseen, and probably the biggest stumbling block is that there's limited joined-up thinking.

Some of the bigger hurdles arise because agriculture is extremely diverse and it is also hard to know the readiness or willingness of farmers to share data. So, this activity should not just be a stick, it should also be a carrot. There needs to be an effort to collect data from every farmer, but also guarantee the farmer that they will not be penalised for unfavourable data – if the farmer is afraid to show that they do actually have a real problem with emissions then it is difficult to address the issue. EIT Food could help in this with the design of private public funding to overcome and analyse the situation and help the transition. Among primary producers, 95% of them don't even use digital tools, so they need to be brought into this digital transition. One avenue highlighted by the workshop participants was a gamification approach where the farmer would play a computer game to decarbonise their farm, and then they would enter information which could be collected. They would use a water bill or electricity bill, all the input bills as the evidence.

Specific topics are highlighted regarding carbon accounting. One is the GHG national inventory. However, the workshop participants stressed that it is not sophisticated enough to pick up farmer behaviour and second, even if it did, it isn't aligned and farmers can be prosecuted for example for not doing enough on nitrous oxide, while at the same time delivering significant carbon sequestration or investing in renewables. A third issue highlighted was around inconsistencies in reporting scope 3 emissions. There's a fundamental problem, so there is an immediate issue around governance of the framework that needs to be corrected.

EIT Food can play a key role in establishing a clear definition of Net Zero food and the metrics (e.g. carbon accounting, carbon sequestration, greenhouse gas emissions, environmental impact indicators); and appointing an appropriate body to manage and implement MRV processes for Net Zero food (e.g. global ISO standard). As already mentioned, a critical part of this will be big data and managing big data. EIT Food should establish a leadership role, partnering with FAO and putting a proposal together with stakeholders, on a global harmonised system. Then education and public engagement is critical to build trust, encourage adoption of digital technologies on farm and a globally aligned and operational process. Finally, collaboration and lobbying will be key for regulatory intervention which supports the transition.

The overall impact of the Data and MRV processes opportunity is very high (18/20) across the whole food and drink sector. With commitment, the opportunity has the potential to scale across the globe and deliver improvements to the roadmap by 2030 and positive impacts towards the SDGs and other missions. There are potentially some negative impacts of this opportunity pathway, including the potentially increased price of food, reflecting the true cost of food and climate change; and it is critical that there is time to ensure communities catch-up and are not left behind.

The overall feasibility of the Data and MRV processes opportunity is fair (12/20). The technical probability of success and feasibility of the key technologies and capabilities required is medium-high and will rely on adoption levels and buy-in by all stakeholders. However, the likelihood of adoption across the value chain will be a challenge. While big brands and large retailers are already highly digitalised, farmer business is mostly analogue, and this will be challenging to transition. Additionally, there is limited opportunity for collaborations in regulatory, legal, safety and governance. The challenges and barriers around collaboration, alignment, data protection, company IP, renumeration, fraud, good faith practice, best practice and regulatory alignment (locally, internationally and globally) need to be tackled to enable the transition. EIT Food has a key and relevant role here in public engagement and education to overcome these hurdles.

The successful end outcomes for the contribution to A Net Zero Food System are:

- EU lead the global harmonisation of the food system by standardising and agreeing robust MRV processes and principles related to Net Zero food (LCA, carbon accounting principles, global databases) by 2025
- An appropriate body is appointed to manage and implement MRV processes related to Net Zero food by 2025 (e.g. global ISO standard for food products and production – from farm to fork)
- Standardised nutri- and eco- scoring and labelling by 2025
- Globally aligned and operational MRV processes for a Net Zero food system by 2030

Mission Synergies: The Data and MRV processes opportunity also has strong synergies with Mission 3: A fully Transparent, Resilient and Fair food system.

The resultant roadmap for the " Data and value-chain integration, and measure, report, verify MRV methods" Priority Opportunity, including the trends/drivers, market needs, opportunities, capabilities and enablers as determined by the workshop participants, is available in the appendix.

Table 4: Summary of Measure, Report and Verify Processes Opportunity Area that emerged from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System
Measure Report and Verify Processes	EU lead the global harmonisation of the food system by standardising and agreeing robust MRV processes and principles related to net zero food (LCA, carbon accounting principles, global databases) by 2025	Ensures verified reduction of CO_2 equivalent emissions on the food system every year (enabling targets set in other impact pathways to be achieved)	2023 – 2025 – 2030 – 2050 LEADERSHIP Partner with an appropriate body to manage and implement MRV processes related to net zero food FAO Proposal with stakeholders for global harmonised system Globally aligned and operational MRV processes for net zero food INNOVATION Standardised and robust MRV process design, principles and indicators related to net zero food + peer review Computer game for farming communtiy to input farm details, capture data and model impact EDUCATION Educate, build trust and assist farmers transition to adopt more digital ways of working Train key stakeholder groups on MRV processes - primary producers and processors PUBLIC ENGAGEMENT Engage, build trust and learn from industry and society including farmers and primary producers (farming co-ops, associations and unions), food processors and brand owners, advisors, & regulators and citizens BUSINESS CREATION Scout and support the acceleration of the priority capabilities & innovative technologies which could deliver positive impact towards the regenerative agriculture indicators LOBBYING Lobby for strong regulatory and legislative base to support and protect stakeholders and goverance of MRV processes COLLABORATION & PARTNERSHIPS Full supply chain collaboration and visibility Technology providers IT and Big data experts
	An appropriate body is appointed to manageand implement MRV processes related to net zero food by 2025 (e.g. global ISO standard for food products and production – from farm to fork)	Encourages behaviour change and drives impact in terms of environmental performance of the food system set out in all of the priority impact pathways	
	Standardised nutri- and eco- scoring and labelling by 2025	Net zero positive food system	

Priority Area: Food Loss and Waste Prevention and valorisation of side streams, recycling

Overview: For this topic, the workshop participants defined food loss as loss that occurs from the farm up until the door of the retailer, and anywhere from there on becomes food waste. Overconsumption is actually also a form of food waste, but that was considered too broad and so was considered out of scope for this exercise.

Successful outcomes: The workshop determined two key priorities in relation to the successful outcome of this opportunity. The first is an aim to reduce food loss by 50% and reduce food waste by 50% by 2030. And the second is for EIT Food to be recognised as a privileged and preferred Advisory Board to the key stakeholders, policy makers and legislators by 2025.

The role of EIT Food: Policymakers and legislators need partners to provide the evidence while they decide on government policy and legislation. During the workshop it was evident that the EIT Food network contains people who could position themselves as the expert advisors in this space. Key activities include engagement with key stakeholders. Retailers are a good example: they are not yet partnered with EIT Food but they are key in tackling waste. It is also important to define the statistics for waste and act on the commonly accepted statistics and target the hotspots in the food system. The creation of a working group for EIT Food to analyse this and to highlight the priorities internally for the Community but also externally to policymakers would be a positive step. For example, it is important to create new business models connecting supply and demand to make sure that there is no loss from the production side. Digital technology and digitalisation can also help to monitor and coordinate the whole supply chain. Supporting innovation and entrepreneurship will be essential in delivering new solutions to both reduce losses and waste and reuse or recycle side-streams, by-products, and waste streams. Regulatory, legal and safety issues are still under-coordinated and there is still no large-scale coordinated movement towards food waste and food loss reduction. EIT Food needs to bring actors together, including retailers and consumers to facilitate change.

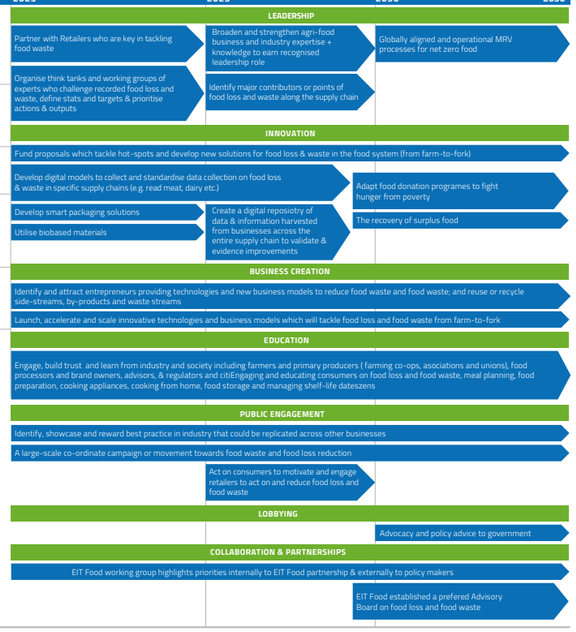
The overall impact of this priority area is very high (18/20) with a positive overall impact across the whole food and drink sector and there is a high potential to scale and deliver improvement of the roadmap vision by 2050. The common problem is that not enough is being prioritised in this space. The opportunity will have positive impacts related to the other SDGs. However, there could be negative impacts in terms of potential food safety issues and higher costs. The food loss and food waste opportunity area will lead to impact in the following areas:

- Value from food waste or side streams in production
- More products on the market that use food waste or side streams
- Reduction in CO_2 emissions in the food system
- Increase in products that use alternative new ingredients which improve environmental outcomes
- Percentage reduction of food waste and loss along key identified elements of the supply chain

The overall feasibility of this opportunity is fair (13/20). The likelihood of adoption across the value chain is high. However, there is a need to recognise financial constraints and limitations within the regulatory, legal, safety and governance framework. The technical probability of success and feasibility of new technologies and capabilities is fair. EIT Food has a key role in identifying and developing new technologies and business models; creating working groups to broaden and strengthen the knowledge base; identifying, showcasing and rewarding best practice; educating consumers; driving a large-scale movement towards a reduction in food loss and food waste; and advising policy makers and to ensure this opportunity is realised.

