Roadmap for Resilience:
A UK Food Plan for 2050

Stronger, more resilient farming

Smarter, more integrated land use

Healthier diets made easier

UK Research and Innovation

AFN Network+

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The Agri-Food for Net Zero Network+

UK Research and Innovation

October 2025

Preface

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. Since then, we've built a community of over 3,000 researchers, practitioners and policymakers from across the UK dedicated to finding pathways to a more sustainable future.

Over recent years, the food system's vulnerability to sudden shocks has become starkly apparent – from pandemic upheavals to conflict-driven price spikes and extreme weather events. These disruptions underscore why transformation cannot wait. We publish this Roadmap at a pivotal moment: the UK government in July 2025 launched a new food strategy process and set out an aspirational vision for change. The question now is how to turn vision into reality.

Our approach to producing this Roadmap 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, economic trends and evolving social values might reshape our food system in the decades ahead. Third, we've employed an inclusive methodology that engages diverse people and interests to develop a more nuanced understanding of practical challenges.

Through commissioning research projects, hosting expert webinars, convening workshops and developing scenario-modelling tools, we have brought together expertise and evidence from across disciplines and sectors. By synthesising these diverse insights, we have developed a Roadmap for transformational change – recognising that the climate 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 issues – maintaining food security, improving public health, enhancing biodiversity, reducing inequality and supporting livelihoods – as well as helping the food system play its part in achieving the UK's net zero objectives. This report represents the culmination of this collective effort, exploring plausible pathways for transformational change and identifying robust interventions that work across different future scenarios.

The goal of our Network has been 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 inspire thought and inform 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 Network+ Team

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Executive Summary

OUR FIVE KEY MESSAGES

1. Change is coming – let's shape it, not be shaped by it

The way we produce and consume food in the UK is under mounting pressure – from climate change, global instability and health problems. But with these threats comes a pivotal opportunity: if we act now to shape the future, we can build a fairer, healthier, more secure food system that works better for everyone.

2. We need stronger, more resilient farming and food production

Farmers are on the front line of climate change and economic shocks. We must back them with a clear plan, with long-term financial confidence, transition support and skills development, that enables their businesses to flourish as diets shift – so we can grow more fruit, vegetables and pulses, reduce business over-reliance on livestock, and develop mixed farming systems that bring animals and cropping together. We must help farmers boost productivity and resilience so they are better able to feed us in difficult times, because food security is national security.

3. Smarter land use will benefit the nation

Land is a limited resource, and those who manage it are in a unique position of responsibility to meet the national interests of food production, habitat management, climate change mitigation and producing multiple other public goods. Working with farmers and land managers to collectively plan land use creates a major opportunity to better meet these needs for the nation, while giving farmers the clarity they need for their businesses. This requires government leadership, balancing trade-offs, and fair incentives for farmers and communities.

4. Healthier diets must become the easier option

Eating well shouldn't be a struggle. We need to make healthy food the easiest option for people. That means changing how food is marketed, sold and priced. As we eat differently, new opportunities will arise for UK farming to grow more of what we need for better health. Healthier diets will also reduce our dependence on imported animal products. A healthier population will mean a less burdened health system, a stronger economy and a fairer society.

5. A better future will take joined-up action

These transformations connect emissions, nature, health and the economy. The changes we propose can bring real everyday benefits: healthier families, resilient farms, secure food supplies and a vibrant countryside. But we need to plan ahead – not muddle through from crisis to crisis. With effective leadership, we can build a food system that's fairer, fitter and future-ready.

A FOOD SYSTEM UNDER PRESSURE

The UK food system faces pressures that make transformation inevitable. The food system accounts for 38% of UK emissions, when imports are included, and will become our biggest source by the 2040s.[1] Climate impacts are estimated to have added 1% annually to food price inflation in European countries.[2] Poor diet costs the UK £268 billion annually in health impacts and lost productivity.[3] Two-thirds of adults live with overweight or obesity, yet under 1% fully meet dietary guidelines.[4] We import 50% of vegetables and 85% of fruit, while much of our cereals harvest goes to feed animals rather than people.[5] More than 7.2 million people live in food-insecure households – an 80% increase in just three years.[6] Things needn't be this way. UK agriculture and land use have a key role to play in building a much better food system that works for everyone.

Our food, farming and landscapes will change radically over the next half century, whether we like it or not. The question is whether we actively manage change for the public good, or respond haphazardly as changes are forced on us. We only have a brief window but if we grasp the opportunity, we can ensure everyone has access to healthy and sustainable food, nature flourishes, our emissions fall and our food system is fair and secure for future generations of farmers and citizens.

This Roadmap, developed with input from over 150 experts through the AFN Network+ (UK Agri-Food for Net Zero Network+), offers practical pathways to transform our food system by 2050. National net zero commitments and material pressures mean changes within the broader food system are required, but the goal isn't just to meet climate targets – it's to future-proof the UK's food system while boosting public health, protecting the environment, and strengthening our economy and national security.

Our approach addresses what we grow, how we use land and what we eat – and will bring benefits for health, resilience and sustainability.

THE CASE FOR TRANSFORMATION

We used a whole-systems approach to understand the pressures and trade-offs in the UK food system. Using the 'Future Food Calculator' modelling tool, we explored how different choices would affect emissions, land use and food security under different scenarios. We found that across all scenarios key issues cannot be avoided:

- We can't hit net zero across the UK economy without reducing food system emissions and increasing carbon capture through sequestration.
- Land use must change significantly to support climate, food and nature goals.
- Shifting diets and allowing livestock numbers to continue to decline would unlock extensive benefits – from public health to farming resilience.
- More strategic planning is essential to reduce our vulnerability to global shocks.

Because other sectors are reducing emissions, the food system will soon be the UK's largest source of greenhouse gas emissions. Our analysis shows that even with technological advances, the UK cannot meet net zero targets without three linked transformations.

Our three transformations can unlock remarkable opportunities. By 2050 they could deliver many co-benefits: a UK where thriving farms produce the healthy foods we need while operating within carbon budgets. Animal numbers will continue to decline, and new opportunities will emerge, but livestock farming will remain a valued and valuable part of UK agriculture. Domestic horticulture will expand significantly, with increased production of fruits, vegetables and

salad crops suited to the UK's changing climate. Forest cover will expand to 20% and more, while restored peatlands lock in more carbon.

Multifunctional landscapes will deliver food security alongside flood protection and nature recovery, and build resilience to the effects of climate change. Healthy food becomes the affordable option by default, with flourishing UK horticulture creating rural jobs and reducing import dependence. Farmers earn fair returns as valued stewards, while communities help shape how land is used. Our modelling confirms these kinds of changes are achievable and would strengthen national resilience. But we must act now to build a food system that works for everyone.

ONE FUTURE: THREE CORE TRANSFORMATIONS

The three core transformations involve **resilient agricultural production**, **smarter land use** and **healthier diets**. Taken together, they create a virtuous cycle that can meet climate goals, health imperatives and nature recovery needs, underpinned by strengthened food security and economic resilience.

Stronger, more resilient farming

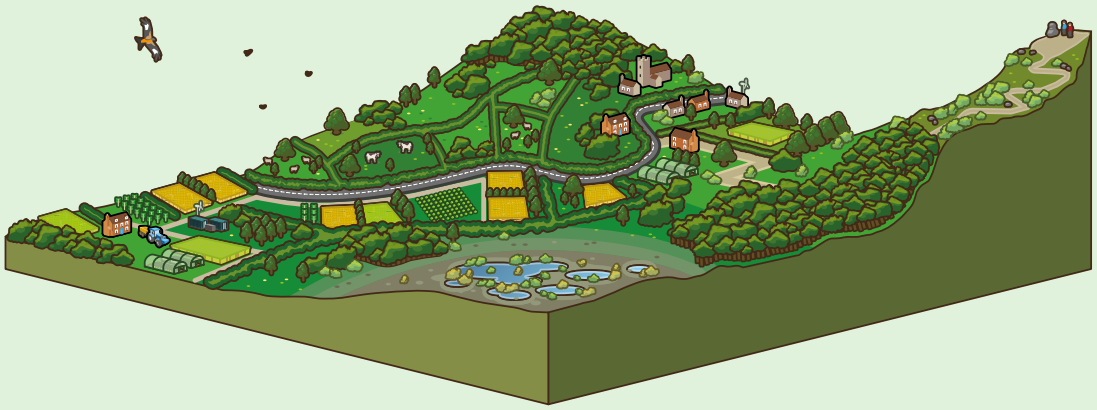
Climate pressures, global instability and dietary shifts mean farming will inevitably need to change. But if we act now, we can adapt in a way that supports farmers and rural economies, and builds national resilience. We need to:

- Grow more of the foods we need most – especially fruits, vegetables and wholegrains.
- Support the evolution of animal farming towards more sustainable systems, reintegrating animals into arable systems to make better use of land and nutrients. Overall animal numbers will need to continue to decrease, by at least a third from current levels to free up land for other uses including carbon sequestration as well as direct emissions reduction.
- Farm business development and diversification will need to be supported, to reduce reliance on livestock farming while increasing overall business profitability and resilience.

- New supply chains – including processing and distribution – will need to be supported, along with skills development, to match new production patterns and reduce our vulnerability to import disruption and food price inflation.

This is about making farming more secure and sustainable. Livestock will remain a valued part of UK agriculture, becoming better integrated across landscapes and farming systems.

Smarter, more integrated land use



A net zero UK will be achieved through a pace of land use change not seen since the Second World War – with more-active management than in the past four decades. Our modelling shows that the UK needs between 1.3 million and 5.1 million hectares of new woodland and energy crops, and restored peatland, all without increasing imports and threatening food security. This land use change sequesters carbon and reduces agricultural emissions to achieve net zero. We need to:

- Increase woodland cover from 14% to at least 20% of UK land by 2050.
- Prioritise multifunctional land uses that combine farming, nature and carbon sequestration.
- Actively plan land use regionally, in partnership with communities, rather than leaving it to market forces.
- Support farmers with transition financing, technical assistance, advice and longer-term contracts.

This is about smarter land use to meet multiple national priorities at once. Done well, land use change will support food security, climate targets and rural jobs.

Healthier diets made easier

Poor diets cost the UK dearly – through pressures on the NHS, lost productivity and poor quality of life. Almost 2.8 million people are economically inactive due to long-term sickness.[7] Shifting towards healthier diets is a win-win that cuts emissions, saves public money, and helps people live better and more productively for longer. We need to:

- Encourage diets richer in fruits, vegetables and wholegrains that include less red and processed meat and unhealthy ultra-processed foods.
- Make healthy, nutritious food more affordable and accessible for all income groups.
- Invest in healthier food environments through public procurement, retail standards and advertising rules.
- Coordinate action across government departments – health, farming, environment, education and the Treasury.

Effective change means building a 'good food cycle' – an environment where the healthy option is the easy and affordable one for everyone.

MAKING CHANGE HAPPEN

These transformations won't happen without decisive leadership and coordinated action from government and in partnership with the farming community, food companies, local authorities, and many others. We also need a pathway through the coming decades that is fair, and sensitive to the needs of different regions, communities and sectors. A combination of legislation, financial support and incentives will be needed to de-risk the transition, create new ways of working and doing business, and unlock change.

Our Roadmap combines a **phased approach** – to ensure the right changes are introduced well and developed as needed – with **cross-cutting principles** that need to be enacted now and throughout to make this work.

Phased Implementation to 2050

The changes can't be achieved in a day, but they do start today. A clear, phased plan gives greater certainty to businesses and communities, and time to adjust:

2025–2030

BUILD FOUNDATIONS

Build a positive vision that all can aspire to and work towards. Establish transition funds for farmers, reform agricultural subsidies to align with nutritional needs, develop long-term contracts for land use change, and transform food environments through advertising restrictions and mandatory labelling. Raise awareness of both the costs of inaction and delay, and the opportunities of acting swiftly. Develop political and public consensus, and rebuild the relationship between government and farming communities. Test and de-risk solutions. Begin regulatory reforms. Invest in research and data systems.

2030–2040

SCALE SOLUTIONS

Roll out major infrastructure investments around new supply chains. Scale horticultural production, triple tree-planting rates, and ensure healthy food becomes the default through comprehensive reform of food marketing and public procurement. Expand market-based incentives for healthy and sustainable food production and consumption. Swiftly scale up successful pilots.

2040–2050

CONSOLIDATE PROGRESS

Realise benefits and refine strategies. Embed transformation as the new normal – with integrated crop–livestock systems, multifunctional landscapes delivering multiple benefits, and healthy diets as default. Address remaining high-emission sectors. Ensure resilience against severe climate impacts. Monitor and verify outcomes. Adapt to emerging challenges.

Cross-Cutting Implementation Requirements

This framework for transformation must operate durably over a 25-year period, with a set of cross-cutting arrangements addressing the complexity of managing changes across agricultural production, land use and healthy diets in a fair way. Joined-up leadership, with the government setting the framework to help companies and farmers alike work towards a common vision, requires that we build public support, ensure no one is left behind and make best use of the technological opportunities on offer.

Governance and Coordination

Strong coordination will be required across government departments:

- A strong National Food System Transformation Committee, politically driven from the centre, backed up with legislation in the form of a Good Food Plan
- Ensuring that health and diet changes are managed in close coordination with food supply, production and land use planning
- Ensuring the right balance between financial incentives, regulatory mechanisms and active engagement and advice
- Ensuring short-term measures fit with and reinforce the long-term plan

A Just Transitions Framework

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

- Support for lower-income households to access healthy food
- Engaging with farmers to adapt to new markets and methods, with co-designed support programmes for affected sectors
- Inclusive governance that gives communities a say in land use decisions, and a robust plan over the long-term to underpin the development of local rural economies across the UK

- Regular reviews of who benefits, who bears costs and how to balance the two

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: More diverse farming, including lengthier crop rotations, integrating animal and plant agriculture, improving soil health and reducing synthetic inputs to improve the resilience and natural productivity of farm systems
- Land use tools: Data and modelling to make better decisions on where and how to grow food, store carbon or restore nature

Building and Maintaining Public Support

Sustained transformation over multiple electoral cycles makes public consent not just desirable but critical for success. That means:

- Developing stronger and more inspirational narratives for change
- Reaching out across political parties to build common ground
- Using citizens' assemblies to enable strong participation
- Maintaining consistent messaging from trusted voices

A NATIONAL OPPORTUNITY

This transformation represents an historic opportunity. It will:

- Save billions in healthcare costs by reducing diet-related disease
- Improve food security through strengthening domestic production
- Create new rural jobs in strengthened local rural economies
- Enhance biodiversity and nature recovery
- Strengthen national resilience against supply disruptions caused by climate change or trade disputes
- Improve water quality and water resource management
- Reduce agricultural emissions to play a part in meeting the UK's net zero goals

The UK has the expertise, institutions and public will to help lead change internationally. But success requires action now – not when crises force our hand. By embracing this Roadmap, the UK can build a food system that benefits farmers, families and future generations alike.

TEN PRIORITY ACTIONS ▶

To drive food system transformation our aim is to reformulate the market drivers – through incentivisation and disincentivisation – to reduce the system's negative health and environmental costs. Our key recommended actions are:

1. Reform agricultural subsidies to prioritise sustainable production, carbon sequestration, and biodiversity – while establishing transition funds to support farm diversification, new supply chains and infrastructure – for a just transition better aligned with climate adaptation, emissions reduction and improved national food security.

