

A Roadmap for UK Food System Transformation: Plausible Pathways to 2050

CONTENTS

Executive Summary

1. Introduction

2. The Context for Transformation

- 2.1 Drivers of Change
- 2.2 Narrative Frameworks
- 2.3 The AFN Network+ Approach
- 2.4 The Four Futures

3. Core Transformations

- 3.1 Resilient Food Production
- 3.2 Land Use Transformation
- 3.3 Dietary Change

4. Enabling the Change

- 4.1 Supporting Technologies and Innovations
- 4.2 Just Transition Framework
- 4.3 Implementation Pathway

5. Conclusions and Recommendations

- 5.1 Conclusions
- 5.2 De-Risking the Food System Transformation

Appendices

This is a draft report under development.

Our quantitative analysis continues, so numbers are still subject to change.

Not for quoting yet, please.

Preface/Foreword

The Agri-Food for Net Zero Network+ was established by UK Research and Innovation (UKRI) in 2022 to consider the challenge of transforming the UK's food system to meet our climate commitments. Over three years, we've built a community of over 3,000 researchers, practitioners, policymakers, and stakeholders dedicated to finding pathways to a more sustainable future.

Our approach has been distinctive in three ways. First, we've taken a whole-systems perspective that examines how food production, land management, supply chains and consumption patterns interconnect. Second, we've looked beyond current trends to explore how different combinations of geopolitical shifts, technological developments, and evolving social values might reshape our food system in the decades ahead. Third, we've employed an inclusive methodology that engages diverse stakeholders to develop a more nuanced understanding of practical challenges.

Through commissioning 30 research projects, hosting over 30 expert webinars, convening many workshops and three annual "Big Tent" events, and developing scenario modeling tools, we have brought together expertise and evidence from across disciplines and sectors. By assembling and synthesising insights from this diverse range of perspectives, we have built a comprehensive understanding of the pathways to transformational change — recognising that the net zero challenge cannot be addressed through a single lens or isolated interventions.

Rather than viewing emissions reduction in isolation, we've examined how transformation could simultaneously address multiple challenges — maintaining food security, enhancing public health, protecting biodiversity, reducing inequality and supporting livelihoods. This report represents the culmination of this collective effort, exploring plausible pathways for transformation and identifying robust interventions that work across different future scenarios.

Our goal is to move beyond current 'business-as-usual' thinking to identify practical steps that can be taken now to enable necessary changes in the coming decades to 2050 and beyond. We hope this Roadmap will inform and inspire action across government, industry, and civil society to create a more sustainable and resilient UK food system that works better for people and the planet.

The AFN Team

Executive Summary

Introduction: A Food System Under Pressure

The UK's food system is under growing pressure. Rising costs, extreme weather, and global instability are disrupting supply chains and driving up prices. Diet-related disease is putting the NHS under strain and damaging the country's productivity. These problems are not isolated — they're connected. Without a serious, joined-up response, the UK risks higher bills, lower resilience, and a system that fails farmers, families, and the planet.

This Roadmap, developed by over 120 experts through the UK Agri-Food for Net Zero (AFN) Network+, offers practical pathways to transform our food system by 2050. The goal isn't just to meet climate targets — it's to future-proof Britain's food system while boosting public health, protecting the environment, and strengthening our economic and national security. Our strategy addresses what we grow, how we use land, and what we eat — delivery benefits for health, resilience and sustainability.

The Case for Transformation

The AFN Network+ used a system-wide approach to understand the pressures and trade-offs in the UK food system. Using a modelling tool called the Future Food Calculator, we explored how different choices would affect emissions, land use, and food security under different future scenarios.

We found that across all futures:

- We can't hit net zero without cutting food system emissions and increasing carbon capture.
- Land use must change significantly to support climate, food, and nature goals.
- Shifting diets unlocks extensive benefits — from public health to farming resilience.
- More strategic planning is essential to reduce our vulnerability to global shocks.

By the 2040s, the food system will be Britain's biggest source of emissions. Our analysis shows that even with technological advances, we cannot meet net zero targets without additional measures like tree planting and better land use.

One Future: Three Transformations

Our Roadmap identifies three essential, interconnected transformations that together create a sustainable, healthy and resilient food system: in food production, land use and diet change.

1. Resilient Food Production

Climate pressures and global instability make business-as-usual unsustainable. Farming will change whether we like it or not. But if we act now, we can adapt in a way that supports farmers, protects rural economies, and builds national resilience.

Key actions:

- Grow more of the foods we need most — especially fruits and vegetables and whole grains.
- Scale back the most land- and emissions-intensive animal farming (ruminants, pigs, poultry) to around two-thirds of current levels.
- Reintegrate livestock with arable farming to make better use of land and nutrients.
- Support supply chains — processing, distribution, and skills development — to match new production patterns and reduce import vulnerability.

This is about making farming more secure and sustainable, not ending animal agriculture. Livestock will still have an important role. But we need a better balance between what's good for our health, our farmers, and the planet.

2. Smarter Land Use

To reduce emissions and restore nature, we must use land differently. Our modelling shows that Britain needs between 1.3 and 5 million hectares of new woodland, plus space for energy crops, all without threatening food security.

Key actions:

- Increase woodland cover to around 20 per cent of UK land by 2050, tripling current planting rates.
- Prioritise multifunctional landscapes that combine farming, biodiversity, and carbon storage to deliver multiple benefits simultaneously.
- Plan land use regionally, in partnership with communities, rather than leaving it to market forces alone.
- Support farmers with transition financing, technical assistance, advice, and long-term contracts to instil confidence in making changes.

This isn't about just taking land out of production — it's about using it better to meet multiple national priorities at once. Done well, land use change supports food security, climate targets, and rural jobs.

3. Healthier Diets

Poor diets cost Britain dearly — through NHS pressure, lost productivity, and poor quality of life. Shifting towards healthier, more balanced diets is a win-win that cuts emissions, saves public money, and helps people live better for longer.

Key actions:

- Make healthy, nutritious food more affordable and accessible for all income groups.
- Encourage diets richer in fruits, vegetables, and whole grains, with less meat overall.
- Invest in food environments through public procurement, retail standards, and advertising rules — to better support healthy choices.
- Coordinate action across government departments — health, farming, environment, education, and the Treasury.

Drugs like appetite suppressants are being promoted as solutions, but they don't address the root causes of the problem. Real change means creating an environment where the healthy choice is the easy and affordable one — for everyone.

Making Change Happen

These transformations are not just desirable — they are necessary. But they won't happen by accident. We need to design a pathway that is fair, evidence-based, and sensitive to the needs of different regions, communities and sectors.

Technologies and Innovations

Innovation will help make the transition easier and cheaper. We need to support:

- **New products:** Tasty, affordable alternatives to high-emissions foods.
- **Better farming practices:** Smarter crop rotations, better soil health, more efficient livestock systems.
- **Land-use tools:** Data and modelling to make better decisions on where and how to grow, store carbon, or restore nature.

This is not about replacing people with robots — it's about giving farmers, producers, and communities the tools to do more with less.

A Just Transition Framework

Fairness must be at the heart of the transformation. That means:

- Support for lower-income households to access healthy food.
- Help for farmers to adapt to new markets and methods.
- Inclusive governance that gives communities a say in land use decisions.
- Regular review of who benefits, who bears costs, and how to balance the two.

The biggest food companies shape what we eat and how supply chains work. Their influence needs to be better directed toward public good — through smart regulation, incentives, and collaboration.

Phased Implementation to 2050

Change will take time—but we must start now. A clear, phased plan gives certainty to businesses and communities:

- **2025–2030: Build Foundations.** Develop political and public consensus. Raise awareness of the costs of delay. Pilot solutions. Begin regulatory reforms. Invest in research and data systems.
- **2031–2040: Scale Solutions.** Roll out major infrastructure investments. Expand market-based incentives. Implement land use frameworks. Scale up successful pilots.
- **2041–2050: Secure Gains.** Consolidate progress and refine strategies. Address remaining high-emission sectors. Monitor and verify outcomes. Adapt to emerging challenges.

This approach ensures we act fast enough to avoid crisis, while giving time for people and businesses to adjust.

Ten Priority Recommendations

To drive this transformation we propose practical recommendations; the most urgent include:

1. **Create a National Agri-Food for Net Zero Committee** reporting directly to the Cabinet Office, with cross-departmental authority to coordinate food, farming and climate policy.
2. **Establish transition funds for farm businesses**, supporting diversification, new technologies and infrastructure development through targeted grants and low-interest loans.
3. **Reform agriculture subsidies** to reward carbon sequestration, biodiversity improvement and sustainable production practices that align with national goals.
4. **Develop integrated Food and Land Strategies** at national and regional levels that balance production, environmental and social needs.
5. **Use citizens' assemblies and other deliberative tools** to build public understanding and consent for system-wide changes.
6. **Support robust carbon and ecosystem service markets** that properly value on-farm emissions reductions and nature-based solutions.
7. **Require major food businesses** to publish food system transition plans with measurable targets aligned with national climate and health objectives.
8. **Expand interdisciplinary research** on socioeconomic aspects of food transitions, focusing on equity, behaviour change and implementation.
9. **Develop more effective food data systems** to track progress, promote transparency and accountability, and inform evidence-based decision-making.
10. **Align trade policies with domestic transformation goals** to prevent exporting emissions and support sustainable production globally.

A National Opportunity

This transformation represents a once-in-a generation opportunity. It will:

- Save billions in healthcare costs by reducing diet-related disease.
- Create new rural jobs in land management, forestry and food processing.
- Enhance biodiversity and improve water quality.
- Strengthen national resilience against global supply disruptions.
- Support more equitable access to nutritious food across society.

The UK has the expertise, institutions and public will to lead this transition. But success requires bold action now – not when crisis forces our hand. By embracing this roadmap, the UK can build a food system that benefits farmers, families, and future generations alike.

We call on all political parties, public agencies, and stakeholders to come together and act — not just in pursuit of targets, but in the spirit of fairness, security, and shared national interest.

The time to plan for the future is now.

1. Introduction

The UK food system (Box 1) faces a set of pressures that make transformation inevitable. Our food, farming and landscapes are going to change beyond recognition over the next half century, whether we like it or not. The question is whether we seek to actively manage change for the public good, or just respond to changes as they haphazardly unfold. We only have a brief window to try and make the best of this. Climate change is already disrupting agricultural productivity and food supply chains, threatening food security. Shifting geopolitics are altering trade relationships and supply chain resilience. Meanwhile public health crises stemming from dietary patterns are straining the NHS and reducing economic productivity. The crises in nature depletion and water quality are in part consequences of how the current system functions.

My biggest worry in this space is that it is so abstract — COP and the Paris agreement — that while citizens on a global basis might feel that climate change is happening and is worrying, there is not enough political push from citizens to drive the political space...What I don't want is so many people to wake up in 2035 and realise that it's time to act, because by then it'll be 20 years too late.¹

Tim Benton, University of Leeds, AFN Network+ co-lead

These converging forces are creating an uncertain world — one that Chatham House characterises as “TUNA”: turbulent, uncertain, novel and ambiguous.² While the UK was the first major economy to legally commit to reaching net zero greenhouse gas (GHG) emissions by 2050, the pathway to transformation must be understood not just as a response to this target, but as an economic and social necessity driven by a wider set of ever-growing pressures.

Addressing climate obligations is challenging enough. Yet the UK food system must adapt to the impacts of climate change while simultaneously reducing emissions — a dual challenge of adaptation and mitigation also bound up with other systemic pressures. Biodiversity loss threatens ecosystems essential for food production. Widespread water pollution degrades aquatic ecosystems. Poor diets strain healthcare systems and undermine national productivity.

The scale of change required is considerable and necessitates the widespread adoption of new farming practices, significant changes in land use and shifts in dietary patterns. The duration of change will span several Parliaments and so mechanisms are needed to reduce the tos and fros of party politics. Current approaches are largely ad hoc and insufficient, characterised by incremental adjustments that fall far short of addressing systemic challenges at their roots.

The Agri-food for Net Zero (AFN) Network+ addresses these challenges through research and dialogue with diverse communities of practice across the UK. Rather than viewing emissions reduction in isolation, we examine how transformations in the food system could simultaneously address multiple challenges — strengthening food security, enhancing public health, protecting biodiversity, tackling inequality and supporting economic growth. Our analysis suggests that

¹ Benton, T. (2023) What next for food and farming at UNFCCC COP?, *AFN+ Network Webinar Series*, 14 November, <https://www.agrifood4netzero.net/resources/what-next-for-food-and-farming-at-unfccc-cop/>

² Ramirez, R. and Wilkinson, A. (2016) *Strategic Reframing: The Oxford Scenario Planning Approach*. Oxford University Press, quoted in Benton, T. (2019) Using scenario analyses to address the future of food. *European Food Safety Authority Journal* 2019;17(S1):e170703.

while the path to a sustainable food system requires difficult changes, it also presents an opportunity to create a more resilient and sustainable UK food system that works much better for people and the planet.

This report explores plausible pathways for this transformation, identifying interventions that could work across different future scenarios. Our goal is to move beyond current 'business-as-usual' thinking to identify practical steps that can be taken now to enable necessary changes in the decades to 2050.

Defining a 'food system'

The term '**food system**' encompasses the entirety of the production, transport, manufacturing, retailing, consumption and waste of food. It includes impacts on nutrition, human health and well-being, the economy and the environment. Food security is a function of variations in the food system in any given location, and is influenced by a range of sociopolitical factors affecting price, availability and access. While there is an overall global food system (encompassing the totality of global production and consumption), there are also many subsystems within it. Each location's individual food system is unique, and is defined by that location's mix of food produced locally, nationally or globally.

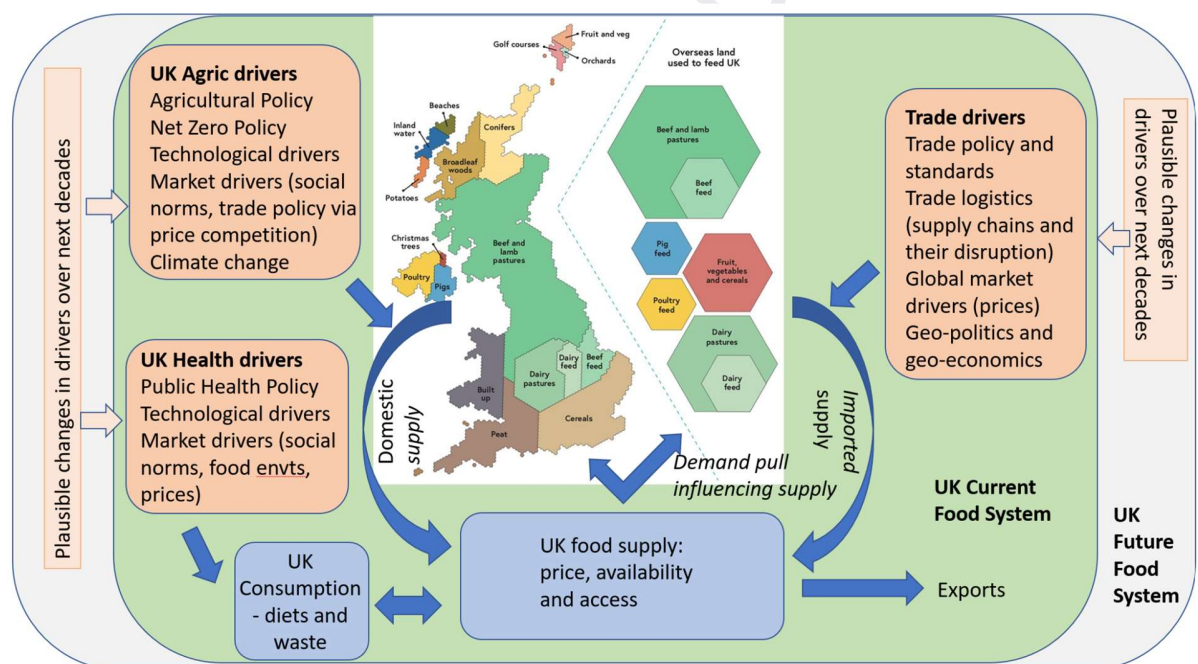


Fig 1. UK food system and its drivers.

For each product consumed there is a **supply chain**, which describes the way food and its ingredients get to consumers. The term **value chain** describes the mechanisms through which the value of a product is increased by transport, processing and packaging along the supply chain. The term 'food system' includes all supply chains (and, implicitly, value chains) as well as their impacts on the environment and people. Food systems inherently incorporate feedback, leading to direct and indirect effects. In turn, this can create feedback loops where

the system responds in unexpected ways to small changes in the forces acting on it. Food systems are therefore dynamically changing systems. Thinking only about supply chains and value chains is unhelpful both analytically and for policy-making, as it avoids consideration of wider system dynamics, especially the interplay between supply and demand.

All activities within a food system — whether production, processing, retail or cooking – have impacts on the environment. For example, land under agriculture is disturbed from its natural state, which affects soils, water, biodiversity and even local microclimates. Processing, transport and retail require energy, water, infrastructure (e.g. roads) and other inputs (e.g. packaging). Throughout, externalities come from chemical usage and disposal (e.g. from fertilizers, pesticides, industrial processes and greenhouse gas emissions), as well as from the disposal of waste, including plastics and other packaging.

Note: this figure is based on a map of UK land use in The National Food Strategy (2021).³

³ The National Food Strategy (2021) The Plan. <https://www.nationalfoodstrategy.org/>

2. The Context for Transformation

The food sector is the UK's largest employer, with over four million workers contributing almost £150 billion to gross value added.⁴ Agriculture occupies over two-thirds of UK land, and is a primary influence on landscapes and ecosystem health. Transforming the UK food system requires addressing a complex set of interconnected challenges. Understanding this complexity is essential for developing effective solutions.

The food system is responsible for about a quarter of the UK's GHG emissions, and half of these emissions are directly from UK agricultural production.⁵ While carbon dioxide dominates emissions from other sectors, most agricultural emissions stem from dispersed biological and biochemical processes, like methane from livestock and nitrous oxide from soils, which are difficult to eliminate entirely and for which there are limited technological options. As the energy and transport sectors decarbonise, so agriculture and the food system will become the UK's largest source of emissions by the 2040s.

The Climate Change Committee (CCC)'s Seventh Carbon Budget (CB7) indicates levels of emissions reduction and sequestration for 2050 that mean that about a fifth of current agricultural land will need to be used for other purposes. It suggests such change is possible without the UK becoming more dependent on food imports. This can only imply fundamental changes in production and consumption patterns.

These changes intersect with other critical challenges. The UK faces a mounting public health crisis, with 30 per cent of the population living with obesity — up from less than 1 per cent 70 years ago.⁶ We may live longer, but in poorer health, often driven by diet-related problems. On current trends, over 50 per cent of adults could be obese by 2050⁷ imposing even greater costs on the UK economy. The British Dietetic Association estimates that 3 million people in the UK may be at risk of malnutrition.⁸ Meanwhile, biodiversity loss threatens the ecosystems essential for food production, and agricultural pollution degrades freshwater ecosystems.

Climate change itself creates additional pressures. The UK's food system currently relies heavily on imports. Domestic production meets only 50 per cent of vegetable demand and 15 per cent of fruit demand.⁹ Climate change is already disrupting supply chains and agricultural productivity and affecting food prices. A recent memo from whistle-blowers inside the UK food industry acknowledged the vulnerability of the system.¹⁰ They argued: *"We have reached a moment of threat to food security like none other we have seen. Yield, quality, and predictability of supply from many of our most critical sourcing regions is not something we will be able to rely upon*

⁴ Defra (2018) *Food Statistics in your Pocket*. (Updated April 2025)

⁵ EDGAR-FOOD database: https://edgar.jrc.ec.europa.eu/edgar_food; Ward, N. (2023) *Net Zero, Food and Farming: Climate Change and the UK Agri-Food System*. London: Routledge, pp.11-12.

⁶ Van Tulleken, D. and Dumbleby, H. (2024) *Nourishing Britain*. London: NESTA, (p.10)

⁷ GBD 2021 Adult BMI Collaborators (2025) Global, regional, and national prevalence of adult overweight and obesity, 1990–2021, with forecasts to 2050, *The Lancet* 405 (10481) 813-38.

⁸ British Association for Parenteral and Enteral Nutrition (2017) *Malnutrition: The Facts*, <https://www.bapen.org.uk/images/pdfs/news/malnutrition-the-facts-july-2017.pdf>

⁹ National Farmers' Union (2023) *UK Horticulture Growth Strategy*. Stoneleigh: NFU.

¹⁰ Quinn, I. (2025) Whistleblowers warn UK food industry is heading for climate disaster, *The Grocer* 3 April

over the coming years.” It has been estimated that temperature projections for 2035 will add an additional 1-5 per cent to annual food price inflation in higher and lower income countries.¹¹

*The evidence is mounting that there are problems ahead and indeed upon us...[W]hen I interviewed very senior head honchos of the British food system they were actually in no doubt the food system is heading for very difficult times.*¹²

Professor Tim Lang, Emeritus Professor of Food Policy

The combination of challenges — emissions reduction, land use change, public health, ecosystem degradation, and climate resilience — means that incremental adjustments to current practices will not be sufficient. In this report, we use the term **transformation** to capture both the scale of change needed and the opportunity to achieve multiple benefits simultaneously.¹³

The UK Government's Carbon Budget Delivery Plan contains 33 measures to reduce emissions from agriculture and land use,¹⁴ but these are widely recognised as inadequate to meet carbon budget requirements. Public health imperatives add further complexity, with diet-related diseases increasing pressure on healthcare systems and disproportionately affecting lower-income and minority populations. Yet policy approaches generally avoid intervention in food environments or marketing practices.

Transforming the food system demands new approaches that can address multiple challenges simultaneously while building broader support for change. This requires coordinating efforts across production, consumption, and land use — domains currently treated separately.

2.1 Drivers of Change

Multiple drivers are converging to make UK food system transformation necessary and increasingly urgent. Understanding these drivers is essential for developing effective responses. These drivers reflect the conditions that are actively reshaping the system, rather than abstract moral imperatives or technical challenges.

Market forces are beginning to drive environmental improvement¹⁵ through new financial mechanisms like carbon credit offsets that enable payments for carbon sequestration and supply chain carbon insetting, with payments made within the supply chain for verified emissions reduction. Food manufacturers and retailers are increasingly focused on emissions within their supply chains and are working with their suppliers to implement emissions reduction

¹¹ Kotz et al. (2024) Global warming and heat extremes to enhance inflationary pressures, *Communications Earth and Environment* 5, 116

¹² Lang, T (2025) Civil food resilience and UK preparedness for food system shocks, *AFN Network+ Webinar Series*, 21 January, <https://www.agrifood4netzero.net/resources/tim-lang-civil-food-resilience-and-uk-preparedness-for-food-system-shocks/>

¹³ See Anderson, M. (2024) *Transforming Food Systems: Narratives of Power*. London: Routledge (pp.4-5) for a discussion.

¹⁴ HM Government (2023) *Carbon Budget Delivery Plan*. HC Paper 1269. London: Stationary Office.

¹⁵ Lyon, F. and Burnett, A. (2023) *Natural Capital Markets: What Farmers and Policymakers Need to Know*. Bristol: Food, Farming & Countryside Commission

measures.¹⁶ The Science Based Targets initiative (SBTi) is becoming a common framework for setting emissions reduction goals among larger companies, with over 4,000 companies setting validated targets by late 2023.¹⁷ However, food manufacturers and retailers work in a ruthlessly competitive environment in which shareholder pressure can easily default to short-term prioritisation of profitability concerns over transformational change to deliver environmental sustainability. These market mechanisms operate within a broader economic structure that continues to emphasise short-term profitability over longer-term resilience, creating tensions between shareholder expectations and systemic transformation needs.

Other **environmental priorities** are driving change in farming practices as post-Brexit agricultural policies increase support for environmentally-sensitive land management. Recent environmental policies set targets and improvement plans for air and water quality, biodiversity and ecosystems and across the UK we see targets for tree-planting, peatland restoration, and the area under improved soil management. Growing concern about river water quality has also created pressure for changes in agricultural practices.