Table 5: Overview of Food Loss and Food Waste Priority Area that emerged from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System
Food Loss and Food Waste Prevention & Valorisation of side streams	Robustly determine percentage of food waste and loss along key identified elements of the supply chain	Value from food waste or side streams in production	2023 – 2025 – 2030 – 2050
	Reduce food loss by 50% by 2030	More products on the market that use food waste or side-streams	
	Reduce food waste by 50% by 2030	Reduction in CO2 eq. emissions in the food system	
	EIT Food recognised as privilged and prefered Advisory Board on food loss and food waste reduction & valorisation to key stakeholders	Increases in products that use alternative or new ingredients which improve environmental outcomes	
		Percentage reduction of food waste and loss along key identified elements of the supply chain	



Priority Area: Overcoming barriers to behaviour change of consumers

Summary: The workshop participants exploring this priority opportunity area looked at consumer behaviour and understanding the barriers associated with changing consumer behaviour to support a Net Zero transition. Their vision was that by 2050 consumers will have adopted a diet or lifestyle that reflects a holistic understanding of their consumption better. This was split out into people, planet, profit, to be inclusive, fair and equitable throughout the value chain. Food must be healthy, nutritious and close to Net Zero, and it must be affordable for the consumer. The workshop participants reflected that as societies become more affluent, we have a rising middle class across Europe, shifting towards eating meats, more imported produce, more complex processed foods, etc. that are often a more carbon and resource intensive diet. This type of behaviour needs to be moderated if the food system is to stay within planetary boundaries and at the same time feed a growing population of perhaps 10 billion by 2050.

To this end, this topic focuses on education, awareness building, and true pricing that reflects the environmental and social impacts of production and consumption. The exploration focused less on taxation and subsidies but given that consumers are known to be price sensitive and the current cost-of-living pressures, financial mechanisms to shift behaviour may be part of the solution. Consumers need to understand the impact of their diet, and European education and labelling need to empower consumers by providing visibility on the health implications and Net Zero contributions.

The successful outcome of this mission area defined by the workshop participants would be that:

- By 2040, 90% of consumers have a Net Zero diet.
- By 2050, consumers will have adopted a diet/ lifestyle that reflects a holistic understanding of their consumption: People – inclusive, fair, and equitable; Planet – healthy, nutritious, and close to Net Zero; and Profit – equitable, fair, and affordable.

It is vital to bring the retailer on board so retail channels increase visibility for the healthier products. Schools also can play a key role in consumer education and changing the attitudes, expectations, and behaviour of future generations. Apart from educating and labelling, there's no new technology needed. Three potential leverage points are 1. Public procurement buys a lot of food – schools, hospitals, prisons, etc. and 2. The service sector – restauranteurs, hospitality where consumers eat out. How do we positively influence the people who make the food/health judgments and recipe choices used for food cooked outside of the home? 3. Retailers – particularly the big brands and supermarkets. For retailers and service providers, how do we frame products that are closer to carbon zero? How do we position them in the right place and how do we also nudge and entice retailers to do that?

EIT Food is in a strong position to take the lead in this programme, and should lead in developing eco-labelling, engaging with policymakers and educating about the eco-labels. This topic relies on the data – a good sensible LCA that everybody agrees upon to be the basis of the label to make it credible is necessary as credibility is needed for adoption. If it works, consumers can be the main driver of change because they will demand products that work better for them and better for the world. But it does take time for consumer behaviour to change. One of the potential risks in this area is misinformation or ill-formed initiatives, that further down the road may prove to be detrimental to health or environment. For example, the workshop participants described how there is great enthusiasm for new alternative proteins, but to date there is little robust scientific understanding of the environmental and health impacts of these emerging new proteins. There is therefore a fundamental role for policymakers to protect consumers from misinformation and to ensure definitions and objectives are robust. EIT Food through its support for innovation and research can play a key role in ensuring the evidence base is sound and well understood before defining new and alternative diets.

The overall impact of this opportunity is high (16/20) with a strong overall positive impact on the whole food and drink sector and the SDGs. The consumer will be the main driver for change, demanding better products for themselves and the planet. However, the potential to scale and deliver improvement to the roadmap by 2030 is quite low as consumer behaviour change takes time. There may potentially be negative impacts of this opportunity with the price rising for some food types which may impact on affordability, accessibility, and food security.

Table 6: Overview of Changing Consumer Behaviour Priority Area which emerged from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System (2023 / 2025 / 2030 / 2050)
Consumers Behaviour Change	By 2040, 90% of European consumers have a net zero diet	Value from wastes or side-streams in production	**LEADERSHIP** Partner with an appropriate body to manage and implement MRV processes related to net zero food Co-creation - how do we frame & position products that are closer to carbon zero? And nudge & entice reatilers to do that?
	By 2050, European consumers will have adopted a diet/lifestyle that reflects a holistic understanding of their consumption: • People – inclusive, fair, and equitable; • Planet – healthy, nutritious, and close to net zero; • Profit – equitable, fair, and affordable	More products on the market that use food waste or side-streams	**INNOVATION** Robust, sensible & credible LCA which is translated into ecolabel
		Reduction in CO2 equivalents in the food system	Eco-Labelling which empowers consumers and provides visibility on health implications and net zero contributions True cost accounting
		Increase in products that use alternative or new ingredients which improve environmental outcomes	**EDUCATION** Educating school age children and consumers European educational packages, including focus on eco-labelling Develop bespoke content recording food (systems) per demographic
			PUBLIC ENGAGEMENT Understand diets per demographic and develop interventions tailored to that demographic Introduce and promote European eco-label Engage with schools who are educating our future generation of consumers Increase consumer visibility of healthy & net zero products Engage with Public procurement: schools, hospitals, prisons etc. who buy a lot of food Engage with Food Service where consumers eat out - restaurants, hospitality venues Engage with retailers - particularly big brands and supermarkets
			LOBBYING Engaging with policy on eco-labels Engage with policy to prevent misinformation & make sure definitions and objectives are robust
			LEADERSHIP Leadership position in ensuring the evidence base is sound and well understood before defining new and alternative diets

Priority Area: Diversification of Protein Sources

Overview: The working group on the diversification of protein sources priority area described how the literature suggests that about 80% of the carbon emissions from the food sector in Europe are linked to production of animal protein including production of feed for livestock, and ruminants particularly are a significant contributor to GHG emissions. Animal farming and the demand for animal feed also has significant impacts on land use, freshwater use, eutrophication, pesticides and fertiliser use and use of antibiotics. Meat and dairy make up 75% of protein consumption in Europe. Agriculture and livestock production will continue to play a key role in our food system, and the Net Zero agenda notably through its capacity to sequester carbon. Moreover, GHG emissions and the environmental performance of animal farming can be improved as outlined by the Regenerative Agriculture Priority Opportunity. However, with a growing population and increasing demands for protein, there is a need to diversity our sources of protein to sustainably meet this demand.

The successful outcome for protein diversification, outlined by the working group during the workshop, would be that by 2030 we reduce the carbon footprint of proteins for human consumption by 50%.

In scope are proteins that complement or replace traditional meat and fish sources of protein, to deliver improved environmental and sustainability benefits, reduce animal welfare concerns, and potentially deliver human health benefits. This includes plant-based proteins, insects, cell based fungal, micro and macroalgae, and novel aquaculture, through to synthetic biology, precision fermentation, and cell-grown meats. GMO, GMO genetics, CRISPR, are included in this as well.

The immediate milestones are policy and legislation to incentivise the transition to more diversified and sustainable protein sources. Consumer acceptance is a key issue with many of the emerging alternative proteins. Therefore, awareness and education are required to encourage and influence consumption of a more diversified protein diet for consumers. Consumers need to have confidence in incorporating novel and alternative proteins into their diets and understand how to cook with them. Producers and brand owners also need to be encouraged to explore how to prioritise sustainable and diversified proteins and marketing and associated promotional activities to help with the consumer communication piece. There is also significant technological development and research needed to commercialise the more sophisticated emerging alternative proteins to address price points, taste, texture, energy consumption, and scale-up. Additionally, research is required to validate nutritional and health claims and the actual sustainability benefits these alternative sources may or may not deliver.