2. Set targets for dietary change and animal numbers, so that progress in reducing consumption of the highest emitting foods can be monitored and more actively managed. Public procurement can be used to build new opportunities for suppliers, with one goal to make healthy and sustainable options more straightforward and affordable. Targets could be legislated for through a Good Food Nation Act to establish a statutory obligation on government and public bodies to give effect to food system transformation.

3. Require major food businesses to publish food system transition plans with measurable targets aligned with national climate and health objectives. The NHS *Fit for the Future* plan contains welcome steps but financial incentives for healthier food need to be extended far beyond soft drinks.

4. Create a National Food System Transformation Committee with cross-departmental authority to coordinate food, farming and climate policy. The Committee should oversee the three core transformations we set out to 2050, reporting through the Cabinet Office to the Prime Minister.

5. Develop more effective food systems data to track progress, promote transparency and accountability, and inform evidence-based decision-making. Monitoring and reporting requirements for food businesses need to be used to drive innovation along supply chains and inform public sector food procurement.

6. Introduce measures to protect and strengthen food security and ensure trade policies align with domestic transformation goals. Place food security on a par with energy security, as equally essential to national security. Trade deals require adequate scrutiny so as not to compromise the UK's food security and domestic production capacity.

7. Take advantage of emerging opportunities to offset emissions and inset within supply chains. Ensure carbon markets work to deliver incentives for change in land management, including adequate systems of monitoring, reporting and verification for buyers' and sellers' confidence. Establish a British quality standard for carbon calculator tools for estimating agricultural emissions.

8. Develop integrated 'Food and Land Strategies' at national and regional levels that balance production, environmental and social needs. Integrate current and new land use frameworks with large-scale changes in food production. Drive land use change at the sub-national and sub-regional levels, rather than leave it to the market.

9. Use citizens' assemblies and other deliberative tools to engage and build public understanding and consent for system-wide change, protecting it from culture war politics. Use new tools of dialogue and decision-making to gain common understandings among citizens and farmers, build consensus and handle complex trade-offs.

10. Expand interdisciplinary research on socioeconomic aspects of food transitions, focusing on behaviour change, implementation and distributional effects. Make interdisciplinary research the norm for agriculture and food systems research.

CHAPTER 1.

Introduction

The UK food system faces pressures that make transformation inevitable. Our food, farming and landscapes will change radically over the next half century, whether we like it or not. The question is whether we actively manage change for the public good or respond haphazardly as changes are forced on us. We only have a brief window but if we grasp the opportunity, we can ensure everyone has access to healthy and sustainable food, nature flourishes, our emissions fall and our food system is fair and secure for future generations of farmers and citizens.

Climate change is already disrupting agricultural productivity and food supply chains, threatening food security.[8] Trade and supply chain resilience are being disrupted by geopolitical instability.[9] Meanwhile, public health pressures from poor diet are straining the NHS and reducing economic productivity. These converging forces are creating a turbulent and uncertain world.

This set of mounting pressures means that, 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.

The Agri-food for Net Zero (AFN) Network+ has identified four plausible scenarios for how the food system may look in 2050 as it adapts to a shifting world and meets net zero emissions in different ways.[10] These scenarios differ depending on the ways social values, geopolitics or economics may develop. Yet, analysing the details of these scenarios shows that certain aspects of the food system must transform, whichever scenario might be hoped for or expected.

The scale of change required necessitates the widespread adoption of new farming practices, significant changes in land use and shifts in diets. The duration of change will span several Parliaments and so needs to be robust to party politics. To date, recent approaches have largely been ad hoc and insufficient – incremental adjustments that fall far short of addressing systemic problems at their roots. The UK government has launched a process to develop a new food strategy and in July 2025 set out its vision.[11] This vision was widely welcomed, but practical steps are needed to ensure it can be realised.

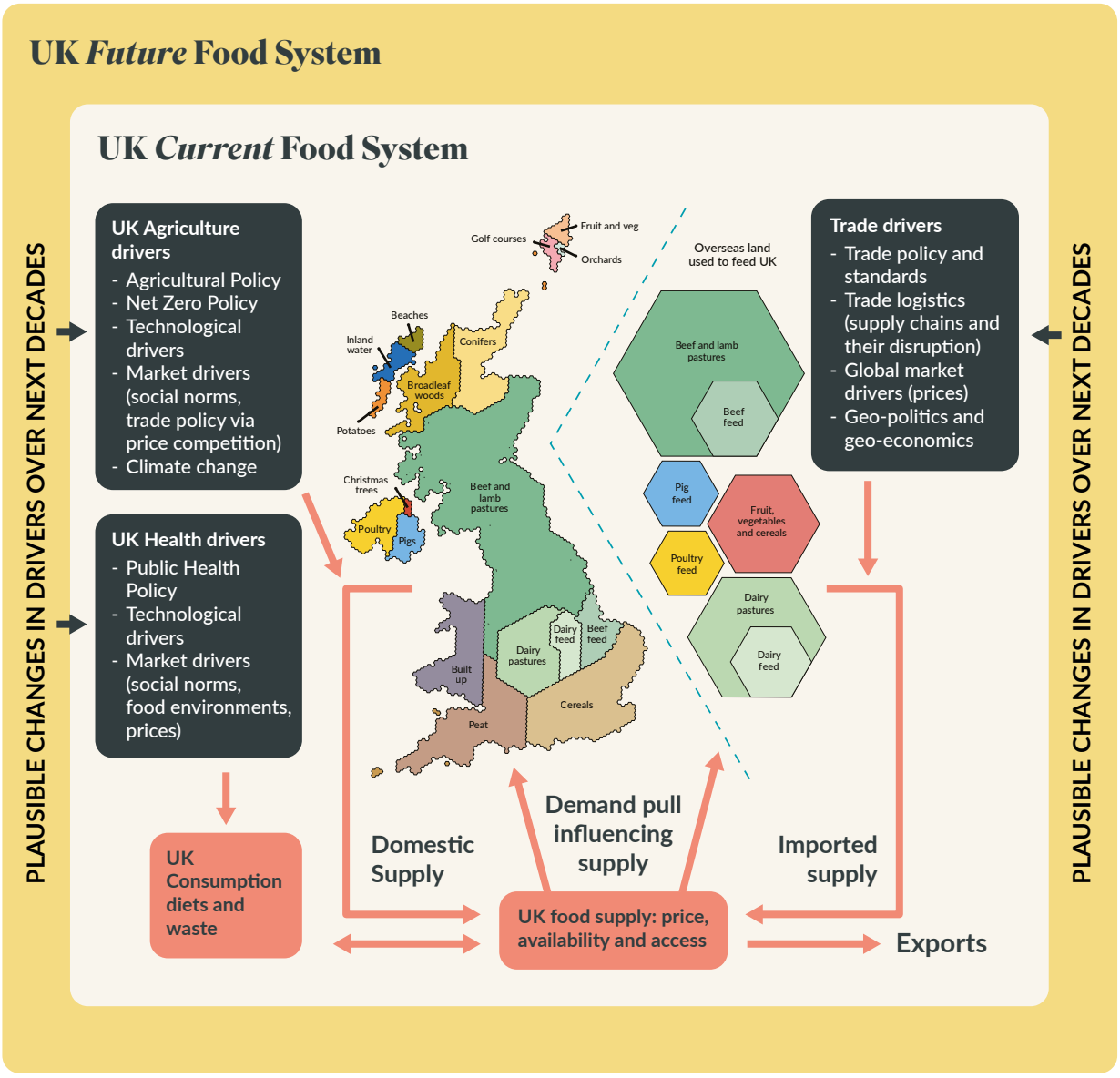
The AFN Network+ addresses these challenges. Rather than viewing net zero in isolation, we examine how transforming the UK food system could address multiple challenges together – strengthening food security, improving public health, tackling inequality, enhancing nature and supporting economic growth. Our analysis[12] suggests that while the path to a sustainable food system requires changes that will stretch us, it also presents an opportunity to create a more resilient and sustainable UK food system that works much better for people and the planet. For this reason, we use the term ‘transformation’ to signal both the scale of change needed and the possibility of achieving multiple benefits simultaneously.[13]

This report explores plausible and concrete pathways for this transformation, identifying interventions that could apply across different future scenarios. It seeks to move beyond ‘business as usual’ thinking to identify practical steps to enable necessary changes in the decades to 2050. These steps are grouped into those that must come in phases, each building on the previous, and those that must cut across these stages and remain in focus continually in order to achieve a sustainable, fair and resilient food system.

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, health and wellbeing, economy and environment. Food security is the result of variations in the food system in any given place, and is influenced by sociopolitical factors affecting price, availability and access.[14] While there is a global food system, each locality's food system is unique, and is defined by its mix of food produced locally, nationally or globally.

Figure 1. UK food system map and drivers.



Map reproduced from National Food Strategy, Part Two (2021), with additional elements (drivers and system connectors) added by the authors.

For each product consumed there is a supply chain, which describes the way food and its ingredients get to people. The term ‘value chain’ describes the ways in which the value of a product is increased along the supply chain. The term ‘food system’ includes all supply 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 policymaking, 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, agricultural practices affect soils, water, biodiversity and even local microclimates. Processing, transport and retail require energy, water, infrastructure and other inputs (e.g. packaging). Throughout, externalities come from chemical usage and disposal (e.g. from fertilisers, pesticides, industrial processes and emissions), as well as from the disposal of waste, including plastics and other packaging.

CHAPTER 2.

The Context for Transformation

The UK's food system is extensive. The food sector is the country's largest employer, with over four million workers contributing almost £150 billion to gross value added.[15] Agriculture occupies over two-thirds of UK land and heavily influences landscapes and ecosystem health. In addition, transforming the UK food system requires addressing a complex set of interconnected challenges. Understanding this complexity is essential for developing effective solutions.

COMPLEX CHALLENGES

The food system is responsible for an estimated 38% of the UK's GHG emissions when imports are included.[16] Most UK agricultural emissions stem from relatively dispersed processes, like methane from livestock and nitrous oxide from soils, which are difficult to eliminate entirely and for which there are limited technological options.[17] As other sectors decarbonise, so agriculture and the food system will become the UK's largest emissions source by the 2040s.

The UK government's independent statutory advisor on climate change, the Climate Change Committee (CCC), produced *The Seventh Carbon Budget* (CB7) in February 2025 to map out a proposed plan for reducing net emissions. CB7 suggests that about a fifth of current agricultural land will need to be used for other purposes, primarily establishing woodland, to reduce net emissions and strengthen sequestration. Such change is technically possible without the UK becoming more dependent on food imports, but only through substantial changes in production and consumption patterns.

In addition, the international context has become a disrupter. Wars in Europe and the Middle East and the shift in emphasis away from globally liberalised trade towards greater protectionism have heightened concerns about food security and supply chain resilience.[18] Geopolitical shifts affect food system operations, as climate impacts directly undermine agricultural productivity and protectionist measures disrupt trade flows. These dynamics are prompting interest in domestic production capacity.

These changes intersect with other challenges. The UK faces a mounting public health crisis, with 30% of the population now living with obesity.[19] We may live longer, but in poorer health caused by poor diet. Adults typically consume too many ultra-processed foods high in fat, salt and sugar, while consumption of fibre, fruit, vegetables and oily fish are below recommended levels.[20] Current trends suggest over 50% of adults could be living with obesity by 2050.[21] At the same time, it is estimated that 3 million people may be at risk of malnutrition.[22]

Alongside human health issues, some intensive production systems raise concerns about animal welfare and the environment. The current power imbalances between food producers, retailers and households create structural barriers to change that cannot be addressed through individual choices alone.[23] Long-term financial pressures on farm production have led to changes in practice that threaten biodiversity and ecosystems essential for food production, while agricultural pollution contributes to problems with poor water quality.[24] Marketing heavily influences demand and commonly promotes less healthy and sustainable options.[25]

Food price inflation has deepened inequalities, as healthier options remain less accessible in deprived areas.[26]

> *"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."* [27]
>
> **Professor Tim Lang, Emeritus Professor of Food Policy, City St George's University**

Climate change itself creates additional pressures. In 2025, the UK experienced its warmest spring and summer on record. Extreme weather events and climate change are bringing great stress and uncertainty for British farmers.[28] The UK's food system also currently relies heavily on imports. Domestic production meets only 50% of vegetable demand and 15% of fruit demand.[29] Climate change is already disrupting supply chains and agricultural productivity and affecting food prices.[30] A recent memo from whistle-blowers inside the UK food industry highlighted the vulnerability of the system.[31] 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 over the coming years."* Temperature projections for 2035 have been estimated to add an additional 1% to annual food price inflation in European countries.[32]

The combination of challenges – emissions reduction, land use change, public health, ecosystem degradation, market inequalities and climate resilience – means that incremental adjustments to current practices will not be sufficient.

The UK government's Carbon Budget Delivery Plan contains 33 measures to reduce emissions from agriculture and land use.[33] However, approaches to reducing emissions have generally avoided intervention in food environments or marketing practices for the purpose of influencing dietary change.[34] Transforming the food system demands new approaches that can address multiple challenges simultaneously while building broader support for change. This requires coordinating efforts across agricultural production, smarter land use and consumption patterns – domains currently largely treated separately.

HOW ARE THESE CHALLENGES DRIVING CHANGE SO FAR?

Despite the scale of challenges facing the UK food system, responses are emerging, although efforts remain fragmented and insufficient for the transformations required.

New market mechanisms are being created for environmental improvement.[35] Carbon credit markets enable payments for carbon sequestration, while carbon insetting allows payments within supply chains for verified emissions reduction. Food manufacturers and retailers are increasingly focusing on emissions within their supply chains and are working with their suppliers to implement emissions reduction measures,[36] with over 4,000 companies setting validated targets through the Science Based Targets initiative (SBTi) by late 2023.[37] However, these companies work in a ruthlessly competitive environment where shareholder pressure often prioritises short-term profitability over longer-term resilience. As companies realise their limited agency in addressing Scope 3 emissions, the gap between ambition and delivery is becoming apparent.

Policy responses are gradually shifting agricultural practices. Post-Brexit agricultural policies increasingly support environmentally sensitive land management, with 49,000 farm businesses across the UK now participating in agri-environment schemes.[38] Environmental policies set new targets for air and water quality, biodiversity, tree-planting, peatland restoration and improved soil management. Growing public concern about river water quality has created additional pressure for agricultural reform.

Animal welfare concerns are beginning to influence markets. Public surveys consistently show animal welfare as a priority, creating opportunities for farmers who can meet these expectations while addressing environmental challenges. Retailers increasingly recognise that future-proofing supply chains requires addressing welfare alongside sustainability.[39]

Research and innovation investments are substantial. UKRI funded over £1 billion in food-related research and innovation support from 2020 to 2025.[40] Artificial intelligence (AI) is creating opportunities for more precise resource management, while advances in biotechnology offer potential for emissions reduction. Understanding of gut and soil microbiomes is advancing rapidly, promising new approaches to health and sustainable production.

In retail, some businesses are taking initial steps – Lidl recently became the first UK multiple retailer to commit to protein diversification.[41] The Food Data Transparency Partnership aims to improve data collection while *Fit for the Future*, the new NHS health plan for England, contains measures to discourage marketing of less healthy foods. Consumer groups continue to press for transparency in labelling.

These responses represent important first steps but are insufficient given the scale of challenges. They are largely voluntary, piecemeal and lack the coordination needed for systemic change. They also do little to address the scale of uncertainty and lack of business confidence within the farming industry. The mismatch between these emerging responses and entrenched system structures explains why more comprehensive approaches to transformation are needed.