Research and innovation in agriculture, biosciences, and environmental science support the sustainable development of the food system. Data analytics and artificial intelligence are creating opportunities for more precise resource management, while advances in biotechnology offer new potential for emissions reduction. UKRI funded over £1.3 billion in food-related research and innovation support from 2016/17 to 2020/21.¹⁸ AI is transforming analytical capacity in the biosciences and understanding of the gut and soil microbiomes is advancing at an unprecedented pace.

The **international context** has become a disrupter. Wars in Europe and the Middle East have broken out unexpectedly. There has been a shift away from globally liberalised trade towards greater protectionism, typified by new tariffs and trade disputes, heightening concerns about food security and supply chain resilience. Confidence in international cooperative arrangements has fallen and more assertive national economic self-interest is heightening geopolitical tensions. Climate impacts on agricultural productivity worldwide are driving interest in domestic production capacity. International climate commitments like the 2015 Paris Agreement and the 2021 Global Methane Pledge also require signatories to meet specific emissions reduction targets. These geopolitical shifts are not merely policy preferences, but represent real constraints on food system operations, as climate impacts directly undermine agricultural productivity and protectionist measures create tangible barriers to trade flows.

UK **dietary patterns** have shifted over recent decades towards unhealthy foods. The UK population has one of the highest obesity rates among higher income countries, and unhealthy diets are the primary driver of health problems associated with obesity.¹⁹ Adults typically consume 200-300 excess calories daily, dominated by ultra-processed foods high in fat, salt and sugar.²⁰ At the same time, consumption of fibre, fruit, vegetables and oily fish have fallen below recommended levels — trends most pronounced in lower-income groups.

¹⁶ World Business Council for Sustainable Development (2024) *Scope-3 Action Agenda for the Agrifood Sector: Tackling Land-Based Emissions and Removals*. Geneva: WBCSD.

¹⁷ <https://sciencebasedtargets.org/about-us/>

¹⁸ Lowenberg-DeBoer et al. (2022) *Application of Science to Realise the Potential of the Agricultural Transition*. Harper Adams University, Shropshire

¹⁹ House of Lords Food, Diet and Obesity Committee (2024) *Recipe for Health: A Plan to Fix Our Broken Food System*. Session 2024-25. HL Paper 19. London: House of Lords, p.20.

²⁰ House of Lords Food, Diet and Obesity Committee (2024).

Marketing heavily influences **consumer demand**, predominantly promoting less healthy and sustainable options.²¹ Food price inflation has intensified inequalities, as healthier options remain less accessible in deprived areas.²² Although awareness of health and sustainability is increasing, many consumers still face challenges due to cost, limited access, and convenience. Some retailers are responding — Lidl recently became the first UK multiple retailer to commit to protein diversification²³ — while consumer groups demand transparency in labeling and ethical production. The current power imbalances between food producers, retailers, and consumers create structural barriers to change that cannot be addressed through individual choices alone. Government intervention remains limited, though the Food Data Transparency Partnership aims to improve data collection.²⁴

These drivers create both pressures and opportunities for transformation. However, their interaction with existing system structures and competing interests helps explain why new approaches to driving change are needed.

2.2 Narrative Frameworks

The challenges already outlined make clear that transforming the UK's food system requires more than technical solutions or incremental policy adjustments. Limited progress thus far partly stems from problematic narrative framing. When changes are presented primarily as 'impositions upon farmers' to achieve net zero targets, they generate resistance rather than engagement.²⁵ This suggests that we should reconsider how we understand, frame and talk about the transformation, recognising that while net zero commitments provide legal impetus, the transformation is increasingly driven by wider material necessities and social problems.

The UK has legally committed to reaching net zero greenhouse gas emissions by 2050 — an ambitious, science-backed goal. Yet as political resistance becomes more vocal, how we think about this transition is just as important as how we achieve it. Three perspectives — teleological, mechanistic, and materialist — offer different ways to understand the coming changes, each influencing how we think about policies and the futures we can imagine.

A **teleological** lens focuses on purpose and moral imperatives. Net zero becomes a scientific goal grounded in ethical responsibility — protecting future generations, restoring ecological balance, and leading globally. This perspective has dominated UK climate policy discourse, but there is a danger of target fixation — achieving the numerical emissions goal while ignoring deeper issues like ecological degradation, social inequalities, or public mistrust. We risk hitting the target but missing the point. Moreover, in the face of growing political headwinds around net

²¹ McCarthy *et al.* (2022) The influence of unhealthy food and beverage marketing through social media and advergames on diet-related outcomes in children-A systematic review. *Obesity Reviews*. 23(6):e13441. doi: 10.1111/obr.13441.

²² Dominic Watters discussed this problem in an AFN webinar in December 2023.

<https://www.agrifood4netzero.net/resources/the-undeserving-poor-how-food-system-transformation-is-middle-class-and-why-this-needs-to-change/>

²³ <https://corporate.lidl.co.uk/sustainability/healthy-sustainable-diets/sustainable-diets>

²⁴ <https://www.gov.uk/government/groups/food-data-transparency-partnership>

²⁵ This point was made by Chris Stark, former CCC Chief Executive, in an AFN Network+ webinar. <https://www.agrifood4netzero.net/resources/chris-stark-what-ive-learnt-about-climate-change-policy-and-agri-food/>

zero, relying on moral arguments alone has proven insufficient to maintain momentum for change.

*We've had for a while now [a] focus on net zero as being the reason to do this. And my feeling is that that alone is not going to be a successful strategy for very much longer...Net zero has become a bit like a containment vessel for a load of political concerns...that are not really about net zero at all.*²⁶

Chris Stark, Head of UK's Mission for Clean Power, UK Department for Energy Security and Net Zero and former Chief Executive of the UK CCC

The **mechanistic** approach views transformation as a technical problem. Emissions result from how we generate energy, travel, build, and produce food. Change the system components, and reduce emissions. This lens provides structure, measurable progress, and a clear pathway. Yet it can be too narrow. Humans are not machines. Social behaviours, political forces and resistance to change complicate plans. A mechanistic focus might also overlook social questions — who pays, who benefits, and whether change builds a fairer society.

The **materialist** perspective digs deeper. It examines the underlying political, economic, and physical systems that drive emissions and shape possibilities for change. From this view, achieving transformation is not just about switching from fossil fuels to renewables or adopting low-carbon farming techniques. It requires rethinking how society's systems are organised in response to concrete constraints. Materialist thinkers highlight issues like resource limitations, climate impacts on production, and economic power imbalances. This lens is increasingly relevant as climate change itself becomes a driver of behavioural and structural shifts.

Our Roadmap incorporates all three perspectives, but recognises the centrality of material conditions for change. Food system transformation has moral dimensions — we must meet our legal climate goals. It also involves precise technical strategies — measuring emissions, carbon budgeting, and improving resource efficiency. But most fundamentally, it requires addressing the material forces — climate impacts, resource constraints, and structural economic arrangements — that will increasingly shape societal choices regardless of political preferences.

Our modelling shows that material conditions will exert growing pressure on the food system in coming decades. Climate change itself will become a key driver of behavioural and structural shifts as the food system is forced to adapt to the **effects** of climate change. Ensuring our food system is resilient and socially just means preparing for these realities and adapting accordingly. The time for change is now not simply because net zero provides a moral imperative, but because physical and economic constraints make forced change inevitable.

Net zero is much more than just a fixed point on a graph. It represents an opportunity to rethink how we live, what we value, and how we share responsibility for the future. But moral and legal arguments alone will not sustain action. To build consensus and chart a viable path forward, we must focus on the material realities driving change, while using the rigour of quantitative models and the moral clarity of teleological thinking as complementary tools.

²⁶ Stark, C. (2024) What I've learnt about climate change policy and agri-food, *AFN Network+ Webinar Series*, 23 July, <https://www.agrifood4netzero.net/resources/chris-stark-what-ive-learnt-about-climate-change-policy-and-agri-food/>

2.3 The AFN Network+ Approach

The AFN Network+ has developed methodologies that can effectively engage with the complex forces underpinning food system transformation. Progress on this journey requires new ways of thinking and working together. The complexity of the challenge demands approaches that can engage with multiple perspectives, analyse interconnected systems, and identify practical pathways forward. The AFN Network+ does this in part by bringing together expertise from across research disciplines, industry sectors, and communities of practice. Our approach (see Fig X) is distinctive in three key respects.

Food system transformation needs a systemic innovation approach. We cannot transform the food system piecemeal. It has to be seen as a system, as we know. It's a complex adaptive system, a sociological system, and we need to think, we need to have systems thinking to be able to navigate the complexity.²⁷

John Ingram, Environmental Change Institute, University of Oxford

First, we take a whole-systems perspective that examines how food production, land management, supply chains, and consumption patterns are interconnected. Demand for food flows through the food system to influence the supply, and vice versa. This means interventions directed at agriculture can affect agriculture, but also interventions targeted elsewhere in the system can feed through to changing agricultural practice, if it affects demand and the signals are transmitted through the market. This systems-based approach identifies physical and economic limitations, power dynamics and resource flows that might be missed by narrower analyses, helping identify how material changes in one part of the system affect others.

Second, we recognise that the context for the food system is changing rapidly: the interplay between demand and supply, mediated through markets, is dynamic and evolving. Rather than assuming current trends will continue, we explore how different combinations of geopolitical shifts, technological developments, and evolving social values might reshape the operating environment. Using methodically constructed future scenarios and a specialised *Future Food Calculator*, this approach allows us to identify robust interventions that respond to necessities across different possible futures.

Third, we employ an inclusive and collaborative methodology that engages diverse stakeholders — from farmers and food businesses to researchers and policymakers. By bringing these perspectives together, we develop a more nuanced understanding of the practical challenges and constraints, as well as the opportunities that will shape transformation, while identifying areas of shared interest. This participatory approach has guided both our research and the development of this Roadmap.

²⁷ Ingram, J. (2024) Using systems thinking to transform our food: Beans as an analytical lens, *AFN Network+ Webinar Series*, 19 June, <https://www.agrifood4netzero.net/resources/using-systems-thinking-to-transform-our-food-beans-as-an-analytical-lens/>

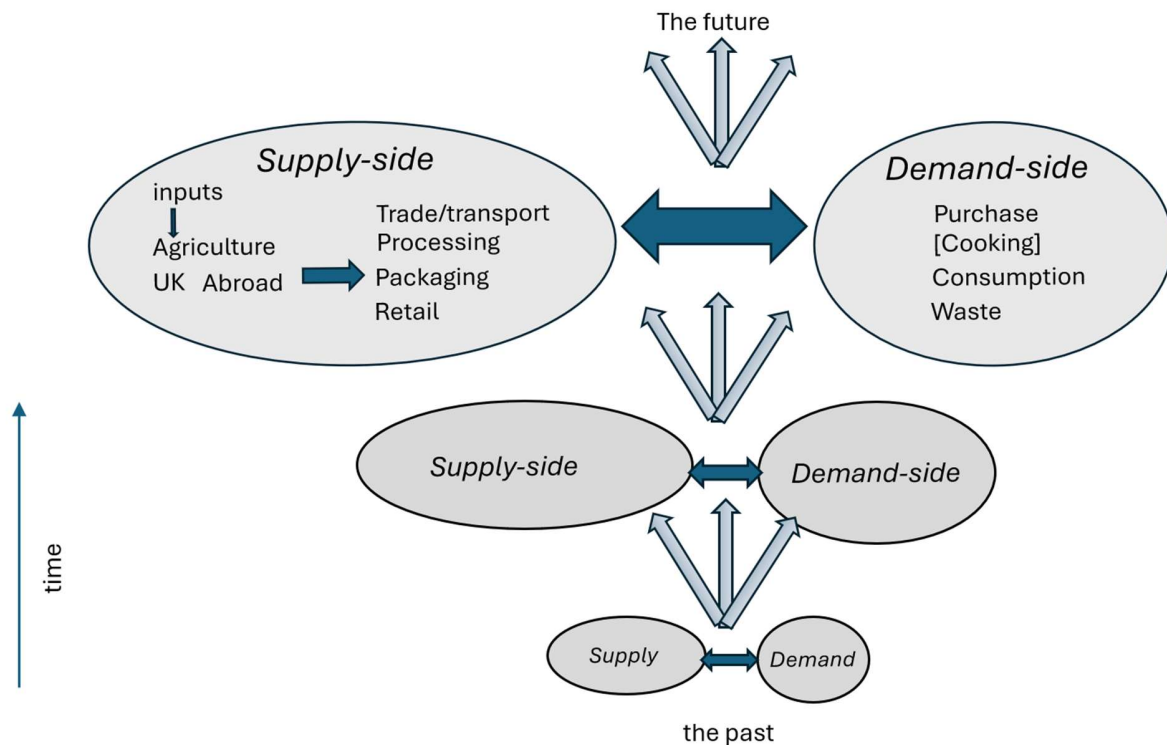


Fig 2

2.3.1 Scenario Development

The future operating context for food and agriculture is inherently uncertain, shaped by geopolitical tensions, economic pressures, technological developments, and shifting social values. Adopting a 'business as usual' approach based on implicit assumptions that the world in the decades ahead is essentially a version of the world today, with values, attitudes, incentives, markets and politics remaining effectively unchanged. It risks developing strategies that may quickly become obsolete or counterproductive.

To stretch beyond 'business-as-usual' thinking, we used scenario analysis. A scenario is a plausible, internally-consistent set of assumptions about the state of the world in the future. We developed four scenarios based on different combinations of features across three axes:

Geopolitics and stability: Will the world be increasingly volatile, conflicted and contested or return to cooperative, rules-based and calmer times?

Economics and markets: Will we rediscover open, global markets and drive back towards globalisation, or move towards more regionalised, regulated and securitized markets?

Values impacting on demand. How will peoples' values affect demand: will per capita consumption grow and demand increase, or will attitudes shift, decoupling consumption from resource demand as we switch towards more sustainable consumption based on circular economies?

2.3.2 The Future Food Calculator

The Future Food Calculator plays a central role in this Roadmap by enabling a quantitative assessment of how different interventions in food production, land use, and dietary change might affect emissions, land requirements and food security across the four plausible future scenarios.²⁸ Developed as an open-source, modular tool, the Calculator allows users to experiment with variables such as consumption patterns, farming practices, and land allocation to explore trade-offs and system-wide implications. Its primary function is to test how the UK food system could transform under diverse future conditions while remaining aligned with net zero goals and maintaining or improving self-sufficiency.

By simulating each of the four scenarios in the Roadmap, the Calculator shows that the set of core transformations - in production, land use and diet - are essential regardless of how external drivers evolve. As such, the Calculator does not provide a single forecast, but rather enables robust, evidence-based thinking about strategic intervention points that are likely to matter in any future, helping policymakers and stakeholders navigate uncertainty with greater confidence.

The Calculator was developed using Python, a general-purpose programming language, and GitHub, an online version-control and code-management platform.²⁹ It was initially devised under the FixOurFood project by Juan Pablo Cordero and Sarah Bridle and further developed with the AFN team. The model relies on four main data sets: the UKCEH Land Cover Map for land utilisation; UN population prospects time series data; FAOSTAT Food Balance Sheets for annual food supply, consumption and trade; and the UK National Greenhouse Gas Inventory.

The Calculator assesses resources based on three fundamental principles. First, food supply quantities are always balanced so that total domestic use plus imports equal the sum of production and imports at all times. Second, everyone is fed.³⁰ Third, domestic production and land use are tied, with changes in land use reflected in changes in food production.

The model enables users to adjust parameters governing consumption of foodstuffs, production of animal and plant products, afforestation and other land use changes, and the adoption of different agricultural practices such as agroforestry or use of feed additives. The Calculator has several distinctive features compared to other models of the UK food system. Open source design makes modelling choices completely transparent and fully customisable. This makes it a powerful tool for decision-making and for scrutinising other models by adjusting its base assumptions and parameters. A modular approach allows easy extension to include more complex models and datasets. An interactive slider system enables users to experiment with different settings and visualise trade-offs related to land, emissions, production and consumption, as well as implications for the UK's level of self-sufficiency in food.

This combined scenario-modelling approach offers several benefits. It enables identification of robust intervention strategies that can work effectively across multiple possible futures rather than being optimised for only one expected set of outcomes. It allows exploration of system-wide implications of different policy choices, and helps identify critical intervention points where action is most needed regardless of which future eventually emerges.

²⁸ A detailed discussion of the model and how it has been used can be found at Appendix B.

²⁹ Cordero *et al.* (2024) AgFoodPy: a package for modelling food systems, *Journal of Open Source Software* 06305.

³⁰ Using a value of 2250 kCal per person per day, based on the average NHS recommended daily intakes for men (2500) and women (2000).

The analysis demonstrates that while specific implementation tactics might vary, certain fundamental transformations are essential across all plausible futures if the UK is to achieve net zero by 2050. These core transformations - in diets, food production approaches, and land use - emerge as robust requirements regardless of global dynamics or how value systems evolve.

2.4 The Four Futures

We used the Calculator to explore the pattern of emissions, food production and consumption under different scenarios. Our scenario development process yielded four distinct but plausible futures for the UK food system in 2050.³¹ Each represents a different combination of geopolitical stability, economic organisation, and societal values, with significant implications for how the food system might operate and the challenges it would face.

Table 1 - The four futures at a glance

Scenario	Global context	Dominant values	Drivers of change	Key Food system features	Emissions pathway
A. Build back fast again	Unstable, globalised	Growth, profit, short-termism	Market volatility, tech-led fixes	Technology focused, ultra-processed diets, declining support for farmers, pasture loss for biomass	Low reductions; net zero reliant on removals
B. Circular worlds	Stable, globalised	Sustainability, wellbeing	Values-led change, circular economy	Agroecology, flexitarian diets, forest expansion, improved producer margins	Balanced: reductions + sequestration
C. Self-sufficiency	Unstable, regionalised	Security, self-reliance	Resource scarcity, protectionism	Traditional mixed farming, low meat consumption, high food self-sufficiency, limited imports	Strongest emissions reductions
D. Right to food	Stable, globalised (green growth)	Equity, innovation	Technology innovation, global cooperation	Tech-enabled sustainable diets, high alternative protein consumption, rewilding, right to food rules	Balanced with strong ruminant reductions

³¹ Benton, T., Curry, A., Fredenburgh, J., McMillan, T., Bridle, S., Sanderson Bellamy, A., Kepinski, S. and Ward, N. (2023) *What Could the UK Agri-Food System Look Like in 2050?* Bristol: AFN Network+.

2.4.1 Scenario A: 'Build back fast again'

This scenario depicts an unstable and globalised world where economic growth remains the dominant political driver. It essentially represents a continuation and intensification of many current trends - what we might consider 'business as usual' accelerated by growing instability.

In this future, permanent economic crises increase inequality and reduce financial support for farming. Climate volatility and trade disruptions make resilience-building critical for households, supply chains, and agricultural operations, yet the resources to achieve this are increasingly unevenly distributed. Access to agricultural inputs becomes more variable and unpredictable globally, creating supply challenges for UK farmers.

Technology is widely promoted as the solution to sustainability challenges, but adoption is patchy and benefits limited without the necessary systemic changes. Food is predominantly grown intensively and is heavily ultra-processed, with implications for both environmental outcomes and public health. Large areas of less productive farmland are converted to other uses (such as energy generation and biomass), often driven by immediate economic returns rather than long-term sustainability. Strong corporate control exists throughout the food chain, with small profit margins for food producers, limiting their ability to invest in sustainability measures.

When modelled through the Calculator, this scenario achieves net zero primarily through extensive engineered carbon removals (68 MtCO₂e yearly) rather than deep agricultural emissions reductions (only 17.7 per cent reduction). The self-sufficiency ratio (0.63) is reduced, with substantial reductions in arable (-25.7 per cent) and pasture land (-13.7 per cent) as land is converted to other uses. Cattle herd size remains the same as today at 9.15 million animals.

2.4.2 Scenario B: 'Circular worlds'

The 'circular worlds' scenario represents a geopolitically stable and globalised world that has undergone significant transformation towards circular systems based on widely accepted sustainability values. This represents the most optimistic trajectory for global cooperation and values shift.

Economic growth is no longer the primary focus, with sustainability and wellbeing becoming stronger drivers of policy and investment decisions. Agricultural production shifts towards mixed and diversified farming systems where farming shares more land with nature and trees are integrated throughout the landscape. Agricultural practices feature lower chemical inputs but higher integration of ecological processes, with technologies specifically developed to support agroecological and regenerative approaches.

Dietary patterns shift significantly toward 'flexitarian' models based on more whole foods, less ultra-processed products, and stronger connections to local food networks. A circular economy reduces resource pressures throughout the system, while carbon-border taxes make high-emissions imports more expensive, incentivising domestic sustainability. Food prices are generally higher, but this is offset by reduced waste and shifts in diet composition. Farmgate prices increase, providing better margins for producers, and more farmers develop dual income streams through diversification.

The Calculator shows this scenario achieving net zero through a balanced approach combining moderate emissions reductions (28.5 per cent) with significant engineered carbon sequestration (47 MtCO₂e yearly). Agricultural emissions fall by 38 per cent. Forested land increases substantially (to 28 per cent of UK land), with reductions in arable (-11.0 per cent) and especially pasture land (-38.7 per cent). Self-sufficiency strengthens slightly at 0.7 despite these land use changes, indicating more efficient use of agricultural land. There is a significant reduction in cattle herd size (-4.5 million heads), driven by pasture land converted to forests, and reduced stocking density on farms.

2.4.3 Scenario C: 'Self-sufficiency for security'

This scenario portrays an unstable, regionalised world where circular economy approaches are driven primarily by resource scarcity concerns rather than environmental values. Trade becomes unstable and risky, prompting nations to focus intensively on self-reliance, particularly for essential resources like food.

Life is challenging, with economic contraction and global crises driving an 'island-fortress' mentality in the UK. Food security dominates the policy agenda, with agricultural policy primarily focused on feeding people regardless of environmental costs. Technology adoption in food production is limited by economic constraints, and mixed farming prevails due to the high cost and limited availability of imported fertilisers and other inputs.

Biomass and green composting thrive out of necessity, and farmers focus on 'traditional' UK crops best suited to local conditions, with some adaptation to growing new crops that suit a warming climate. Meat becomes a luxury for many due to its resource intensity. Food prices are high, leading people to buy less, consume less, waste less, and generally reduce their resource footprint through economic necessity rather than environmental concern.

In the Calculator, this scenario shows the strongest agricultural emissions reductions (45 per cent) of all four futures, with moderate carbon sequestration (47 MtCO₂e) from engineered removals. It achieves the highest food self-sufficiency (0.95) through more intensive use of available agricultural land, with relatively modest reductions in arable land (-10.8 per cent) compared to significant reductions in pasture (26.2 per cent) which, together with the reduction in stocking density (-30 per cent) drives a drastic reduction in cattle herd size (-47 per cent) down to 4.89 million animals. Forest cover increases to 23 per cent of UK land area.

2.4.4 Scenario D: 'The right to food'

The final scenario describes a geopolitically stable world with a globalised economy built on 'green growth' principles. It represents a high-tech, post-fossil fuel future with diverse food production technologies, including urban farming, vertical growing, and alternative proteins.

Agriculture becomes more intensive but also more efficient, with greater use of green fertilisers and biotechnology to reduce environmental impacts. Food production increasingly embraces ultra-processed products, but these are specifically designed for improved nutrition rather than merely for shelf-life or profit margins. International trade is organised around comparative advantage, with countries specialising in what they grow best, leading the UK to focus on horticulture, grains, and substantially reduced red meat production.

Ruminant farming becomes more limited and technologically advanced to minimise pollution, using methane inhibitors and selective breeding. Pasture land is increasingly focused on

heritage meat production, rewilding, or used for feedstock for protein extraction. Social inequality is lower than in Scenarios A and C, as food is increasingly recognised as a basic right that should be accessible to all.

The Calculator shows this scenario achieving the most balanced pathway to net zero, combining significant agricultural emissions reductions (42 per cent) with moderate carbon sequestration (37.2 MtCO₂e). It features the largest increase in forest land (an additional 20 per cent of UK land) and the most dramatic reduction in pasture (-51.2 per cent) with cattle herd size being reduced in the same proportion, and with only minimal reduction in arable land (-4.3 per cent). Self-sufficiency remains similar to today at 0.66 despite these major land use changes and consequences for farming livelihoods.