In the medium-term higher carbon taxes may be beneficial to incentivise the diversification and sustainability of protein production and scaling up the technologies on market and push further technology development. Funding support and availability, particularly for production transition will be key. The role of EIT Food in this transition should be in understanding the policy and also lobbying policy to incentivise the diversification. Initiatives should also support the underlying science to help progress the technological readiness levels (TRLs) from early stage, supporting new products to commercialisation through innovation and entrepreneurship programmes, and also public engagement. EIT Food should also use the expertise within its network to robustly evaluate the nutritional and sustainability of emerging alternative proteins and ensure accurate communication and a trustworthy source of information.

Overall, the opportunity for alternative proteins is considered high. Improvements are still needed, and consumer acceptance is critical for adoption, but they are expected to bring significant positive benefits. However, there is some debate over the carbon intensity of animal farming, and one counter argument from the sector is that if we deliver Net Zero meat production, you need less diversification of proteins. Moreover, some of the emerging proteins are highly energy intensive to produce and the carbon footprint of these is still poorly understood – data again is important here to better understand the impacts and benefits. Also, the bioavailability of these emerging proteins and implications on health of long-term consumption are also poorly understood. Affordability, equity in access, impact on traditional animal-based agricultural communities and supply and demand are some of the other considerations for some of these alternative proteins that should not be overlooked.

Finally, proteins for human consumption or for animal consumption present somewhat different challenges and opportunities, and these could be usefully explored because you have different solutions for which one you are looking to achieve.

The impact from the diversification of proteins opportunity is high 16/20. It can have an overall positive impact on the whole food and drink sector as alternative protein sources for human consumption can have large impact on total GHG emissions. The potential to scale is fair as many technologies are in development and demonstration phases but further improvements are needed to scale, improve product quality, texture, taste, energy consumption and reduce costs; while consumer acceptance is critical. The impact on the SDGs is high with spin-off benefits for water use, biodiversity and health. There are potentially some negative impacts in relation to energy requirements and the risk that traditional animal farming industries and farming communities could become redundant. The opportunity will deliver impact to:

- Value from food waste or side streams in production
- More products on the market that use food waste or side streams
- Reduction in CO_2 emissions in the food system
- Increase in products that use alternative new ingredients which improve environmental outcomes
- Consumer health and acceptance
- Land and environment

The feasibility of the Diversification of Proteins is fair (15/20). The likelihood of adoption across the value chain is good and there is interest but existing production and supply chains need incentives to change. The technical probability of success and feasibility of key technologies and capabilities required is fair. There is still need for technical development, improved Technology Readiness Levels (TRL) and consumer acceptance; along with evaluation of environmental and health benefits. Depending on the technology, there are regulatory challenges which need to be overcome too. The relevance and role of EIT Food in enabling a pathway to impact is critical.

Mission Synergies: The Protein Diversification opportunity has strong synergies with both Mission 1: Healthier Lives Through Food and Mission 3: A fully Transparent, Resilient and Fair food system.

Table 7: Diversification of Protein Sources Opportunity Area that emerged from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net zero Food System			
			2023	2025	2030	2050
Diversification of proteins	By 2030, a reduction on the carbon footprint of protein for human consumption by 50%	Value from food waste or side streams in production	**COLLABORATION & PARTNERSHIPS**			
			Engage with producers and brand owners to explore how sustainable and diversified proteins can be prioritised and associated marketing and promotonal activities			
	Take total GHG emissions from meat and dairy from 14% to 7% of global emissions	More products on the market that use food waste or side streams	EIT Food task force or think tank to identify and build expertise and exploit, scale and accelerate existing knowledge and innovation for impact			
			INNOVATION			
		Reduction in CO2 emissions in the food system	Funding to support underlying science to help progress technological development (TRL) of the more sophisticated emerging alternative proteins to address price points, taste, texture, energy consumption	Further technology development and new production methods		
				Further development of new sources with higher proetin yield		
		Increase in products that use alternative new ingredients which improve environmental outcomes	Innovation projects should include exploration of affordability, equity in access, bioavailability of nutrients, nutritional and health claims, implications on health and long-term consumption, sustainability and trade-offs (e.g. impact on animal-based agricultural communities)			
		Consumer health and acceptance	Robust LCA & MRV processes to better understand impacts and benefits of diversification of protein			
		Land and environmental performance	**BUSINESS CREATION**			
			Identify & support the launch, acceleration and scale of diversified proteins innovations underpinned by robust science			
			IP Management	Access to pilot facilities and scaling platforms (particularly in urban settings)		
			EDUCATION			
			Entrepreneurship and innovation training programmes			
			Educate consumers & influence the consumption of a more diversified diet	Train key stakeholder groups on MRV processes - primary producers and processors		
			Educate younger generations as early adopters of new proteins			
			PUBLIC ENGAGEMENT			
			Consumer observatory labs to gather insights and behaviours towards diversified proteins and emerging alternative proteins	Consumer experience labs (taste, texture, presentation development) for innovative technologies for new protein production		
			Campaign to encourage and influence consumption of more diversified and sustainable protein intake			
			Encourage producers and brand owners to explore how to prioritise and promote sustainable and diversified proteins			
			LOBBYING			
			Lobbying for policy to incentivize the transition to diversified and sustainable protein production			

Priority Area: Overcoming barriers to behaviour change within the farming community

Overview: The workshop participants stressed that to unlock the Net Zero challenge, one of the biggest problems is behavioural change within the farming community. Therefore, there is a need to support the key actors to enable the change that we know is feasible, but which is stalled due to embedded behaviours and resistance to change. There are a lot of blockages, but firstly we need an agreed definition for Net Zero. We all need to know what direction of travel we're going in and what we are trying to achieve, how are we going to achieve it, and who decides we have achieved it. This relates strongly to the topic of whole measurement data LCA and MRV processes. This would enable us to unlock our ability to baseline, measure, set new targets, and replicate performance, but a lot of this is also about educating everybody in the food system. It is not just about educating the farmers on what they need to do because actually they know what they need to do. The problem is they are stymied by the confusion in the entire food system over what we're measuring, why we're measuring it and how we're measuring it, and uncertainty and inconsistency in government policy and consumer demands. For example, somebody thinking they're doing the right thing by buying slow-growing chickens, when that is actually more carbon intensive.

Role of EIT Food: There's a big education piece that EIT Food can do and they can bring together the right people to play a lead role as an honest broker across the food chain. From farmer to fork, bringing all the key stakeholders together to educate people to standardise processes so that farmers know they're making the right change at the right time, and it's being measured correctly. Understanding trade-offs is important and deciding what the trade-offs are going to be and who makes the choices. What are acceptable trade-offs? Again, it comes back to the definition.

The impact of changing farmers' behaviour is very high (20/20). It will positively impact the entire food and drink sector as 80% of the carbon footprint and opportunity to sequester is at the farm gate (ruminant). The potential to scale and deliverable improvement to the road map is also very high as we have no other choice but to work on changing farmer behaviour if we want to achieve Net Zero targets. The opportunity will have a positive impact on the SDGs.

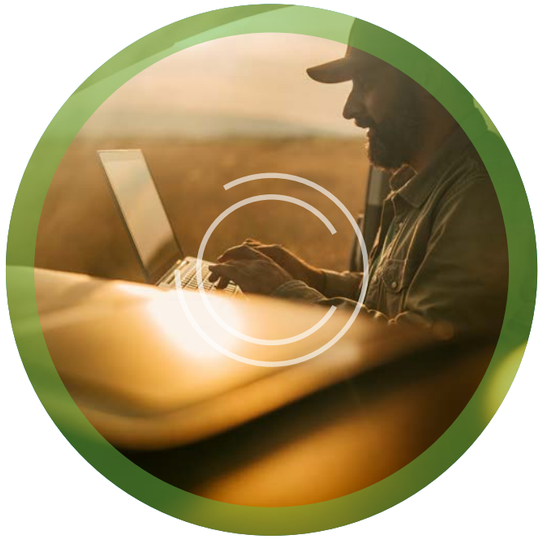
The feasibility of changing farmers' behaviour is fair and considered pretty feasible. The likelihood of adoption across the value chain is low at present as there are a lot of blockers around poor leadership and understanding of the issues, so the issues are being looked at through a single lens. The technical probability of success and feasibility of key technologies and capabilities is high as the technology is in existence. It does need refinement, but we are not looking for something new. Policy and government can be a key blocker, but that's where EIT Food can perhaps play a new role for the organisation by bringing the right people together to lobby for change to highlight what change needs to happen and how it can be done. A lot of this is about showing people how it can be done and what is possible and what they need to do to enable change.