'NET ZERO' – MORALS, MECHANISMS, MATERIALITY

Difficulties with food system reform stem partly from problematic framing. 'Net zero' is poorly understood and has been poorly communicated. It is commonly perceived that net zero must be achieved by individual farmers as well as the whole sector and for this reason, is often felt to be an imposition of rules and hardship upon farming businesses. While the 2050 net zero commitment provides legal impetus, the need for transformation is also driven by broader material necessities and social challenges. So far, the dominant climate policy approach frames net zero as a moral imperative: the need to protect future generations from runaway climate change. However, target fixation risks alienating certain groups, polarising the discussion, and ignoring deeper issues like inequality or biodiversity loss even while achieving emissions goals. Some talk of 'carbon tunnel vision,' referring to the apparent single-minded pursuit of one goal to the potential detriment of all else. 'Net zero' is failing to invoke the positive feeling of beneficial change that had originally been anticipated. As political resistance grows, moral arguments alone may prove insufficient to sustain momentum.

More mechanistic or technocratic thinking treats transformation as an engineering problem – simply change the system components to reduce emissions. While valuable for creating measurable pathways, this way of thinking can be problematic too, often overlooking human factors such as social norms, political resistance and distributional justice questions about who bears costs and benefits.

A key difficulty is that politicians all too often consider it too 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.[42]

A broader, materialist perspective considers the underlying political–economic systems and physical constraints driving change. It recognises that beyond moral imperatives or technical fixes, we must address questions of resources, skills, economic power and physical system constraints that will force change regardless of political preferences. Our analysis shows climate change itself will become a primary driver of food system adaptation in coming decades. The transformation is not just desirable – it is inevitable as material conditions change.

We do not believe that the phrase 'net zero' will cease to be a focus, but it does need to be seen from more than a purely ethical perspective. Effective transformation must draw on all three perspectives: moral framing provides ethical grounding; mechanistic approaches enable precise planning; materialist analysis addresses root causes and coming pressures. However, material conditions must be recognised for the controlling factor it is. Our modelling reveals that climate impacts and resource constraints will force systemic changes regardless of policy choices.[44] Preparing for these realities means building resilience and fairness into the food system now.

> *"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."* [43]
>
> **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**

Net zero therefore represents more than a target. It is an opportunity to rethink how we live and share responsibility for the future habitability of the planet. But lasting change requires moving beyond moral arguments alone. We must acknowledge the material forces making transformation unavoidable, use technical modelling to inform the development of viable pathways, and ground efforts in ethical principles of justice, fairness and sustainability.

THE AFN NETWORK+ APPROACH

The AFN Network+ has developed methodologies to cope with the complexities of food system transformation. Progress requires approaches that can engage with multiple perspectives, analyse interconnected systems and identify practical pathways forward. We do this by bringing together expertise from across research disciplines, industry sectors and communities of practice. Our approach is distinctive in three key respects.

First, we take a whole-systems perspective that examines how food production, land management, supply chains and consumption patterns interconnect. This systems approach identifies physical and economic limitations, power dynamics and resource flows that might otherwise be missed, helping identify how changes in one part of the system affect others.

Second, we recognise a rapidly changing context for the food system. The interplay between demand and supply, mediated through markets, is dynamic and evolving, and the UK system operates in a highly internationalised context. Rather than assuming current trends will continue, we explore how different combinations of geopolitical shifts, market and technological

developments, and changing social values might reshape the operating environment.

> *"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."* [45]
>
> **John Ingram, Environmental Change Institute, University of Oxford**

Third, we employ an inclusive methodology that engages diverse interests – from farmers and food businesses to researchers and policymakers. By bringing diverse 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.

THE FOUR FUTURES

The AFN Network+ used scenario analysis to stretch current thinking. A scenario is a plausible, internally consistent set of assumptions about the state of the world in the future. We developed four alternative scenarios based on different combinations of features across three axes:[46]

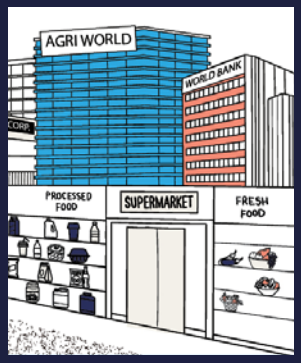
- **Geopolitics and stability:** Will the world be increasingly volatile, conflicted and contested, or return to cooperative, rules-based and calmer times?
- **Economics and markets:** Will we rediscover open, global markets and drive back towards globalisation, or move towards more regionalised, regulated and securitised markets?
- **Values impacting on demand:** Will per capita consumption grow and demand increase, or will attitudes shift, decoupling consumption from resource demand? Will health, or equity, or security take a higher priority?

We then used the Future Food Calculator to quantitatively assess how different interventions in food production, land use and dietary change might affect emissions, land use and food security across the four scenarios.[47] The Calculator allows users to experiment with variables such as farming practices, land allocation and consumption patterns 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, as well as maintaining or improving the UK's self-sufficiency so as not to offshore emissions.

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

The analysis demonstrates that while specific 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 food production approaches, land use and diets – emerge as robust requirements regardless of global dynamics or how value systems evolve.

The Four Futures



SCENARIO A

‘BUILD BACK FAST AGAIN’

An unstable and globalised world, where economic growth is key (essentially business as usual)

This unstable, globalised future prioritises economic growth despite successive crises. Climate volatility and trade disruptions strain food systems, yet resources for resilience remain unevenly distributed. Agricultural inputs become unpredictable, while corporate control dominates supply chains with slim producer margins limiting investments in sustainability. Over the past 20 years, business as usual has become a matter of staggering from crisis to crisis, aiming to recover by building back existing systems, rather than creating something better.

Key characteristics:

- Heavy reliance on engineered carbon sequestration (24.4 $MtCO_2e$/year) with the lowest agricultural emissions reductions of all scenarios (27.8%)
- Significant land conversion: 29.8% less pasture
- Moderate reduction of cattle numbers (30%) with self-sufficiency broadly maintained (0.71 ratio)
- Intensive, ultra-processed food production with environmental/health consequences
-

SCENARIO B

‘CIRCULAR WORLDS’

Geopolitically stable and globalised, underpinned by circular sustainable systems and values

This scenario features global cooperation with sustainability as a core value. Circular economy principles transform food systems, integrating farming with nature through agroecological practices.

Key characteristics:

- More balanced net zero emissions approach: 47% emissions reduction and 18.5 $MtCO_2e$ in agricultural engineered removals
- Major land use shifts: 43.6% less pasture, with 4.9M fewer cattle – the largest reduction of all scenarios
- Improved producer margins through diversification and higher farmgate prices

Flexitarian diets with local food networks and reduced waste

SCENARIO C

‘SELF-SUFFICIENCY’

An unstable, regionalised world, where a circular economy is driven by the need to save resources

Driven by global instability, this regionalised future prioritises food security over environmental concerns. Economic constraints limit technology adoption, leading to a forced reliance on traditional farming methods and reduced consumption of higher emitting and more processed foods.

Key characteristics:

- Highest emissions reductions (50%) with 44 $MtCO_2e$ sequestration, from existing and new forests and bioenergy crops
- Highest self-sufficiency (1.02) through intensive land use and shift to higher yielding production
- Dramatic livestock changes: 50% fewer cattle (down to 4.49M heads), 30% lower stocking density
- 23% forest cover with significant pasture reduction (-32.7%)
- Meat becomes luxury due to resource constraints

SCENARIO D

‘THE RIGHT TO FOOD’

A geopolitically stable world, with a globalised economy built on ‘green growth’

This stable, high-tech future combines green growth with food as a basic right. Advanced technologies enable intensive but efficient production with global specialisation.

Key characteristics:

- Highest reduction of agricultural emissions (52%) and 47.2 $MtCO_2e$ in sequestration from different land uses
- Largest forest expansion (+20% UK land) and pasture reduction (-52.2%) which negatively impacts self-sufficiency (0.60, lowest of all scenarios)
- Focus on horticulture/grains with high-tech ruminant farming

Nutrition-focused processed foods with reduced inequality

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 FOR SECURITY	Unstable, regionalised	Security, self-reliance	Resource scarcity, protectionism	Traditional mixed farming, low meat consumption, high food self-sufficiency, limited imports	Strongest emissions reductions
D. THE 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

The Uncertain and the Inevitable

The scenarios reveal critical trade-offs between different approaches to food system transformation (Table 1 and Appendix B). On economy and sustainability, Scenarios A and C prioritise immediate economic and security needs while Scenarios B and D embed sustainability in their economic models, by choice or necessity. On technology's role, Scenarios A and D rely heavily on technological solutions, while Scenarios B and C emphasise ecological processes with constrained technological adoption. Most scenarios show reduced meat consumption (especially C and D), but only B demonstrates voluntary dietary change through values shift. All scenarios show pasture reduction (29.8–52.2%), and forest cover increases most in B (+15% more land area) and D (+20%). In reducing emissions, Scenario A depends most on carbon removal. Scenarios C and D achieve deepest agricultural reductions (50 and 52% respectively), while Scenarios B and D show most balanced emissions approaches.

Table 1 gives a comparison of various aspects of each scenario. 'Build Back Fast Again' (Scenario A) creates systemic vulnerabilities. 'Circular Worlds' (B) offers the most holistic sustainability benefits. 'Self-Sufficiency for Security' (C) achieves emissions goals but with some hardship. 'The Right to Food' (D) may maintain productivity but with major system changes.

Our analysis of the future scenarios reveals four inescapable truths concerning what is needed to achieve net zero by 2050, regardless of global conditions:

1. **Dual approach: emissions cuts and sequestration**
   - Agricultural emissions must fall by **25–50%**, but these emissions reductions alone are insufficient.
   - **Carbon sequestration** (through expanded forests, Bioenergy Carbon Capture and Storage [BECCS] crops and other measures) is critical, requiring, for example, **5–20% more of the UK land area under woodland cover**.

2. **Large portions of land will be used differently**
   - **30–50% of pasture or grazing land** must be repurposed, mostly for carbon sequestration.
   - **Arable land reductions** can be limited by prioritising introduction of bioenergy crops on pasture land.

3. **Changes in what we eat and what we produce look non-negotiable**
   - **Reduced meat consumption** is essential to free up land for carbon storage.
   - **85% of UK farmland currently supports livestock**, making net zero impossible without **fewer animals**, especially ruminants.

4. **Resilience demands strategic planning**
   - The UK can maintain or improve **food self-sufficiency (with self-sufficiency ratios varying from 0.60–1.02)** while cutting emissions – but only with **coordinated policy** on production, diets and land use.
   - Even with full adoption of low-carbon farming technologies, **only 25–33% of needed agricultural emissions cuts** would be achieved – structural change is essential.

Table 2 compares key food system features across the scenarios. The first column shows the UK's total net emissions whereby each scenario gets to approximately net zero by 2050. BECCS are deployed to arrive at the net zero position. In Scenario C – self-sufficiency for security – the UK moves to a very marginally net negative emissions position.

Why This Matters

- **No scenario** allows reaching net zero while maintaining current livestock numbers.
- **Technological fixes alone won't suffice** – systemic shifts in food production, land use and diets are necessary and inevitable.
- **Policy changes are required now** to ensure a just transition that balances emissions goals, food security and rural livelihoods.

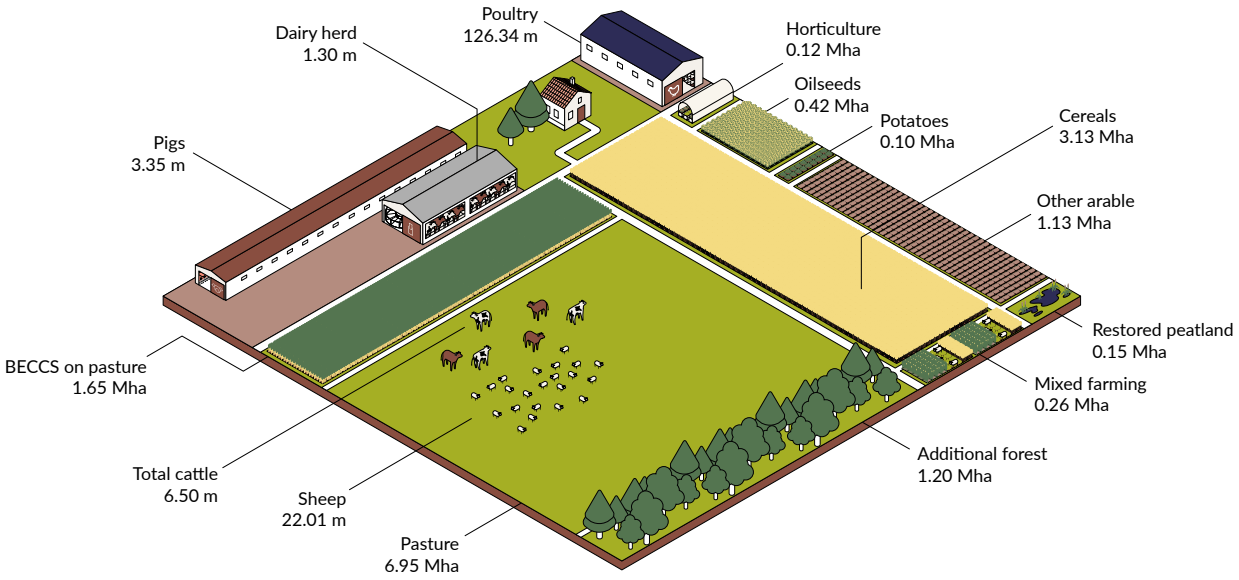
Drawing together these inescapable truths enables us to conceive of three core transformations that hold together the necessary changes facing the UK. The path to net zero is **technically feasible** but requires **purposeful, coordinated action** – starting today.