2.4.5 Common Elements Across Scenarios

While the four scenarios present distinctly different futures, when analysed through the Calculator, important common patterns emerge. These patterns highlight transformations that appear necessary regardless of which future unfolds, suggesting they represent robust strategic priorities for policymakers, businesses, and civil society. Modelling the four scenarios using the Calculator yielded several key insights:

1. Net zero requires both emissions reduction and carbon sequestration
2. Land use must change substantially
3. Dietary transition is a critical enabler of transformation
4. Food system resilience requires strategic planning
5. The land take and emissions from animal agriculture need to shift significantly

All successful pathways to net zero by 2050 require a dual approach: substantial reductions in agricultural emissions combined with significant carbon sequestration. The Calculator shows that agricultural emissions can be reduced by 20 per cent to as much as 40 per cent depending on the scenario, but none achieves net zero through emissions reduction alone. Sequestration through increased forest cover, ranging from an additional 5 to 20 per cent of UK land area, Bioenergy with Carbon Capture and Storage (BECCS) crops replacing between 5 and 20 per cent of arable crops, and other measures, are essential to balance remaining emissions.

Each scenario requires significant changes in land allocation. The Calculator demonstrates that 13 to 50 per cent of current pasture land would need to be repurposed, primarily for carbon sequestration (woodland creation) but also for other crops including horticulture and energy crops. Arable land reductions vary considerably too (from just 4.3 to nearly 25 per cent), depending on the scenario, with smaller reductions in those scenarios prioritising food security.

The analysis highlights how changing diets is a critical factor in all scenarios. Without shifts in consumption patterns — particularly reduction in meat consumption — the land required for food production would make it impossible to allocate sufficient area for carbon sequestration. The scenarios with the greatest reductions in emissions (C and D) feature the most significant dietary shifts, with meat increasingly becoming a luxury rather than a daily staple.

Sensitivity analysis indicates that self-sufficiency ratios are robust across all scenarios (0.63-0.95), suggesting that a transformed food system could maintain or even improve UK food security even while achieving net zero targets. However, this requires strategic coordination of production, consumption and land use change. Simply optimising for one factor (such as maximising carbon sequestration or production rates) compromises the others.

The Calculator also shows that across all scenarios, the balance between different agricultural activities needs to shift significantly. The current dominance of animal agriculture — which directly and indirectly accounts for over 85 per cent of UK agricultural land use — is not compatible with meeting net zero objectives while maintaining UK food security. From the modelling to date, we cannot find a way to reduce emissions sufficiently to get to a net zero UK while maintaining animal numbers and avoiding greater food imports. To reach a net zero UK, all scenarios show substantial reductions in land allocated to livestock and in animal numbers, particularly ruminants, with varying degrees of intensification on remaining livestock land.

These insights from the Calculator underscore that while pathways to net zero may vary depending on global and domestic circumstances, certain transformations appear necessary across all plausible futures. These include substantial changes in how we produce food, how we use land and what we eat. The relative emphasis may differ across scenarios, but the need for fundamental transformation in these three areas remains constant.

To return to our three perspectives in Section 2.2., through a teleological lens, if we are to meet the UK's legal target of net zero emissions by 2050, significant shifts in diet, the agricultural system, and land use patterns look necessary whatever happens in terms of international politics or changing social values. From a mechanistic perspective, even if all low carbon farming technologies were to be universally adopted, this would only deliver between a quarter and a third of required emissions reduction and leaves it inescapable that broader structural change is necessary. And from a materialist perspective, the scale of change is likely to require a rethink of some of our taken-for-granted assumptions about how food, farming and land use are organised and managed.

Our analysis demonstrates that achieving net zero targets by 2050 through the food system is technically feasible across a range of future conditions, but requires deliberate and coordinated transformation. We next explore these three core transformations in detail, examining the changes required, the benefits they can deliver, and implementation pathways.

Table 2 - Key Features of the Food System Under the Four Net Zero Scenarios

Scenario	UK Emissions Mt CO ₂ e / yr	Self- sufficiency ratio	Herd Size Million heads	% change in ruminant consumption	UK forest area % of UK land	% increase in UK horticulture	% of arable to BECCS crops
Baseline	94.23	0.67	9.15	0	13.17	0	0
A Build back fast	0.29	0.63	9.14	-10	18.17	-20	25
B Circular worlds	0.00	0.71	4.60	-60	28.17	70	10
C Self- sufficiency	0.42	0.95	4.89	-60	23.17	400	10
D Right to food	0.40	0.67	4.57	-70	33.17	50	3

3. Core Transformations Required

Transforming the UK food system by 2050 to reduce net emissions while delivering improved outcomes for people and the planet requires fundamental, systemic changes rather than incremental adjustments. Our analysis indicates that regardless of how the broader context evolves, three core transformations are needed to ensure a sustainable and resilient future.

These transformations are deeply interconnected and mutually reinforcing, with changes in food production and supply, land use and diets to create a coherent and effective response. Focusing on any single dimension in isolation would create new problems elsewhere in the system, or simply fail to deliver the scale of change required. Taken together, the three core transformations create a virtuous cycle that can meet climate goals, health imperatives, and nature recovery needs, underpinned by strengthened food security and economic resilience. Critical to their success is that benefits and costs are fairly distributed.

The following sections set out the available evidence and highlight gaps across each of these core transformations, examining the changes required, potential implementation pathways and identifying the multiple benefits they can deliver.

3.1 Resilient Food Production

The first core transformation needs to be strengthening resilience in food production and food supply. By strengthened resilience, we mean ensuring the food system operates within ecological and environmental limits, with production well-matched to consumption and public health objectives, and while enhancing the UK's food security in turbulent times.

Agriculture is at the heart of this transformation. It accounts for around half of all current food system emissions, with the vast majority coming from direct emissions from animal production or from growing crops to feed animals. Furthermore, livestock production (covering both ruminant and monogastric animals) accounts for around 85 per cent of the UK's agricultural land area when growing animal feed is also included.³² While measures can improve resource efficiency in food production, for UK agriculture to become a net zero compatible sector, CB7 suggests its emissions need to be almost halved by 2050, with other negative environmental impacts adequately addressed, and new non-food demands from land met.

While we can get down to close to zero [emissions] for machinery, there's still quite a lot of emissions left in the system. At the moment, there's no silver bullet that can reduce emissions from livestock and soils down to zero.³³

Indra Thillainathan, Team Leader for Land, Agriculture and Nature, UK CCC

³² Defra's Land Use Framework Consultation cites 85 per cent for England (p.12). WWF's calculation is 85 per cent for the UK.

³³ Thillainathan, I. (2025) CCC answers your questions on net zero, farming, diets & land, *AFN+ Network Webinar Series*, 7 April, <https://www.agrifood4netzero.net/resources/ccc-answers-your-questions-on-net-zero-farming-diets-land/>

Based on our modelling, our Roadmap focuses on the benefits of releasing some land (currently used for grazing or growing animal feed) to be used for growing other food crops (such as legumes or horticultural crops), energy crops, and new woodland for sequestration. This change would represent an acceleration of existing trends that can simultaneously help improve resilience to climate change, strengthen the UK's food security, help address the nature crisis and bring benefits for public health. In this section, we discuss the evidence base and key gaps in knowledge around this core transformation in the structure of the agricultural industry.

3.1.1 Current State and Challenges

Meat and dairy production dominates UK agriculture's use of land. Our climate and physical geography have lent themselves to growing grass and rearing beef cattle and sheep, and a large proportion of our arable land — estimated to be 40 per cent³⁴ is given over to growing animal feed, not just for beef and dairy cattle but also to serve the pig and poultry sectors. Around half the UK's cereals production goes to feed animals.³⁵ Most commonly when considering the climate, nature and public health issues around the food system, the structure of the agricultural sector (the balance between animal husbandry and cropping, and the balance between arable crops directly for human food and animal feed) is taken as a given. Attention then focuses on the techniques and technologies to reduce emissions or improve productivity.

This may be because of the degree of technical 'lock-in' which constrains the operation of the system and stifles innovation. It can also be thought of as an unconscious cognitive bias or what we might call '**agri-normativity**' — "a cultural inability to think objectively and dispassionately" when it comes to the types of crops grown on agricultural land.³⁶ This taken-for-granted assumption about what we produce needs to be questioned.

The structure of UK agriculture poses significant challenges to transformation. In the last 80 years, farms have become increasingly specialised as either arable or livestock operations, with arable production increasingly concentrated in the east and livestock in the west and north. This geographical specialisation accentuates some environmental pressures. Recent years have also seen the growth in number of so-called 'megafarms' with very large numbers of livestock.³⁷ A shift is required towards reintegrating livestock and arable cropping in more self-sustaining farming systems. However, the dominance of animal agriculture contributes substantially to GHG emissions, with CB7 suggesting a reduction in ruminant animal numbers by almost 40 per cent is needed over the next 25 years. Farmers face uncertain market conditions, unfair prices

³⁴ WWF (2022) *The Future of Feed: How Low Opportunity Cost Livestock Feed Could Support a More Regenerative UK Food System*. Godalming: WWF, p.6.

³⁵ Defra (2024) *UK Food Security Report*. London: Defra. Indicator 2.16.

<https://www.gov.uk/government/statistics/united-kingdom-food-security-report-2021/united-kingdom-food-security-report-2021-theme-2-uk-food-supply-sources>.

³⁶ Walker *et al.* (2023) Motonormativity: How social norms hide a major public health hazard, *International Journal of Environment and Health* 11, 1

³⁷ *The Guardian* has reported research that found 1,824 pig and poultry megafarms in the UK (with 40,000 or more poultry, 2,000 or more fattening pigs or 750 or more breeding sows). A Freedom of Information request by Terry Jermy MP found such farms were increasing in number, and over 120 have been identified in Norfolk alone. (<https://www.theguardian.com/environment/2025/jun/12/research-reveals-24000-megafarms-across-europe>) Although UK average dairy herd size is around 150 cows, it is possible to find dairy farms with over 1,500 milking cows. Geographical concentration of livestock means there are simply too many animals in some river catchments for slurry and manure to be safely spread without heightened pollution risks or the need to transport waste further afield.

and contract terms making changes to production systems challenging. The uncertainty over government funding for climate and nature outcomes and lack of consistent messaging on the vision for agriculture in future has not given farmers confidence to invest in resilience. It is understandable that there is caution and reticence in the face of the need for change.

What is Agri-normativity ?

Agri-normativity is an unconscious cognitive bias which takes the current structure and pattern of production from agriculture as an unremarkable social norm. We have adapted the term, inspired by the work of Ian Walker and colleagues at Swansea University, who coined the term 'motornormativity' to show taken-for-granted assumptions around a car-centric society.

Agri-normativity means the pattern and structure of food production is seen as a natural and given state of affairs with a logic of its own that is not commonly questioned. Agri-normativity is rendered more visible and open to discussion and debate when a longer term perspective is adopted. The scale and geographical extent of changes to what is produced, farming systems, and the social and economic structure of the industry become more apparent over a period of several decades. From this perspective, there have been large-scale changes in what is produced, and how. These include the major decline in the production of oats and hay during the mid-twentieth century, the rapid expansion in the production of silage from the 1960s to the 1990s, the rise since the 1970s (and subsequent fall) in the area of oilseed rape grown, and the structural concentration of pig, poultry and dairy production of a smaller number of ever-larger farm units.

Implicit in agri-normativity is a moralisation of food production as inherently virtuous, irrespective of the relative efficiency of the calorific value of food produced per land area, or the social costs of different production systems.

Resource use and input systems present further challenges. With most farmers practicing intensive systems with limited crop diversity in their rotations, agriculture remains dependent on nitrogen fertilisers to stimulate growth and sustain yields, which contributes to nitrous oxide emissions.³⁸ While these emissions have reduced since 1990 as fertiliser usage has fallen (accelerated by the higher energy prices since the Ukraine war),³⁹ more systemic changes are needed to strengthen circularity in agricultural resource use. Farm operations including soil cultivation and livestock movements currently rely on fossil fuel-based machinery, requiring transition to alternative technologies as part of the broader decarbonisation effort.

Production patterns and climate adaptation represent a third area of concern. UK horticulture production has declined by more than 20 per cent since 2020 and currently meets demand for only half of vegetables and a fifth of fruit.⁴⁰ A significant proportion of current domestic horticulture production takes place on lowland peat soils that are either reaching the end of their productive life or need rewetting to mitigate emissions.⁴¹ Climate change is already affecting

³⁸ Upcott, E. *et al.* (2023) A new approach to characterising and predicting crop rotations using national-scale annual crop maps, *Science of the Total Environment* 860, 160471.

³⁹ <https://www.sruc.ac.uk/all-news/new-farmers-handbook-highlights-impact-of-ukraine-conflict/>

⁴⁰ National Farmers' Union (2023) *UK Horticulture Growth Strategy 2023*. Stoneleigh:NFU.

⁴¹ Caudwell, R. (2023) *Lowland Agricultural Peat Task Force Chair's Report*. London: Defra.

crop yields and production patterns, necessitating adaptations in the types of crops grown and presenting opportunities for crop diversification.⁴²

As the dominant user of UK land and a major source of emissions, farming has a critical role in reaching net zero. Yet more than this, a strategy to strengthen the resilience of farming, improve food security and public health requires change in what is grown and how land is used. Agriculture will remain an emitter of GHGs even after 2050.⁴³ However, the consequences of climate change, for both home-produced and imported food,⁴⁴ and geopolitical changes affecting international trade, mean that **agriculture is going to have to change, whether the UK Government were to stick to its net zero target or not.**

3.1.2 Vision for Transformation

If agriculture is inevitably going to have to change, how can changes bring optimal benefits across the economy, environment and health? Our vision for a food system transformation by 2050 is for farms to be financially viable and efficient, producing healthy food that meets national needs, with a trend towards better protecting and enhancing national self-sufficiency in feed and inputs, and greater circularity in farming processes. Animal agriculture would be better integrated with arable production. The UK would become less vulnerable to shocks and disruptions in food supply chains. The agricultural sector would operate within the emissions limits of the UK's carbon budget, and wider benefits from nature restoration and enhanced biodiversity would be realised.

Re-introducing more mixed farming would follow the principles of regenerative and agroecological approaches. This could work at the individual farm level, or through groups of farmers collaborating locally to develop more circular systems that use animal production as part of a healthy crop rotation. Such systems would enhance soil health, improve water quality, and increase resilience while reducing dependence on manufactured and imported inputs. It would require the development of more regionalised supply chain logistics with, for example, more abattoirs and dairies in the east.

In our vision, domestic horticulture would become a much more significant component of UK agriculture, with increased production of fruits, vegetables, and salad crops that are well-suited to the UK's changing climate. This shift would reduce reliance on imports from water-scarce countries while capitalising on horticulture's land-efficiency compared to animal agriculture.⁴⁵ Expanding this sector would strengthen UK food security and resilience while improving the nutritional quality of domestically produced food. A key challenge is in the labour requirements. Automation and robotics can help, but a growth plan for horticulture will need to include how these requirements are to be met.⁴⁶

The transformed agricultural sector would incorporate technological innovations and practices to reduce emissions, including precision farming techniques, feed additives, including natural feed

⁴² Masters *et al.* (2009) *Climate Change and Agricultural Commodities*. CABI. Wallingford: CABI

⁴³ <https://defra.farming.blog.gov.uk/2023/04/06/the-net-zero-growth-plan-and-our-farming-offer/>

⁴⁴ <https://eciu.net/analysis/reports/2023/climate-impacts-on-uk-food-imports-2>

⁴⁵ <https://phys.org/news/2025-01-scientists-crops-uk-due-climate.html>

⁴⁶ A review for Defra of controlled environment agriculture in 2023 found that there is an expectation of potential growth but that capital costs are currently a barrier to expansion: Monaghan, J. (2023) *Controlled Environment Agriculture - A Review of Technology Utilisation*. Harper Adams University.

additives, to reduce enteric methane, improved manure management, and selective breeding for efficiency and reduced environmental impact. On-farm renewable energy generation would help decarbonise operations and potentially provide additional income streams for farmers.

British people don't want seasonal jobs. Regardless of whether they want manual jobs or not they don't want seasonal ones...[The horticulture sector is] having to rely on overseas workers like we have since the 1950s. That's not new, and that's not going to change anytime soon...

[Y]ou're trying to encourage people into the industry because it is rewarding...But there [are] so many other pressures that go with it. A lot of growers are discouraging their sons and their daughters from taking it on, because they know how hard it is, they know how they're treated by the retailers and they just don't want that for their family.⁴⁷

Lee Stiles, Secretary of Lee Valley Growers Association

This vision represents a reorientation of the agricultural sector, acknowledging that even after 2050, agriculture will remain an emitter of GHGs. However, through transformation it can operate within the boundaries of the UK's carbon budget while better fulfilling its primary purpose of feeding the nation.

3.1.3 Co-Benefits

Strengthened resilience in the agricultural sector brings multiple co-benefits beyond emissions reduction. The CCC's Balanced Pathway for agriculture and land use identifies several important benefits that would result from this transformation, and there are others as well.

First are the health and well-being benefits resulting from improved diets through greater quantities of legumes and pulses being grown domestically, and less reliance on meat and dairy. More diverse domestic food production would improve access to fresh, nutritious foods. It will take time for the effects to be felt, but improved diets among the UK population ought to reduce the pressures on the NHS that arise from poor diets today. The expansion of woodland and nature-friendly farming also creates potential opportunities for increased countryside recreation and connection with nature, which have established mental and physical health benefits.

Economic benefits would emerge as farmers and landowners gain greater confidence and clarity from a long-term national strategy. A national commitment to strengthening food security would enable the state, the agricultural sector, environmental interests and public health groups to converge around a central mission of improving diet, environmental performance and national self-sufficiency simultaneously. This would help cement the agri-food system's place in the Government's key missions, especially around economic growth, but also the NHS and clean energy. New employment opportunities would develop in growing sectors like horticulture, agroforestry and environmental land management and growth in these sectors would contribute to GVA growth in rural regions. The aim should be to drive labour productivity via technology, which should drive up skills levels and pay.

⁴⁷ Stiles, L. (2024) Food security under pressure: UK vegetable & salad crops in an era of climate change, AFN Network+ Webinar Series, 8 February, <https://www.agrifood4netzero.net/resources/food-security-under-pressure-uk-vegetable-salad-crops-in-an-era-of-climate-change/>

The transformation would significantly enhance climate resilience. Increased farmland tree-planting and agroforestry measures would improve shelter for farm livestock, reduce soil erosion, and improve drainage. Diversified production systems would be more resilient to extreme weather events, pests and diseases, reducing production variability and strengthening food security. The UK would become less vulnerable to international supply chain disruptions and climate impacts on overseas production.

Structural changes in agricultural production would reduce GHG emissions and create greater scope for biodiversity enhancement through mitigating the more damaging impacts of current practices and creating space for new habitat and rewilding. A reduced scale and intensity of cattle and sheep production would contribute to improved water quality and aquatic ecosystem health by reducing water pollution risks, especially in the most heavily stocked catchments.

A broader definition of food security incorporating health and environmental objectives alongside efficient land use in supplying domestic nutritional needs is key to realising these wider benefits. Simply maintaining existing production patterns does not optimise food security, especially when current land use is so inefficient at delivering nutrition for the UK population.

Establishing this virtuous circle of change in agriculture, land use and diets would bring social, economic and environmental benefits across the UK. It requires a new vision and approach to infrastructure development to support a more regionalised and resilient system. There would also be political benefits from a stronger sense of long-term strategy and direction and reduced fiscal pressures from improved population health. The UK could also re-establish its position as a global leader in climate action and enhance its influence in international negotiations.

3.1.4 Required Scale of Change

What needs to happen to strengthen the resilience of UK food production in the ways described in our vision? Transformation requires action across multiple fronts, with several key priorities.

CB7 provides clear parameters for the required scale of change. It suggests that emissions from agriculture and land need to fall from 67 million tonnes of carbon dioxide equivalent (MtCO₂e) in 2018 to 40 MtCO₂e in 2035 and 16 MtCO₂e in 2050 — a more than 75 per cent reduction. Meeting these targets while maintaining food production will require extensive land use changes, with the CCC anticipating that, by 2050, the same proportion of the UK's food consumption requirements would need to be met from around a fifth less agricultural land.

A significant shift from the current dominance of animal agriculture is required. Ruminant production will continue to be an essential feature of UK agriculture, but the CCC suggests a reduction in cattle and sheep of around 11 per cent by 2030, 20 per cent by 2035, and 38 per cent by 2050.⁴⁸ This reduction is primarily about freeing up land for other crops and outcomes, such as woodland, nature recovery and water storage. Reductions in methane emissions per animal will be required through improved feeding and breeding practices and improvements to

⁴⁸ Climate Change Committee (2025) *The Seventh Carbon Budget: Advice for the UK Government*. London: Climate Change Committee, p.189. For some historical comparison, total cattle and calves in the UK fell from 13.33m in 1984 to 9.41m in 2024, a fall of 29.4 per cent. Total sheep numbers fell from their 1990 peak of 44.47m to 31.02m in 2024, a fall of 30.25 per cent.

<https://www.gov.uk/government/statistics/livestock-populations-in-the-united-kingdom>

manure management. Currently, animal breeding is not strongly oriented to reducing emissions, but this could become a more prominent feature through advice, R&D, and positive or regulatory incentives. In manure management, encouraging anaerobic digestion or covering slurry pits and capturing emissions can help reduce GHG emissions substantially.

We used the Future Food Calculator to explore whether there were any feasible pathways to a net zero UK by 2050 that could involve maintaining livestock numbers at their current levels and not involving the importation of more food (*i.e.* offshoring emissions). Even if 80 per cent of post-retail food waste was eliminated from the system, and 90 per cent of farms adopted all available low-carbon technologies (such as methane inhibitors, capturing emissions from manure management etc), and a large-scale shift from specialised to mixed farming systems took place, the Calculator suggests a reduction in animal numbers would be required to underpin sufficient emissions reduction and land use change.

There are likely to be a smaller number of farmers earning a living from livestock production in 2050 than is the case today. Some farms may leave ruminant production entirely, with land given over to other activities such as energy crops and woodland creation. A structural change of the scale envisaged is sufficient to warrant advice and support in developing new income streams and benefiting from new markets in carbon sequestration and biodiversity net gain as well as more traditional farm-based diversification. Transformation also needs to be sensitive to the cultural role farming and land management can play in some more remote rural localities in the UK.

At the same time, a radical expansion in horticulture is needed. To meet the recommended portions of fruit and vegetables per day for the UK population, domestic horticulture production would need to increase nearly five-fold from the current 3.1 million tonnes to 15.2 million tonnes.⁴⁹ This dramatic scaling up would require addressing market failures that currently inhibit growth and investment in fruit, vegetable and salad crop production, including revising supply chain structures, pricing mechanisms, farm contracts, and labour availability. Stimulation of the supply of horticultural products needs to be accompanied by measures to grow domestic demand too (see Section 3.3).

Agriculture will also need to decarbonise its operations. Around a fifth of agricultural emissions come from using fossil fuels in agricultural machinery. While many vehicles can be electrified, heavy fieldwork may require alternative fuels, potentially including methane captured from animal slurry, which have emissions of CO₂ around 70-80 times lower than conventional diesel engines.⁵⁰ CB7 predicts that farm operations will need to be electrified by 2050. It suggests that farms should become energy creation hubs for themselves and their local communities.⁵¹

3.1.5 Implementation Mechanisms

A transformation of this scale requires coordinated action across multiple domains. Successful implementation must address both the supply side and regulatory frameworks simultaneously, with carefully sequenced interventions to support change.

⁴⁹ <https://foodfoundation.org.uk/sites/default/files/2023-05/Cultivating-Success-Final-March-2023-2.pdf>

⁵⁰ Ward, N. *et al.* (2024) Estimating methane emissions from manure management: a suitable case for treatment ?, *Environmental Research: Food Systems* 1, 025003.

⁵¹ <https://www.nuffieldscholar.org/sites/default/files/2025-01/TRC%202024%20Report.pdf>

There are lessons from history in orchestrating large-scale transformation for UK agriculture. In the 1940s and 1950s, UK agriculture underwent profound change as the Second World War exposed the nation's vulnerability to food imports. A new system of agricultural support was introduced, with the government and agricultural sectors working in close partnership to drive dramatic change in land use and productivity. The pattern of crops and animals, and the use of new technologies in agricultural production, went through revolutionary change. The balance between rough grazing and improved pasture and cropland shifted from two-thirds/one-third to one-third/two-thirds in the space of just a few years.⁵²

Crucial to the last food transformation was a unity of purpose and close partnership between public and private sectors, investment in R&D, financial incentives for farmers, and a strong regulatory approach through County Agricultural Executive Committees that oversaw farm modernisation locally.⁵³ While today's context differs, this historical example demonstrates that rapid, system-wide transformation is possible when properly co-ordinated and supported.