The successful end outcome and contribution to the mission, as defined by the workshop participants, would be:

- Farmers achieve Net Zero by 2050
- Better connected/smarter food system where innovation is more impact focused and rewarded
- Farmers more directly connected with research (connected pipeline)

Table 8: Overcoming barriers to behaviour chain in the farming community opportunity area outputs from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System 2023 – 2025 – 2030 – 2050
Overcoming barriers to behaviour change in the farming community	15% of farmers in Europe have changed their behaviour towards sustainable farming practices	Reduction in CO2 eq. emissions in the food system to net zero by 2050	**COLLABORATION & PARTNERSHIPS** Agreed definition on Net Zero, direction of travel, metrics, basline, targets, barriers & MRV processes Facilitate public / private collaboration to achieve net zero including fair pricing policy Cross sectoral engagement program - identify and deliver opportunities for other sector change
	European Farmers achieve net zero by 2050	Sequestering carbon to deliver beyond net zero by 2050	**INNOVATION** GAP analysis for LCA Development Fund local lighthouses & living labs Establish scientifically robust LCA & Measure, Report and Verification processes Refine tools (MRV) - Continuous innovation to measure & enable change LCA Tier 3 factors LCA Tier 2 factors Repeat measurement of baseline Carry out baseline measurements Evaluate trade-offs
	Better connected and smarter food system where farmers are directly connected with research	Delivering other public good: biodiversity, water, job creation etc.	**BUSINESS CREATION** Identify, support and refine technology for LCA & MRV processes
	Reduce average age of farmers from 59 to 55 by 2040		**EDUCATION** Education programme to empower farmers on robust and standardised LCA MRV processes, targets and sustainable farming practices Disseminate results from baseline measurements & inteventions to farmers Facilitate peer-to-peer learning & continuous professional development Educate upstream in value chain Educate consumers on responsible net zero food choices
			PUBLIC ENGAGEMENT Communicate clear consistent message on Net Zero targets and agreed LCA metrics + MRV processes to farmers Raise awareness and opporutunities of farming to encourage young farmers into sector Clear consistent message to consumers on Net Zero and agreed MRV processes to ensure consistent & aligned consumer demands from industry on net zero Showcase farmers as solution providers, not just the problem Clarity and communication on purpose of farmer (empower) Clarity & dissemination around net zero trade-offs for all stakeholders (consumer, farmer, industry, government)
			LOBBYING Lobby for change to highlight what needs to happen & how it can be done Support development of incentivisation policy – rewarding outputs, not processes Consistent government policy on Net Zero targets and LCA MRV processes to farmers
			INNOVATION EIT Food convenor of networks EIT Food established as the honest broker in the food chain



Priority Area: Food and Beverage Packaging Never Becomes Waste

Summary: The vision defined here by the workshop participants is that food and beverage packaging never become waste. The opportunity is firstly about reducing the amount of food packaging and hence resource that end up lost in landfill or polluting the environment. The other part of this is the monomers used in packaging come from fossil fuels much of the time, therefore carrying embodied carbon and sustaining a carbon-intensive sector. In scope for this topic are sustainable packaging by design. As well as packaging, we should not overlook the additives that go in with the substrate such as the glues, inks, etc. so these should also be within scope for this particular theme. Success would look like reusable, compostable, recyclable, biodegradable and reduced packaging (not necessarily in that order). Success would be measured using data, LCAs in particular, to assess environmental impact.

Recycling has dominated the discussion on packaging for many years now, but it should be noted that generally when materials are recycled and captured, they are down-cycled. For most plastics, the material is continually down-cycled – losing strength and quality – until it is rendered completely useless for recycling. For instance, a plastic may start life as a PET bottle, be reused as a carpet or other textile, before ending up in a landfill, where it breaks down and releases microplastics into the environment. Refillable and reusable packaging seek to address this problem, and deposit return schemes to support refill/reuse are a key initiative that was common-place in the 1970s, and continues today in some countries like the Netherlands.

The workshop participants identified that how to develop viable deposit return schemes and reuse/refill is one piece of the puzzle, and the other piece relates to how we maintain the value so the recycled PET bottle becomes a new PET bottle in the future. We've seen deposit return scheme infrastructure being the short-term priority, with a focus on how to get the right actors in place to support such schemes. In the medium-term, brands are looking at things such as alternative packaging materials to PET, and investments in things such as active and intelligent packaging that interact with the food product to enhance longevity, etc. The regulatory framework must be in place, but industry actors suggest that legislation should is not governments primary be the only focus. The key is having actors within supply chains coming together, including the big brands, entrepreneurs, municipalities, funding institutions working together to bring innovations to market. For example, Pepsico has been working with start-ups since it is where knowledge and innovation are – they just need funding, and they need feedback from corporate players on how they're performing so they can improve.

Role of EIT Food: The working group highlighted that this where EIT Food can play a role as they are ideally placed to bring those actors together. This means connecting actors, educating people, creating the infrastructure to support entrepreneurship, and having the financial mechanisms in place to enable this, and creating the right monetary/fiscal incentives. For example, EIT Food could step forward and coordinate an industry-wide pilot with a startup and deliver a certificate or stamp of approval that wider industry can then adopt. These are the kind of possibilities where EIT Food and the resources that it has at its disposal can make a real difference in terms of moving the TRL along. The problem is just getting it set up properly, funded properly and being very results- and KPI-oriented, which is what businesses are ideally geared to do.

Important with respect to packaging innovation is that any sort of decision being made has to be based on the science. The workshop participants stressed it can't be on a whim or just someone's idea. As with the other topics in this study, change has to be based on scientific evidence and sound data – primarily LCA data. CO_2 emissions with packaging are not so high when you compare it to food production or transport, but if you look at the impact on water, biodiversity and environmental impact indicators, that is where the impact becomes significant. EIT Food probably need another indicator there to address these dimensions of a Net Zero system.

The successful end outcome and contribution to the vision of mission 2, as defined by the workshop participants would be that:

- Food and beverage packaging should be reduced, compostable, recyclable, biodegradable
- Country differentiation
- LCS measurement – cross cutting

The impact of the "food and beverage packaging never becomes waste" opportunity is high (15/20) with positive impacts on the SDGs, environmental impact and health through micro-plastic reduction. The potential to scale and deliver improvement to the roadmap is high as the technology is available. However, the barrier is implementation, including infrastructure, willingness, cost etc. A potential negative consequence of this opportunity areas is the price increase of the product. It is important that the solutions are economically viable for consumers.

The feasibility of the food and beverage packaging never becomes waste is fair (14/20). The likelihood of adoption across the value chain is low as there is low willingness and different interests. But there is recent EU policy for food packaging. The technical probability of success is high as the technology is well developed and innovation is continuous. EIT Food has high potential to fill gaps with all actors to create an enabling pathway to impact in this opportunity area.

Table 9: Overcoming barriers to behaviour chain in the farming community opportunity area outputs from the roadmapping workshop

Priority Area	Successful Outcomes	Impact	Roadmap Milestones to A Net Zero Food System (2023 – 2025 – 2030 – 2050)
Food and Beverage Packaging Never Become Waste	Fully circular food and beverage packaging system by 2050	Value from waste or side-streams in production	**COLLABORATION & PARTNERSHIPS** Bringing together the right actors to support a viable deposit return scheme infrastructure; optimising mechanical recycling; and collection infrastructure development Deeply involve retailers to explore the future of retail in a world free from single-use plastic
	100% reusable, compostable, recycable, biodegradable and reduce packaging by 2050	Many products on the market that use food waste or side-streams	Joint consortia of stakeholders co-creating and addressing gaps in knowledge & technolohy development
	Better connected and smarter food system where farmers are directly connected with research	Reduction in CO2 eq. emissions in the food system	Bringing together big brands, entrepreneurs, municipalities, funding institutions to help innovations get to market and support collaboration
	Reduce average age of farmers from 59 to 55 by 2040	Reduction in CO2 eq. emissions in the food system	**INNOVATION** Alternative packaging materials to R&D&I Avoid downcycling by improving recycling and packaging design Sustainable packaging by design Active and intellignet packaging to enhance longetivity etc. Robust and standardised LCA measurement for science-based decision making
		Reduction in CO2 eq. emissions in the food system	Robust LCA and MRV processes to assess environmental impact and measure success (waste and pollution as important indicators to drive positive change) Deliver a certificate or stamp of approval that wider industry can adopt
		Reduction in CO2 eq. emissions in the food system	Use resources to move the technology readiness of sustainable, active and intelligent packaging along
			BUSINESS CREATION Scout startups with new products around sustainable packaging Bring innovations to the market Infrastructure to support entrepreneurship EIT Food co-ordinate an industry-wide pilot with a startup Connect entrepreneurs with industry for feedback and improvement towards market needs Financial resources to support startups with solutions for sustainable, active and intelligent packaging
			EDUCATION Food solutions projects focusing on the redesign and alternative packaging materials Educating people to understand waste and recycling information
			PUBLIC ENGAGEMENT Inform citizens on recycling and importance of reducing packaging waste

5.4 Roadmap Synthesis and Conclusions

Linking Grid

To better visualise the relationships and cross-linkages between the value creation opportunities/impact pathways, the trends and drivers, capabilities and enablers, a linking grid is used, as shown in Figure 14 and Figure 15. This linking grid helps explore where multiple opportunities might act together to address common trends/drivers or market needs, and where certain capabilities and enablers can have importance in delivering multiple opportunities.