Table 2. Key features of the food system under the four AFN scenarios[48]

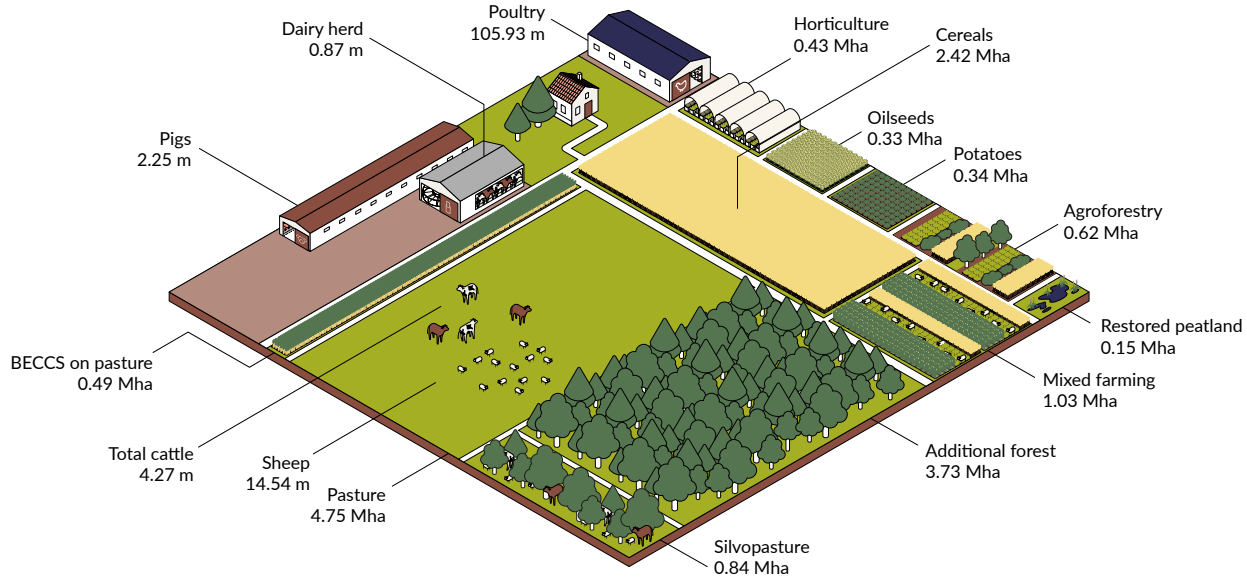
Scenario	UK Emissions $MtCO_2e$ /yr	Self-sufficiency ratio	Herd Size, Million heads	% change in ruminant consumption	UK forest area % of UK land	% increase in UK horticulture	% of agricultural land to BECCS
Baseline	70.16	0.67	9.15	0	13.17	0	0
A. BUILD BACK FAST AGAIN	0.68	0.71	6.49	-10	18.17	-20	11
B. CIRCULAR WORLDS	0.06	0.72	4.27	-60	28.17	70	3.2
C. SELF-SUFFICIENCY FOR SECURITY	-0.24	1.02	4.49	-60	23.17	400	4.4
D. THE RIGHT TO FOOD	0.14	0.60	4.48	-70	33.17	50	0.7

THE FOUR AFN SCENARIOS ILLUSTRATED ▶

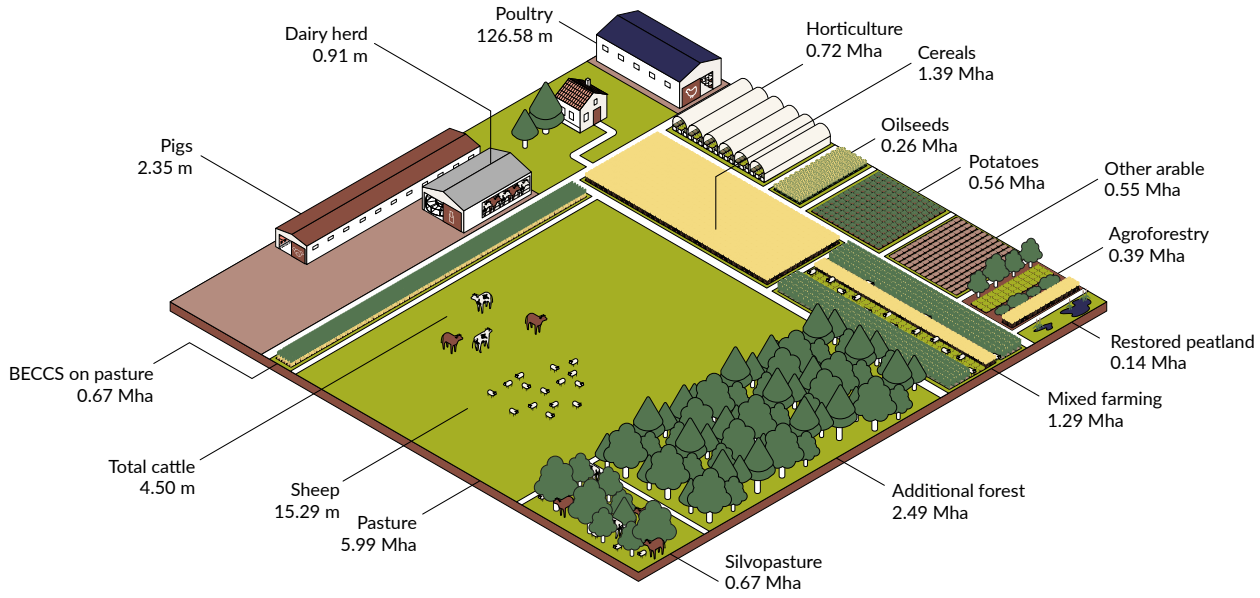
SCENARIO A: BUILD BACK FAST AGAIN



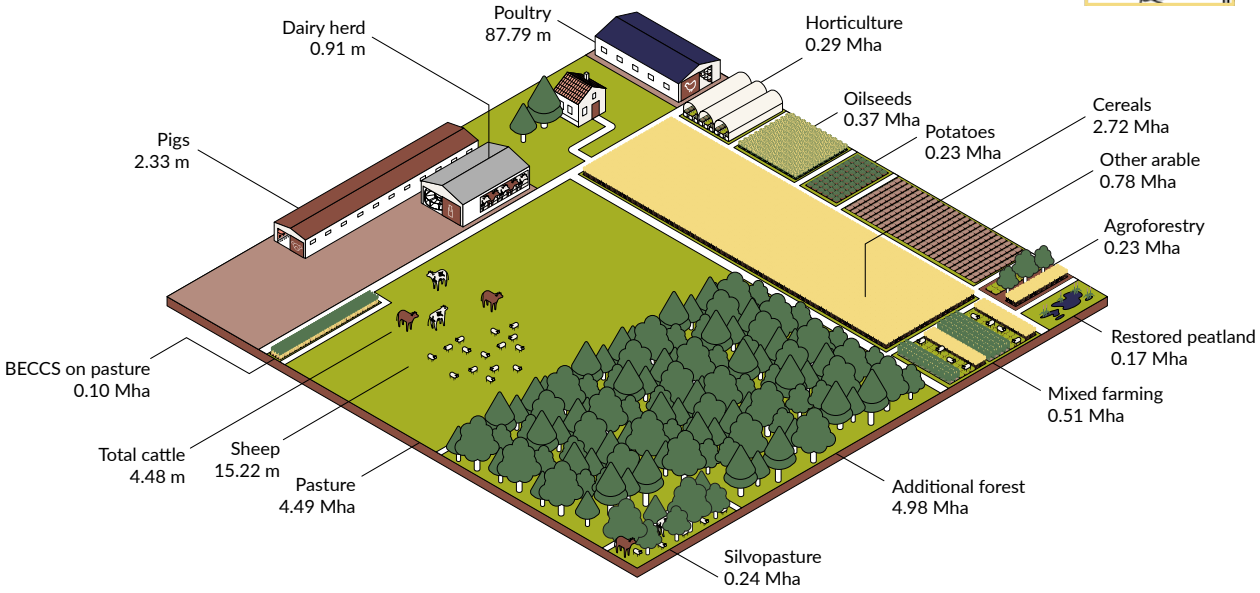
SCENARIO B: CIRCULAR WORLDS



SCENARIO C: SELF-SUFFICIENCY FOR SECURITY



SCENARIO D: THE RIGHT TO FOOD



CHAPTER 3.

Three Core Transformations

Transforming the UK food system by 2050 requires 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:

- Resilient agricultural production
- Smarter land use
- Healthier diets

These transformations are interconnected and have to be pursued together. 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, they 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.

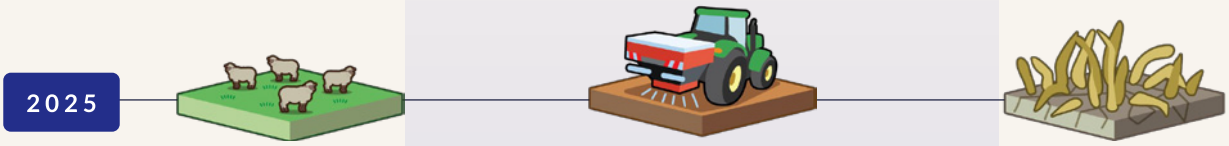
The following sections consider each of these core transformations, setting out what the future can look like and identifying the multiple benefits they can deliver, before turning to the current reality and what changes are needed to achieve transformation.

> *"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."* [49]
>
> **Indra Thillainathan, Team Leader for Land, Agriculture and Nature, CCC**

UK FOOD PLAN FOR 2050

3 essential transformations

Stronger, more resilient farming



2025

SPECIALISED FARMING

Largely livestock or crop monocultures, separated geographically

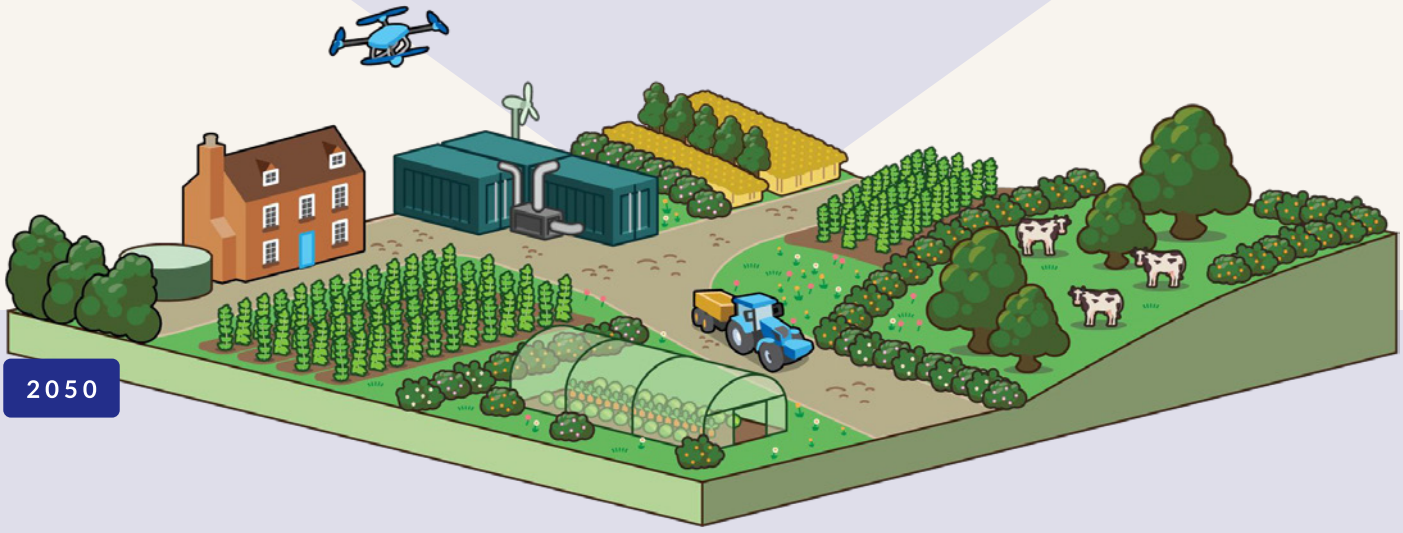
HIGH EMISSIONS

Dominated by livestock production, synthetic fertilisers and diesel machinery

VULNERABLE TO SHOCK

Dependent on imports for feed and manufactured inputs and exposed to extreme weather events

proactive planning & coordinated action



2050

MIXED & DIVERSE FARMING

Livestock and crops more integrated on farms and in regions, with more UK-grown vegetables, fruits and wholegrains

LOW-CARBON TECH

Full deployment of methane reduction and capture technologies, precision tools and renewable energy

FARM BUSINESS RESILIENCE

More diversified income sources and better matched to UK healthy dietary needs

A sustainable, prosperous and secure UK

RESILIENT AGRICULTURAL PRODUCTION

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

Agriculture is at the heart of this transformation. It accounts for around 12% of all UK 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 (cattle, sheep) and monogastric (pigs, poultry) animals – accounts for around 85% of the UK's agricultural land when growing animal feed is included.[50] While measures can improve resource efficiency in food production, for UK agriculture to become a net zero compatible sector, *The Seventh Carbon Budget* (CB7) suggests its emissions need to be almost halved by 2050. In addition, other negative environmental impacts need to be adequately addressed, and new non-food demands from land met.

Based on our modelling, we focus on the opportunities for transforming UK agriculture to produce more of the foods we need for healthy diets – particularly fruits, vegetables and plant proteins – while developing more sustainable and integrated farming systems. This means evolving from specialised livestock production towards more diversified operations that bring together crops and animals more effectively, improve soil health, reduce emissions, and strengthen farming's resilience to climate change.

Agriculture faces significant opportunities from transformation – not just because it plays a role in reaching the UK's wider net zero target, but because the change will strengthen the resilience of farming, improve food security and public health and the quality of life for farmers. Moreover, the impacts of climate change on both domestic and imported food,[51] combined with geopolitical instability, mean that **agriculture is facing significant change, irrespective of the UK government's net zero target**.

Our Vision of the Transformation

By 2050 UK farms will be financially viable businesses producing healthy food that meets national needs while operating within carbon budgets. As a result of this opportunity, agriculture will better protect and enhance national self-sufficiency in food, animal feed and other inputs. It will feature greater circularity, with animal and arable production better integrated within mixed farming systems that enhance soil health, improve water quality and reduce dependence on imports. The UK will become less vulnerable to shocks and disruptions in food supply chains.

This transformation recognises the important role livestock farmers play in shaping our landscapes and rural communities. Animal numbers will continue to decline, and new opportunities will emerge, but livestock farming will remain a valued and valuable part of UK agriculture. Many livestock farmers are already pioneering innovative approaches that demonstrate how animal agriculture can be part of the solution through enriching biodiversity, improving soils and providing high quality protein.[52]

Domestic horticulture will expand significantly, with increased production of fruits, vegetables and salad crops suited to the UK's changing climate. This reduces reliance on imports from water-scarce countries and capitalises on horticulture's land-efficiency compared to animal agriculture.[53] Expanding this sector strengthens

UK food security and resilience while improving the nutritional quality of domestically produced food. However, labour needs will have to be addressed. Meeting these labour needs will require automation and robotics alongside strategies to develop a skilled workforce and the 'rebranding' of UK agriculture as a vibrant, attractive and rewarding place to work.[54]

> *"[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."*[55]
>
> **Lee Stiles, Secretary of Lea Valley Growers Association**

A transformed agricultural sector is likely to include some of the following: precision farming techniques, feed additives to reduce enteric methane, improved manure management, and selective breeding for efficiency and reduced environmental impact. On-farm renewable energy generation will help decarbonise operations and provide additional income streams for farmers. Agriculture will remain a GHG emitter after 2050, but it will operate within the UK's carbon budget and protect nature while better fulfilling its primary purpose of feeding the nation.

Co-Benefits

Strengthened resilience in the agricultural sector brings multiple benefits beyond emissions reduction. These include benefits for health, economic development, environmental quality and food security.

Health and wellbeing
Greater domestic production of legumes, including beans and pulses, will reduce reliance on meat and dairy. It will take time for the effects to be felt, but increased consumption of fruits, vegetables and wholegrains among the UK population should reduce pressures on the NHS that arise from poor diets. Expanded woodland and nature-friendly farming creates opportunities for increased countryside recreation and connection with nature, which have established mental and physical health benefits and bring benefits for rural economic development.

Economic opportunities
A long-term national strategy provides farmers greater certainty and confidence to invest. New employment opportunities would emerge in growing sectors like horticulture, agroforestry and environmental land management, also stimulating rural economies. Technology will boost labour productivity, skills and wages. Aligning food security with the government's missions on economic growth, health and clean energy creates policy coherence and momentum.

Climate resilience
Tree-planting and agroforestry provide shelter for farm livestock – thereby improving animal welfare – reduce soil erosion and improve drainage. Diversified production systems would better withstand extreme weather events, pests and diseases – reducing disruption to production and strengthening food security. The UK would become less vulnerable to international supply chain disruptions and the impacts of climate change on overseas production.

Biodiversity and ecosystem health
Reduced scale and intensity of cattle and sheep production would improve water quality and aquatic ecosystem health by reducing water pollution risks, especially in the most heavily stocked catchments. Structural changes create space for biodiversity enhancement and supporting ecosystem services while mitigating agriculture's most damaging environmental impacts.