In the short term (2025-2030), developing an incentive framework to stimulate widespread adoption of low carbon farming practices is essential. Every available tool to address methane emissions needs to be deployed with speed, including feed additives, improving animal breeding to reduce emissions, and covering slurry stores. Regional farmer networks should be established or strengthened to help disseminate good practices, building on the proven success of collaborative cluster groups to support the uptake of new environmental practices.⁵⁴

A fundamental mindset shift is needed to overturn the implicit assumptions of agrinormativity — taking as given the products produced. For policymakers, agriculture needs to be conceptualised not just as a growth-oriented economic sector, but as a strategic sector supporting national security, public health and climate resilience. Politicians find it straightforward to think of national security in terms of defence and also energy security. The Secretary of State for Defence recently said: “The lesson from Ukraine ... is that a country's armed forces are only as strong as the industry that stands behind them You reinforce your resilience, and actually your country's deterrence, if you've got an industry that has the capacity to innovate and produce at wartime pace and scale up rapidly if we're faced with conflict in the future”.⁵⁵ The same sort of arguments are employed about energy security and the mission to become a ‘clean energy superpower’ — one of the Government's six key missions. Food has hitherto been treated differently, but needs to be thought of alongside energy and national defence. This should be accompanied by rapid research programmes into integrated farming systems that better combine crops and livestock production.

Building supply chains for alternative proteins, particularly beans and legumes, should begin immediately.⁵⁶ A horticultural growth strategy should be developed to support the four-to-five-fold expansion in UK horticultural production needed by 2050.

⁵² Murray, K. (1955) *Agriculture*. The History of the Second World War United Kingdom Civil Series. London: HMSO. pp.229-31.

⁵³ Short, B. (2014) *The Battle of the Fields: Rural Community and Authority in Britain During the Second World War*. Woodbridge: Boydell Press

⁵⁴ Sander *et al.* (2024) Participation in individual and collective agri-environmental schemes: A synthesis using the Theory of Planned Behaviour, *Journal of Rural Studies* 107, 103255.

⁵⁵ John Healey, quoted in *The Sunday Times*, 2nd June.

⁵⁶ This issue was the focus of an AFN webinar led by AFN Champion John Ingram in June 2024. See: <https://www.agrifood4netzero.net/resources/using-systems-thinking-to-transform-our-food-beans-as-an-analytical-lens/>

While fish and seafood currently represent a small share of UK calorie and protein supply, the sector has underexploited potential to support improved self-sufficiency. The UK has substantial marine resources, and domestic production of farmed fish and mussels could be harnessed, particularly through innovation in aquaculture and greater use of underutilised species.⁵⁷

Local food networks and procurement systems are being established at pilot scale, linking local production with local food needs through initiatives like modern market gardens.⁵⁸ These can serve as proof-of-concept for wider implementation in the medium term.⁵⁹

In the medium term (2031 to 2040), these initiatives must be scaled and systematised. The bean and broader alternative protein supply chain should be fully built out on both supply and demand sides. New stakeholders will need to be brought into being to help drive the development of new supply chains. A more adaptive, responsive breeding licensing system for plants and animals should be implemented to strengthen climate-mitigating attributes.

Regulations and sustainable finance to support the set up of renewable energy on the farm will be pivotal to reduce the carbon footprint of machinery used in the farm. This will help more farmers invest in diverse food production systems that will control environmental agriculture especially as we transition to increase horticulture farming.

Introducing farmers to seeds that enhance insect pollination will help to increase biodiversity while supporting them to preserve and re-use their seeds. Agricultural biotechnology offers selective breeding, precision gene editing and genetic modification. These approaches seek to improve crop yield, nutritional quality, and resilience to environmental stressors, but differ in their mechanisms, precision, and efficiency while they depend on the ability to select preferred traits. Regulations will be necessary for thorough review of gene edited crops and livestock to evaluate the long term impacts on productivity, health and the environment.

Food waste and food loss reporting should be mandatory. The simpler recycling scheme by Defra mandates that no organic waste should be sent to landfill, hence they must be upcycled/recycled. Manures can be treated on site using anaerobic digesters for safe treatment of the animal waste with by-product as renewable energy and bio-nutrient.

Climate change adaptation needs to be hardwired into the agricultural system. This would be supported by a transformed research, innovation and training system, as in the post-WWII years, but focused on driving system transformation for climate, health, nature and resilience.

New tenancy agreements for climate resilience and effective sequestration should be introduced, along with structural adjustment support for livestock producers transitioning away from ruminant livestock farming. This should include guidance on exploiting new income streams from carbon sequestration and renewable energy.

A national campaign to recruit new talent into the food sector should be launched, with training specifically focused on food system transformation for resilience. The pilot local food networks

⁵⁷ Garrett, A, S. Watson, and S Pegg-Darlison (2024) Fish as Food 2024 update: A review of developments in UK seafood consumption, implications and practical responses, <https://www.seafish.org/document/?id=525029cc-a7e3-4acd-b352-da4007fb9a42>; Garrett, A and A Caveen (2018) UK seafood supply base to 2030, <https://www.seafish.org/document/?id=525029cc-a7e3-4acd-b352-da4007fb9a42>

⁵⁸ <https://www.foodsensewales.org.uk/what-we-do/pilot-project-welsh-veg-in-schools/>

⁵⁹ See also: Morgan, K. (2025) *Serving the Public: The Good Food Revolution in Schools, Hospitals and Prisons*. Manchester University Press.

from the short-term phase should be expanded into a national programme of community food hubs linking local production with local food needs.

The effectiveness of this ‘new model agriculture’ will need to be continually reviewed and monitored, with lessons learned swiftly adopted and approaches adapted accordingly. In the face of accelerating climate change and geopolitical instability, a resilient agriculture and food system will be an adaptable one.

3.1.6 Conclusion

To strengthen the resilience of UK food production, transformational change will be required in what is grown and reared on British farms. Hitherto, Defra and other agricultural interests have focused on adopting novel technologies to reduce emissions from farming practices incrementally. The 2023 Carbon Action Plan, for example, includes 33 measures across arable and livestock sectors, including improving animal health, better selective breeding, adopting feed additives, covering slurry stores and so on. Our analysis suggests these measures, though necessary, will not be sufficient. They will need to be adopted widely and quickly, but there also needs to be a structural shift in the balance between livestock and cropping.

The scale of reduction in animal numbers suggested in CB7 — a 38 per cent reduction by 2050 — is such that a more fundamental shift is required than simply the adoption of low-carbon farming techniques. Crucially, a shift of this scale brings considerable additional benefits, including public health, nature recovery and reduced water pollution risks. It would also mean that British agriculture becomes more resilient to shocks to the system — whether they be from climate change or the effects of international geopolitical instabilities.

Food security, climate resilience, health, and the environment go hand in hand. Transforming agricultural production represents not just a response to net zero requirements but an opportunity to create a more sustainable, productive, and resilient food system that better serves both people and the planet. By changing what we grow and how we grow it, UK agriculture can reduce its environmental footprint while better fulfilling its primary purpose of feeding the nation. And although the basis of farming livelihoods will continue to change, as it has over recent decades, the fact that farming and land management produce such essential services (food and sequestration), means farming will be a highly valued activity at the heart of the transformation.

3.2 Land Use Transformation

Transformation of the UK food system raises the central question of land. We face a 'land squeeze' as multiple drivers — including social and economic change, climate change impacts, nature protection, and emissions reduction — place new demands on land use. From the net zero perspective, UK land must transition from being a net source of emissions to a net sink but the transformation must achieve much more than emissions reduction alone.

Land is a complex and politically-charged issue in the UK. Debates about land use change are refracted through concerns about national identity and social justice in all four nations. In England, notions of traditional rural landscapes persist in public consciousness, often built around large-scale arable farming, class harmony and landlord paternalism, where everyone knows their place.⁶⁰ In Wales, farming communities and land are intricately bound up with Welsh language and culture.⁶¹ In Scotland, the troubled history of the Highland clearances and feudal landownership still influences land reform discussions.⁶² In Northern Ireland, land ownership must be understood through the prism of divided communities and the particular challenges of Northern Ireland governance.⁶³ 'UK land use change' efforts embody a complex history of struggle and political meaning. Our sophisticated maps of land use cannot adequately capture these socio-political factors.

Over the last 80 years, the state has taken a more active role in land management, though climate change and the nature crisis now bring new questions about optimal land use. Following a period of reluctance to embrace and develop land use planning, there has been increasing interest in how the land squeeze might be understood and addressed. UKRI, Defra and the devolved administrations have jointly funded a Land Use for Net Zero (LUNZ) Hub and research programme.⁶⁴ In England, Defra have engaged in a lengthy process to develop a land use framework to help guide policy and practice. This section examines the role of land use change in food system transformation, discussing the current state, required changes over the next 25 years and implementation pathways to achieve multiple benefits beyond net zero.

3.2.1 Current State and Challenges

The question of land use and land use change has become an increasing preoccupation of the UK Government and the devolved governments over recent years as the pressures on land use have mounted and the pathway to net zero has come into sharper focus. Demographic changes like population growth and an ageing population require more land for housing. Commitments to nature conservation necessitate space for habitat creation. Climate change impacts demand

⁶⁰ Readman, P. (2008) *Land and Nation in England: Patriotism, National Identity, and the Politics of Land, 1880-1914*. Woodbridge: Boydell Press, p.3.

⁶¹ Cragoe, M. (2010) 'A contemptible mimic of the Irish': The land question in Victorian Wales, pp.92-108 in M. Cragoe and P. Readman (eds.) *The Land Question in Britain, 1750-1950*. Basingstoke: Palgrave.

⁶² Cameron, E. (2010) Setting the heather on fire: The land question in Scotland, 1850-1914, pp.109-25 in M. Cragoe and P. Readman (eds.) *The Land Question in Britain, 1750-1950*. Basingstoke: Palgrave

⁶³ Bull, P. (2010) Irish land and British politics, pp.126-45 in M. Cragoe and P. Readman (eds.) *The Land Question in Britain, 1750-1950*. Basingstoke: Palgrave

⁶⁴ <https://lunzhub.com/>

new approaches to managing flood risk. However, the most significant new driver is the role of land in climate change mitigation.

Prior to 2020, land use had been a policy backwater. As the CCC's carbon budgets were developed, it became clearer that meeting the UK's legally binding net zero target would require significant areas of land for woodland creation and energy crops.⁶⁵ The UK is relatively unwooded. Only 14 per cent of UK land is under woodland today, compared to 33 per cent in Germany and Italy and 46 per cent for Europe as a whole.⁶⁶

The integration of land use goals is becoming a major concern, particularly regarding how the planning system interacts with agricultural, economic and environmental objectives. In England, Defra is developing a land use framework that sets out the principles for integrated land use decision-making.⁶⁷ An example is the adoption of Biodiversity Net Gain in the planning system in England. In Scotland, Wales and Northern Ireland, there is increasing interest in natural capital approaches to economic planning and ecosystem service thinking around land use. Net emissions from land use, land use change and forestry are currently close to zero at 0.8 MtCO₂e.⁶⁸ By 2050, the sequestration associated with afforestation and other land use changes needs to offset the residual emissions from agricultural production, expected to be around 29.2 MtCO₂e.⁶⁹ The forestry subsector is the main carbon sink, responsible for 19.3 MtCO₂e of sequestration, while peatland is the main source, making up much of the 13.6 MtCO₂e emitted from croplands.⁷⁰ In the CCC's Balanced Pathway, land use becomes a net sink only in 2038.⁷¹

Current land use patterns are poorly matched to meet the UK population's nutritional needs. For example, the least productive twenty per cent of farmed land in England produces just three per cent of the calories we grow. Analysis by Green Alliance showed that using the least productive ten per cent of land for natural habitat and carbon removal would save half the carbon needed by 2035 from the whole land system and raise bird populations by 48 per cent by 2050.⁷² However, this change would fall predominantly on upland farmers.

The CCC envisages the proportion of UK land under woodland rising from 14 per cent today to 19 per cent by 2050. This requires tree planting rates to increase from 17,000 hectares annually in 2025 to 37,000 by 2030 and 60,000 per year by 2040 — a more than three-fold increase in planting rates over 15 years.⁷³ The Government suggests that around one-fifth of land in England needs to change use by 2050 to meet statutory targets for environmental delivery and climate change.⁷⁴ Scotland's Third Land Use Framework (2021-2026) suggests that tree

⁶⁵ Foresight Land Use Futures Project (2010) *Land Use Futures: Making the Most of Land in the 21st Century*. Final Project Report. London: Government Office for Science.

⁶⁶ The proportions are 19 per cent in Scotland, 15 per cent in Wales, 10 per cent in England and 9 per cent in Northern Ireland. <https://www.forestresearch.gov.uk/tools-and-resources/statistics/publications/forestry-statistics/forestry-statistics-2024/>

⁶⁷ Defra (2025) *Land Use Consultation*. London: Defra

⁶⁸ Climate Change Committee (2025) *The Seventh Carbon Budget: Advice for the UK Government*. London: Climate Change Committee, p.186. Land Use, Land Use Change and Forestry (LULUCF) is the UN's category for emissions reporting purposes and is separate from agriculture.

⁶⁹ Climate Change Committee (2025).p.188.

⁷⁰ Climate Change Committee (2025) p.187.

⁷¹ Climate Change Committee (2025) *The Seventh Carbon Budget: Advice for the UK Government*. p.189.

⁷² Elliott *et al.* (2022) *Land of Opportunity: A New Land Use Framework to Restore Nature and Level Up Britain*. London: Green Alliance

⁷³ Climate Change Committee (2025) *The Seventh Carbon Budget: Advice for the UK Government*. p.191

⁷⁴ Defra (2025) *Land Use Consultation*. p.15.

planting rates need to increase to 18,000 hectares per year by 2024-25, and Scotland needs 250,000 hectares of restored peatlands by 2030 to meet its net zero targets.⁷⁵

The current approach to incentivising land use change in the UK is heavily centred on the ‘public money for public goods’ model, which was promoted after Brexit by Michael Gove the then Secretary of State for Defra as the rationale for agricultural support in England. The approach builds on that of the Second Pillar of the Common Agricultural Policy (CAP) from the mid-1980s. It operates on the principle that farmers and landowners should be financially compensated for providing environmental benefits that may not be economically optimal from their perspective.

While this model has become the dominant framework for environmental land management, it faces significant challenges. Fiscal pressures on UK governments since 2020 have constrained public spending, with agricultural and environmental funding now competing directly with priorities like healthcare, education and defence. The sudden closure of the Sustainable Farming Incentive Scheme in March 2025 in England signals that this model may face greater constraints than previously anticipated. The Comprehensive Spending Review for 2026-29, published in June 2025, commits to an average of £2.7 billion per year on environmental land management schemes over the spending period, although this does include the £100 million cut to some schemes announced in March.

The balance between direct and environmental payments has become variable across the different parts of the UK.⁷⁶ This variability creates additional complexity for implementing coordinated land use change at the scale required. Limited public budgets may necessitate greater consideration of regulatory approaches and market mechanisms to complement public financial support in driving the transformation needed. Scotland’s target is for expanding woodland cover from 19 per cent to 23 per cent by 2045.⁷⁷ In Wales, the Welsh Government’s target is for an additional 180,000 ha of woodland by 2050, while the CCC’s Balanced Pathway in CB7 suggests a figure of 208,000 ha, or 26 per cent of the Welsh land area.⁷⁸

3.2.2 The Vision for Transformation

Land use change is fundamental to transforming the UK food system and needs to proceed hand-in-hand with changes in agricultural practices and diets. Our vision for land use transformation by 2050 is for land to be seen as delivering multiple benefits across climate, nature, health and food security objectives. If the net zero goal is to be taken seriously, there needs to be a strong strategic drive to achieve a pace of land use change not experienced since the Second World War. This requires a much more actively managed approach than has been seen over the past four decades.

Land use change must be planned and closely integrated with transformational change in what agriculture produces and in diets. It is only through managing these three areas of change together that we can realise benefits in nature recovery and public health and improve food security and agricultural resilience.

⁷⁵ Scottish Government (2021) *Getting the Best From Our Land: Scotland’s Third Land Use Strategy*. Edinburgh: Scottish Government.

⁷⁶ Baldock, D. and Kam, H. (2024) *Agri-Environmental Policies in England after Brexit*. London: Institute for European Environmental Policy.

⁷⁷ Climate Change Committee (2025) *Scotland’s Carbon Budgets*. London: CCC, p.72.

⁷⁸ Climate Change Committee (2025) *Wales’ Fourth Carbon Budget*. London: CCC, p.61

Land must be viewed as multifunctional, that is contributing to multiple objectives. We must move away from the exclusive zoning of land for agriculture, nature, forestry or other single purposes. Instead, we need new approaches that integrate carbon sequestration, food production, biodiversity enhancement, and climate resilience in the same landscapes. This is as well as the other valuable uses of land, including for recreation and for development.

The principles to support spatial planning and the targeting of land use incentives in Defra's *Land Use Consultation* provide a starting point, but do not fully address the fundamental questions of land ownership and property rights that are crucial to unlocking transformational change. These principles include co-design with local and regional stakeholders, enabling multiple benefits on land, targeting land use change to locations where benefits are greater and trade-offs less problematic, taking a long-term view of changing land suitability, and ensuring policy remains responsive to new data and opportunities.⁷⁹

However, these principles alone do not instill confidence that we can accelerate land use change at the pace and in the direction required to achieve a net zero UK and realise the associated benefits from the transformation we advocate. The land use framework must be robust enough to help drive the required change over the next three decades, accompanied by effective regulation and financial incentives to landowners and managers, not just serve as a 'light-touch' piece of analysis.

To guide this transformation the CCC has developed valuable principles for managing land use change that can reduce the risk of unintended consequences and maximise co-benefits. These principles should underpin the implementation of any land use framework:⁸⁰

- **Right measure, right place:** Changes should be targeted to land types most suitable and available for change such as woodland creation modelling that avoids tree planting on organic soils where doing so could release more carbon than it sequesters.
- **Following regulatory principles:** Land use changes should follow regulatory principles like the UK Forestry Standard open ground requirements for biodiversity that ensure environmental safeguards.
- **Long-term transition:** Land use changes must be designed to be longstanding, giving confidence for future investment and commitment to changing approach. For example, UK-grown domestic energy crops are based on perennial types to minimise disturbance and build soil carbon.
- **Sharing the load:** Changes should be distributed proportionally across the UK based on land type and capability, creating a resilient mix of measures across a range of locations and land types.

Additionally, any strategy must consider and plan for the implications for rural economies and local livelihoods from extensive land use changes. Balancing the urgency of climate action with the needs of communities that depend on the land will be essential for securing broad support for this transformation.

3.2.3 Co-Benefits

CB7 combines land use and agriculture for a holistic approach to net zero. Agriculture will always have some emissions from livestock and soil management, but combining land and

⁷⁹ Defra (2025) *Land Use Consultation*. London: Defra, p.18.

⁸⁰ Climate Change Committee (2025) *Seventh Carbon Budget*, p.124.

farming means that farming's residual emissions can be offset by nature-based removals. The consequence is that the more effectively agriculture reduces its emissions, the fewer additional trees are needed and the more capacity there is for productive farming. One of the main perceived conflicts over net zero has therefore been internalised for farming.

Land use transformation brings significant health and wellbeing benefits through dietary changes. Expanded woodland and enhanced nature also create more opportunities for outdoor recreation and nature connection, with benefits for mental and physical health.

Climate resilience benefits are substantial. Greater farmland tree-planting and agroforestry measures improve shelter for farm livestock, reduce soil erosion, and improve drainage. These nature-based solutions will be increasingly important for mitigating flood risks — particularly valuable given Environment Agency projections that one in four properties in England could be at risk of flooding by mid-century due to climate change.⁸¹ Diverse landscapes are inherently more resilient to climate impacts, providing natural buffers against extreme weather events.

Diversifying land use brings biodiversity benefits. Removing some less productive agricultural land from production can benefit nature considerably. Reduced chemical inputs, restored habitats, and improved ecological connectivity create more space for wildlife. The UK Government has committed to halting the long-term decline in species abundance and protecting 30 per cent of land and sea by 2030. Transformed land use patterns are essential to meeting these targets.⁸²

Economic benefits include new employment opportunities in woodland creation, energy crops and peatland restoration work. While conventional livestock management may support fewer jobs, these new areas of growth in 'net zero land management' sectors can help offset losses. They can also be incorporated as part of new farming identities, supported through education and training programmes in farming and land management, and as part of farmer demonstration networks. Moreover, the integration of trees and other nature-based solutions with agriculture can increase farm resilience and create new income streams.

Water resource benefits are increasingly critical. A predicted 5 billion additional litres of water daily will be needed by 2050 to meet growing demand from industry and homes.⁸³ Improved land management can enhance water retention, reduce pollution, and support sustainable management of this increasingly scarce resource. Many irrigation-dependent food producers and growers are in water-depleted areas,⁸⁴ making this benefit particularly valuable.

By 2050, UK land use will be characterised by more trees, more diversity and more nature. These visible changes will underpin greater resilience to climate change, more effective flood risk management, and a more robust agricultural sector supporting stronger national food security. The transformation of land use is not merely about emissions reduction but represents

⁸¹ Environment Agency (2024) *National Assessment of Flood and Coastal Erosion Risk in England 2024*.

⁸² Parliamentary Office of Science and Technology (2022) *Climate Adaptation for Nature*. POST Note 679. London: POST.

⁸³ Environment Agency (2024) *Meeting Our Water Needs for the Next 25 Years*. London: Environment Agency

⁸⁴ Agriculture and Horticulture Development Board (2019) *Establishing a Resilient Water Supply* AHDB Factsheet 06/19

a fundamental reimagining of our relationship with the land and its multiple contributions to human and ecological well-being.

3.2.4 Required Scale of Change

The scale of land use change required for net zero and associated benefits is substantial. In England, Defra's Land Use Consultation sets out details of the transformation needed (Table 3.3.4). Approximately 50,000 ha would undergo relatively small changes in agricultural land use, involving introducing more nature within fields and field margins and riparian buffer strips. Almost four times as much land (370,000 ha or 4 per cent of agricultural land) would need to incorporate more trees alongside food production for environmental and sequestration benefit.

Some 430,000 ha (or 5 per cent of agricultural land in England) is envisaged as being farmed but principally for environmental purposes. This would include the establishment of species-rich grassland habitats, responsible management of peat and planting short-rotation coppice. Finally, around 760,000 ha in England (approximately 9 per cent of agricultural land) would need to come out of agricultural production entirely to become more fully dedicated to environmental purposes. This would include woodland creation, maintenance of peat-dependent habitats and the creation or restoration of coastal and lowland heathland habitats.⁸⁵

On the remaining 81 per cent of farmland, there may be land management changes such as greater use of cover crops to reduce soil loss, but these constitute changes in land management changes rather than land use. Together, Environment Act commitments and net zero targets suggest around 1.6m ha of land in England will have to change use over the next 25 years.

Table 3 - England's Total Agricultural Land Area Under Different Types of Change

Category of change	Estimated amount to 2050 across Environment Act Targets and Net Zero (current assumptions, rounded figures)
Category 2 - Small changes maintaining the same agricultural land use	50 kha. c.1% of utilised agricultural area
Category 3.1 - Changes in agricultural land use, for food/environmental /climate benefits	370 kha. c.4% of utilised agricultural area
Category 3.2 - Changes in agricultural land use, mainly for environmental and climate benefits with limited food production	430 kha. c.5% of utilised agricultural area
Category 4 - Change away from agricultural land, for environmental and climate benefits	760kha. c.9% of utilised agricultural area

Source: Defra (2025) *Land Use Consultation*. London: Defra, p.15.

Defra concludes that this level of land use change in England is possible alongside the maintenance of, or even moderate improvement in, food production levels.⁸⁶ They anticipate that rates of change will be highest on areas of lowest agricultural productivity with a level of 'background' growth in agricultural productivity of 0.5 per cent per year, on average, until 2050.