Of the trends/drivers/market needs, six are highlighted as they are addressed to some extent by a majority (four or more) of the seven opportunities:

- Growing and increasingly affluent global population demanding more and better food;
- Biodiversity loss and species extinction;
- Consumption level: Carbon-intensive diets;
- Society has got used to cheap food that has been subsidised below the real value;
- A need for market signals (e.g. policy and regulation) to drive industry;
- Lack of information and misinformation to consumers: Need to enable informed decision making.

Also of note are capabilities and enablers that are deemed relevant in the development, deployment, or realisation of four or more of the opportunities. They are:

- Need to increase understanding of environmental implications of CO_2 removal strategies;
- LCA literature not representative or reliable. Need for careful interpretation when using LCAs for decision making;
- Forecasting models for optimum plant production for feed based on soil, weather (new agronomic systems);
- Connecting consumers to the food system to help them understand where food comes from;
- Educating young people around agriculture, Net Zero, climate change;
- Policy and governance which guides responsible consumer behaviours;
- True cost accounting integrated into food policy and Investment in new technologies.

The list of market needs and the identified enablers points clearly towards the role of EIT Food in education and public engagement to raise awareness, increase understanding, and drive policy and behavioural change.

Figure 14: Linking grid – Trends/drivers and market needs

Trends, drivers and market needs												Market needs															
TD02. Growing and increasingly affluent global population demanding more and better food	TD15. Biodiversity loss and species extinction	TD03. Population growth in urban settlements changing food distribution requirements	TD39. Waste and losses in the food system	TD22. Global food system contributes to climate change, environmental degradation and biodiversity loss	TD35. Labour and skills availability	TD36. Availability of new technologies transforming the food system	TD01. Over-consumption and over-exploitation of resources	TD06. Climate change adding pressure to food system - extreme weather, rising temperatures, sea-level rise	TD11. Increase in industrial activity and intensive food production systems	TD10. The world's food system and energy consumption is dependent on fossil fuels.	TD12. Deforestation and depletion of natural resources for food and biofuels	M60. A need for market signals (e.g., policy and regulation) to drive industry	M11. Consumption level: Carbon-intensive diets	M33. Society has got used to cheap food that has been subsidised below the real value	M61. Lack of information and misinformation to consumers: Need to enable informed decision making.	M19. Current agri-environmental policies and practices are insufficient in protecting the environment. Law and regualtion creating unsustainable practices.	M21. Agricultural intensification has led to the degradation of soils and water pollution.	M45. Social disengagement with food production and preparation	M02. Fossil fuel energy and natural resources used for food production and delivery	M09. Food and packaging waste (retail, distribution, consumption).	M15. Land use and land use change (CO2) as a result of agricultural activities	M01. Rising costs and farmers real living wage is so low, farmers can't afford to adapt and innovate	M05. Livestock production - Methane from enteric fermentation, animal excreta (methane and nitrous oxide)	M07. Food manufacturing and processing level: Energy and water consumption	M47. Global and complex food systems	M61. Lack of information and misinformation to consumers: Need to enable informed decision making.	Value Creation Opportunities
	X			X		X		X	X			X	X	X		X	X	X			X						A: Regenerative Agriculture
X	X		X			X						X		X	X	X		X	X								B: Data and value-chain integration
	X				X					X		X	X		X					X							C: Food loss and waste
X					X							X		X	X												D: Behaviour change of consumers
X	X	X	X									X	X				X										E: Diversification of Protein
X		X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	F: Behaviour change within the farming community
		X		X	X		X					X								X							G: Food and beverage packaging

Figure 15: Linking grid – Capabilities and Enablers (addressing 3 or more opportunities)

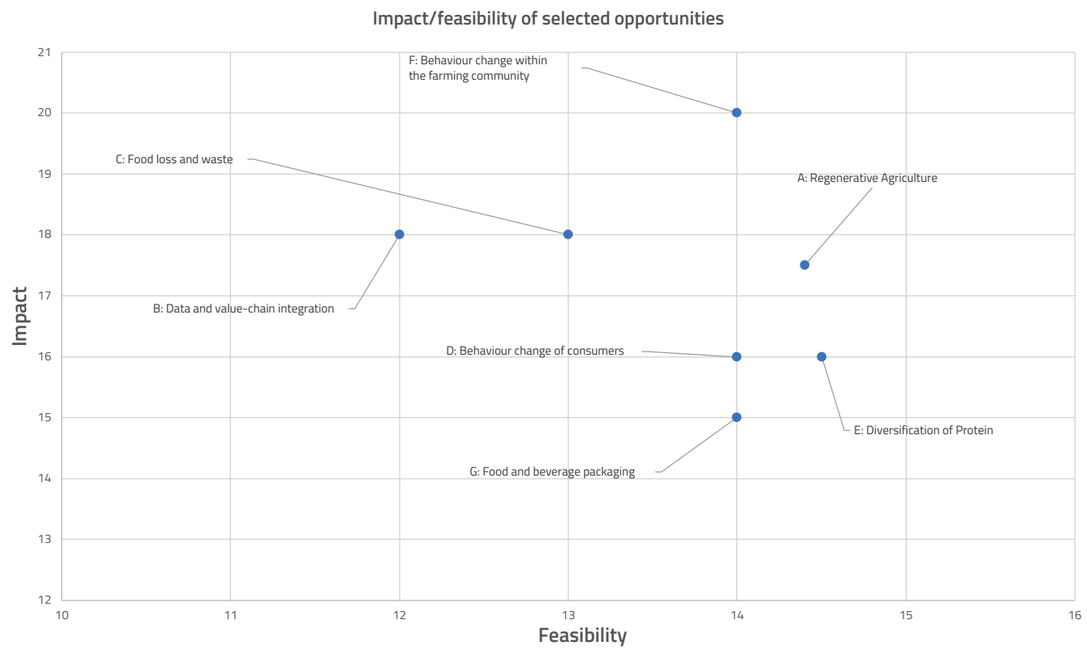
Capabilities and Technologies							Enablers														
C05. Need to increase understanding of environmental implications of CO2 removal strategies. LCA literature not representative or reliable. Need for careful interpretation when using LCAs for decision making.	C61. Forecasting models for optimum plant production for feed based on soil, weather (new agronomic systems)	C10. Standardise the carbon footprinting process	C57. Precision farming	C63. Apps for farmer monitoring	C72. Enhanced tools for measurement, reporting, verification MRV	C79. Consumer acceptance - whole value-chain communication	E24. Connecting consumers to the food system to help them understand where food comes from.	E25. Educating young people (10 years old) around agriculture, net zero, climate change	E48. Policy and governance which guides responsible consumer behaviours	E69. True cost accounting integrated into food policy	E76. Investment in new technologies	E01. Farmer participatory demonstrations	E05. Designing dynamic policies for long-term climate change adaptation in agriculture.	E06. Need for the institutional setup to implement and disseminate technical solutions.	E07. Strong policy support for new tech ind. gene editing	E20. Need for interdisplinary research, thinking, system-reflection, sectorial collaboration	E29. Sustainable national policy on climate change and net zero	E53. Programmes focuing on improved cooking and food management skills	E54. Academia and industry consortiums working together is critical	E78. Engagement and collaboration between stakeholder groups	E79. Clarity around net-zero and trade-offs and clarity of purpose for farmer
X	X	X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
X	X	X	X	X	X		X	X	X	X	X	X	X				X				X
	X		X	X			X	X	X	X	X	X	X	X	X	X		X	X	X	
X							X	X		X								X			
	X					X	X	X	X		X				X	X	X	X	X		
					X																X
X		X				X			X	X	X			X						X	

Impact and Feasibility of Opportunities

The scoring for the impact and feasibility of the seven individual impact pathways suggests that all seven of these opportunities are considered to have good potential to deliver impact and have good feasibility for adoption overall (Figure 16). However, the potential to scale for deliverable improvement by 2030 is considered medium or low for a number of the opportunities, particularly for consumer behaviour change.

Also, some concerns over negative impact on other SDGs are identified notably about potential price increases and hence affordability and equitable access to food. The feasibility of widespread behavioural change of consumers and of the farming community is considered low, highlighting a particularly important role for EIT Food in education and public engagement. For almost all the impact pathways, regulatory challenges are foreseen, and in some cases, this may necessitate a major rethink of standards and regulations.