Food security and systems benefits
This transformation redefines food security to incorporate health, environmental and nutritional objectives alongside efficient land use.[56] Creating virtuous cycles of change between agriculture, land use and diets would deliver social, economic and environmental benefits across the UK. Political benefits include stronger and longer-term strategic direction, reduced healthcare costs and renewed UK international leadership in climate action.

Current State and Challenges

UK agriculture plays a critical role in feeding the nation, but is set in patterns that undermine its own resilience and future viability. Transforming the future is built on an understanding of the present, so we briefly summarise system issues here before looking at specific changes.

Structural lock-in[57]
Meat and dairy production dominate UK agriculture. Our climate and physical geography have lent themselves to growing grass and rearing beef cattle and sheep, and an estimated 40% of our arable land is used to grow animal feed.[58] Around half of UK-grown cereals feed animals rather than people.[59] This pattern of production is often taken as given – a form of *'agri-normativity'* (see below). Animal agriculture contributes substantially to GHG emissions. Farms have become increasingly specialised and geographically divided – arable concentrated in the east, and livestock in the west and north. This separation accentuates environmental pressures and geographically concentrates pollution risks.[60]

Pervasive agri-normativity
Agri-normativity is an unconscious bias that treats current agricultural patterns as natural and unchangeable. Like 'motornormativity',[61] which normalises car-centric planning, it stifles the questioning of why agricultural production patterns are as they are. History shows how dramatically agriculture can change. The collapse in oats and hay production during the 20th century, the rapid expansion of silage production from the 1960s to the 1990s, the boom and bust in oilseed rape since the 1970s, and the concentration of pigs, poultry and dairy into larger farm units – all of these show how agricultural production can shift dramatically over relatively short periods of time. Agri-normativity also moralises the current pattern of food production as inherently virtuous, regardless of efficiency or social costs. Shedding this mindset is essential for transformation.

Market and policy uncertainty
Farmers face uncertain market conditions, unfair prices and poor contractual terms that make transformation risky. Uncertainty over government funding for environmental schemes and inconsistent messaging are undermining farmer confidence to invest in change. When survival is uncertain, innovation becomes unaffordable. In addition, trade-liberalising imperatives can at times produce new uncertainty or instability for UK farmers, as has been the case with the Australia–UK Free Trade Agreement signed in December 2021.[62]

Resource dependence
Intensive systems with limited crop diversity depend on nitrogen fertilisers to stimulate growth and sustain yields, contributing to nitrous oxide emissions.[63] While fertiliser usage and corresponding emissions have fallen since 1990 (accelerated by higher energy prices since the

Ukraine war),[64] systemic change towards circular resource use remains elusive. Farm machinery relies on fossil fuels, requiring transition to alternative energy sources.

Production imbalances
UK horticulture production has declined by more than 20% since 2020, meeting demand for just half of vegetables and a fifth of fruit.[65] Much domestic horticulture production occurs on lowland peat soils that either need rewetting to reduce emissions or are reaching productive limits.[66] Meanwhile, climate change is already forcing crop adaptations across UK agriculture.[67]

Priority Actions for Food Production Transformation

Transforming agricultural production towards greater resilience requires not just technical improvements but a large-scale shift in what UK agriculture produces, with changes to the balance between animal husbandry and cropping. Achieving this transformation requires coordinated action across multiple fronts:

Financial and transition support:
- **Establish dedicated transition funds for farm businesses**, providing targeted grants and low-interest loans for diversification, new technologies and infrastructure development.
- **Ensure farmers have 10–15-year-minimum security** through long-term contracts and policy commitments to enable confident planning.
- **Develop economic support for UK horticulture expansion**, providing capital grants for infrastructure to meet a five-fold increase in production.

Policy and market mechanisms:
- **Reform agricultural subsidies** to reward sequestration, biodiversity improvement and sustainable production practices aligned with national nutritional needs.
- **Develop robust carbon and ecosystem service markets** that properly value on-farm emissions reductions and nature-based solutions.
- **Create structural adjustment mechanisms** similar to EU Structural Funds for communities most affected by agricultural transition.

Knowledge and innovation:
- **Expand research on the socioeconomic aspects of transitions**, focusing on equity, behaviour change and implementation pathways.
- **Build knowledge exchange networks** between researchers, advisors, farmers and food businesses to support system transformation.
- **Strengthen interdisciplinary research through UKRI and other funding bodies** to address not just technologies but more fundamental questions about what is produced and consumed.[68]

Together, these interventions will enable UK agriculture to become a sector that not only meets climate targets but delivers multiple benefits for farmers, communities and the environment.

Required Scale of Change

Transformation requires action across multiple fronts. CB7 provides clear parameters: net emissions from agriculture and land must fall from 67 $MtCO_2e$ in 2018 to 40 $MtCO_2e$ in 2035 and 16 $MtCO_2e$ in 2050 – a greater than 75% reduction. By 2050, the UK must meet at least the same proportion of food consumption requirements from around a fifth less agricultural land.

This requires significant rebalancing. While livestock will continue playing an important role, the CCC envisages cattle and sheep numbers falling 11% by 2030, 20% by 2035, and 38% by 2050.[69] This continues in the direction of recent trends (since 2022), and frees land for other uses, including woodland, nature recovery and water storage.

We used the Future Food Calculator to explore whether UK net zero was achievable by 2050 while maintaining current livestock numbers and without offshoring emissions. Even with 80% less food waste, 90% adoption of low-carbon technologies on farms and widespread shifts to mixed farming, livestock numbers would still need to continue to fall to meet climate and land use goals.

The structure of livestock farming is likely to change substantially by 2050, with opportunities for farmers to diversify income streams, adopt new technologies, develop premium markets for sustainably produced animal products, and benefit from carbon sequestration markets and biodiversity net gain. Some farms may choose to leave ruminant production entirely, with land given over to other activities such as energy crops and woodland creation.[70] Change of this scale warrants advice and support for developing new income streams and must be sensitive to the economic, social and cultural role farming and land management can play in remote rural areas.

Horticultural expansion is also needed, from 3.1 million tonnes to 15.2 million tonnes to meet recommended vegetable and fruit intake.[71] This increase requires addressing market failures in supply chains, contracts and labour availability, alongside measures to grow domestic demand.

Agriculture can also extensively decarbonise its operations. Around a fifth of agricultural emissions come from fossil fuel use in machinery. While lighter vehicles can be electrified, heavy fieldwork may require alternative fuels like methane captured from animal slurry, with CO_2 emissions around 70–80 times lower than diesel engines.[72]

UK FOOD PLAN FOR 2050

3 essential transformations

Smarter, more integrated land use

2025

SINGLE-PURPOSE LAND

Farming, nature and forestry largely kept separated

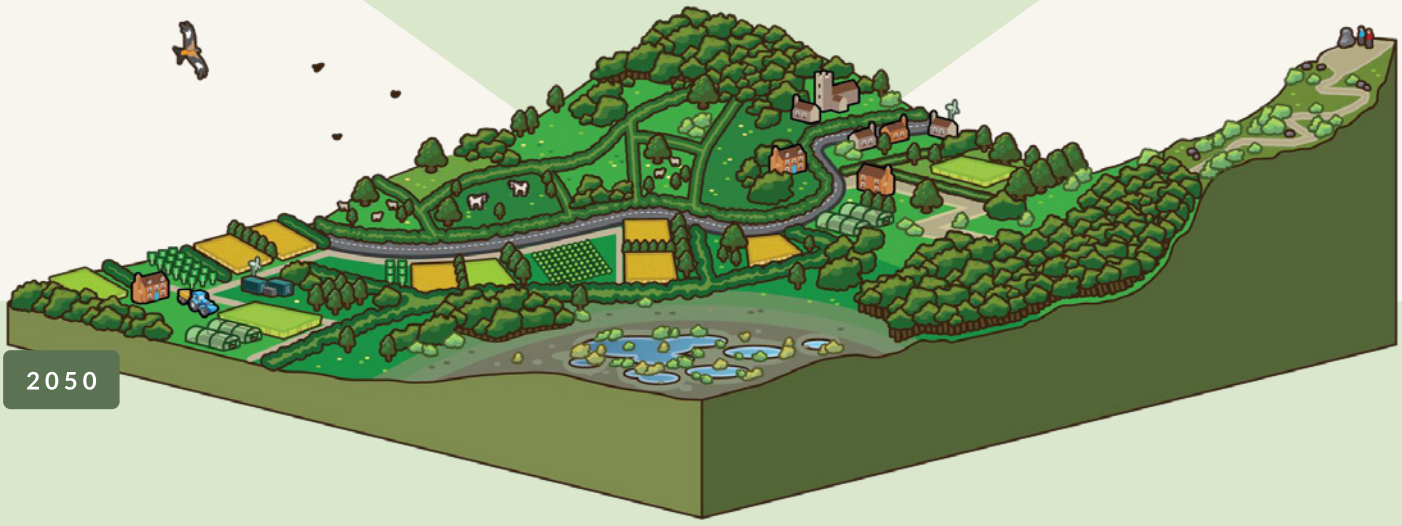
MINIMAL TREE COVER

The UK's 14% woodland cover is much less than Germany's 33% (and 46% across Europe)

DEGRADED PEATLANDS

Too much peatland emitting carbon rather than storing it

proactive planning & coordinated action



2050

MULTIFUNCTIONAL LANDSCAPES

Most land provides diverse types of food and also stores carbon and supports wildlife

ECOSYSTEM SERVICES

Harnessing nature to strengthen climate change resilience

EXPANDED WOODLANDS

At least 20% tree cover, integrated with farming

A sustainable, prosperous and secure UK

SMARTER LAND USE

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 a 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. Nature restoration targets and commitments under the Kunming-Montreal Global Biodiversity Framework (2022) commit the UK to protecting 30% of land by 2030 and halting and reversing the loss of species. And environmental policies across the UK, including Defra's *Environmental Improvement Plan*, set out a basket of targets and indicators in all areas of the environment.

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.[73] In Wales, farming communities and land are intricately bound up with Welsh language and culture.[74] In Scotland, the troubled history of the Highland clearances and feudal land ownership still influences land reform discussions.[75] In Northern Ireland, land ownership must be understood through the prism of divided communities and the particular challenges of Northern Ireland governance.[76] 'UK land use change' efforts embody a complex history of struggle and political meaning. Our sophisticated, computer-generated maps of land use cannot adequately capture these important but often intangible sociopolitical 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.[77] In England, Defra have engaged in a lengthy process to develop a land use framework to help guide policy and practice. In Scotland, a Land Use Strategy has been in place for some time and Regional Land Use Partnerships have been trialled. 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.

Our Vision of the Transformation

By 2050 UK land will deliver multiple benefits across climate, nature, health and food security through multifunctional landscapes that integrate carbon sequestration, food production, biodiversity enhancement and climate resilience, alongside recreation and sustainable development. A net zero UK will be achieved through a pace of land use change not seen since the Second World War – with more active management than in the past four decades.

This transformation will proceed hand-in-hand with changes in agricultural production and diets. The management of these three areas together will realise benefits for nature recovery, public health and food security.

The principles for managing land use change developed by the CCC will be embodied in land use frameworks, reducing the risk of unintended consequences and maximising co-benefits.[78]

- **Right measure, right place:** Changes to suitable land types will be targeted – i.e. woodland creation modelling will avoid tree-planting on organic soils where it could release more carbon than it sequesters.

- **Following regulatory principles:** Environmental safeguards will be ensured through regulatory principles like the UK Forestry Standard open ground requirements for biodiversity.
- **Long-term transition:** Changes will be designed to be enduring, giving confidence for future investment and commitment to changing approach: for example, UK-grown domestic energy crops will be based on perennial types to minimise disturbance and build soil carbon.
- **Sharing the load:** Changes will be distributed proportionally across the UK based on land type and capability.

Following Defra's *Land Use Consultation* – emphasising co-design with communities and targeting locations for maximum benefit – these principles will be backed by robust regulation and financial incentives for landowners and managers to drive change at the required pace. The chosen strategy will balance the urgency of climate action with the needs of communities who depend on the land, ensuring broad support for this transformation.

Co-Benefits

Land use transformation delivers multiple benefits beyond carbon sequestration. By 2050, UK landscapes will feature more trees, diversity and nature, underpinning climate resilience, flood risk management and food security. And we will have fundamentally reimagined our relationship with the land and its multiple contributions to human and ecological wellbeing.

Health and wellbeing
Expanded woodland and enhanced nature also create more opportunities for outdoor recreation and nature connection. Their proven mental and physical health benefits support dietary and lifestyle transformation.

Economic opportunities
New employment will be created in woodland creation, energy crops and peatland restoration. These sectors can help offset losses from conventional livestock farming while becoming part of new farming identities, supported through education, training and demonstration networks. Trees and other nature-based solutions integrated with agriculture create additional income streams and increase farm resilience.

Climate resilience
Strategic tree-planting in landscapes creates natural flood management systems, slowing water flow and increasing soil absorption. These nature-based solutions are increasingly important for flood risk mitigation – 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.[79] Diverse landscapes provide natural buffers against extreme weather events, protecting both agricultural production and communities.

Biodiversity and ecosystem health
Removing some less productive agricultural land from intensive production can benefit nature considerably. Reduced chemical inputs, restored habitats, and improved ecological connectivity create more space for wildlife recovery – essential for meeting UK government commitments to halt long-term species decline and protect 30% of land and sea by 2030.[80] With a predicted 5 billion additional litres of water daily needed by 2050 to meet growing demand from industry and homes,[81] nature-based land management can also helpfully enhance water retention, reduce pollution and support sustainable water resources – particularly valuable for irrigation-dependent producers and growers in water-depleted areas.[82]

Current State and Challenges

Despite growing recognition that land use transformation is essential for net zero, the UK lacks the mechanisms and momentum to deliver change at the pace and scale required.

Policy awakening

Prior to 2020, land use was a policy backwater. Only as carbon budgets were developed and gained prominence did it become clear that meeting the UK's legally binding net zero target would require unprecedented land use change for woodland creation and energy crops.[83] The UK is one of Europe's least wooded nations, with only 14% coverage, compared to 33% in Germany and Italy and 46% for Europe as a whole.[84]

Net emissions from land use, land use change and forestry are currently close to zero at 0.8 $MtCO_2e$,[85] but must become a net sink by 2038.[86] 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 $MtCO_2e$.[87] The forestry subsector is the main carbon sink, responsible for 19.3 $MtCO_2e$ of sequestration, while peatland is the main source, making up much of the 13.6 $MtCO_2e$ emitted from croplands.[88]

Competing pressures

Multiple demands compete for finite land: housing for growing populations, space for nature recovery, flood management infrastructure, renewable energy, carbon sequestration and food production. Current land use patterns poorly serve these needs. The least productive 20% of farmland in England produces just 3% of our calories. Green Alliance analysis shows that using the least productive 10% of land for natural habitat and carbon removal would deliver half the carbon savings needed by 2035 and increase bird populations by 48% by 2050.[89]

These changes are provoking public controversy. The Welsh Government's 2023 Sustainable Land Management strategy[90] – which required farmers receiving agri-environment payments to place land under woodland – met such strong resistance it was withdrawn in 2024 for review.[91] In England, campaigns oppose solar developments on farmland, particularly in East Anglia where proposals cover thousands of hectares.[92]

Our modelling suggests that across future scenarios some bioenergy with carbon capture and storage (BECCS) will be necessary to achieve sufficient reduction in net emissions by 2050. The more animal numbers decline the less reliant the scenario is upon BECCS, which remains a relatively untested technology still in the pilot and demonstration phase. A recent review of the UK's progress found that the current capacity for carbon removal is behind the government's ambition.[93]

The benefits of transformational land use change are poorly communicated, highlighting the need for better engagement strategies. Defra's emphasis on co-design may help ensure marginalised communities shape land use decisions, supporting more acceptable outcomes.