⁸⁵ Defra (2025) *Land Use Consultation*. London: Defra, p.15.

⁸⁶ Defra (2025) *Land Use Consultation: Analytical Index*. London: Defra, p.34.

In Scotland, land use frameworks have been established for longer. The Third Land Use Framework covers the period 2021-26, with the Scottish Government expressing an “ongoing and unwavering commitment to land reform”.⁸⁷ The framework states that “[t]hroughout the lifetime of this Strategy (2021-2026), Scotland’s tree planting rates need to increase to 18,000 hectares per year by 2024-25. Peatland restoration will need to increase dramatically to achieve 250,000 hectares by 2030.”⁸⁸ The CCC suggest that Scottish planting rates will have to increase to 22,000 ha per year by 2040.⁸⁹

The land use change required is beginning to provoke some public controversy across parts of the UK. The Welsh Government published its Sustainable Land Management Strategy in 2023.⁹⁰ The Welsh Government’s original efforts to require farmers receiving agri-environment payments to ensure a proportion of their farmland was under woodland met with strong resistance and was withdrawn in 2024 for further review.⁹¹ In England, local campaigns are being fought against introducing solar panels on farmland, especially in East Anglia where the scale of such developments are being considered runs into thousands of hectares.⁹²

The benefits of transformational land use change are not well communicated, highlighting the need for better engagement strategies alongside policy implementation. Defra’s proposed emphasis on co-design may help to ensure that marginalised communities are included in the process of determining land use changes, supporting improved and more acceptable outcomes.

3.2.5 Implementation Mechanisms

Implementing land use change of this scale requires a balanced and co-designed approach combining financial incentives, regulatory frameworks and market mechanisms. While the post-Brexit ‘public money for public goods’ model has been central to rural land management policy, the scale of transformation needed for net zero objectives may require additional approaches, including targeted regulation, carbon market development, and potentially reforms to property rights. In the short term, carbon offsets and insets can drive change, but long-term transformation will require more comprehensive strategies that address questions about land ownership, use rights, and national priorities.

The first step in the short term (2025-2030) is to devise a national land use strategy with appropriate zoning in each part of the UK based on delivering national food security, public health and environmental needs. These strategies must go beyond analysis to provide actionable frameworks that drive real change. National plans in England, Scotland, Wales and Northern Ireland will need to strengthen resilience in light of climate change impacts, particularly addressing flooding and water resource pressures.

Tree-planting rates will need to be significantly increased to meet CB7 targets and in the environmental plans in the four UK nations. For example, there should be a target to treble tree-

⁸⁷ Scottish Govt (2021) *Third Land Use Framework*, 2021-2026. Edinburgh: Scottish Government, p.5.

⁸⁸ Scottish Government (2021), p.12.

⁸⁹ Climate Change Committee (2025) *Scotland’s Carbon Budgets*. London: CCC, p.71

⁹⁰ Welsh Government (2023) *Introducing the Sustainable Land Management Strategy*. Cardiff: Welsh Government.

⁹¹ <https://www.bbc.co.uk/news/articles/cpdv3z7ej5po>

⁹² <https://eastangliabylines.co.uk/business/development/startling-17000-acre-solar-surge-sparks-norfolk-uproar/>; See CPRE - <https://www.cprenorfolk.org.uk/get-involved/current-campaigns/norfolk-solar-mega-farms/>

planting rates on marginal uplands by 2030. Lowland peatland restoration should be accelerated so that the 9 per cent currently restored or near natural increases to over 30 per cent by 2040, while grazing intensity on upland peatland should be reduced with better management of the uplands more broadly for ecosystem services. CB7's Balanced pathway requires the total restored or near natural area of upland peatland doubles from 30 per cent now to 60 per cent by 2040.⁹³

The planning system should be strengthened and extended to better deliver national needs. Governments should publish comprehensive land use statistics that improve visibility of all land uses, including land-hungry leisure uses such as horses and golf courses. Calculations of the land required to achieve public procurement targets would also help transparency and planning.

In the medium term (2031-204), implementation will require monitoring tree establishment and incorporating lessons learned. Similarly, peatland restoration should be continuously assessed and adapted to ensure both sequestration and biodiversity benefits are achieved. Supporting agroforestry will ensure that lands dedicated to growing trees are used for food production.

Annual energy crop planting rates should increase to 12,000 ha by 2030, focusing on areas where multiple benefits can be captured without compromising food production priorities. CB7 requires that they subsequently more than treble again to 38,000 ha a year by 2040.⁹⁴ This will require careful integration with food production and biodiversity priorities. Structural adjustment support mechanisms for livestock producers transitioning away from high-emission farming practices will need to be developed with the sector and rolled out.

Climate adaptation frameworks should be regularly reviewed and revised in response to emerging impacts and changing conditions. Throughout this period, mitigation measures should be continually evaluated to ensure they enhance biodiversity alongside carbon sequestration, creating truly multifunctional landscapes.

3.2.6 Conclusions

Land use change is the second of our three core transformations, alongside strengthening agricultural resilience and dietary change. All three are inherently interlinked and cannot be separated from one another. Changes to the balance of crops and animals both reflect diet change and are prerequisites for the necessary land use transformation to ensure that residual agricultural emissions in 2050 can be suitably offset by establishing sufficient woodlands and other nature-based solutions on farmland. CB7 and the various land use frameworks in operation or under development across the UK are strengthening understanding of the scale of the challenge. Significant tracts of land — about 20 per cent in England, and more elsewhere — are likely to need to change their use. Agriculture may continue on parts of this land, but in a secondary role to environmental management.

The 2.5 MHa of UK land required for new woodland or energy crops will no longer be available for food production.⁹⁵ These ambitious changes call into question assumptions about the governance of land use and the structures that underpin current land ownership and property rights. Successfully effecting change on this scale will require focus, imagination and boldness

⁹³ Climate Change Committee (2025) *The Seventh Carbon Budget*. London: CCC, p.195.

⁹⁴ Climate Change Committee (2025) *The Seventh Carbon Budget*. London: CCC, p.191

⁹⁵ This figure comprises around 1.6 MHa of additional woodland and 0.7MHa of energy crops. See Climate Change Committee (2025) *Seventh Carbon Budget*. London : CCC, p.191 & 196.

not yet evidenced in the governmental exercises that to date have sought to grapple with the UK's increasingly urgent land use challenges.

3.3 Dietary Change

Transforming the UK food system is an urgent priority, not just for environmental and economic stability but for the health and resilience of the population. The way food is produced, marketed, and consumed is driving multiple, interrelated crises — rising levels of diet-related ill-health, escalating pressures on the healthcare system, poor economic productivity, widening social inequalities in food access, and accelerating environmental degradation.

A shift in dietary patterns represents both a critical lever and essential outcome for achieving food system resilience. Our framework for dietary transformation is based on a vision for nutritionally adequate, culturally acceptable and environmentally sustainable dietary patterns by 2050 that improve public health outcomes. Dietary transformation offers substantial co-benefits, including reduced healthcare costs, enhanced food security, decreased environmental impacts and greater social equity — ultimately creating a more resilient food system.

In the UK 64 per cent of adults are overweight or obese,⁹⁶ while significant numbers face hunger.⁹⁷ The squeeze on household incomes is also exacerbating food insecurity.⁹⁸ As an enabler of healthy diets, the UK food system is weak and fragile. System shocks, including climate change impacting on imported foods, pose further challenges to national nutritional security over time. We produce around 60 per cent of food consumption through domestic production, but our reliance on imports for healthy food, including fruits, vegetables and seafood, has grown.⁹⁹ For example, we rely on imported fruits and vegetables as sources of vitamin A and C, with domestic production contributing just 50 per cent of total demand for vegetables and 15 per cent for fruit.¹⁰⁰

Addressing food consumption is necessary alongside changes in food production to improve people's health, reduce the burden on healthcare systems, and also bring the food system to within planetary boundaries. Recent survey data shows that 20 per cent of UK adults self-report as food insecure and most adults report that they have recently changed their eating habits due to financial pressures (69 per cent) and health concerns (47 per cent).¹⁰¹ These findings underscore the scale of dietary challenges.

At population level, we are over-reliant on meat and dairy consumption and ultra-processed foods that are high in fat, salt, and sugar.¹⁰² The UK population has, on average, been

⁹⁶ Obesity statistics. House of Commons. 2025. Health Survey England (2021) Health Survey for England. <https://researchbriefings.files.parliament.uk/documents/SN03336/SN03336.pdf> <https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england>

⁹⁷ J. Kennedy, D. Cameron. Ipsos MORI. One in Seven People Face Hunger Across UK Because They Don't Have Enough Money; 2023

⁹⁸ Balogan, B. (2023) *Obesity Policy in England*. London: House of Commons Library

⁹⁹ DEFRA. (2025). *UK Food Security Report 2024*. London: Defra; see also A. Garret and A. Caveen (2018) *UK Seafood Supply Base to 2030*. Edinburgh: Seafish. <https://www.seafish.org/>

¹⁰⁰ National Farmers' Union (2023) *UK Horticulture Growth Strategy 2023*. Stoneleigh: NFU.

¹⁰¹ Armstrong, B. et al (2024) Food and You 2: Wave 5 Key Findings, UK Food Standards Agency, <https://doi.org/10.46756/sci.fsa.fqg357>

¹⁰² Public Health England (2020). NDNS: results from years 9 to 11 (2016 to 2017 and 2018 to 2019).

consuming more than the daily recommended calorie intake for some time.¹⁰³ Meanwhile, widening disparities in access to nutritious food are symptomatic of a system oriented more for profit than human and planetary resilience. The most deprived fifth of the population would need to spend 45% of their disposable income on food to afford the government-recommended healthy diet — rising to 70% for households with children.¹⁰⁴

A transition towards more sustainable and health-promoting consumption patterns requires coordinated action across multiple levels — government policy, industry, commercial governance reform, and public engagement. This transformation is inherently linked to how we use land and what we grow, with diet change as both a driver and outcome of broader food system change.

3.3.1 Current State and Challenges

The UK's dietary landscape is marked by contradictions. National dietary guidelines advocate for a balanced diet that includes high intakes of fruit, vegetables, and whole grains, but actual consumption patterns indicate a persistent reliance on energy-dense, nutrient-poor foods.¹⁰⁵ The National Diet and Nutrition Survey (NDNS) confirms that fibre intake remains well below recommended levels, fruit and vegetable consumption is insufficient, and diets are dominated by foods high in sugar, salt, and unhealthy fats.¹⁰⁶

UK adults (aged 19-64) do not consume enough high-fibre food groups such as wholegrains, fruits, vegetables, nuts and legumes.¹⁰⁷ This inadequate fibre intake directly correlates with the challenge of insufficient fruit and vegetable consumption. Only 33 per cent of adults and 12 per cent of children meet the 5-a-day fruit and vegetable target recommended by the Eatwell Guide.¹⁰⁸ The socioeconomic gradient in nutritional quality is particularly stark with fruit and vegetable intake correlated with income. People with lower incomes have significantly lower fruit and vegetable intake, and consumption increases by up to 4 per cent for every £10,000 increase in household equivalised income.¹⁰⁹

Food environments are fundamental determinants of dietary behaviours and health outcomes. One third of advertising spend by the food industry in 2022 to 2023 was on marketing confectionery, snacks, desserts and soft drinks, while only approximately 1 per cent of advertising spending was on marketing fruits and vegetables.¹¹⁰ This marketing imbalance contributes significantly to the dominance of ultra-processed foods in the national diet. Ultra-

¹⁰³ <https://ourworldindata.org/grapher/daily-per-capita-caloric-supply>

¹⁰⁴ Food Foundation. Broken Plate Report. 2025.

¹⁰⁵ Public Health England (2020). *Global Burden of Disease for England: International Comparisons*.

¹⁰⁶ House of Lords Food, Diet and Obesity Committee (2024) *Recipe for Health: A Plan to Fix Our Broken Food System*. Session 2024-25. HL Paper 19. London: House of Lords, p.20.

¹⁰⁷ Public Health England (2020). NDNS: results from years 9 to 11 (2016 to 2017 and 2018 to 2019).. <https://www.gov.uk/government/statistics/ndns-results-from-years-9-to-11-2016-to-2017-and-2018-to-2019>

¹⁰⁸ Pastorino *et al.* (2023). The future of meat and dairy consumption in the UK: exploring different policy scenarios to meet net zero targets and improve population health. *Global Sustainability* 6, 1–24.

¹⁰⁹ Public Health England. (2020b). *National Diet and Nutrition Survey: Years 1 to 9 of the Rolling Programme (2008/2009–2016/2017): Time trend and income analyses*.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/772434/NDNS_UK_Y1-9_report.pdf

¹¹⁰ Food Foundation. (2023). *The State of the Nation's Food Industry 2023*.

<https://foodfoundation.org.uk/publication/state-nations-food-industry-report-2023>

processed foods¹¹¹ comprise 57 per cent of the adult diet in the UK and 66 per cent of the adolescent diet.¹¹² These foods are often high in nutrients of concern, including salt, fat and sugar — and low in fibre. At a population level in the UK, our diet quality is poor — only 1 per cent of people achieve the recommendations of the Eatwell guide.¹¹³

People in the UK eat double the amount of meat compared to the global average, and 34 per cent of UK adults exceed the red and processed meat recommendations.^{114,115} Excessive meat consumption has profound implications for resource use, with livestock farming contributing significantly to GHG emissions, biodiversity loss, and land and water use.¹¹⁶ The emissions footprint of meat and dairy production far exceeds that of plant-based foods, with beef and lamb producing 4–6 times the emissions of poultry and 10–12 times those of pulses.¹¹⁷ Cattle and sheep graze on grass, but cattle may also be fed grain-based animal feed, as are pigs and poultry, from farmland that could be used to grow plant crops for human consumption.¹¹⁸ Half the UK cereal crop goes to feeding farm animals.

Fish and seafood can offer high nutritional value and potential environmental benefits, but their role in the UK diet is limited. Consumption has declined significantly in recent years and remains below recommended levels, despite significant marine resources.¹¹⁹

The consequences of these consumption patterns are far-reaching. Poor diet is now the leading cause of ill health in the UK, contributing to rising rates of obesity, type 2 diabetes, and heart disease.¹²⁰ Nearly two-thirds of adults are overweight or obese, and childhood obesity rates continue to rise, particularly in the most deprived areas.¹²¹ The burden on the NHS of diet-

¹¹¹ We take UPFs to be those foods which have been processed and contain ingredients not typically available in a home kitchen.

¹¹² NIHR (2023). *Beyond Taste and Nutrient content: Ultra-Processed Foods and their Impact on Adolescent Health in the UK* - NIHR School for Public Health Research.

¹¹³ In the UK national dietary guidelines (the Eatwell Guide) outline the Government's recommendations for food and nutrients — or healthy eating. The Eatwell Guide is a tool for framing public health policy and is used widely by national and local government, the NHS, health care professionals (including nutritionists and dietitians), industry and the public. <https://www.gov.uk/government/publications/the-eatwell-guide>

¹¹⁴ Food Foundation. (2025). *Our response to Climate Change Committee's 7th Carbon Budget*. <https://foodfoundation.org.uk/news/our-response-climate-change-committees-7th-carbon-budget>

¹¹⁵ Stewart, C. *et al.* (2021). Trends in UK meat consumption: analysis of data from years 1–11 (2008–09 to 2018–19) of the National Diet and Nutrition Survey rolling programme. *The Lancet Planetary Health* 5(10), e699–e708.

¹¹⁶ Takacs *et al.* (2022). Comparison of environmental impacts of individual meals - Does it really make a difference to choose plant-based meals instead of meat-based ones? *Journal of Cleaner Production*, 379, pp.134782–134782.

¹¹⁷ Ritchie, H. (2020). The carbon footprint of foods *Our World in Data*.

¹¹⁸ WWF (2022) *The Future of Feed: How Low Opportunity Cost Livestock Feed Could Support a More Regenerative UK Food System*. Godalming: WWF

¹¹⁹ Garrett, A, S. Watson, and S Pegg-Darlison (2024) Fish as Food 2024 update: A review of developments in UK seafood consumption, implications and practical responses, Seafish, <https://www.seafish.org/document/?id=525029cc-a7e3-4acd-b352-da4007fb9a42>

¹²⁰ Food Standards Agency. (2021). Chapter 1: The nation's plate, our diet and food choices today.

¹²¹ Obesity statistics. House of Commons. 2025. Health Survey England (2021) Health Survey for England.

related illnesses accounts for an estimated £92 billion in annual healthcare costs, with an additional £206 billion lost in productivity due to long-term sickness and economic inactivity.¹²²

Food insecurity across the UK has surged to alarming levels. More than 7.2 million people now live in food-insecure households, an 80 per cent increase in just three years, reflecting the impacts of the cost-of-living crisis, wage stagnation, and structural inequalities in food access.¹²³ The demographic pattern of food insecurity reveals clear social inequities. These households are disproportionately characterised by families with children, and with heads of household who are disabled or from minority social groups. Recent economic pressures have intensified these vulnerabilities. Food prices have increased by over 30 per cent since 2021, disproportionately affecting lower-income households, who spend a larger proportion of their income on food.¹²⁴ The coping strategies adopted in response to food insecurity further compromise nutritional quality. Worryingly, nearly half of UK consumers say they have had to cut back on the quality of food they buy due to financial pressures, with two-thirds of people saying healthy food is something "only some or a few" can afford.¹²⁵

Food bank usage has reached record levels, with the Trussell Trust distributing 3.1 million emergency food parcels in 2023–24 — a 240 per cent increase from a decade ago.¹²⁶ While food charities have worked to address immediate needs, systemic policy interventions that ensure long-term access to affordable, nutritious food have been largely absent from policymaking.

Consumers face difficulties in adopting healthier diets, including taste and price perceptions, cultural habits, and industry-led marketing that continues to promote animal-based products as dietary staples.^{127,128} The physical presence of food outlets significantly impacts dietary habits. Food deserts — areas with limited access to supermarkets or stores offering affordable, nutritious food — can be a feature of socially-deprived localities. Residents in these areas often rely on convenience stores and fast-food outlets, which predominantly offer energy-dense, nutrient-poor options. This limited access to healthy foods contributes to poor dietary quality and increases the risk of obesity and related chronic diseases.¹²⁹ These dietary patterns directly shape our agricultural landscape.¹³⁰

¹²² Food, Farming and Countryside Commission. (2023). *The False Economy of Big Food*.

¹²³ Food Foundation (2024). Call for new government to reduce children's food insecurity as part of child poverty taskforce.

¹²⁴ Institute for Fiscal Studies. (2024). *Cheaper grocery products rose in price much faster than more expensive products between 2021 and 2023*. London: Institute for Fiscal Studies.

¹²⁵ Food, Farming and Countryside Commission. (2023). *The False Economy of Big Food*.

¹²⁶ Trussell.org.uk. (2024). End of year food bank stats | Trussell.

¹²⁷ FSA. 2021. <https://www.food.gov.uk/sites/default/files/media/document/healthy-and-sustainable-diets-consumer-poll.pdf>.

¹²⁸ Food Navigator. 2020. <https://www.foodnavigator.com/Article/2020/07/31/Price-the-biggest-barrier-to-healthy-diets/>

¹²⁹ Seligman *et al.* (2009). Food Insecurity Is Associated with Chronic Disease among Low-Income NHANES Participants. *Journal of Nutrition* 140(2), 304–310.

¹³⁰ Gergel *et al.* (2020). Conceptual Links between Landscape Diversity and Diet Diversity: A Roadmap for Transdisciplinary Research. *BioScience*, 70(7), 563–575. doi:<https://doi.org/10.1093/biosci/biaa048>.

3.3.2 Vision for Transformation

Healthier diets which are focused on more plant-rich diets are central to improving public health as well as meeting the UK's climate targets, and ensuring food security. Our vision for dietary transformation by 2050 is a food system that delivers nutritious and sustainable food that is accessible and affordable for all.

In this transformed food system, UK diets would broadly follow our national dietary guideline recommendations, with most people meeting the EatWell recommendations, compared to just 1 per cent today.¹³¹ Evidence shows that shifting the UK public to high adherence to the Eatwell Guide has the potential to reduce risk of total mortality by 7 per cent and bring climate co-benefits through reducing GHG emissions (-30 per cent) and water use (-4 to -7 per cent).¹³²

While classifications of 'healthier UPFs' (e.g. plant based meat alternatives and wholemeal bread) are contested, those UPFs which are considered non-essential foods and those with low nutrient density and poor environmental impacts would be reduced.¹³³ Our vision includes a significant reduction in the consumption of those UPFs high in fat, salt, and sugar, and a shift toward more whole foods, particularly fruits, vegetables, legumes, and whole grains. The UK Food Security Report 2024 outlines that there has been a reduction in meat consumption and an increase in non-dairy milk consumption.¹³⁴ Our vision is that the trend in reducing meat and dairy consumption accelerates at least in line with the expectations in CB7.

In our vision, a transformed food system would see food environments that actively promote and facilitate healthy, sustainable choices. Marketing, pricing, and availability would support rather than undermine public health goals. Food would be produced, distributed, and consumed in ways that respect planetary limits while ensuring fairer access across socioeconomic groups.

Dietary transformation would drive and be supported by parallel changes in UK agriculture and land use. As consumption patterns shift toward healthier options, agricultural production would evolve in complementary ways, with more land dedicated to growing fruits, vegetables, legumes, and grains for direct human consumption. This integrated approach would create positive reinforcement where changes in diet support changes in land use and vice versa, enhancing public health and environmental outcomes simultaneously and strengthening UK food security.

3.3.3 Co-Benefits

The health benefits of dietary change are substantial and far-reaching. Increasing intake of whole grains, legumes, nuts, and vegetables is associated with a lower risk of chronic disease, improved life expectancy, and reduced healthcare costs. Diets rich in plant-based foods have been shown to lower the risk of cardiovascular disease, type 2 diabetes, and some types of

¹³¹ Scheelbeek *et al.* (2020) Health Impacts and Environmental Footprints of Diets that Meet the Eatwell Guide recommendations: Analyses of Multiple UK Studies. *BMJ Open*; 2020

¹³² Scheelbeek *et al.* (2020)

¹³³ Moran *et al.* (2025). Ultra-Processed Foods and Dietetic Practice: Findings From a Survey and Focus Group With UK Dietitians. *Journal of Human Nutrition and Dietetics* 38(1).

¹³⁴ DEFRA (2013) Family food statistics. <https://www.gov.uk/government/collections/family-food-statistics>

cancer.¹³⁵ These figures highlight the potential for dietary changes to improve individual well-being and alleviate pressure on the NHS.

In the UK, we are spending significantly more on healthcare, social care, and welfare support for those affected by chronic, food-related diseases than it would cost to improve our diets.¹³⁶ As the Food Farming and Countryside Commission has argued, as well as the direct costs to the healthcare system, the productivity losses (through long-term inactivity and early mortality) from unhealthy diets are more than twice what it would cost to ensure access to healthy food.¹³⁷

The economic case for change is compelling. Modelling shows that although there is a substantial cost to the nation of providing the Eatwell diet (£57 billion), which would require a 55 per cent increase in food spending, the increase is less than the direct health-related costs (£91.9 billion) spent each year in the UK to tackle food-related chronic disease and far less than the total health-related costs (£268 billion) attributable to poor diet.¹³⁸ The sums of money are vast, but the benefits of this transformational change are even more spectacular.

Beyond health, dietary transformation would strengthen UK food security and resilience. Our Calculator suggests that shifting toward more plant-based foods would reduce dependency on imported animal feed and so enable more efficient use of agricultural land. Decreasing consumption of resource-intensive animal products while increasing demand for fruits, vegetables, and other ingredients including legumes would create opportunities to expand domestic horticulture and pulse production, potentially reducing reliance on imports and vulnerabilities to international supply chain disruptions.

The environmental benefits extend beyond reduced emissions. A review of the environmental impact of UPFs found they accounted for 17-39 per cent of diet-related energy use and 36-45 per cent of diet-related biodiversity loss amongst adults in high-income countries. UPFs were responsible for up to one third of diet-related GHG emissions, land use and food waste, and up to one quarter of diet-related water use.¹³⁹ UPF production is also shown to contribute to other poor outcomes including eutrophication, land degradation and pesticide use.¹⁴⁰

By ensuring affordable access to nutritious, sustainable food for all income groups, we could address the current disparities in diet quality and associated health outcomes. Policies that promote healthy eating across society would help break the cycle of diet-related ill health that disproportionately affects lower-income communities.