Figure 16: Impact/feasibility chart for selected opportunities



Category Indicators

EIT Food has defined four category-based indicators for the Net Zero food system, and these were discussed during the workshop. The work with the delegates shows strong agreement with the existing indicators identified by EIT Food, but suggests a need for additional indicators covering other areas of impact in a Net Zero food system. The list below is not exhaustive but gives an indication of the scope of coverage that needs to be considered for a Net Zero food system:

- Sequestration of carbon to go beyond Net Zero carbon (net-positive).
- Reduced absolute values of food losses and food waste at all stages of the value chain.
- Increased biodiversity levels (quantity, diversity, and stability) across all parts of the agricultural system.
- Reduced environmental pollution and contamination and landfill from plastics and other food system impacts.
- Reduced freshwater and land use per volume of food/calories output.
- Enhanced consumer health and wellbeing outcomes from consumer education and awareness, alternative and new agricultural processes, ingredients, and products

6. Summary and Recommendations

The aim of the EIT Food Mission roadmapping exercise to A Net Zero Food System was to critically analyse and synthesise all the information collected through the literature reviews, questionnaires, surveys and expert opinions in order to provide key recommendations on how EIT Food can make a distinctive and significant impact on A Net Zero Food System, and how EIT Food's impact indicators can be consistently met in the next 3–5 years. The recommendations took into consideration the objectives of EIT Food as described in the EIT Food Strategy 2021–2027 and the EIT Food Business Plan 2025–2030. In particular, recommendations were explored in line with consideration of EIT Food's four pillars: Education, Innovation, Business Creation and Public Engagement. However, additional enablers where EIT Food can play a critical role also emerged, notably: partnerships, collaboration and facilitating think tanks and working groups; becoming the preferred advisory body in relation to a Net Zero food system; and lobbying government and policy.

At the end of the roadmapping for EIT Food's Mission "A Net Zero Food system" **four priority opportunity areas** with **three overarching enabling impact pathways** were established**.** Together, these priority impact pathways can help towards the delivery of a food system with Net Zero GHG emissions with carbon dioxide, nitrous oxide and methane identified as the most important to consider. They can also have a positive impact on environmental impact indicators, notably: biodiversity, energy consumption, water pollution and acidification, land use, soil health and soil sequestration, fish stocks, water scarcity and use, ozone depletion, air pollution and ammonia, as identified through this roadmapping exercise (Figure 22).

A number of **cross-cutting priority impact areas and topics emerged in line** with the other EIT Food Missions: "Healthier Lives Through Food" and "A Fully Transparent, Resilient and Fair Food System". However, only general insights resulting from the co-design process were captured and more work is required for concrete actions and recommendations.

6.1 The Priority Areas for Action for A Net Zero Food System

6.1.1 Priority opportunity areas within the food system

The four hotspots within the food system to address to have the greatest positive impact towards a Net Zero food system are:

- Tackling emissions in Agriculture
- Food and Beverage Packaging
- Food Loss and Food Waste
- Protein Diversification.

Tackling Emissions in Agriculture :

Problem Statement: Agriculture has the most impact on the overall carbon cycle and the environment, including biodiversity and the quality and health of soils, water and air – positive or negative. Agriculture relies heavily on natural resources, nitrogen inputs and pesticides. Notably, in Europe, ruminant livestock production is a significant contributor to methane emissions as a consequence of enteric fermentation and excreta. Whilst feed from deforested areas has a significant impact on GHG emissions as a result of land use change. Therefore, concentrating on these areas will provide the most opportunities for reduction in GHG emissions. Importantly, soil is one of our greatest assets. Soils across the earth hold more carbon than any other source. Therefore, building on it and retaining it will fundamentally drive a reduction in GHG emissions.

Opportunity: Regenerative farming has been consolidated as the opportunity with the most distinctive and significant impact on a Net Zero food system. However, there is no commonly accepted definition of Regenerative Agriculture and its impact indicators. Regenerative Agriculture should incorporate low emission, carbon sequestration and sustainable farming practices to regenerate soils, boost productivity, increase yields, reduce emissions and capture carbon. Such sustainable farming practices have the potential to reduce CO_2 equivalents by 10.5Gt every year whilst simultaneously improve other environmental indicators. Technological innovations and capabilities which support regenerative agriculture outcomes should also be leveraged. For example, innovations which support methane capture, feed additives, precision farming, plant and soil microbiome, new breeds, gene editing, animal health and husbandry, solutions to fertiliser and anaerobic digestors, among others. The pricing of carbon will a key component in supporting farmers to fund the negative emission technology needed to achieve Net Zero.

Role of EIT Food: To enable a Net Zero food system, EIT Food has a key role in:

- Defining regenerative agriculture and the impact indicators.
- Establishing scientifically robust, standardised and adopted life cycle analysis and measure, report and verification processes for demonstrating impact towards regenerative agriculture indicators.
- Measuring the success and impact of different farming practices to reduce emissions, sequester carbon and improve environmental performance through established and scientifically robust LCA and MRV processes.
- Driving projects in all 4 functional areas linked to increasing the build-up of CO_2 and other GHG emissions in the soil, reducing its emissions and rebuilding stock from depleted areas.
- Increasing work in carbon credit schemes to ensure the EU can be a leader in this area.
- Focus on education and public engagement programmes across Europe that showcase the role of soil health, and the positive influence that agriculture and farmers can have in achieving Net Zero and climate change targets.
- Develop tool kits and interventions to lift barriers to change in the farming community to embrace regenerative, carbon building, and low emission farming techniques and technologies.
- Develop pilots and testing farms to evaluate the Net Zero agenda and activities that have most effect. Sharing the outputs will be key.

Goal: In Europe, 15% of farmers are under regenerative farming practices by 2030; and 100% of farmers are under regenerative farming practices by 2050.

Food Loss and Food Waste

Problem Statement: The latest statistics on food loss and food waste reveal that over 40% of food is lost or wasted, contributing to approximately 10% of GHG emissions from the food system, whilst negative impacting on other environmental impact indicators. The majority of food loss occurs on the farm, followed closely by retail, food service and consumer homes. One of the greatest challenges in tackling food loss and food waste, particularly on the farm is the difficulty measuring loss and progress. There is a need to improve and standardise the food waste evidence base and methodologies. In particular, estimates of the division of food waste into edible and inedible parts need to be disaggregated to help inform decision making towards food waste prevention or circular uses of commonly eaten and inedible food parts. Consumers also need to be educated on use-by and best before dates.

Opportunity: A reduction of food loss and food waste at primary production and by consumers, and valorisation of side streams. End-of-use and waste recovery, e.g. improved recycling and anaerobic digestion of food waste (rather than conventional landfill). The innovations, technologies and capabilities which can help drive this opportunity includes game-based apps.

The Role of EIT Food: To drive this opportunity area and enable a Net Zero food system, EIT Food can:

- Organise think tanks and working groups who challenge recorded food loss and waste; define targets; prioritise actions and outputs; and gather robust data and knowledge
- Establish EIT Food as a preferred advisory board on food loss and waste
- Develop digital models to collect and standardise data collection
- Create a digital repository of data with info from entire value chain to validate and evidence improvements
- Launch, scale and accelerate innovative technologies and startups
- Run a large-scale campaign, education programmes and interventions for consumers to reduce and tackle food waste
- Engage with retailers who are key to tackle food waste
- Fund R&D&I activities to tackle hotspots and develop new solutions
- Support existing circular food systems programmes across Europe rather than develop its own projects. Many examples show the richness of such programmes (see case studies in Appendix). These initiatives need support and increased awareness. A starting point could be to develop a database of existing projects across Europe and build awareness
- Focus on short-supply chains with restorative and regenerative emphasis

Food Packaging

Problem Statement: The food packaging sector contributes over 5% of food GHG emissions. Although quantitatively small in comparison to the opportunity presented through soil, agriculture and livestock production, petroleum-based packaging negatively contributes to pollution and other environmental impact indicators and is a very important topic for the consumer. It is high on the agenda for food manufacturers, retailers and brand owners and should therefore be prioritised by EIT Food.

Opportunity: Food and beverage packaging should never become waste. The opportunity is to transform the packaging system from a linear model towards a circular system where value can be captured in the system and out of the environment. The key opportunities include reducing the amount of food packaging used and wasted; transitioning from monomers that come from fossil fuels to sustainable packaging materials; sustainable packaging by design; and the additives that go into the substrate (glues, inks etc.). The technologies and capabilities which can support this transition include: sustainable packaging materials, active and intelligent packaging, smart labels and edible coatings.

The Role of EIT Food: To enable a Net Zero food system, EIT Food can play a key role to:

- Support innovation activities centered around moving solutions for zero-plastic packaging and sustainable, active and/or intelligent packaging solutions up the TRL
- Scout startups with innovative technologies, connect them with industry and co-ordinate an industry-wide pilot and support them in bringing innovations to market
- Establish scientifically robust, standardised and adopted LCAs (based on sound data) and measure, report and verification processes to assess and report environmental impact, support informed decision making and measure success
- Provide leadership in eco labelling and front-of-pack information for consumer goods
- Develop a certificate of approval which industry can adopt
- Educate and inform people to understand packaging waste & recycling information and interventions which change consumer behaviour to proper recycling and management of food packaging waste
- Deeply involve retailers to explore the future of retail without single-use packaging
- Bring together the right actors to support innovation, viable deposit return and reuse/ refill schemes, optimise mechanical recycling and collection infrastructure development (short term)
- Drive collaboration and partnerships between key actors within supply chains to support bringing innovations to market
- Lobby for the right regulatory framework to be in place

Goal: Achieve 100% reusable, compostable, recyclable, biodegradable and reduced packaging in the food sector by 2050.