Funding constraints

The post-Brexit 'public money for public goods' model promoted as the rationale for agricultural and environmental land management support in England faces severe challenges. Fiscal pressures have constrained public spending, with agricultural and environmental funding now competing directly with priorities like healthcare, education and defence. The sudden closure of England's Sustainable Farming Incentive scheme in March 2025 signalled concerns that the scheme was becoming oversubscribed and budgets were under pressure. The Comprehensive Spending Review for 2026/29 commits to maintaining an average of £2.7 billion per year on environmental land management schemes over the spending period.

Fragmented governance

Integration of planning systems with agricultural, economic and environmental objectives remains weak. In England, Defra is developing a land use framework for integrated land use decision-making,[94] and a system of biodiversity net gain has been introduced in the planning system, while Scotland, Wales and Northern Ireland show increasing interest in natural capital approaches to economic planning and ecosystem

service thinking around land use. Ambition and implementation varies significantly across the UK.

Limited public budgets highlight the need for regulatory approaches and market mechanisms to complement public financial support. The balance between direct and environmental payments has become variable across the different parts of the UK.[95] This variability creates additional complexity for implementing coordinated land use change at the scale required. Scotland's target is for expanding woodland cover from 19% to 23% by 2045.[96] 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, reaching 26% of the Welsh land area.[97] Recent experience of new woodland creation (2023/24) suggests progress is strongest in Scotland (75% of all new woodland planting), followed by England (20%), with much less planting currently taking place in Wales and Northern Ireland.[98]

Priority Actions for Land Use Transformation

Transforming UK land use requires moving beyond incremental changes to fundamentally rethink how we allocate and manage our finite land resource, balancing food production, carbon sequestration, nature recovery and community needs. Achieving this transformation requires the following coordinated actions:

Financial and transition support:

- **Establish dedicated funding for landscape-scale transformation**, tripling tree-planting rates through enhanced grants and streamlined approval processes, particularly on marginal uplands.
- **Ensure landowners and tenants have long-term certainty** through 15–25-year contracts for ecosystem services and carbon sequestration.
- **Develop fair transition mechanisms for rural communities** affected by land use change, ensuring new economic opportunities from woodland creation and nature recovery.

Policy and market mechanisms:

- **Create integrated food and land strategies** at national and regional levels that balance production, environmental and social needs through spatial planning.
- **Develop robust carbon and biodiversity markets** that ensure benefits flow to land managers and tenant farmers, not just large estates.
- **Strengthen planning systems to deliver multifunctional landscapes** that combine farming, biodiversity, carbon storage and community benefits.

Knowledge and innovation:

- **Accelerate peatland restoration research and implementation** to increase restored areas from 9% to 30% by 2040.
- **Build comprehensive land use monitoring systems** including all land uses (agriculture, forestry, leisure, development) to improve transparency and decision-making.
- **Develop integrated spatial planning tools** that combine climate, biodiversity, productivity and social data to identify optimal locations for different land uses, supporting evidence-based decisions on priorities for food production, carbon sequestration, nature recovery and other needs.

Together, these interventions will enable the unprecedented scale of land use change needed for net zero while creating landscapes that deliver multiple benefits for climate, nature and thriving rural communities.

Required Scale of Change

The CCC envisages UK woodland rising from 14% today to 19% by 2050. This requires tree-planting 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.[99] In England, around one-fifth of land must change use by 2050 to meet statutory environmental and climate change targets.[100] *Scotland's Third Land Use Strategy: 2021–2026* suggests tree-planting rates need to increase to 18,000 hectares per year by 2024–25, and 250,000 hectares of restored peatlands by 2030.[101]

Defra's *Land Use Consultation* sets out the transformation needed in England, affecting 19% of its agricultural land (Table 3). Approximately 50,000 ha would undergo small changes – introducing more nature within fields, field margins and riparian (watercourse edge) buffer strips. Almost four times as much land (370,000 ha or 4% of agricultural land) would incorporate more trees alongside food production for environmental and sequestration benefits. Another 430,000 ha (or 5% of England's agricultural land) would be farmed principally for environmental purposes – including species-rich grasslands, peat management and short-rotation coppice. Around 760,000 ha (approximately 9% of agricultural land) would leave agricultural production entirely for woodland creation, peat habitat maintenance and heathland restoration.[102]

On the remaining 81% of farmland, management changes such as greater use of cover crops would reduce soil loss without changing land use. Together, net zero targets and Environment Act commitments require around 1.6m ha of land use change in England to 2050.

Defra concludes that this level of land use change in England is achievable alongside maintaining or moderately improving food production,[103] anticipating that the highest rates of change will be in the least productive areas, and assuming 0.5% average annual agricultural productivity growth until 2050.

Table 3. England's total agricultural land area under different types of change

Category of change	Estimated land area affected by 2050 to meet Environment Act and net zero targets (current assumptions, rounded figures)
Category 2 – Small changes maintaining the same agricultural land use	50 kha / ~1% of utilised agricultural area
Category 3.1 – Changes in agricultural land use, for food/environmental/climate benefits	370 kha / ~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 / ~5% of utilised agricultural area
Category 4 – Change away from agricultural land, for environmental and climate benefits	760 kha / ~9% of utilised agricultural area

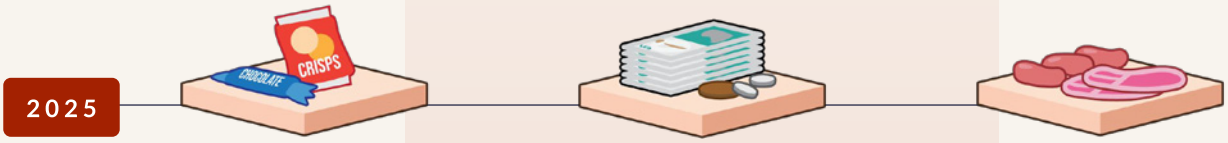
Source: Defra (2025) *Land Use Consultation*. London: Defra, p.15.

Scotland's third Land Use Strategy rests on an "ongoing and unwavering commitment to land reform".[104] It states (in 2021): "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."[105] The CCC suggests that Scottish planting rates must reach 22,000 ha annually by 2040.[106]

UK FOOD PLAN FOR 2050

3 essential transformations

Healthier diets made easier



UNHEALTHY IS THE DEFAULT

Foods high in fat, sugar and salt dominate our diets, with heavy marketing of unhealthy ultra-processed foods

HEALTH INEQUALITY

A healthy diet is **unaffordable for the poorest** in society

OVER-RELIANCE ON MEAT

85% of land supports animal agriculture, rather than diverse human diets

proactive planning & coordinated action

ACCESSIBLE HEALTHY FOODS

Fruit & vegetables, wholegrains and other plant-based options are **accessible and affordable**

BALANCED CHOICES

Some meat and dairy but **more plant-based and less unhealthy foods**

FOOD SECURITY

Thriving domestic food production, with large-scale expansion of UK fruit and vegetable production and consumption

A sustainable, prosperous and secure UK

HEALTHIER DIETS

Transforming the UK food system requires marked shifts in dietary patterns to address interconnected crises in public health, healthcare costs, economic productivity, widening social inequalities in food access and environmental degradation. Poor diet is now the leading cause of ill health in the UK and significant numbers face hunger.[107] The squeeze on household incomes is also exacerbating food insecurity.[108] Recent research shows that 20% 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%) and health concerns (47%).[109]

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.[110]

As an enabler of healthy diets, the UK food system is weak and fragile.[111] Around 60% of food is produced domestically, while much of our healthy food – including fruits, vegetables and seafood – is imported.[112] Domestic production contributes just 50% of total demand for vegetables and 15% for fruit.[113] The UK population is over-reliant on meat and dairy consumption and ultra-processed foods that are high in fat, salt and sugar,[114] and has on average been consuming more than the daily recommended calorie intake for some time.[115]

There is increasing interest in the potential of appetite-suppressing drugs such as Glucagon-like peptide-1 (GLP-1) to encourage dietary change.[116] GLP-1s are changing the way the food system operates, reshaping consumption patterns with potential implications for both human and planetary health. Users notably reduce consumption of high-calorie, processed, and snack foods, opting instead for increased intake of proteins, fruits, vegetables, and wholefoods.[117] There is a concern, however, that people put on weight after ceasing using the drugs and that potential side-effects remain poorly understood.[118]

Dietary transformation represents both a critical lever and essential outcome for food system resilience. This shift requires coordinated action across government, industry and civil society to create food environments where healthy, sustainable choices become accessible and affordable for all. Like agricultural production and land use, dietary change cannot be addressed in isolation. These transformations are inherently linked and mutually reinforcing.

Our Vision of the Transformation

By 2050, the UK food system will deliver nutritious and sustainable food that is accessible and affordable for all. UK diets will broadly follow our national dietary guideline recommendations, with most people meeting the Eatwell Guide recommendations. This change has the potential to reduce risk of total mortality by 7%, food-related emissions by 30% and water use by 4–7%.[119]

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 will be reduced.[120] Consumption of those UPFs high in fat, salt and sugar will be significantly reduced, and more whole foods will be eaten, particularly fruits, vegetables, legumes and wholegrains. The *UK Food Security Report 2024* outlines that there has been a reduction in meat consumption and an increase in non-dairy milk consumption.[121] This trend will have accelerated at least in line with the expectations in CB7.

Food environments will actively promote and facilitate healthy, sustainable choices through marketing, pricing and availability that supports rather than undermines public health goals. Food products will be reformulated so that they are tasty and healthy. Food production, distribution and consumption will respect planetary boundaries while ensuring fairer access across socioeconomic groups.

Dietary transformation will help support changes in UK agriculture and land use. There will be an opportunity for UK growers to supply the increased demand for fruits, vegetables, legumes, and grains for direct human consumption rather than animal feed. Falling demand for red meat is likely to first reduce imports, then reduce demand for UK-produced goods. As more grazing land is transformed to woodland and natural habitats, falling red meat demand will help ensure that any reductions in red meat production do not increase dependence on food imports.

Co-Benefits

Dietary transformation yields multiple benefits beyond emissions reduction, delivering a triple win: better health outcomes, stronger food security and reduced environmental impacts – while saving billions in healthcare costs and creating a more equitable food system.

Health and wellbeing
Plant-rich diets lower the risks of cardiovascular disease, type 2 diabetes and some types of cancer.[122] Increasing intake of wholegrains, legumes, nuts and vegetables is associated with a lower risk of chronic disease, improved life expectancy and reduced costs from ill health. Ensuring affordable access to nutritious, sustainable food for all income groups 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.

Economic opportunities
The economic case for change is compelling. A 2024 review of pressures on the NHS found that 2.8 million people are economically inactive due to ill health,[123] and much of this is diet-related or exacerbated by poor diet. Providing the Eatwell diet would cost an estimated £57 billion annually which would require a 55% increase in food spending on average per household. But this is less than the £91.9 billion in direct health-related costs spent each year in the UK to tackle food-related chronic disease and far less than the £268 billion in total health-related costs attributable to poor diet.[124] Research for the Food Farming and Countryside Commission has found that, in addition to the direct costs for 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.[125] A healthier population would improve national productivity.

Biodiversity and ecosystem health
Ultra-processed foods in adult diets account for an estimated 17–39% of diet-related energy use and 36–45% of diet-related biodiversity loss in high-income countries. UPFs are 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.[126] Reducing UPF consumption and increasing whole foods can address these impacts while also reducing eutrophication, land degradation and pesticide use.

Food security and systems benefits
Shifting towards plant-based foods reduces dependency on imported animal feed, enabling more efficient use of UK agricultural land and reducing the UK's climate footprint internationally. With around half of the UK's wheat production fed to livestock,[127] reducing the need for meat production frees up this land for crops for human consumption. Expanding domestic horticulture and pulse production to meet increased demand for fruits, vegetables and legumes reduces reliance on imports and

vulnerability to international supply chain disruptions.

Current State and Challenges

UK dietary patterns show a profound disconnect between nutritional guidelines and actual consumption, with serious consequences for health, equity and the environment.

The nutrition gap
National dietary guidelines advocate for a balanced diet, high in fruit, vegetables and wholegrains, but current consumption patterns rely on energy-dense, nutrient-poor foods.[128] Fibre intake remains well below recommended levels.[129] Only 33% of adults and 12% of children meet the 5-a-day fruit and vegetable target[130] and under 1% of people fully achieve the Eatwell Guide recommendations.[131] UK adults (aged 19–64) do not consume enough high-fibre food groups such as wholegrains, fruits, vegetables, nuts and legumes.[132] The socioeconomic gradient is stark – fruit and vegetable intake increases by up to 4% for every £10,000 increase in household equivalised income.[133]

Unhealthy food environments
One-third of food industry advertising spend in 2022 to 2023 promoted confectionery, snacks, desserts and soft drinks, while just 1% was on marketing fruits and vegetables.[134] This drives consumption of ultra-processed foods,[135] which comprise 57% of adult diets and 66% of adolescent diets.[136] These foods are often high in nutrients of concern – including salt, fat and sugar – and low in fibre.

Unsustainable consumption
Over a third of UK adults exceed recommended red and processed meat intake,[137] with profound environmental consequences. Livestock farming contributes significantly to GHG emissions, biodiversity loss, and land and water use.[138] Beef and lamb produce 4–6 times the emissions of poultry and 10–12 times those of pulses.[139] Fish and seafood offer nutritional and environmental benefits, but consumption remains below recommended levels despite significant marine resources.[140]

Health system challenges
Poor diet contributes to rising rates of obesity, type 2 diabetes and heart disease.[141] Nearly two-thirds of adults are living with overweight or obesity, with childhood obesity rates continuing to rise, particularly in the most deprived areas.[142] Diet-related illnesses cost an estimated £92 billion in annual healthcare costs, with an additional £206 billion in lost productivity due to long-term sickness and economic inactivity.[143]

Food insecurity
More than 7.2 million people in the UK live in food-insecure households, an 80% increase in just three years, reflecting the impacts of the cost-of-living crisis, wage stagnation and structural inequalities in food access.[144] Food-insecure households are disproportionately characterised by families with children, single parent families[145] and by those whose heads of household are disabled or from minority social groups.

Recent economic pressures have intensified these vulnerabilities. Food prices rose by over 30% since 2021, disproportionately affecting lower-income households, who spend a larger proportion of their income on food.[146] Nearly half of UK respondents 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.[147] Food bank usage has reached record levels. The Trussell Trust distributed 3.1 million emergency food parcels in 2023–24 – a 240% increase from a decade ago.[148]

Structural barriers
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.[149] At our 2025 'Big Tent' event in March 2025, Dominic Watters explained that in his council estate blueberry vapes and mango vodka can be purchased but blueberries and mangos themselves cannot.[150]

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.[151] The physical presence of food outlets significantly impacts dietary habits. These dietary patterns directly shape our agricultural landscapes.[152]

Gravitating to status quo thinking
Actively promoting diet change for the sake of food system transformation feels politically risky. Officials and politicians may seek comfort in equilibrium modelling that suggests reduced UK meat and dairy consumption would first reduce imports rather than domestic production, potentially causing carbon leakage.[153] In a global market, acting alone seems questionable.