¹³⁵ Kim, H. *et al.* (2019). Plant-based diets are associated with a lower risk of incident cardiovascular disease, Cardiovascular disease mortality, and all-cause mortality in a general population of middle-aged adults. *Journal of the American Heart Association* 8(16); Hemler, E. and Hu, F. (2018). Plant-based diets for personal, population, and planetary health. *Advances in Nutrition*, 10, S275–S283; Aune, D. *et al.* (2016). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality — a systematic review and dose-response meta-analysis of prospective studies. *International Journal of Epidemiology*, 46(3), 1029–1056.

¹³⁶ FFCC. (2024) *The False Economy of Big Food: and the Case for a New Food Economy*.

¹³⁷ FFCC (2024)

¹³⁸ FFCC (2024)

¹³⁹ Anastasiou *et al.* (2022). A conceptual framework for understanding the environmental impacts of ultra-processed foods and implications for sustainable food systems. *J of Cleaner Production*, 368 133155

¹⁴⁰ Soil Association. (2015). How bad is ultra-processed food for the climate, nature and health? <https://www.soilassociation.org/blogs/2022/august/24/how-bad-is-ultra-processed-food-for-the-planet/>

3.3.4 Required Scale of Change

The scale of change required in UK diets by 2050 is substantial but achievable through coordinated action. Meeting the multiple challenges of climate change, public health, and food security requires significant shifts in what we eat and how our food is produced and distributed.

The Climate Change Committee (CCC)'s CB7 outlines that by 2040, 25 per cent of meat (30 per cent of red meat) and 20 per cent of dairy would need to be replaced with lower-carbon foods (legumes, nuts, pulses, meat alternatives, novel proteins), compared to 2019 consumption levels.¹⁴¹ A more conservative approach suggests a 20 per cent reduction in red meat and dairy by 2050 but even this could enable FLAG (Forestry, Land and Agriculture) emissions reductions of 9 per cent to 22 per cent.¹⁴² These scenarios assume that protein is switched to come from pulses, but also that substitution to chicken or fish would slightly reduce emissions savings (e.g. doubling chicken and egg consumption would add around 1MtCO₂e annually — less than 1 per cent of FLAG emissions and doubling pork consumption would add around 2.5 MtCO₂e).¹⁴³

While red meat consumption in the UK has declined over time per capita, diet quality, including intake of fruit, vegetables, and other nutrient-dense foods, remains too low, particularly in low-income households.¹⁴⁴ This raises a combination of questions around health, sustainability and equity, as diets rich in whole plant-based foods are linked to lower mortality and reduced risk of chronic diseases such as cardiovascular disease, cancer, and type 2 diabetes.

Other organisations have proposed more ambitious targets. Eat Lancet recommends a 50 per cent reduction in meat and dairy consumption by 2030 with a recommendation to: “Aim to consume no more than 98 grams of red meat (pork, beef or lamb), 203 grams of poultry and 196 grams of fish per week”.¹⁴⁵ WWF UK in *‘Eating for Net Zero’* suggests animal protein consumption should be significantly reduced across all land-based meat types with 69 per cent less meat, 25 per cent less dairy and 32 per cent less eggs.¹⁴⁶

The Food Foundation has highlighted that the CCC's 35 per cent reduction in meat consumption equates to just one less rasher of bacon or two chicken nuggets less a day.¹⁴⁷ Eating smaller portions of meat has been shown to be the most effective way to reduce total meat consumption, resulting in a 52 per cent decrease.¹⁴⁸ The National Food Strategy recommends reducing meat intake with a focus on ensuring reductions are driven by more sustainable sourcing and consider origin rather than simply shifting production overseas.¹⁴⁹

¹⁴¹ Climate Change Committee (2025) *Seventh Carbon Budget*. London: CCC.

¹⁴² IGD, WRAP, EY. (2024). *A Net Zero Transition Plan for the UK Food System*.

¹⁴³ Pastorino, S. (2023). Meat and dairy-reduction policies would help meet net zero targets and improve. London School of Hygiene and Tropical Medicine Newsletter.

¹⁴⁴ PHE. (2020). NDNS: results from years 9 to 11 (2016 to 2017 and 2018 to 2019).

¹⁴⁵ EAT. (n.d.). *EAT-Lancet Commission Brief for Everyone*.

¹⁴⁶ WWF. (2023). *Eating for Net Zero: Full Report*. WWF UK.

¹⁴⁷ Food Foundation. (2025). Our response to Climate Change Committee's 7th Carbon Budget. <https://foodfoundation.org.uk/news/our-response-climate-change-committees-7th-carbon-budget>

¹⁴⁸ Vonderschmidt *et al.* (2024). Smaller meat portions contribute the most to reducing meat consumption in the United Kingdom. *Nature Food*. doi:<https://doi.org/10.1038/s43016-024-01070-2>.

¹⁴⁹ National Food Strategy. (2021). *The National Food Strategy - The Plan*.

<https://www.nationalfoodstrategy.org/>

Meeting any recommendations on meat reduction will require the food industry to provide healthy, accessible, affordable, and appealing plant based alternatives. Although there are examples of industry moving towards a model of protein diversification in its core operating model (such as Lidl in the UK), stronger policy interventions are needed such as via reform of public procurement, and financial incentives that make plant-based foods more competitive in the marketplace. Crucially, the transition must also be managed in a way that supports farmers and food producers, ensuring that they are able to respond to opportunities opened up by shifting consumer demand and the need to sequester carbon on land.

3.3.5 Implementation Pathways and Mechanisms

A dietary transformation of this scale requires coordinated action across multiple domains and combining regulatory approaches with educational initiatives and structural changes to food environments. Implementation must address both the supply and demand sides of the food system simultaneously, with carefully sequenced interventions to support change.

Effective implementation requires unprecedented policy coherence across government departments. The UK's transition to healthier, more sustainable diets requires coordinated government intervention across multiple policy domains that addresses both the immediate challenges and long-term transformation needed in our food system.

Our scenario analysis demonstrated that dietary change is essential across all four plausible futures to 2050. The policies we outline are designed to be robust across different future conditions, whether the UK faces geopolitical instability, economic pressures, or shifts in social values. This approach ensures that dietary transformation can proceed regardless of how circumstances evolve, steering the UK towards a more sustainable and resilient food system.

In the short term (2025-2030), the focus will be on establishing coherent governance structures and transforming food environments. A cross-departmental Food Systems Lead should be created, responsible for both health and environmental outcomes for all food-related policies to ensure cross-departmental coordination and reinforce objectives between supporting British farmers and promoting healthier, more sustainable diets.

Food environments must be transformed through regulating high fat, salt and sugar foods via stronger advertising restrictions, mandatory front-of-pack labelling and fiscal measures like a Reformulation Tax as advocated by Recipe for Change.¹⁵⁰ Healthier food environments initiatives should emphasise making healthy choices the default option.

Public procurement represents a powerful lever for change, with measurable targets needed for increasing fruit and vegetable intake and reducing processed meat consumption by 2030, aligned with both climate and health outcomes. Food and sustainability education must be embedded across the curriculum, particularly in Key Stages 3 and 4, using school food and kitchens as hands-on learning environments that link knowledge with dietary behaviour.

Ensuring equitable access requires implementing social prescribing including fruit and vegetable voucher schemes for vulnerable populations to help address the significant price disparity between nutritious foods and processed alternatives. Economic barriers to healthy eating must be addressed by targeting interventions to low-income households that currently need to spend

¹⁵⁰ Recipe for Change (2023) *Campaign Launch Report*. London: Recipe for Change.
<https://www.recipeforchange.org.uk/>

a disproportionate share of income on healthy foods. The food GCSE should be promoted more widely to help build food literacy from an early age, with food system education embedded at all levels, from primary schools through higher education.

Crucially, domestic production capacity must be aligned with dietary goals by quantifying the UK land required to deliver increased fruit and vegetable consumption, and integrating this into land use strategy, national horticulture strategy and public procurement strategies. This should help reduce reliance on imports and animal-based production while strengthening UK resilience.¹⁵¹

In the medium term (2031-2040), an ambitious edible horticulture growth plan should be developed that supports the production and increased consumption of a diverse range of plant foods that can be grown in the UK, reducing reliance on imports and creating rural jobs. Transition pathways into plant protein production should be created with targeted subsidies and long-term market guarantees.

Supply chain regulation should be established that gives farmers fairer prices and contracts, enabling investment in more sustainable practices and supporting farm incomes during the transition. Building circular food systems becomes increasingly important through reducing edible food waste via improved food storage and distribution systems and supporting the upcycling of inedible food waste to create bio-nutrients for local food production, ensuring food system circularity while improving food access.

Throughout implementation, economic and socio-cultural barriers to healthy eating must be addressed. The price disparity between nutritious foods and processed alternatives forces individuals, particularly from low-income households, to opt for cheaper, less nutritious but calorie-dense options. The effectiveness of this dietary transformation approach will need to be continually reviewed and monitored, with lessons learned swiftly adopted and approaches adapted accordingly. In the face of accelerating health challenges and economic pressures, a resilient food system will need to be adaptable, ensuring no one is left behind in the transition to a food system that nourishes people and protects the planet.

3.3.6 Conclusions

Dietary transformation represents a critical pillar in our roadmap to a sustainable and resilient UK food system. The shift toward healthier, more plant-rich diets and moderated consumption of animal products offers multiple benefits — from reducing GHG emissions to improving public health, enhancing food security, and addressing social disadvantage. Moreover, a healthier population can support the Government's growth strategy through greater productivity, and so underpin its core missions.

The scale of change required is substantial but achievable through coordinated policy action, industry innovation, and public engagement. By approaching this transformation systemically,

¹⁵¹ Here we follow the CCC's assumption that because most UK meat exports go to the European union, and EU Member States are likely to be going through very similar transformations in food production and consumption patterns over the next 25 years, it is unlikely that there will be growing opportunities for British farmers to increase exports

we can create food environments that make healthy, sustainable choices easier for everyone, regardless of income or location.¹⁵²

Dietary change is inherently linked to the other core transformations in our roadmap - resilient food production and land use transformation. As consumption patterns shift, they can enable and reinforce changes in what we grow and how we use land, provided policy measures are in place to ensure that shifting diets are not undermined by simply exporting more high-emitting foods. The mutually reinforcing nature of these transformations creates a virtuous cycle that can collectively drive progress toward net zero while delivering wider benefits.

¹⁵² FFCC (2025) *A Citizen Mandate for Change*. <https://ffcc.co.uk/publications/a-citizen-mandate-for-change>

4. Enabling the Change

The three core transformations — dietary change, resilient food production and land use change — provide the essential framework for the UK food system to deliver public benefits in a rapidly changing context and support net zero objectives by 2050. Identifying what needs to change is only the first step. The more challenging task is creating the conditions that enable these transformations to take place at the pace and scale required.

This chapter explores the key enablers that can accelerate and support these transitions. First we examine the supporting technologies and innovations that can drive change across the food system, from consumer-facing interventions to farm-level techniques. Second, we propose a just transitions framework to ensure that the costs and benefits of transformation are fairly distributed, protecting vulnerable people. Finally, we present an implementation pathway that sequences actions over the short, medium and long term to build consensus, drive implementation and consolidate progress toward a resilient, sustainable UK food system.

The transformations required will necessitate coordinated action across multiple domains and groups of people. By addressing both the technical and social dimensions of change, we can create an enabling environment that makes transformation not only possible but preferable to maintaining a business-as-usual approach that is likely to lead to systemic failure.

4.1 Supporting Innovations for Transformation

Transforming the UK food system requires not only policy frameworks and behavioural changes but also the development, investment and deployment of supporting technologies and innovations. These span the entire food system, from consumer-facing technologies that support dietary change to production techniques that reduce agricultural emissions and approaches that optimise land use for multiple benefits.

4.1.1 Supporting innovations for diet change

For dietary transformation, the food industry's engagement is essential. Major food manufacturers and retailers have significant influence over what people eat through their product development, marketing and pricing strategies. The Institute for Grocery Distribution (IGD), working with WRAP, produced a plan for achieving net zero by 2050. Food companies are increasingly framing their environmental work around the Science Based Targets Initiative (SBTi),¹⁵³ which helps companies set emissions reduction targets aligned with climate science and the Paris Agreement goals.

The IGD report divides emissions targets into Forest Land and Agriculture (FLAG) and non-FLAG sources. For FLAG emissions, which include agricultural production, the target is for at least a 30 per cent reduction by 2030 and a 70 per cent reduction by 2050.¹⁵⁴ Significantly, the analysis acknowledges that *“without diet change, the food system would not be able to ... meet*

¹⁵³ SBTi is a collaboration between CDP (formerly the Carbon Disclosure Project), the United Nations Global Compact, World Resources Institute and Worldwide Fund for Nature.

¹⁵⁴ Among non-FLAG sources (e.g. energy, transport, heat, food waste, packaging and refrigerants), the transition plan aims for a 100 per cent reduction by 2050. Institute for Grocery Distribution & WRAP (2024), p.9.

SBTi FLAG targets” and recommends urgent industry action to develop approaches to diet that “balances net zero and health objectives”.¹⁵⁵

While the food industry is increasingly recognising and acknowledging its role in influencing dietary patterns, much of its focus remains on changes in production rather than actively driving dietary shifts. For example, the IGD net zero transition report dedicates 50 pages to how agriculture can reduce emissions from production but only 2 pages to diet change.¹⁵⁶ This indicates a hesitation to lead on consumer behaviour change, suggesting that government leadership will be essential in this area.

The SBTi initiative has been successful in signing up large numbers of companies to ambitious emission-reduction targets. However, companies are beginning to realise the relatively limited agency they might have in addressing Scope 3 emissions. The SBTi assumption is that if all companies along the value chain sign up, then collective success is ensured. The risk is that as deadlines approach and companies realise they may not reach SBTi targets, the framework will come under severe pressure. There is a role for government and consumers in helping ensure SBTi is a success.

Government interventions to support dietary change could include incentives for product reformulation, similar to the successful Soft Drinks Industry Levy, which effectively reduced sugar content in beverages. This could incentivise the development of both lower-emission and healthier foods. Additionally, investment in alternative protein development could accelerate the transition from emission-intensive animal products while maintaining protein levels in diets.

4.1.2 Supporting innovations for agricultural production

Agricultural transformation requires widespread adoption of emission-reducing practices and technologies, alongside structural changes in what is produced. Analysis by the Scottish Rural University College for the IGD identifies key measures for reducing agricultural emissions including improving grass-legume mixes to reduce fertiliser use, improving livestock health and breeding, covering slurry stores, and adopting precision farming techniques.¹⁵⁷

*We believe we're already net zero on farm because of the sequestration that we're doing, but it's getting the science to catch up with that. So I think one of the things we need is good methodology so that we can prove that what we're already doing is benefiting the environment.*¹⁵⁸

Sophie Gregory, First generation organic dairy farmer

These measures need to be adopted at scale and with urgency. The Government's Farming Roadmap in England, and similar strategies in the devolved administrations should include clear plans with measurable targets for the adoption of these emission-reducing practices. Where voluntary uptake proves inadequate, regulatory approaches may be necessary to achieve the

¹⁵⁵ Institute for Grocery Distribution & WRAP (2024), p.11.

¹⁵⁶ Institute for Grocery Distribution & WRAP (2024), p.115-116.

¹⁵⁷ The complete set of measures is provided in Annex Table x.x.x.

¹⁵⁸ Gregory, S. (2023) Young farmers and the drive to net zero, *AFN Network+ Webinar Series*, 11 October, <https://www.agrifood4netzero.net/resources/young-farmers-and-the-drive-to-net-zero/>

required scale of change. Progress is also constrained by inadequate measurement and monitoring systems that can capture what some farmers are already delivering through innovative practices.

However, technology adoption alone will not deliver the scale of net emissions reduction needed. New models of agricultural production, such as regenerative agriculture, are gaining interest for their potential to address multiple challenges simultaneously. The British Ecological Society has reviewed regenerative approaches, highlighting the importance of minimising exposure of bare soil in agricultural land management and increasing the diversity of crops grown.¹⁵⁹ While regenerative approaches can significantly improve biodiversity outcomes, they must still be accompanied by the structural changes in agricultural production set out in Section 3.2 to meet emissions reduction targets.

4.1.3 Supporting innovations for land use change

Land use transformation presents distinct technological and capacity challenges. The CCC's recommendation to more than triple annual tree planting rates by 2040 raises questions about the forestry sector's capacity to deliver on this scale. Innovations in forestry management, nursery production, and planting techniques will be essential to meet these ambitious targets. Recent experience of new woodland creation (2023/24) suggests progress is strongest in Scotland (75 per cent of all new woodland planting) followed by England (20 per cent) with much less planting currently taking place in Wales and Northern Ireland.¹⁶⁰

Not all additional woodland needs to come from active planting. Innovation in approaches to natural regeneration and rewilding could complement traditional forestry methods, potentially delivering carbon sequestration alongside enhanced biodiversity benefits. However, these approaches require development of robust monitoring and verification methods to ensure they deliver the anticipated carbon and ecological benefits.

For energy crops, innovations in harvesting, processing and conversion technologies are needed to create viable supply chains and markets. Research into optimal crop varieties for different UK contexts could improve yield and economic viability while minimising competition with food production.

Digital technologies and remote sensing offer significant potential for optimising land use decisions, enabling more precise targeting of interventions to maximise multiple benefits. These technologies can help identify areas where land use change would deliver the greatest carbon sequestration, biodiversity, flood mitigation and water quality benefits while minimising impacts on food production.

4.2 Just Transitions Framework

The concept of a 'just transition' emerged from labour movements concerned with protecting workers as economies shift away from fossil fuels toward sustainable alternatives. In the food system, this concept takes on broader dimensions, encompassing fairness throughout the transformation process for farmers, food workers, consumers and communities, especially in the

¹⁵⁹ British Ecological Society (2025)

¹⁶⁰ Forest Research (2024) *Forestry Statistics and Forestry Facts and Figures 2024* Edinburgh: Forest Research <https://www.forestresearch.gov.uk/tools-and-resources/statistics/publications/forestry-statistics/>

most agriculturally-dependent rural economies. Just transitions in our food system ensure that the necessary shifts toward sustainability do not disproportionately burden vulnerable groups, that those most affected by change have a voice in shaping policies, and that the benefits of transformation are widely shared.

*I hope we can move towards an 'OUR world' understanding, because what happens in Mayfair impacts on what happens in London Road Estate...and it [is of] value to understand that interconnectedness to bring around transformation.*¹⁶¹

Dominic Watters, Food Foundation Ambassador & single parent living on a council estate

The three core transformations — dietary change, resilient food production, and land use transformation — will reshape rural economy and livelihoods, and food access. Without deliberate attention to justice and equity, these changes could exacerbate existing inequalities. Farmers may lose economic viability as production patterns shift. Low-income consumers could face higher food costs, and rural communities might experience rapid demographic and economic changes. A just transitions framework addresses these challenges by providing support mechanisms, inclusive governance processes, and policy tools that ensure no one is left behind in the transition to an agri-food system that better supports people and the planet. There are models for managed adjustment in rural economies facing structural change, such as the rural development schemes in the EU Structural Funds deployed in the 1990s to provide matched investment funding for rural diversification.¹⁶²

4.2.1 Supporting dietary change equitably

Dietary change must proceed with careful attention to food justice and accessibility concerns. The CCC has calculated that diet changes envisaged in CB7 should lead to a small reduction in household food costs overall, but these benefits may not be equally distributed. Currently, healthier and more sustainable foods often cost more and are less accessible in some places.

*Food choices in lower income groups are strongly constrained by structural issues...like affordability, accessibility of food, and this is a major barrier to consuming healthy and sustainable diets and achieving net zero in agri-food.*¹⁶³

Professor Charlotte Hardman, Psychologist of Eating Behaviour, Institute of Population Health, University of Liverpool

¹⁶¹ Watters, D. (2023) The 'undeserving poor': How food system transformation is middle class and why this needs to change, *AFN Network+ Webinar Series*, 13 December, <https://www.agrifood4netzero.net/resources/the-undeserving-poor-how-food-system-transformation-is-middle-class-and-why-this-needs-to-change-2/>

¹⁶² Ward, N. and McNicholas, K. (1998) Objective 5b of the Structural Funds and rural development in Britain, *Regional Studies* 32, 369-74; Ward, N. and McNicholas, K. (1998) Reconfiguring rural development in the UK: Objective 5b and the new rural governance, *Journal of Rural Studies* 14, 27-39

¹⁶³ Hardman, C. (2023) Net zero and dietary shift – how psychology and poverty determine choices, *AFN Network+ Webinar Series*, 12 May, <https://www.agrifood4netzero.net/resources/net-zero-and-dietary-shift-how-psychology-and-poverty-determine-choices/>

A just transition for dietary change requires policy interventions that ensure healthy, sustainable options are affordable and available to all communities. This could include targeted subsidies for nutrient-dense foods, expanded fruit and vegetable voucher programmes through social prescribing, and investments in local food infrastructure in under-served areas. There is a role for the UK Government, the devolved governments and local government in supporting dietary change. Special attention must be paid to preventing nutritional inequality, where higher-income groups benefit from improved diets while lower-income households face barriers to accessing healthier options. Food education initiatives must also be culturally appropriate and accessible to diverse communities rather than imposing uniform dietary guidelines that fail to account for varied food traditions and preferences.

4.2.2 Supporting farming communities through agricultural change

Transforming agricultural production will particularly affect livestock producers, as CB7 suggests reducing ruminant numbers by almost 40 per cent over the next 25 years. This scale of change requires support mechanisms similar to those developed under the EU Structural Funds, which provided investment for economically vulnerable areas experiencing significant transition.

A just agricultural transition requires dedicated programmes to support farmers diversifying away from emission-intensive livestock production. These programmes should be co-designed with the sector and include assistance for transitioning to different production systems, skills development programmes, and new market development for alternative enterprises. The postwar experience of agricultural transformation offers valuable lessons, where close state-farmer cooperation and comprehensive advisory services helped orchestrate sector-wide change. For a just agricultural transition, a new approach to rural and regional development is needed that treats agriculture and land management as vital underpinnings of successful rural economies — focusing not only on conventional food production but on new goods and services land-based businesses can provide — high-value sustainable foods, sustainable tourism, and renewable energy as well as other farm-based economic activities. Such a shift is likely to need a change in emphasis from the direct payments of ELMS scheme to capital grants to support emissions reduction technologies and the development of the new rural economy.

4.2.3 Supporting farming communities through agricultural change

Land use transformation raises profound questions about property rights, access and control over critical natural resources. The recent Rock Review in England found that around a third of agricultural land was rented, and almost half of farm businesses are essentially tenanted farms.¹⁶⁴ As approximately 20 per cent of UK land shifts to different uses — including increased woodland, energy crops and restored peatlands — we must ensure this process does not reinforce existing patterns of inequality in land ownership and access.

A just transitions approach to land use change requires inclusive governance arrangements that engage local communities as well as landowners and managers in decision-making about landscape changes. Regulatory frameworks must balance the need for land use transformation with protections for vulnerable communities. Carbon markets and ecosystem services payments should be designed to benefit diverse landholders, not just large estates with significant capital resources. There are important questions that need resolving around tenant farmers and opportunities to capitalise upon sequestration. In protected areas, planning regulations should safeguard landscape quality and high-value habitats while enabling appropriate diversification

¹⁶⁴ Rock, K. (2022) *Working Together for a Thriving Agricultural Tenanted Sector*. London: Defra.

that supports rural livelihoods. Financial mechanisms should be developed to ensure that the costs and benefits of land use change are fairly distributed, with targeted support for small-scale landholders and tenant farmers who may otherwise lack the resources to participate in transition opportunities.

4.2.4 Integrated just transitions mechanisms

Successfully implementing just transitions across these three dimensions requires coordinated policy tools and governance approaches. These include:

- Meaningful participation mechanisms that engage affected communities in decisions, ensuring that lived experience informs policy design.
- Dedicated financial support structures that help vulnerable groups navigate the transition.
- Regular social impact assessments to monitor how the benefits and burdens of change are distributed.
- Cross-sectoral coordination to address interconnected justice concerns across food, health, environment and economic domains.
- Long-term planning (that considers a twenty-five years time horizon) to provide greater certainty for affected stakeholders to adapt over time.