Protein Diversification

Problem Statement: There are three food production systems that produce most of the food globally. These three systems use about 40% of the land and a small number of plant and animal species. They are: cropland to produce grains; rangelands, pastures and feedlots to produce meat and meat products; and fisheries and aquaculture to provide fish products. Of the 30,000 edible plant species, 14 supply 90% of the world's calories. This food specialisation violates the principle of biodiversity whilst intensive agriculture food production and over exploitation of the wild fisheries to produce enough of these commodities to feed a growing population are a significant cause of GHG emissions and environmental degradation.

Opportunity: Diversified protein production and consumption presents an opportunity to complement and support the agriculture sector and wild fisheries to feed a growing population. The technologies and capabilities which can support this opportunity include, for example, plant diversification, aquaculture and algae biotechnology and synthetic biology.

The Role of EIT Food: To drive this opportunity area and enable a Net Zero food system, EIT Food can play a key role to:

- Support existing EIT Food Diversified Protein think tanks and establish working groups to identify technologies; build expertise; and exploit, scale and accelerate existing knowledge
- Provide funding to support underlying science to progress TRL and address price points, taste, texture, energy consumption, bioavailability of nutrients, nutritional & health claims, sustainability & trade-offs
- Provide funding for further technology development & new production processes related to diversified proteins
- Support innovative technologies and new products to commercialisation through business creation programmes
- Establish scientifically robust, standardised and adopted LCA and MRV processes to better understand impact of diversified proteins (including: nutritional, health and sustainability)
- Support IP Management; facilitate access to pilot plant; and establish expertise in policy and regulation for diversified protein production to support innovation and startups in this space
- Engage, encourage and influence consumers to consume a more diversified protein diet
- Public engagement around emerging technologies related to diversified proteins
- Educate consumers on cooking and incorporating sustainable, diversified and sustainable proteins into their diet
- Carry out consumer observatory labs and experience labs to gather insights, behaviour and perception of alternative and emerging proteins
- Address consumer acceptance of emerging proteins through targeted awareness campaigns and education programmes
- Co-create, collaborate and partner with producers, brand owners and retailers to explore how to prioritise sustainable and diversified proteins. Consumer knowledge can be boosted through marketing and associated promotional activities.
- Lobby policy to incentivise the diversification of protein
- Establish a leadership position and advisory role related to diversified protein production and robust scientific evidence in relation to sustainability, nutrient density, health claims and food safety.

6.1.2 Overarching Enabling Impact Pathways

The EIT Food Missions roadmapping exercise for A Net Zero Food System established three overarching enabling impact pathways that are critical for the priority opportunity areas to be realised. These are detailed below.

Changing Consumers Behaviour

The consumer has a powerful role in the food system in terms of their behaviour related to food consumption and food and packaging waste. Carbon-intensive diets are cited as a major contributor to GHG emissions, while consumers are often exposed to misinformation and misleading claims on food packaging. EIT Food can play a key role in this enabling pathway as follows:

- Drive public engagement activities which reconnect consumers with the food system
- Leverage and grow consumer observatory labs to improve consumer insights and understand their perception and misconception of sustainability and responsible food choices; and develop interventions for different demographics based on these insights
- Equip consumers with the knowledge and information to choose more sustainable and healthy ingredients and food choices
- Engage and share scientifically robust information with consumers to improve their trust
- Launch interventions which help to support consumers with meal planning and cooking
- Change dietary patterns towards more diversified protein sources to ensure the highest impact on the environment and in the Net Zero agenda, whilst continuing to ensure nutrient-dense food which meets dietary requirements
- Bring retailers on board to co-create on how to frame, position and increase the visibility of healthy and sustainable products
- Eco-labelling (supported by scientifically robust LCA)
- Engagement activities targeted at schools, public procurement, food service and retailers
- Engaging with policy makers on eco-labels and preventing misinformation
- Establishing a leadership position in ensuring the evidence base is sound and well understood before defining new and alternative diets

Overcoming barriers to behaviour change in the farming community

Farmers are critical in the journey to a Net Zero food system and many of the targets being set out by government and industry are falling on the shoulders of the farming community. However, they are not being provided with adequate and tailored guidance and support on how to reduce their GHG emissions, improve environmental impact indicators and sequester carbon. It is important to understand, educate and drive behaviour change towards low-emission, carbon sequestration and environmentally sustainable farming practices; improved animal farm management practices; and the adoption of innovative technologies which support regenerative agriculture outcomes. EIT Food has a key role in this enabling pathway, as outlined here:

- Establishing an agreed definition on Net Zero, the direction of travel, metrics, life cycle analysis and measure, report and verification processes – including clarity and communication on the role of the farmer and potential trade-offs
- Understanding the barriers to behaviour change towards regenerative farming practices and adopting technology to support the transition in the farming community
- Developing interventions and education packages to overcome barriers to behaviour change and empower farmers
- Facilitate public / private collaboration to achieve Net Zero including fair pricing policy
- Support lighthouse initiatives and living labs on adopting regenerative farming practices
- Disseminate results from baseline measurements and successful interventions with farmers; and facilitate peer-to-peer learning and continuous professional development
- A campaign which raises awareness of the opportunities of farming to encourage young farmers into the sector
- A campaign which showcases farmers as solution providers, not just the problem
- EIT Food lobby for consistent policy on Net Zero targets, what needs to happen and how it can be done and incentives

Data and value chain integration, Measure, Report and Verification Processes

A scientifically robust, standardised and adopted approach related to data, life cycle analysis and measure, report and verification processes was raised as a key concern across all four priority opportunity areas. Without this, it is impossible to establish baseline measurements, robustly and reliably compare data, and establish the success and impact of interventions over time – which in turn, is vital for behaviour change by the farming community and society. In relation to the Net Zero agenda, carbon and GHG emissions are a very important indicator, but other environmental impact indicators must be included in the assessment, as illustrated in Figure 17. Moreover, it is vital that life cycle assessment methodologies not only consider environmental impact indicators, but also account for the nutritional content of foods. The opportunities for EIT Food in this enabling pathway are outlined here:

- Data gathering, quantifying supply chain impacts and supply chain management are all key elements that will drive change towards the Net Zero agenda. Data is central to all this, and it is suggested that EIT Food should be the holder and curator of such sources of data.
- Scoping of emissions (1, 2 and 3) is key to driving emissions from food production down. Data is a key driver for such scoping exercises and EIT Food could play a vital role. Facilitating data and value chain integration from farm to fork.
- Drive LCA analysis at pace using accurate databases and analyses. LCA of nutrients, gases and elements such as carbon is misunderstood and misinterpreted.
- Play the role of standard authorities for LCA, carbon accounting and scope 3 emission reporting.
- Help with the design of private-public funding to overcome and analyse the situation and help the transition
- EIT Food should take an active role to develop sustainability and ethical reporting and tools as part of Net Zero reporting (and/or support organisations in performing this task)
- Educate and build trust across the food system for more digital ways of working and sharing data. That could include training key stakeholders on LCA and MRV processes
- Lobby for strong regulatory and legislative base to support and protect stakeholders and governance of MRV processes
- Develop a proposal for the FAO for a global harmonised system

6.2 EIT Food as an Enabler to A Net Zero Food System

This exercise has involved extensive engagement with multiple stakeholders, through interviews, surveys and and experts workshop complemented with the desktop review. The following recommendations outline how EIT Food, along with key stakeholders, can make a significant and distinctive impact towards a Net Zero economy in Food in Europe.

Central to ensuring the four priority opportunity areas are realised will be clear and standardised definitions, an enabling environment for innovation to flourish, education, enabling policy and incentives for behaviour change. Consumers need to be better connected to the food system whereby they understand where their food comes from and are equipped with clear and accurate knowledge to make informed decisions, particularly around sustainable food choices, diversified protein consumption and reducing food and packaging waste.

6.2.1 Collaboration & Partnerships

- Establish think tanks and work groups in each of the four priority areas to establish, exploit and scale existing knowledge and innovation for impact; identify gaps in knowledge; and translate knowledge and disseminate scientifically robust knowledge to key stakeholders
- Encourage retailers to partner and join the EIT Food network
- Facilitate co-creation workshops
- Engage and support producer organisations to increase power of farmers and contribute to a more equitable system
- Cross EIT Food KIC Activities and Interventions

6.2.2 Innovation

- Provide funding to support underlying science to progress TRL
- Academic and industry consortia working together
- Innovation activities focused on addressing the market needs in each of the priority opportunity areas
- Investment in new technologies to drive the Net Zero agenda
- Prioritise identification of methods and technologies and deep tech with the most positive effect on Net Zero. Development of new evaluation criteria to include Net Zero and sustainability in all innovation project proposals.
- Ensure the innovation process considers unintended effects of a specific idea / process or product and consider a system approach rather than a silo approach to calls.