However, Defra's Agricultural Market Model relies on assumptions that may no longer hold: marginal annual changes, static trading partner preferences, and frictionless globalised trade. This abstracted modelling treats key variables as constants – including comparative advantage, trade relationships and market drivers.

Our analysis suggests these standard assumptions will no longer apply in a rapidly changing world. The relationships between production, trade and consumption are malleable, shaped by geopolitical shifts, market forces, and climate action. The CCC's Food & Trade Advisory Group concluded that linking dietary change to agricultural transformation "is certainly feasible".[154] In our view, assuming the future will mirror the past is problematic. With concerted strategic effort by government in partnership with the sector, carbon leakage can be avoided, and dietary change can drive production changes.

Priority Actions for Healthier Diets

Creating a food system that nourishes people and the planet demands a large-scale shift in how food is produced, marketed and consumed, with particular focus on making healthy, sustainable diets accessible and affordable for all. Such a transformation requires the following actions:

Financial and transition support:
- **Implement targeted subsidies and vouchers for healthy foods**, particularly fruits and vegetables, ensuring lower-income households can afford nutritious diets.
- **Regulate food manufacturers and retailers** to support reformulation, diversification into healthier options, and sustainable supply chains.
- **Extend financial incentives beyond soft drinks** to make healthy foods more competitive, building on the successful Soft Drinks Industry Levy model.

Policy and market mechanisms:
- **Require major food businesses to publish transition plans** with measurable targets aligned with national climate and health objectives, building on measures in the NHS's *Fit for the Future*.
- **Transform food environments through regulation**, including stronger advertising restrictions on high fat, salt and sugar foods and mandatory front-of-pack labelling.
- **Reform public procurement standards** to increase plant-based options and reduce processed meat, using public sector buying power to shift markets.

Knowledge and innovation:

- **Embed food system education across all school levels**, using kitchens as learning labs to build food literacy from primary through higher education.
- **Accelerate research into plant-based alternatives** that meet taste, texture and cultural preferences across diverse communities.
- **Develop robust monitoring of dietary patterns and health outcomes** to track progress and enable evidence-based policy adjustments.

Together, these interventions can create food environments where the healthy option becomes the easy option, delivering benefits for public health, healthcare and planetary wellbeing.

Required Scale of Change

The scale of change required in UK diets by 2050 is large 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.

CB7 outlines that by 2040, 25% of meat (30% of red meat) and 20% of dairy would need to be replaced with lower-emission foods (legumes, nuts, meat alternatives, novel proteins), compared to 2019 levels.[155] A more conservative approach suggests a 20% reduction in red meat and dairy by 2050 but even this could enable FLAG (Forestry, Land and Agriculture) emissions reductions of 9–22%.[156] These scenarios assume that the protein gap is filled by pulses, and that substitution by chicken or fish would slightly reduce the savings in emissions (e.g. doubling chicken and egg consumption would add around 1 $MtCO_2e$ annually – less than 1% of FLAG emissions – and doubling pork consumption would add around 2.5 $MtCO_2e$).[157]

Other organisations have proposed more ambitious targets. Eat Lancet recommends a 50% reduction in meat and dairy consumption by 2030 with a recommended 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”.[158] WWF-UK suggest animal protein consumption should be significantly reduced across all land-based meat types with 69% less meat, 25% less dairy and 32% fewer eggs.[159]

The Food Foundation has highlighted that the CCC’s 35% reduction in meat consumption equates to just one rasher of bacon, or two chicken nuggets, less a day.[160] Eating smaller portions of meat has been shown to be the most effective way to reduce total meat consumption, resulting in a 52% decrease.[161] The National Food Strategy recommends reducing meat intake with a focus on ensuring reductions are driven by more sustainable sourcing and considering the origin rather than simply shifting production overseas.[162]

UK FOOD PLAN FOR 2050

Change is inevitable – how can we shape it?

Proactive planning & coordinated action

SHORT-TERM THINKING

Policy changes with each government, and with no long-term vision, the UK food system lurches from crisis to crisis

DEPARTMENTAL SILOS

Health, farming and environment policies too often work against each other

GROWING PRESSURES

A pressure cooker of increasing climate impacts, poor diets and nature decline

MISSED CONNECTIONS

Lack of recognition of how diet, farming and climate interact

25-YEAR PATHWAY

Long-term planning, clear phases with broad political consensus

COORDINATED GOVERNANCE

Cross-departmental arrangements to drive joined-up change

RESILIENT COMMUNITIES

Shorter supply chains with vulnerabilities addressed to better prepare for shocks

VIRTUOUS CYCLES

Healthy diets to support sustainable farming, better land use and improved health

3 essential transformations

Stronger, more resilient farming

Smarter, more integrated land use

Healthier diets made easier

A sustainable, prosperous and secure UK

CHAPTER 4.

Pathways to 2050

The three core transformations – in agricultural production, land use and diets – provide the essential framework for the UK food system to deliver public benefits. Identifying what needs to change is only the first step. The critical challenge lies in orchestrating these changes in a coordinated way that builds support, maintains momentum and ensures no one is left behind. By approaching transformation systemically, we can create food environments that make healthy, sustainable choices easier for everyone, regardless of income or location.[163]

This chapter sets out practical pathways for implementing these transformations over the next 25 years, divided across three distinct phases.[164] Rather than treating each transformation in isolation, we present an integrated approach that recognises how changes in farming, land use and diets must advance together in each phase, reinforcing each other to create a virtuous cycle of improvement.

Alongside these phases, other critical work must take place continuously. These cross-cutting factors are just as vital as the phased changes:

- **Governance and coordination** that breaks down silos between government departments and integrates supply- and demand-side decision-making
- **Just transition principles** that ensure costs and benefits are fairly shared
- **Sustained investment in innovation** to accelerate progress and reduce transition costs
- **Building and maintaining public support** that ensures genuine participation in shaping transformation

Phase 1 (2025–2030)
BUILD FOUNDATIONS

The immediate priority is to build broad agreement on the need for change while establishing the institutional frameworks, funding mechanisms, skills development and early demonstration projects that will enable larger-scale transformation. This phase focuses on winning hearts and minds, co-designing solutions with affected communities, and creating the conditions for accelerated progress.

Phase 2 (2030–2040)
SCALE SOLUTIONS

With foundations in place, this decade sees rapid and purposeful scaling of proven approaches. Tree-planting rates triple, alternative protein supply chains mature and low-carbon farming practices become mainstream.

Phase 3 (2040–2050)
CONSOLIDATE PROGRESS

The final decade focuses on embedding changes, optimising systems based on experience and addressing remaining challenges. By this stage, the benefits of transformation – improved public health, enhanced biodiversity, strengthened food security – should be increasingly evident, helping to sustain support for the direction of change.

PHASE 1 (2025–2030): **BUILD FOUNDATIONS**

PHASE 1: **BUILD FOUNDATIONS**

The first phase establishes the foundations of food system transformation. Without broad agreement on both the necessity and direction of change, later implementation efforts will face constant resistance and pressure for reversal. The objectives of Phase 1 are:

1. **Forge political consensus beyond party lines**
   Food system transformation must be protected from short-term political cycles and culture war dynamics. Cross-party agreement on core principles – similar to the consensus previously achieved on the Climate Change Act and the net zero target – should be sought to provide the stability needed for businesses, farmers and communities to invest in change with confidence.

2. **Establish institutional architecture**
   Current governance structures fragment responsibility across departments, hampering coordinated action. New institutional arrangements – such as a National Food System Transformation Committee reporting to the Prime Minister through the Cabinet Office – must be established to drive integrated policymaking and monitor progress. Research and training in food, farming and land management needs to be geared up for rapid transformational change.

3. **Develop financing mechanisms**
   The scale of transformation requires capital and innovative funding approaches. This phase must establish transition funds for farmers, develop functioning carbon markets, align existing agricultural subsidies with transformation goals, and create incentives for private sector investment in sustainable food infrastructure.

4. **Launch demonstration projects**
   Practical examples of successful transformation will be essential to provide proof of concept and build confidence for wider rollout. Early adopter farms will showcase profitable low-carbon systems, regions will pilot integrated land use planning and communities will successfully shift dietary patterns.

Building Foundations for Agricultural Production

In the short term, incentive frameworks need to be developed for widespread adoption of low-carbon farming practices. Key measures for reducing agricultural emissions include improving grass–legume mixes to reduce fertiliser use, improving livestock health and breeding, covering slurry stores, and adopting precision farming techniques.[165]

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.

Reform of agricultural subsidies must begin immediately, shifting payments further towards carbon sequestration, biodiversity improvement and sustainable practices aligned with national

nutritional needs. Where voluntary uptake proves inadequate, regulatory approaches may be necessary to achieve the required scale of change.

A fundamental shift in mindset is needed to replace 'agri-normativity'. For policymakers, agriculture must become seen as a strategic sector supporting public health, climate resilience and national security, and on par with defence and energy security.[166] This requires rapid research programmes into integrated farming systems and immediate action to build supply chains for alternative proteins, particularly for legumes.[167] A horticultural growth strategy should support the required five-fold expansion in UK horticultural production by 2050.[168] Establishing regional farmer networks to engage with farmers, understand opportunities and barriers, and disseminate good practices will build on the proven success of collaborative cluster groups to support uptake of environmental practices.[169]

Marine resources represent a small share of UK calorie and protein supply, but the sector has under-exploited potential through innovation in aquaculture and greater use of underutilised species to support improved UK food self-sufficiency.[170] Local food networks and procurement systems linking production with local needs – through initiatives like modern market gardens[171] – can serve as proof of concept for wider implementation.[172] Alongside technical research, expanded studies on the socioeconomic aspects of transitions – including equality impacts, behaviour change drivers and implementation pathways – will ensure transformation strategies are grounded in social realities.

Building Foundations for Land Use Change

With land use change, the first step is to devise national land use strategies in England, Scotland, Wales and Northern Ireland whose aim is to deliver national food security and public health, as well as community and environmental benefits. These strategies must go beyond analysis to provide actionable frameworks that drive real change, strengthening resilience against climate change impacts, particularly flooding and water resource pressures.

Tree-planting rates must significantly increase to meet The Seventh Carbon Budget (CB7) targets, aiming to treble rates on marginal uplands by 2030. Lowland peatland restoration will need to be accelerated from the current 9% to over 30% by 2040, while reducing grazing intensity on upland peatland and improving 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% now to 60% by 2040.[173] Achieving these targets requires offering landowners and tenants 15–25-year contracts for ecosystem services and carbon sequestration, providing the long-term certainty needed for landscape-scale change. These arrangements need to be put in place well before 2030.

The planning system should be strengthened and extended to better deliver national needs with comprehensive land use statistics published to improve visibility of all land uses, including land-hungry leisure pursuits like equestrian activities and golf courses. Integrated spatial planning tools that combine climate, biodiversity, productivity and social data will help identify optimal locations for different land uses. Calculations of the land required to achieve public procurement targets would also help transparency and planning. Spatial coordination at landscape scales, rather than for individual farms, could help ensure changes benefit whole communities while managing trade-offs between competing land uses.

Building Foundations for Healthier Diets

Making healthier diets easier will require robust governance structures. A National Food System

Transformation Committee – responsible for food supply, health and environmental outcomes – will need to ensure coordination and reinforce objectives between supporting farmers and promoting healthier, sustainable diets.

Food environments must be transformed through stronger restrictions on advertising high fat, salt and sugar foods, mandatory front-of-pack labelling, and fiscal measures like a Reformulation Tax.[174] This should extend financial incentives beyond the successful Soft Drinks Industry Levy model to make healthy food more competitive across all categories. Major food businesses must be required to publish transition plans with measurable targets aligned with national climate and health objectives. Public procurement offers a powerful lever, with measurable targets for increasing fruit and vegetable intake and reducing processed meat consumption by 2030.[175] Food sustainability education must be embedded across the curriculum, particularly in Key Stages 3 and 4, using school kitchens as hands-on learning environments. 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 to higher education. There are lessons to learn from the promotion of healthy diets in other countries such as Japan.[176]

Ensuring equitable access through social prescribing – including fruit and vegetable voucher schemes for vulnerable populations – will help address the significant price disparity between nutritious foods and processed alternatives.

Crucially, domestic production capacity must be aligned with dietary goals by quantifying UK land required for increased fruit and vegetable consumption, and integrating this into land use strategies, national horticulture strategies and public procurement.[177] This reduces reliance on imports and animal-based production while strengthening UK resilience.[178]

PHASE 2 (2030–2040): **SCALE SOLUTIONS**

With foundations established and consensus built, the second phase marks the decade of most intensive change. This is when the UK food system undergoes its most significant transformation since the Second World War.

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.[179]

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.[180] While today's context differs, this historical example demonstrates that rapid, system-wide transformation is possible when properly coordinated and supported.

PHASE 2: **SCALE SOLUTIONS**

Success requires moving from pilots to mainstream adoption, from early adopters to the majority, and from incremental adjustments to structural change. The objectives of Phase 2 are:

1. **Rapidly scale up proven approaches**
   Solutions must be rolled out nationwide. This requires moving from hundreds of participating farms, for example, to thousands, and from regional programmes to national implementation. Success depends on streamlined processes, rapid knowledge transfer and removing the barriers that prevent widespread adoption of already-proven approaches.

2. **Support communities through structural change**
   As livestock production changes and some farmland transitions to a greater variety of uses, entire communities may face economic upheaval. Just transition mechanisms – including retraining programmes, diversification support and regional development funds – must ensure rural economies emerge stronger than before.

3. **Transform food environments at scale**
   Dietary change in this phase must see comprehensive reform of food marketing, retail environments and public procurement. Healthy, sustainable options must become the default through regulatory reform and market restructuring.

4. **Build resilient supply chains**
   As production patterns shift dramatically – with UK horticulture expanding and alternative protein sectors emerging – entirely new supply chains need development. This includes processing facilities, distribution networks and market linkages that can handle different crops and products while maintaining food security.

5. **Accelerate natural capital investment**
   Tree-planting and peatland restoration requires skilled workers and landscape-scale coordination mechanisms that balance multiple land use objectives.

Scaling Solutions for Agricultural Production

Phase 1 initiatives for production must be scaled and systematised. Complete alternative protein supply chains should be built on both supply and demand sides, with the development of new networks to drive their development. The horticultural growth strategy established in Phase 1 must now be scaled to achieve the five-fold expansion needed by 2050. This requires major infrastructure investment, skills development for the expanded workforce, and new supply chains connecting increased production of fruits and vegetables with domestic markets.

More adaptive and responsive breeding licensing systems for plants and animals will strengthen climate-mitigating attributes. This includes introducing farmers to seeds that enhance insect pollination, increasing biodiversity while supporting seed preservation and re-use. Regulations and sustainable finance will support renewable energy production on farms to reduce the carbon footprint of machinery, enabling farmers to invest in diverse food production systems including controlled environment agriculture.

Food waste and loss reporting should become mandatory, with organic waste upcycled rather than landfilled, in line with Defra's Simpler Recycling scheme. Manures can be treated using anaerobic digesters, yielding renewable energy and bio-nutrients as by-products. Climate adaptation must be hardwired into the system through a transformed research, innovation and training system, as in the years following the Second World War, but focused on system transformation for climate, health, nature and resilience.

New tenancy agreements should support climate resilience and sequestration, with comprehensive support for livestock producers transitioning their businesses through system improvements, diversification or a change to other enterprises and 10–15-year-minimum security through long-term contracts and policy commitments to enable confident planning. A national recruitment campaign should attract new talent, with training specifically focused on food system transformation for resilience. Pilot local food networks should be expanded into a national programme of community food hubs.