The implementation pathways outlined in Section 4.3 incorporate these justice considerations through carefully sequenced actions. By embedding justice principles throughout the transformation process, we can achieve a food system that not only reduces emissions but also contributes to a more equitable and resilient society.

4.3 Implementation Pathways

We presented the headline outcomes of our modelling at a meeting of AFN Network+ members in Manchester in March 2025. Almost 200 participants engaged in discussion to produce suggested priorities for action over the short, medium and longer term to 2050 and spanning the realms of diet change, land use change and agricultural production practices. A wide range of responses were analysed and distilled into the Roadmap Pathways.

In the short term (Phase 1, 2025-2030) the priority is **building consensus**. In this initial phase, the argument needs to be settled, consensus built and unity of purpose forged around the way forward. This requires making the case for change, breaking out of conventional thinking, and co-designing strategies and investments. Priorities include creating incentives for low-carbon farming practices and building agricultural resilience, devising land use strategies that reflect the need for significant change, and developing ambitious plans for population-wide diet change. There is a crucial role for government in thinking through how to make the finances underpinning the transformation work sufficiently. Regulation and financial incentives both have a role to play in making new markets work, as has been the case with the energy transition. There are also examples from elsewhere of successful population-scale behaviour change (e.g. school meals in Brazil or reduced consumption of dairy products in Finland¹⁶⁵) but more systematic social research into successful change management is urgently required.

¹⁶⁵ Boklis-Berer, M. *et al.* (2021) The adherence to school meals is associated with a lower occurrence of obesity among Brazilian adolescents. *Preventative Medicine* 150:106709; Prättälä, R. (2003) Dietary changes in Finland—success stories and future challenges, *Appetite* 41, 245-49. See also: Tirion, A. *et al.*

The medium term (Phase 2, 2031-2040) is characterised by **accelerating implementation**. In this decade, change must progress rapidly and purposefully to accelerate dietary change, remove land from agriculture for other uses including sequestration, reduce farm animal numbers, and roll out low-carbon technologies and practices across the farming sector. A crucial target is increasing annual tree-planting from 37,000 ha in 2030 to 60,000 in 2040. This phase requires significant investment, including in building alternative protein supply chains, transforming the R&D and training system and implementing structural adjustment support for farmers transitioning away from livestock.

The following decade (Phase 3, 2041-2050) is about **consolidation and refinement**. Implementation will continue while patterns and priorities are adjusted based on experience. By this point, the benefits of transformation should become increasingly apparent through improving health outcomes, enhanced biodiversity, strengthened resilience to climate impacts, and reduced emissions. This should help strengthen support for the direction of change.

4.3.1 Implementation pathways for dietary change

The dietary change pathway requires coordinated approaches that operate at multiple levels simultaneously. This begins with building broad consensus across political parties, industry and civil society around the scale of change required — emphasising that this is not merely about individual choice, but about restructuring food environments and systems.

Cross-cutting considerations include addressing existing and potential socioeconomic inequalities that could arise during transition. Without careful management, dietary change could disproportionately benefit affluent populations while placing burdens on already disadvantaged groups. Creating inclusive governance mechanisms that incorporate diverse voices, particularly those with lived experience from such communities, will be essential throughout all phases.

The phased approach must also recognise that dietary change does not happen in isolation but is intimately connected with agricultural production patterns. Coordinating demand-side and supply-side policies is critical — encouraging consumption shifts that align with changes in domestic production capacity to prevent simply offshoring emissions.¹⁶⁶ This connection between diet and production requires joined-up institutional arrangements, potentially including cross-departmental coordination bodies with sufficient authority to drive integrated action. There needs to be strong and effective partnership working between the public and private sector.¹⁶⁷

4.3.2 Implementation pathways for agricultural production

Transforming agricultural production requires more than technological changes to existing farming systems — it demands fundamental shifts in how we conceptualise food production and rural economies. Throughout all phases, a cross-cutting need is to develop comprehensive

(2025) Identifying behaviour change techniques for sustainable food consumption: A systematic review using the BCTTv1, *Appetite* 214, 108057.

¹⁶⁶ This issue was the focus of an AFN webinar led by AFN Champion John Ingram in June 2024. See: <https://www.agrifood4netzero.net/resources/using-systems-thinking-to-transform-our-food-beans-as-an-analytical-lens/>

¹⁶⁷ Mazzucato, M. (2021) *Mission Economy: A Moonshot Guide to Changing Capitalism*. London: Allen Lane.

support mechanisms for farmers navigating structural changes, particularly those transitioning away from livestock-intensive systems.

The good news is that we already have different skills that previous generations have not....I think we're much happier to trial new ideas and take a risk in doing something a bit different, and we're probably more open to collaboration. The biggest challenge we face at the moment is not knowing which way to turn. Once we've got a direction, we'll run in it, but we need to know that direction soon, before too many people leave the industry.¹⁶⁸

Luke Cox, Vice Chair, National Federation of Young Farmers' Clubs and agricultural policy advisor

Knowledge infrastructure is another crucial through-line across the implementation periods. The current agricultural knowledge and innovation system is primarily oriented toward incremental improvements in existing production models. Transforming this system to support radical innovation and system redesign will require new relationships between researchers, advisors, farmers and food businesses, with different forms of knowledge valued and exchanged. Further and higher education institutions involved in food, farming and environment will have valuable roles to play, as they did in the last agricultural transformation of the 1940s to 1960s.

Throughout the transition, spatial coordination becomes increasingly important as agricultural land use patterns shift. This requires developing governance mechanisms that can manage change at landscape scales rather than individual farm levels, enabling coordinated approaches to integrating food production with carbon sequestration, biodiversity enhancement, and other ecosystem services.

4.3.3 Implementation pathways for land use change

The land use transformation pathway has several cross-cutting considerations that span all implementation periods. First is the need to develop governance arrangements that can manage complex trade-offs between competing land uses at appropriate spatial scales. This requires new institutional arrangements that bridge traditional divides between agricultural, environmental and planning authorities.

Second is addressing fundamental questions about property rights and land control. Current frameworks of land ownership and occupancy can create significant barriers to transformational change. Progressive evolution of these frameworks will be needed to balance private interests with public goods provision, particularly for carbon sequestration and nature recovery. One question is the role of tenant farmers in carbon sequestration and how this can be adequately incentivised. Another is the balance between regulation to control high emitting practices versus agri-environment payment schemes that actively pay land managers to refrain from emitting.

Third is ensuring that communities dependent on current land use patterns are not left behind. As land shifts from agricultural production to other uses, rural communities need pathways to

¹⁶⁸ Cox, L. (2023) Young farmers and the drive to net zero, *AFN Network+ Webinar Series*, 11 October, <https://www.agrifood4netzero.net/resources/young-farmers-and-the-drive-to-net-zero/>

new economic opportunities, requiring investment in skills development, infrastructure and diversified rural economies throughout all phases of implementation. In some agriculturally-dependent localities, the farming population plays an important role in valued distinctive cultures which makes agricultural change particularly sensitive.

4.3.4 Integrated approaches to implementation

The cross-cutting themes across all three transformations highlight the need for system-level coordination mechanisms that can bridge traditional siloes. Several key enablers stand out as priorities across all phases.

First, significantly strengthened governance arrangements are needed to coordinate across traditionally separate domains and across spatial scales. Food system transformation will require collaboration across health, agriculture, environment and economic departments in Westminster and the devolved governments that typically operate independently. New institutional arrangements could be based on the structures put in place in Whitehall to manage the current UK Government's priority missions, which include cross-departmental Mission Boards to drive change and monitor progress. Currently, transformational change is inhibited by the weak leverage Defra has over other central government departments. Food system transformation will necessitate not only the central involvement of the Department for Energy Security and Net Zero, but also, crucially, the Treasury and Prime Minister's Office.

Second, economic mechanisms need alignment across the system. The approximately £2.5 billion per year currently allocated in the UK to agricultural support represents just one economic lever. This needs coordination with health budgets, environmental financing, and private sector investment to create coherent incentives throughout the food system.

Third, effective transformation requires robust data and feedback mechanisms to track progress, identify emerging issues, and enable adaptive management. Developing integrated monitoring frameworks that capture interconnections between dietary patterns, agricultural production, and land use outcomes will be vital for managing the complexity of these changes.

Finally, building and maintaining public support requires a co-design approach and consistent narrative framings that highlight multiple benefits beyond emissions reduction. Emphasising connections between food security, public health, rural livelihoods and environmental improvements can build broader constituencies for change than climate mitigation alone.

By focusing on these system-level coordination needs rather than specific interventions alone, we can create enabling conditions for the transformations detailed in Chapter 3 to unfold at the necessary pace and scale, while ensuring the changes are just, efficient and durable.

5. Conclusions and Recommendations

Transforming the UK food system requires more than incremental technical change. It demands a fundamental reimagining of what we eat, what we grow, how we farm, and how we use our land. Our scenarios analysis demonstrates that regardless of how social values, geopolitics or economics evolve, three interconnected transformations are essential — in the resilience of agricultural production, land use and diets.

These ‘home truths’ form the backbone of any credible pathway to a net zero UK by 2050. They are mutually reinforcing — changes in diet enable and are enabled by shifts in farming, which facilitate land use change — creating a dynamic cycle of benefits beyond emissions reduction.

The conclusions that follow distill insights from our research, identifying both the scale of change required and strategic implementation priorities. They highlight the once-in-a-century opportunity to simultaneously address climate goals, public health, nature restoration and food security. Our recommendations outline practical steps to accelerate this transformation, focusing on building broader support while implementing policies that deliver results across different future scenarios.

While the challenges are substantial, our analysis shows that coordinated action across government, industry, and civil society can create a food system that is both compatible with net zero objectives, and more productive, healthier, and more resilient than what we have today.

5.1 Three Essential Transformations

The first essential transformation concerns how we produce food. Even if all 33 measures in Defra’s Carbon Budget Delivery Plan were extensively adopted across UK agriculture, our analysis suggests that this would be insufficient to successfully achieve a net zero UK. The adoption of low-carbon techniques and technologies is necessary but not sufficient. A critical review of inputs to food production such as gene edited or genetically modified organisms could help build public confidence in long term safety. Beyond the biological sciences, there are considerable opportunities in the application of AI and robotics to production systems. There will need to be significant change in what UK agriculture produces, with animal production significantly reduced. We will need to radically expand horticultural production, develop new supply chains and markets for beans and pulses, and other alternative healthy crops, and dedicate less arable land to growing animal feed. The scale of reduction in animal numbers suggested in CB7 — a 38 per cent reduction by 2050 — requires a fundamental shift in agricultural practices, not just incremental change.

The second core transformation is land use change. This must proceed in parallel with changes in diets and agricultural practices. The CCC envisages the proportion of UK land under woodland rising from 14 per cent today to around 19 per cent by 2050, requiring tree planting rates to increase from 17,000 hectares annually in 2025 to 37,000 by 2030 and 60,000 per year by 2040. Additionally, significant areas of peatland require restoration and land must be allocated for energy crops. Because it takes time to become established and sequester carbon, there is real urgency to free up land for these purposes. In England alone, approximately 1.6 million hectares of land will need to change use over the next 25 years. Agroforestry and regulations to maximise the use of land closer to urban areas will be crucial to diversifying food produce to meet the population nutritional demand.

The third transformation is dietary change. This requires strong political leadership to acknowledge the crucial role that demand-side management, as well as supply-side management, plays in reorienting the food system, and actively plan for accelerating the trends currently underway in British diets. People need to better appreciate the link between their choice of food and health and environmental outcomes enabling them to opt for sustainable healthy diets. Meat and dairy consumption needs to be reduced by around 20 per cent over the next 10 years and 35 per cent over the next 25 years in line with the CCC's Balanced Pathway. The scenarios we modelled showed that without shifts in consumption patterns, the land required for food production would make it impossible to allocate sufficient area for carbon sequestration.

5.1.2 Benefits beyond net zero

The transformations we describe are not solely about emissions reductions. They represent a profound opportunity to simultaneously address multiple challenges.

Public health improvements: Poor diet is a major driver of ill health in the UK. The dietary shifts needed to address climate change — more fruits and vegetables, fewer ultra-processed products, moderate meat consumption — align directly with public health recommendations and could significantly reduce healthcare costs and improve workforce productivity.

Enhanced food security: Our approach to agriculture and land use change must be guided by the need to strengthen UK food security, treating it on par with energy security. Contrary to some claims, this does not mean encouraging farmers to simply maximise production of what they currently produce. Rather, improved security means producing more of our national demands, while moderating and adjusting to those demands through dietary change. By using UK agricultural land more efficiently to grow food for direct human consumption rather than for animal feed, we can improve self-sufficiency without expanding agricultural land.

Biodiversity and nature recovery: The UK is heavily nature-depleted. Transforming land use and agricultural practices presents an opportunity to halt and reverse biodiversity decline, restore habitats, and improve ecosystem services. These changes can simultaneously address climate, nature and food production goals through multifunctional landscapes.

Economic resilience: Climate change and geopolitical tensions are creating an increasingly unpredictable operating environment for the food system. The transformations we describe would enhance resilience to climate impacts and supply chain disruptions, while creating new economic opportunities in growing sectors like horticulture, agroforestry and land management.

Water quality and resources: Reducing livestock numbers would contribute to improved water quality through reduced pollution risks, especially in heavily stocked catchments. Changes in land management could also enhance water retention, particularly important as climate change increases pressure on water resources.

5.1.3 Implementation pathways: the three phases

In our networking, we have been struck by the argument that is increasingly made that the broad shape of the food transition is now clear. Multiple robust independent analyses have converged on the same pattern of proposed change suggesting we now need to move from the **'what'** to the **'how'**. Yet the reality is more complex. Large parts of the population are not yet persuaded by the **'what'**. There remains significant work in convincing interest groups and the wider public of the case for transformational change in the direction we set out. Some key facts are not sufficiently widely accepted, and need to be for progress to be made:

- Net zero does not mean eradicating all emissions from agricultural production.
- Climate-friendly farming does not mean producing the same crops and animals but with cleverer technologies.
- Improving food security does not mean simply removing obstacles to farmers producing more of what they already produce.

Moving from ‘why’ to ‘what’ to ‘how’ requires a coordinated approach across our three implementation phases. Phase 1 (2025-2030) involves consensus-building and jointly designing strategies and investments. In Phase 2 (2031-2040), implementation accelerates for diet change, freeing land from agriculture for other purposes including sequestration, and rolling out low-carbon technologies and practices across the farming sector. Phase 3 (2041-2050) is a period of consolidation and refinement to adjust patterns and priorities based on experience.

5.1.4 The challenge: beyond technical solutions

The main challenges we face are not primarily technical or scientific. There has been a relatively strong and stable consensus in the scientific community for some years about the broad shape and direction of the transformation required for the food system to bring emissions within acceptable limits, both in the UK and internationally. The key difficulty is that politicians all too often consider it too politically risky to drive the scale of change needed. They reflect a concern that not enough of the public would support such change, despite evidence that UK citizens want government intervention to create a fairer food system.¹⁶⁹

What we found is a lot of concern, and levels of anger about the state of things at the moment, concern about finding and affording the healthy, nourishing food that's around them. Concern about big food businesses ... concern about farmers ... and how they're coping, as well as concerns around the environment and so much more ... Really, it's not what that dominant narrative has said for years. I think just getting voices out there has really opened up a bit of a political opportunity.¹⁷⁰

Mhairi Brown, Head of Food Futures, Food, Farming and Countryside Commission

‘Net zero’ is generally poorly understood, and misunderstandings about its scope and purpose lead to polarising debate. In theory, we could reach net zero by simply off-shoring all our food production. Net zero therefore must be considered alongside other concerns, including food security, public health, economic resilience and nature recovery. The coming period of transformational change represents a chance to address this bundle of problems together.

A market-only approach is insufficient — we cannot simply ‘leave it to the market’ and expect the necessary transformations spontaneously to occur. Changes are required to the types of agricultural commodities produced. It is no use just to say farmers ‘respond to the market’. What, after all, is a market? It is a set of producers and consumers, sellers and buyers, operating within a system of rules. Active government leadership, co-ordinated policy frameworks and strategic investments are essential.

¹⁶⁹ FFCC (2025) *A Citizen Mandate for Change*. <https://ffcc.co.uk/publications/a-citizen-mandate-for-change>

¹⁷⁰ Brown, M. (2025) Power in the food system – how to shift it for citizens, farmers, & nature, *AFN Network+ Webinar Series*, 20 March, <https://www.agrifood4netzero.net/resources/power-in-the-food-system-how-to-shift-it-for-citizens-farmers-nature/>

Profound change and uncertainty are likely to be key features of the years ahead. Strengthening resilience and adaptability need to be a key guiding principle in managing progress towards 2050. This means resilience in the face of climate change impacts on the operation of our food systems and also in the face of geopolitical instabilities and trade disruptions.

By embracing these three core transformations and implementing them in a coordinated, strategic manner, the UK can create a food system that is not only compatible with net zero objectives, but also healthier, more productive and more resilient than what we have today.

5.2 Implementation Recommendations: De-risking Transformation

Our recommendations centre on **de-risking food system transformation** at three levels: **in practice** with respect to how markets work, incentives are structured and supply chains operate; **in policy-making** with respect to how policies can be designed and implemented to avoid unintended consequences and build consensus and support over time, and **in research and innovation** with respect to developing knowledge and tools that support transformation.

Transforming agricultural production requires not just technical improvements but a fundamental shift in what UK agriculture produces, with changes to the balance between animal husbandry and cropping. De-risking strategies in this domain include:

- In practice: analysts and policy-makers should learn from historical precedents in agricultural transformation, particularly the 1940s/50s approaches that combined financial incentives with direction and supervision; ensure farmers have longer-term security (10-15 years minimum) to plan transitions.
- In policy-making: the UK and Devolved Governments should develop comprehensive transition plans that include support for farm businesses adapting to changed market conditions, with respected local leaders championing change.
- In research and innovation: agricultural research should be recognised as an interdisciplinary domain, with the research power of UKRI unleashed to strengthen knowledge exchange networks between researchers and farmers not only to support the adoption of new lower-emission technologies, but also to reconfigure what is produced and consumed¹⁷¹.

Land use change must proceed hand-in-hand with dietary and agricultural transformation, with more active management than has been seen over the past four decades. De-risking land use change involves:

- In practice: balance financial incentives with regulatory frameworks and market mechanisms; develop carbon markets to provide new income streams for landowners.
- In policy-making: address fundamental questions about land ownership, property rights, and national priorities; ensure rural communities benefit from transition through diversified economic opportunities.
- In research and innovation: develop better tools for measuring and monitoring land use change impacts; improve modelling of multiple benefits from different land use options.

¹⁷¹ A summary of our headline research priorities can be found at Appendix C.

Dietary change is an urgent priority and requires strong political leadership to acknowledge the crucial role that demand-side management plays in reorienting the food system. De-risking strategies include:

- In practice: engage major food retailers and manufacturers in creating transition plans that align commercial strategies with public health and climate goals; develop collaborative supply chain initiatives to make healthier options more affordable.
- In policy-making: use deliberative processes to understand and address public concerns; ensure policies address equity issues to avoid disproportionate impacts on lower-income households and use regulation to create a level playing field for innovation.
- In research and innovation: increase funding for behaviour change research; develop better methodologies for measuring and monitoring dietary impacts; support development of appealing, affordable plant-based alternatives.

Some recommendations address multiple transformation areas simultaneously and are critical to enabling system-wide change.

Governance and coordination:

- The UK Government should establish a National Agri-food for Net Zero Advisory Committee reporting jointly to the Cabinet Office, Defra and Devolved Administrations to consider the food system holistically.
- The UK Government should create cross-departmental co-ordination, akin to Mission Boards, to drive change and monitor progress, ensuring coordination across traditionally siloed policy areas.
- The UK and Devolved Governments should each develop an integrated Food and Land Strategy that ties together emissions reduction, biodiversity, health, and food security.
- Use deliberative democracy techniques, including Citizens' Assemblies to inform policy development and build public support.

Financial mechanisms:

- The UK and Devolved Governments should over the next Spending Review period work to repurpose the approximately £2.5 billion currently allocated to agricultural support to leverage transformational change. This may involve some shift from revenue to capital expenditure.
- The UK Government should work with the commercial sector to develop robust carbon pricing and markets to incentivise land use change while ensuring benefits flow to land managers.
- The UK and Devolved Governments should review rural development support to create structural adjustment funds for sectors and communities most affected.
- The UK Government should reform the tax system to better reflect environmental and social costs of food production and consumption.

Knowledge and research:

- Working with UKRI, devolved partners and stakeholders, the Department for Science, Innovation and Technology should strengthen cross-Council prioritisation arrangements within UKRI to address research questions that span the remits of multiple Research Councils.

- Working with UKRI, devolved partners and stakeholders, the Department for Science, Innovation and Technology should increase funding for interdisciplinary research that addresses the social and political dimensions of transformation.
- Defra and its devolved partners should together develop an open-source approach to food data and modelling to improve transparency and collaborative problem-solving.
- Defra and its devolved partners should together build a new suite of official statistics to monitor uptake of low-carbon agricultural practices and trends in sustainable diets.
- Defra, its devolved partners and commercial and other stakeholders should together develop a single authoritative system for calculating emissions and sequestration at the farm level to replace the multitude of competing calculators currently used.

International dimensions:

- The UK Government should develop a clear UK trade position on food standards that supports domestic transformation while avoiding offshoring emissions.
- The Department for Energy Security and Net Zero should develop and publish consumption-based emissions accounting alongside production-based reporting to monitor potential leakage from offshoring.
- Defra, its devolved partners and commercial and other stakeholders should work to build resilience in international food supply chains while strengthening domestic production capacity.
- Defra, its devolved partners and commercial and other stakeholders should develop a detailed national contingency plan for rapidly improving food self-sufficiency in response to global disruptions.
- The UK Government should include food and agricultural products under the new carbon border adjustment mechanism as soon as possible after January 2027.

By implementing these recommendations in a coordinated, phased approach, the UK can create the conditions for successful transformation of the food system. This will require sustained commitment from government, industry, and civil society, but offers the opportunity to simultaneously address climate goals, public health challenges, nature recovery, and food security in a way that strengthens economic resilience and social equity.

Appendices

- A. Scenario Development Process
- B. Future Food Calculator / Modeling Approach
- C. Research Priorities
- D. Author Contribution Statement

Appendices

B. Future Food Calculator / Modeling Approach

The Future Food Calculator is an online tool to visualise the potential effects of systemic interventions to the food system on a selected set of environmental and food security metrics. Interventions include consumer demand shifts, changes to land use and the implementation of new technologies and techniques to improve food production and reduce emissions.

This model has been developed using Python, a general-purpose programming language, and is available on GitHub,¹⁷² an online version control and code management platform. Both are industry standards that allow for readable, transparent, and efficient code development. The online app that serves as an interface with the model has been built using Streamlit¹⁷³, a Python package designed for quick user interface development, and cloud service for app hosting. The model operates by using user-defined parameter values, set via interaction with sliders, to dictate the behavior of multiple modeling functions that simulate specific food system interventions. These functions are executed as part of a pipeline, ensuring that every update dynamically reflects the effects of interventions (See Figure B.1). The model uses a persistent data structure to store and update the state of the system at each execution step.

Unlike financial models that constrain interventions based on economic feasibility, this model focuses on physical resource constraints. This approach enables an unrestricted exploration of the true potential benefits and trade-offs of different systemic transformations.

The model differs from other UK agri-food system models in three fundamental ways:

1. **Open-Source Design:** Code is open access and available on a public repository. All modeling choices are transparent and customizable, enabling users to scrutinize and adjust underlying assumptions and parameters.
2. **Modular Structure:** The model is designed for extendability, allowing the incorporation of additional complexity and datasets as needed.
3. **Physical Resource Orientation:** It focuses on land, production, and environmental constraints rather than economic cost-based feasibility.