6.2.3 Business Creation

- Scout for innovations with underpinning IP, which could transform the food system and address market needs, with a particular focus on innovations that can support regenerative farming outcomes, reduce food loss and food waste, transform food packaging into a circular system and diversify protein sources
- Support the pathway for European startups with innovative technologies that could transform the food system and deliver against Net Zero and environmental impact indicators, underpinned by IP, to launch, scale and accelerate
- Establish regulatory expertise to provide support for agrifood startups and better partnerships with policy makers
- Provide startups with access to technical experts, Intellectual Property support and advice, pilot facilities and farms and support them in accelerating from lab to commercial scale
- Provide access to a rich ecosystem of corporates, funders and investors with the same vision and interest in innovations for the food system

6.2.4 Education

- Eco-labelling methodology is a key area recognised by EIT Food with key projects and investment already initiated. Launching an eco-label with EIT Food as an honest broker is an important next step and investment to be considered
- Advocacy and policy advice to governments around consumer change to a healthier and more sustainable diet is key
- Promotion of carbon farming and training farmers to new business models in this space is recommended. The GROW Workshops, running since 2020, should be extended to a wider area of Europe.
- Grassroots interventions which focus and support farmers and increase their knowledge
- Supporting plant-based food options in food service
- Developing the knowledge and skills of the professionals and future leaders of the food system
- Developing consumer insights through the consumer observatory lab
- Engaging and informing consumers
- Consumer interventions focused on food preparation, cooking appliances, cooking from home, limiting processed foods and eating a balanced diet with increased micronutrient intake.
- Developed a cooking guide app for nutrition attached with appliance to educate consumers on how best to cook for nutrient retention in food
- Engaging with the public and communicating complex ideas
- EIT Food must prioritise educating young people (including primary and secondary school children) around agriculture, Net Zero, climate change. These consumers of tomorrow will be the people experiencing the issues of food and crop failures and many other issues linked to food and climate change. They will also be the ones implementing policies and changes to the food system in the next 40 years.
- Skills forecasting exercises to develop insights and identify skills gaps in the agrifood system and what will happen if we do not have them
- Collaborate on the European Commission Pact for Skills, to upskill and re-skill people in agrifood, with a particular focus on the skills identified and needed to deliver the four priority impact opportunities
- Collaborate on The Deep Tech Talent initiative to skill one million people in deep tech fields over the next three years
- Develop state-of-the-art deep tech education programmes to build a skilled labour force which can leverage new technologies for green and digital transition of the food system
- Advanced entrepreneurship, innovation and food systems programmes to educate STEM students and future innovators of food system
- Upskill local farmers on sustainable agriculture practices tailored to the needs of their farm, soil, animals, environmental conditions
- Upskill local workforce and expertise in precision fermentation
- Drive future skills for Bioeconomy
- Educating public health professionals who can play an important role in advising consumers on their food choice
- Develop a pathway for entrepreneurs and startups to launch, accelerate and scale
- Funding which supports innovations to move up the TRL to commercial application and market discovery programmes to de-risk innovations

6.2.5 Public Engagement

EIT Food should engage with the public in the following ways:

- Find novel ways to connect consumers to the food system. For example, provide transparency of information to drive behaviour change and gaming to help show what is possible
- Leverage Consumer Observatory labs to identify trends and gather consumer insights on food choices, perceptions related to the sustainability and the objectives of each of the four priority opportunity areas
- Leverage the consumer observatory lab as a tool for the market discovery journey of startups and entrepreneurs and to help understand trust in new technologies
- Use and extend social media and other digital platforms (e.g. Food Unfolded) to engage with citizens across the globe and disseminate scientifically robust information
- Deliver events and interventions to engage with citizens and disseminate scientific evidence about the food system to build awareness and trust and which can shift citizens from passive recipients to informed and active change agents
- Build upon the Youth Mission, targeted at primary and secondary school audiences to build interest in the food system, on how to choose sustainable products when grocery shopping and attract the future talents into the food system
- Deliver campaigns to showcase farming and agriculture or aquaculture as a desirable occupation to attract young talents
- Build a network of ambassadors across the food system which different stakeholders can relate to and trust
- Apply expertise from social sciences for interventions which drive behaviour change in different demographics
- Measure impact of public engagement interventions to understand what has the greatest impact

6.2.6 Lobby on Policy

In this domain, EIT Food should engage with the public in the following ways:

- Engage with policymakers, which is seen as key in shaping policy & legislation to support the Net Zero transition.
- Accelerating the transition towards regenerative food and farming systems cannot be done without policy makers
- Increase understanding of environmental implications of CO_2 removal strategies.
- Ensure that true cost accounting is integrated into food policy
- Lobby for skills to enter the debate of policy makers
- Encourage participatory policy processes, which listen to different perspectives, consider essential needs, embrace compassion, enable co-learning, help share ownership and promote innovation capacity

6.2.7 Leadership in Net Zero

To ensure that EIT Food is a leader in the Net Zero transition, the organisation should:

- Provide strong leadership through the development of key standards and definition. Specification standards of data management (gathering, holding and reporting) are of particular importance so is the definition of regenerative agriculture.
- Invest resources and build expertise in the development of policies for Net Zero and develop key lobbying strategies at EU, regional and national levels
- Focus on processes, sectors, LCAs, environmental factors and enablers as defined above as key priorities in all four functions of education, business creation, innovation and consumer awareness.
- Forge collaboration & partnerships between government, academia, NGOs, and industry (from the big brands down to the individual farmers).
- Develop knowledge & skills among the farming communities and among society, particularly young people to enable the future Net Zero food system – technologies and methodologies do now already exist for Net Zero, but adoption will require a new generation of farmers willing and able to work differently.
- Help to ensure that resources, infrastructure and the technological innovation is there to scale up solutions within the Net Zero transition. Costs must be driven down to make solutions economically attractive and affordable for consumers.
- Facilitate a supportive funding landscape for innovation and entrepreneurship to drive experimentation in new production methods, products, services, and innovative new business models. New models for use of food waste will be particularly important.
- Engage the public – particularly young people – to inform on Net Zero and raise awareness and increase consumer acceptance of innovative new Net Zero solutions such as protein diversification.
- Adopt complex system thinking approaches within the EIT Food agenda and priorities.
- Focus on research and innovation that provides best return on investment quickest.

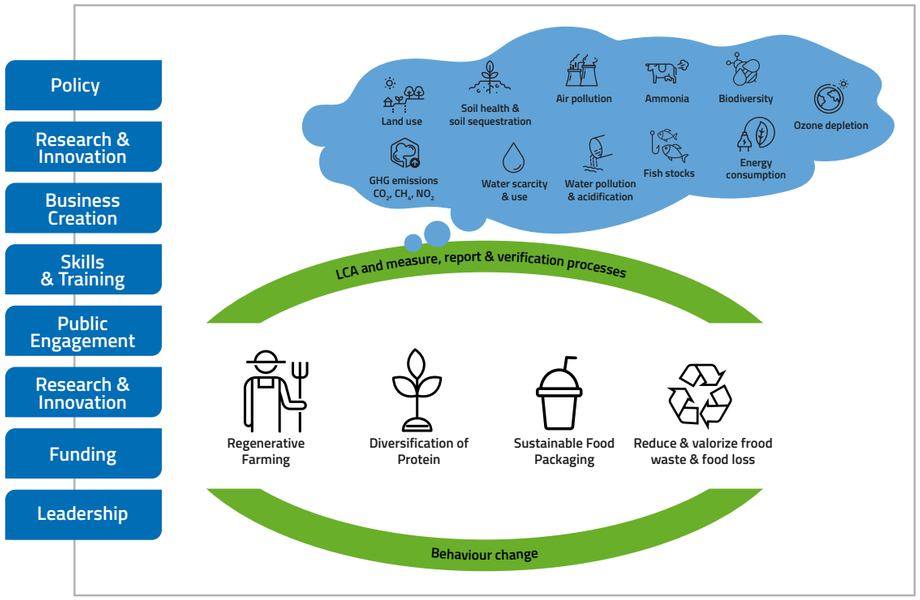


Figure 17: A Roadmap to A Net Zero Food System

In summary, a simplified roadmap for EIT Food's Mission "A Net Zero Food System" is presented in Figure 17. It includes the 4 priority areas, namely Regenerative Agriculture, Diversification of Protein, Sustainable Food Packaging and Waste reduction. Value can be added to the four priorities via MRV processes and LCA analysis on the one hand, and the behaviour change tools on the other. Transition to a Net Zero food system also requires enablers and capabilities, specifically: policy, R&I, Business Creation, and Skills and Training. EIT Food can help to facilitate profound changes in all four areas through public engagement, partnerships & collaboration, funding and leadership.

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8. Appendices

All appendices can be downloaded from www.eitfood.eu/download-reports/net-zero

Approach & Methodology

8. Survey Instruments

9. Results

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