The model relies on four key datasets to characterize the interactions between resources and their environmental and food security implications:

- **UKCEH Land Cover Map:** A 1 km resolution grid of the UK, detailing land utilization by category, including arable, pasture, woodland, and other land types.
- **UN Population Prospects:** Time-series data providing past and projected population figures for the UK under different fertility, mortality, and migration scenarios.
- **FAOSTAT Food Balance Sheets:** Annual data on food supplies, broken down by commodity, covering production, imports, exports, and domestic use categories.
- **UK National Inventory Report (NIR):** A breakdown of emissions per industry sector, including emissions from agriculture. These data are used alongside FAOSTAT production figures to derive per-commodity emission factors.

¹⁷² https://github.com/FixOurFood/agrifood_consultation_calculator

¹⁷³ <https://streamlit.io/>

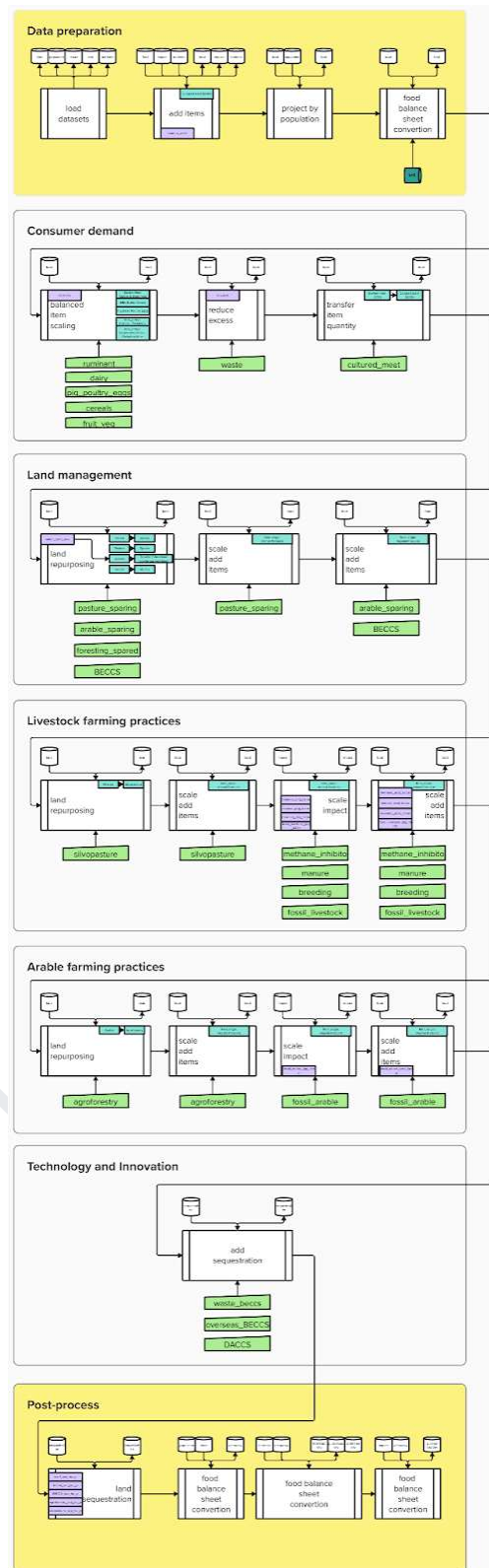


Figure B.1: Structure of the Agrifood Calculator modelling pipeline. (For an interactive version of this figure visit [this link](#).)

Features and modelling

The model adheres to three key resource-balancing principles:

- **Food Supply Quantities are always balanced:** The total domestic use plus exports must equal the sum of production and imports at all times. Domestic use is the sum of all commodity sinks, including animal and human consumption, and processing uses. Each of these elements change as a function of changes on diets and/or total production.
- **Everyone is fed:** The model ensures a minimum caloric intake per person is met by adjusting trade balances as necessary. Cereals are used to balance changes in diets. The model incorporates four projections from the UN's Population Prospects models, each based on different assumptions about fertility, mortality, and migration. These projections are used to estimate future food demand and its implications on production and land use.
- **Domestic production and land use are linked:** Unless explicitly modified by interventions (e.g. through changes in agricultural productivity), alterations in total production lead to proportional shifts in agricultural land use. If additional land is needed, forested areas serve as the trade-off land.

Agricultural emissions are estimated by attributing total reported emissions from the National Inventory to present-day food production, generating emission factors (g CO₂e/g food). These factors account for CO₂, CH₄, and N₂O emissions, using IPCC-recommended global warming potential factors. To contextualize agricultural emissions, the model also includes projections for other sectors based on the Balanced Pathway scenario from the Seventh Carbon Budget for 2050. Modifications in domestic food use impact food supply dynamics, leading to shifts in production levels needed to maintain balance. Land use changes proportionally with production shifts — arable land scales with plant-based production, while pasture land adjusts with livestock product demands.

The model assumes that food supply remains balanced at all times, meaning that production and imports must always match exports, stock changes, and domestic use. Changes in domestic use affect both production and imports, with their relative contributions controlled by an elasticity parameter (ϵ). A value of $\epsilon=0$ means all changes originate from domestic production, whereas $\epsilon=1$ implies that only imports adjust, fully decoupling consumption from production.

The AFN+ scenarios

We quantified slider positions for the AFN+ 2050 scenarios. This required some exercise of judgement and some adjustment so the narratives of each scenario retain their relative strength. For example, all scenarios mention the need to reduce animal origin product consumption, but no specific values were originally provided. We assigned values of reduction according to the relative narratives for each scenario, resulting in Scenario D having the highest reduction, while Scenario A had only a modest change. The assumptions underpinning the slider positions for the scenarios are detailed below

- Scenario A (Build back fast again),
 - Large fraction of land converted to BECCS crops (20%, highest of all scenarios) which impacts SSR but greatly reduces total emissions.
 - Small changes in diets, with pulses being the highest contributor (50% increase) and fruits and vegetables actually decreasing by 20%.

- Moderate introduction of vertical farming (additional 40% of horticulture production from vertical farms), but a 20% decrease in horticulture crops.
- Small change in production methods. No adoption of agroforestry and silvopasture, and only 5% of arable crops transition to a mixed system. Forest land percentage has a small 5% increase over today's value.
- Intensification reflects on a moderate increase of 15% in stocking density, in line with yield increases across all agricultural production.
- Lowland and highland peaty soils have significant restoration rates (25% and 60%, respectively) which significantly lowers emissions from soils.
- Scenario B (circular worlds),
 - There is a significant (50-60%) reduction in consumption of animal products.
 - Of the remaining meat and dairy, half are replaced by meat and dairy alternatives.
 - Significant reduction in food waste (50% of calories over recommended daily intake).
 - 15-20% shift of arable to mixed farming which helps with SSR but also slightly increases emissions. Agroforestry and silvopasture have an adoption rate of 15% each, which lowers emissions, and SSR.
 - Part of the reduction in meat consumption is absorbed by a reduction in stock density (-20%)
 - Moderate adoption of low emissions practices in meat production and crops.
 - Similar but higher peatland restoration percentages to scenario B.
- In Scenario C (self-sufficiency),
 - Smaller changes in diets with a moderate shift towards poultry and pigmeat (+15%), and in some cases alternative protein products (+15%). Still, bovine meat consumption decreases by 60%, offset by pulses and fruits/vegetables, which have significant increases in consumption (200% and 50%, respectively)
 - Significant reduction of food waste (80%)
 - Significant changes in the productive landscape, with a shift towards horticulture and pulses which double relative to other crops. This significantly contributes to a higher self-sufficiency rate. Agroforestry and silvopasture also has relatively high adoption rates of 10%.
 - Significant reduction in stocking density (-30%); high uptake of low carbon farming, nitrogen efficiency practices.
- In Scenario D (right to food),
 - Big increase in fruit/veg consumption and production - including through urban/CEA (additional 60% of current production) and UK horticulture (+50%).
 - Significant (80%) uptake of alt meat + dairy
 - Small changes to alternative agricultural land utilisation (silvopasture, agroforestry, mixed farming)
 - Very high forestation with an additional 20% of total UK land now covered in forests (33% total)
 - Very high uptake of low carbon farming practices

All AFN Scenarios reach net zero with Scenario A reducing the self-sufficiency ratio (SSR) and Scenario C reaching an SSR above 80%. The key features of the scenarios are set out in Table 1 in Section 2.4. In order to identify the main factors in the emission reductions and changes to self-sufficiency in each scenario, we did a sensitivity analysis to estimate the relative change in emissions rate (Mt CO₂e / year) and self-sufficiency ratio. From the configurations selected for each scenario, we perturbed each intervention by a set value ($\Delta I = 10\%$) and registered the changes in the above metrics, relative to a fixed fiducial value used across all scenarios.

Dividing by the perturbation value, we obtain a percentage change relative to the fiducial value which we can use to compare the intensity of change for all interventions. Figures B.2 and B.3 show the results from perturbing each intervention around all 4 AFN+ scenarios.

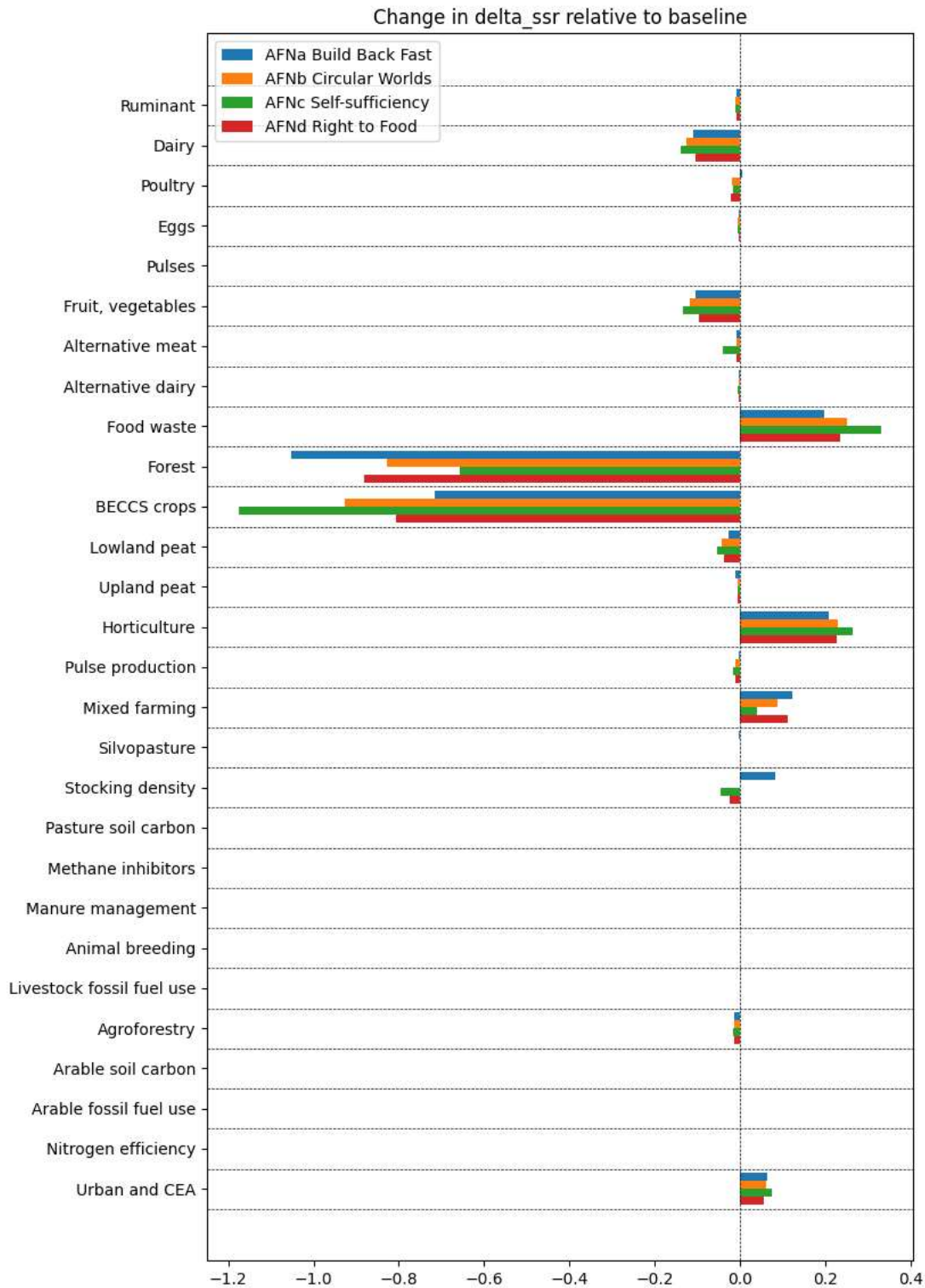


Figure B.2 Sensitivity of SSR to moving the sliders relative to each Scenario.

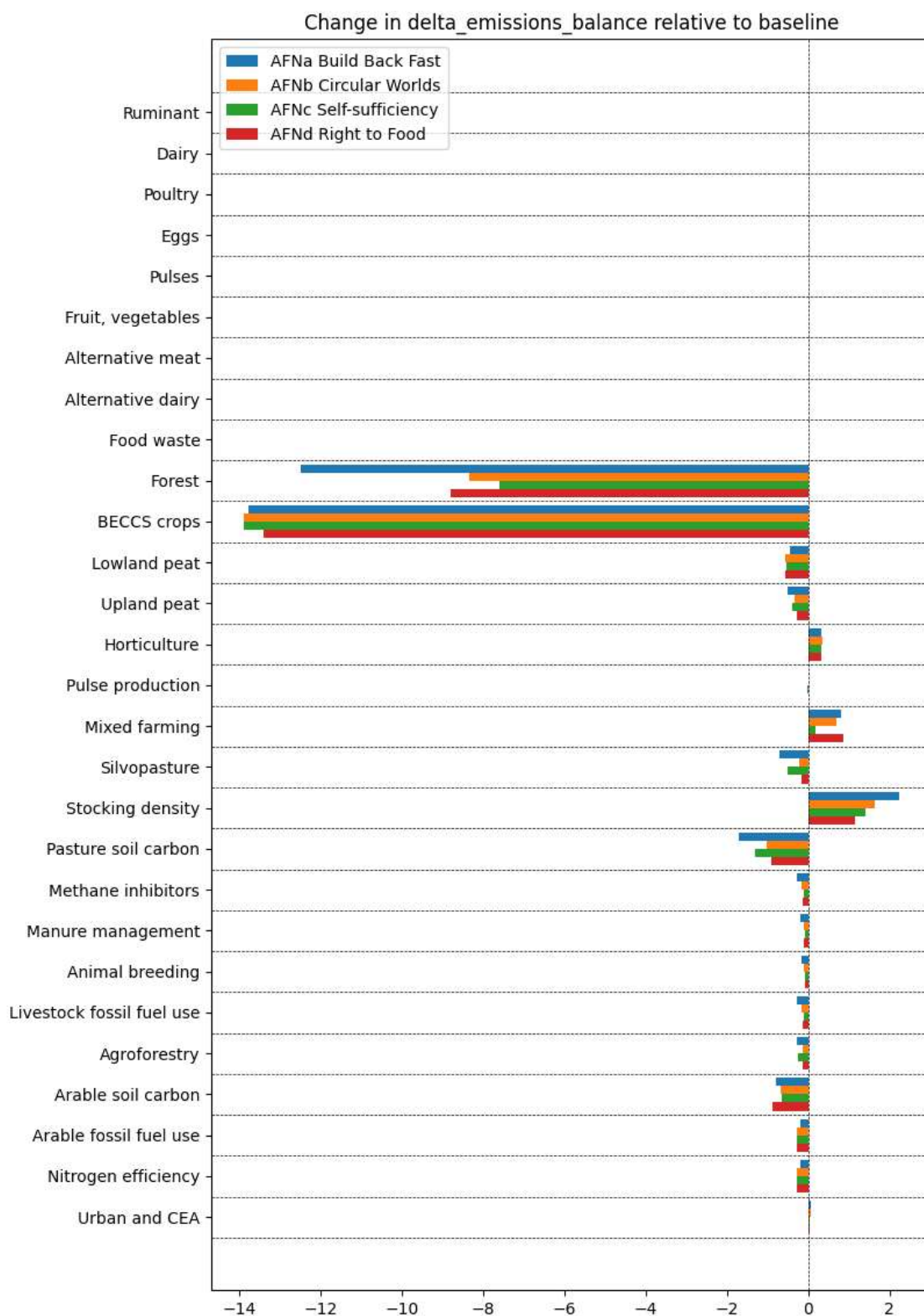


Figure B.3 Sensitivity of SSR to moving the sliders relative to each Scenario.

- The 'Consumption' changes (top section of sliders) do not affect net zero because we are changing trade (balance between imports and exports) and not UK production - so we can control UK production more carefully).
- Changes in consumption do have small effects on self-sufficiency
 - e.g. if dairy consumption is reduced then the kcal lost from diets is replaced by increasing cereal consumption. SSR is defined in terms of weight (not kcal) and since dairy has fewer kcal per gram than cereals, then less weight of food is needed if we shift away from dairy (to cereals) so SSR is increased. Because decreasing dairy increases SSR then the SSR sensitivity for dairy is negative.
 - Food waste reduction increases self-sufficiency because less food is used domestically (and production is unchanged). Because increasing food waste reduction increases SSR then the SSR sensitivity for food waste (reduction) is positive
- Increasing UK forest area is one of the top two most impactful levers
 - Increasing UK forest area decreases self-sufficiency, if no other sliders are moved simultaneously to compensate.
 - Increasing UK forest area reduces emissions due to the increased carbon storage in forests. In addition, since forest is taken from pasture, and the amount of pasture scales the animal production of grazing animal production, then there is less emissions from the animal production (and increased offshoring of emissions due to the lack of corresponding change in consumption).
- Increasing the area used for BECCS crops is the other of the two most impactful levers
 - Increasing land area used for BECCS crops decreases self-sufficiency because arable land is converted to BECCS crop production in the model.
 - The balance of emissions becomes more negative (net negative) because of the additional carbon storage.
- Unsurprisingly, peatland restoration decreases self-sufficiency but improves the emissions balance (more negative). The size of the effect is small relative to Afforestation and BECCS because the slider is the percentage of peatland, and the total amount of peatland in agricultural land is relatively small compared to all agricultural land.
 - NB we do not have different yields in the model for peatland production of non-peatland production. This means the lowland peat SSR sensitivity is too small.
 - The change in emissions balance is similar for upland and lowland peat because we are using the same factor for peatland sequestration, and the total areas of lowland and upland peatland available to be converted in the model are similar.
 - The change in SSR is higher for lowland peat than upland peat because the kcal per hectare is higher for arable (which we are assuming is the use of all lowland peat) than for pasture (which we are assuming is the use of upland peat).
- Increasing UK horticulture production is one of the best changes for SSR, because the yield per hectare is higher for horticulture than the other arable production it replaces.
 - It has a small impact on the emissions balance, making it slightly worse because the gCO₂e per gram of food is slightly higher for UK fruit and veg than for the other arable crops it replaces.

An open source approach

Open source software provides several advantages over traditional closed source code development:

- **Transparency:** As modeling choices are easily visible, the model can be both scrutinized and used to scrutinize other modeling efforts. We view this as a fundamental and necessary aspect of evidence based public policy.
- **Accessibility:** Open access tools like the Agrifood Calculator provide an opportunity for a wider audience to access collective knowledge and technical resources, which in some cases would be prohibitively expensive and time consuming due to closed sources alternative costs and setup processes.
- **Community development:** An open code base provides opportunities both for external developers and us to achieve the goal of mature, reliable and efficient code. This is achieved by means of a collaborative identification of issues and proposal of solutions. It also allows for a more coordinated collective development where resources are allocated more efficiently, instead of repeating work on already existing solutions to common problems.

Appendix C - Research Priorities

- 1 How could the economic framework governing UK food production better incentivise domestic production of healthy foods and address the market failures that are inhibiting growth and investment in these crop categories? What are the retailing and supply chain management systems that shape sustainable and unsustainable production practices?
- 2 What social and demographic trends influence dietary choices? How might social trends be actively influenced to promote healthier and more sustainable behaviour? How can more people be more broadly engaged in changing food systems?
- 3 What machinery of government changes may help ensure stronger promotion and co-ordination on healthy and sustainable food across Government Departments? What steps can be taken to avoid the risk of party politicisation of food reforms so avoid 'culture wars' and social division around this important set of issues?
- 4 How can we best improve yields and productivity in a sustainable way? How can the competition for land between food and animal feed be managed for optimum public benefit? How can technological advances in animal breeding and data science be harnessed to improve productivity and reduce emissions, including using individual animal data?
- 5 What are the best strategies for mixing trees, biomass crops and food production on farmland (in terms of food production and sequestration)? How can market failures be corrected through tax, subsidy and regulation? How can tree-planting and other above-ground sequestration measures be most effectively guided to ensure optimum co-benefits (sequestration, flood risk, biodiversity, recreation) and to manage the risk of future forest fires? How can the restoration of peatland for emission-reduction purposes be most effectively balanced with food production priorities?
- 6 What lessons can be drawn about the efficacy of the research, innovation and knowledge exchange system for British agriculture including through learning from other countries' experience?
- 7 What would be the impacts on UK production and exports from large-scale dietary shift in UK consumption (e.g. away from meat and dairy)? Would changed UK consumption patterns prompt changes in land use, or simply increase food exports? Is UK-produced meat competitive enough to be exported if domestic consumption fell dramatically? How elastic are the relationships between changes in yields, land use, diets, and exports? How distinctive are recent patterns of UK dietary change compared to other European countries?
- 8 How can carbon pricing and carbon markets be most effectively developed to support the net zero transition and provide economic incentives for desirable land use and land management practices? How can GHG emissions reduction be handled alongside improving biodiversity, water resource management and water pollution risks? How might the tax system be developed to support net zero objectives around land use and land management?
- 9 How can the true cost of food be included in the financial operation of the agri-food system, so that environmental and public health externalities are properly incorporated? How do food waste cycles operate and how can their environmental efficiency be improved?
- 10 For companies who do not currently have science-based environmental, social and governance reporting, how can they be supported to shift focus from Scope 1 to Scope 3 GHG emissions?

Appendix D - Author contributions statement

[This is based on the CRediT Contributions approach - <https://credit.niso.org/>
This is a first draft pending discussion, iteration and further additions. Being listed as participating in a workshop here does not imply responsibility or support for all the analysis and recommendations in this draft report].

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— potential contributors to be acknowledged if they don't become authors - TBC

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Network+ are: Dimitris Charalampopoulos (University of Reading), Lynn Frewer (Newcastle University), Tom Macmillan (Royal Agricultural University), Simon Pearson (University of Lincoln), Nigel Scollan (Queen's University Belfast), Pete Smith (University of Aberdeen), and Christine Watson (Scottish Rural College).

AFN Network Champions contributing to the work were: in Year 1, India Langley (Climate Bonds Initiative), Richard Pywell (Centre for Ecology and Hydrology), Parag Acharya (University of Greenwich), Robert Costanza (University College London), Heiko Balzter (University of Leicester), John Ingram (University of Oxford), Simon Willcock (Rothamsted Research), Jacquie McGlade (University College London), Anna Macready (University of Reading); in Year 2, Saher Hasnain (University of Oxford), Caeli Richardson (AbacusBio International Ltd), Jude Irons (Tectonic Consulting), Georgie Barber (Food, Farming & Countryside Commission), Charlotte Wheeler (Pasture for Life), Amy Jackson (Oxtale Ltd); and in Year 3, Elta Smith (Elta Smith Ltd), Emily Norton (Farm Foresight Ltd), Rounaq Nayak (University of West of England), Zainab Oyetunde-Usman (Rothamsted Research), Ali Morpeth (Planetary Alliance), Ifeyinwa Kanu (Intellidigest Ltd).

Consultation meetings to inform the development of the Future Food Calculator were conducted with: Chatham House; Defra (various teams); Eunomia; Green Alliance; Joint Nature Conservation Committee; National Trust;

AI use statement

The full report was written by a writing team led by Neil Ward and Elta Smith. An initial round of internal review and feedback took place among the AFN team (around 40 people) in May/June. A full consultation open to the whole membership of the Network (3,000 members) took place in June/July. The writing team wrote an initial Executive Summary for the report. Chat GPT was used to suggest refinements to improve the clarity and 'dejargonise' the Executive Summary, which was then further edited by the writing team.