The effectiveness of this 'new model agriculture' will need continual review and monitoring, with lessons learned swiftly adopted. In the face of accelerating climate change and geopolitical instability, a resilient agriculture and food system will be an adaptable one.

Scaling Solutions for Land Use Change

Continued land use transformation will require monitoring tree establishment and peatland restoration, incorporating lessons learned, with continuous assessment and adaptation to ensure sequestration and biodiversity benefits. Supporting agroforestry will ensure lands dedicated to trees can also contribute to food production.

Annual energy crop planting must increase to 12,000 ha by 2030, then more than treble to 38,000 ha/year by 2040,[181] requiring careful integration with food production and biodiversity priorities. Structural adjustment support mechanisms for livestock producers transitioning away from high-emission farming practices need to be co-designed and rolled out with the sector.

Climate adaptation frameworks require regular review and revision in response to emerging impacts. Throughout this period, mitigation measures should be continually evaluated to ensure they enhance biodiversity alongside sequestration, creating truly multifunctional landscapes.

Scaling Solutions for Healthier Diets

The regulatory frameworks established in Phase 1 of diet transformation will drive food manufacturers and retailers to support reformulation, diversification into healthier options and sustainable supply chains. Demand for diverse plant-based food must be stimulated through targeted marketing and pricing strategies, ensuring the expanded UK horticultural production finds ready domestic markets. Transition pathways into plant protein production should be created with targeted subsidies and long-term market guarantees. Accelerated research into plant-based alternatives that meet taste, texture and cultural preferences will help drive market acceptance.

Supply chain regulation should be established, giving farmers fairer prices and contracts, enabling investment in sustainable practices. Building circular food systems by reducing edible food waste through improved storage and distribution systems, while upcycling inedible waste to create bio-nutrients for local food production, also improves food access.

Throughout implementation, economic and socio-cultural barriers to healthy eating will need addressing. The effectiveness of dietary transformation must be continually reviewed and monitored, with lessons swiftly adopted. Robust monitoring systems tracking dietary patterns across different population groups will enable evidence-based policy adjustments throughout implementation.

PHASE 3 (2040–2050): **CONSOLIDATE PROGRESS**

PHASE 3: **CONSOLIDATE PROGRESS**

The final phase of transformation shifts focus from driving change to embedding and optimising new systems. By 2040, the UK food system will look fundamentally different. Emissions will have fallen dramatically, land use patterns will have been reshaped and dietary norms will have shifted. This phase must ensure these changes endure while addressing remaining challenges. The objectives of Phase 3 are:

1. **Embed transformation as the new normal**
   The practices, behaviours and systems developed over the previous 15 years must become so deeply integrated that reversal becomes unthinkable. A new generation of farmers will have grown up with sustainable practices as standard. Consumers will expect healthy, sustainable food as default. The transformation must move from policy-driven to culturally embedded.

2. **Optimise integrated systems**
   With major structural changes complete, this phase focuses on fine-tuning the relationships between food production, land use and consumption. Agroforestry systems will mature, mixed farming approaches will be refined based on regional conditions, and circular economy principles will be fully realised. The emphasis shifts from adoption to optimisation.

3. **Address remaining high-emission sectors**
   Some emissions will prove harder to eliminate than others. This phase must deploy next-generation technologies and practices to tackle stubborn emission sources – potentially through advanced feed additives, precision fermentation, or novel management systems. The goal is to drive emissions as close to zero as technically feasible.

4. **Ensure resilience against climate impacts**
   By the 2040s, climate change impacts will be substantially more severe than today. The transformed food system must prove its resilience against extreme weather, shifting growing conditions and global supply disruptions. Stress-testing and adaptive management become critical as the benefits of transformation are put to the test.

5. **Export knowledge globally**
   As an early mover in comprehensive food system transformation, the UK will have developed valuable expertise. This phase must systematically capture lessons learned and support other nations in their transitions. UK expertise in sustainable intensification, just transitions and integrated governance becomes a valuable export, strengthening global climate action.

Consolidating Progress for Agricultural Production

The transformed agricultural sector should be demonstrating clear benefits: improved farm resilience to climate extremes, strengthened food security through diversified domestic production, and agriculture operating within its carbon budget boundaries.

The focus shifts to consolidating progress and continuous improvement. Farms will have become energy creation hubs for themselves and their communities. A new generation of farmers, trained in system transformation approaches, will be leading innovation in integrated crop–livestock systems and high-value sustainable food production.

Robust monitoring systems will track delivery of multiple benefits – from emissions reduction to biodiversity enhancement – enabling real-time adjustments. International knowledge exchange will position UK agriculture as a leader in sustainable agriculture, with the lessons learned exported globally. The sector will have completed its transformation from being seen mainly as a food producer to being valued as a provider of food alongside essential ecosystem services, with farmers adequately rewarded for their stewardship role.

Consolidating Progress for Land Use Change

The UK's transformed landscapes will deliver multiple benefits as envisioned. Forest cover will approach at least 19–20% of the UK's land area, with maturing woodlands providing substantial carbon sequestration while supporting biodiversity recovery and natural flood management. Restored peatlands will have shifted from carbon sources to sinks, while multifunctional landscapes demonstrate how food production, nature recovery and climate mitigation can coexist.

Land management will have evolved from a predominantly private concern to a shared responsibility, with new governance mechanisms balancing private interests and public goods. Carbon and ecosystem service markets are likely to develop and could bring benefits to landholders, including tenant farmers. Regardless, rural communities will have successfully diversified their economies around new and growing sectors, with new identities and livelihoods emerging from woodland creation, nature-based solutions and sustainable tourism.

Consolidating Progress for Healthier Diets

The UK average diet will have fundamentally transformed, with most people routinely meeting Eatwell Guide recommendations, and diet-related disease no longer straining the NHS. A thriving domestic horticulture sector will meet much of our fruit and vegetable needs, while plant protein production has become a major agricultural sector.

Food environments will actively support healthy options as the default, with UPFs occupying a much smaller role in diets. The economic benefits will be clear: billions saved in healthcare costs, improved wellbeing, and better workforce productivity. Food education will be embedded throughout society, with cooking skills and food system understanding seen as essential life skills.

Social inequalities in diet quality will have dramatically reduced, with healthy food accessible and affordable across all communities. The transformation will demonstrate how aligning agricultural production with nutrition needs creates a virtuous cycle – improving public health while supporting farmers in producing what the nation needs for optimal health and resilience.

CROSS-CUTTING IMPLEMENTATION REQUIREMENTS

The three phases provide a temporal framework for transformation, but several critical elements must operate continuously throughout the 25-year period. These cross-cutting requirements address the complexity of managing changes across production, land use and healthier diets while ensuring the benefits reach every person and the costs are shared equitably.

Governance and Coordination

Food system transformation requires coordination across health, agriculture, environment and economic departments that typically operate independently. Currently, transformational change is inhibited by Defra's relatively weak leverage over other departments. Success will require central involvement not only from the Department for Energy Security and Net Zero, and Health and Social Care, but crucially from the Treasury, Cabinet Office and Prime Minister's Office.

A National Food System Transformation Committee reporting through the Cabinet Office to the Prime Minister could provide the necessary authority to coordinate across departments. This new institutional arrangement – potentially modelled on the cross-departmental Missions Boards used to manage the UK government's priority missions – must drive integrated policymaking and monitor progress.[182]

Coordinating demand- and supply-side policies is also critical. We must encourage consumption shifts that align with changes in domestic production capacity to prevent simply offshoring emissions.[183] This connection between diet and production requires joined-up institutional arrangements with sufficient authority to drive integrated action, alongside strong and effective partnerships between the public and private sectors.[184]

The approximately £2.7 billion per year currently allocated to UK agricultural support represents just one economic lever. This must be coordinated with health budgets, environmental financing and private sector investment to create coherent incentives throughout the food system. Without alignment, different funding streams may work at cross-purposes.

Economic mechanisms must also address fundamental questions about property rights and benefits distribution. Tenant farmers, who manage around a third of agricultural land, need clear pathways to benefit from carbon sequestration opportunities. The balance between regulatory approaches and payment schemes requires careful calibration – ensuring emissions reductions while maintaining farm viability.

Effective transformation requires robust data and feedback mechanisms to track progress and enable course corrections. Integrated monitoring frameworks must capture interconnections between dietary patterns, agricultural production and land use outcomes. This includes:

- Standardised farm-level emissions calculators to replace competing systems
- Real-time tracking of dietary shifts across different population groups
- Landscape-scale monitoring of land use change and ecosystem services
- Early warning systems for unintended consequences

As climate impacts accelerate and global conditions shift, adaptive management becomes essential. Regular review points should assess whether interventions are delivering their intended outcomes and adjust strategies accordingly. The governance structure must be flexible enough to respond to emerging

challenges while maintaining clear direction towards the 2050 goals.

Just Transitions

The three core transformations will reshape rural economies and livelihoods. Without deliberate attention to justice and equity, these changes could exacerbate inequalities. 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.

> *"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."*[185]
>
> **Dominic Watters, community researcher, University of Southampton**

Transforming agricultural production will affect all farmers, but particularly livestock producers. Support programmes must be co-designed with the sector and include assistance for transitioning to different production systems, skills development and responding to new market opportunities. The postwar experience of agricultural transformation offers valuable lessons, where close state–farmer cooperation and comprehensive advisory services helped orchestrate sector-wide change. There are models for managed adjustment in rural economies such as the EU Structural Funds that provided investment for rural diversification in the 1990s.[186]

Food system transformation should not reinforce existing patterns of inequality in land ownership and access.[187] Carbon markets and ecosystem services payments should be designed to benefit diverse landholders, not just large estates with significant capital resources. Tenant farmers need clear mechanisms to capitalise on sequestration opportunities. Financial support should be targeted particularly at small-scale landholders who may otherwise lack the resources to participate in transition opportunities.[188]

> *"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."*[189]
>
> **Luke Cox, National Federation of Young Farmers' Clubs and agricultural policy advisor**

Beyond individual farm transitions, rural and regional development policies must recognise the role of agriculture and land management in underpinning rural economies. This means supporting land-based businesses to develop new income streams – from high-value sustainable foods and tourism to renewable energy. Achieving this may require a shift from current annual payment schemes to more capital grants that fund emissions reduction technologies and new enterprise development.

Dietary change must also proceed with careful attention to food justice. Currently, healthier and more sustainable foods often cost more and are less accessible in deprived areas. A just transition requires ensuring 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. 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.

> *"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."*[190]
>
> **Professor Charlotte Hardman, Psychologist of Eating Behaviour, Institute of Population Health, University of Liverpool**

Throughout all phases, transformation must address existing inequalities rather than exacerbating them. Implementation must ensure:

- Access to healthy food across all communities, with targeted support for low-income households
- Fair transitions for farmers reducing their reliance on livestock-focused systems, with comprehensive support and particular attention to smaller farms and tenant farmers so as to redress the balance
- Cultural sensitivity that recognises farming communities embody valued cultural traditions
- Regional balance in areas that depend more heavily on agriculture, ensuring enhanced support for economic diversification in affected communities

Coordinated policy tools and governance approaches for just transitions 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 25-year time horizon) to provide greater certainty for affected groups to adapt over time

By embedding justice principles throughout the transformation process, we can achieve a food system that reduces emissions and also contributes to a more equitable and resilient society.

Technologies and Innovation

The transformations described across all three phases will be enabled by new technologies and systemic innovations. While technology alone will not deliver the scale of change needed, strategic innovation can accelerate progress and reduce transition costs.[191]

Per-animal emissions will need to fall through improved feeding, breeding and manure management. Anaerobic digestion and covering slurry pits can reduce GHG emissions while creating renewable energy.[192] Agricultural biotechnology – through selective breeding, precision gene editing and genetic modification – can improve crop yield, nutritional quality and environmental resilience. However, regulations must ensure thorough evaluation of long-term impacts on productivity, health and the environment.

Innovative production models such as agroecological and regenerative approaches offer potential to address multiple challenges simultaneously. The British Ecological Society highlights the importance of minimising bare soil exposure and increasing crop diversity, for example.[193] Yet progress is constrained by inadequate measurement and monitoring systems that can capture what innovative farmers are already achieving.

> *"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."*[194]
>
> **Sophie Gregory, first generation organic dairy farmer**

Meeting the CCC's recommendation to more than triple annual tree-planting rates by 2040 requires innovations in forestry management, nursery production and planting techniques. Not all woodland needs active planting – natural regeneration and rewilding can complement traditional forestry methods while delivering enhanced biodiversity benefits. However, these approaches also need robust monitoring and verification methods.

Agroforestry exemplifies innovation that serves multiple purposes – enhancing biodiversity, reducing emissions and increasing total yield per hectare through multi-layered cropping systems. For energy crops, innovations in harvesting, processing and conversion technologies are needed to create viable supply chains and markets. Digital technologies and remote sensing can optimise land use decisions, identifying where changes would deliver the greatest benefits across carbon sequestration, biodiversity, flood mitigation and water quality while minimising impacts on food production.

Food manufacturers and retailers have significant influence on diets through product development, marketing and pricing strategies. The Science Based Targets Initiative (SBTi) provides a framework for companies to align with climate goals, acknowledging that "without diet change, the food system would not be able to … meet SBTi FLAG targets".[195] Yet much industry focus remains on production rather than consumption – an Institute for Grocery Distribution net zero report dedicates 50 pages to agricultural emissions but only 2 pages to diet change.[196]

Government interventions could accelerate progress through 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. Investment in alternative protein development can help transition from emission-intensive animal products while maintaining nutritional quality and preferences for taste and texture.

Strategic deployment of these technologies and innovations – guided by clear priorities and supported by appropriate regulation and investment – can make the three core transformations both achievable and affordable.

Building and Maintaining Public Support

Sustained transformation requires building broader constituencies for change beyond climate mitigation alone. UK food systems transformation spans at least 25 years and multiple electoral cycles, making public consent not just desirable but critical for success.

Extensive public engagement suggests appetite for change exists – but it must be carefully cultivated and sustained. Building durable public support requires moving beyond top-down communication to genuine participation in shaping transformation.

- **Compelling narratives** that connect transformation to tangible benefits that resonate with daily life: healthier families, lower food bills, thriving rural communities and protected landscapes. Rather than leading with emissions targets or technical solutions, the story must start with what matters to people – their health, their children's future, their local environment. Climate benefits follow naturally from a food system that works better for everyone.
- **Protecting transformation from political volatility** including culture war dynamics and short-term political cycles. Cross-party agreement on core principles – similar to the consensus achieved originally on net zero legislation – can provide stability for businesses, farmers and communities to invest with confidence. This requires deliberate efforts to find common ground across political divides, focusing on shared values around health, security and prosperity.

> *"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."*[197]
>
> **Mhairi Brown, Head of Food Futures, Food, Farming and Countryside Commission**

- **Enabling genuine participation** through citizen's assemblies and deliberative forums that offer proven mechanisms for building informed consent around complex trade-offs. The Food, Farming and Countryside Commission's citizen engagement work demonstrates that when given information and agency, people support ambitious change. These processes must be embedded throughout transformation, not just at the beginning, giving communities real influence over how changes affect them.
- **Consistent messaging from trusted voices** – from farmers and food businesses to health professionals and community leaders. The emphasis must remain on multiple benefits: food security, public health, rural livelihoods and environmental protection delivered together, not traded off against each other.
- **Sustaining momentum through visible progress** in the shape of early wins that must be celebrated and connected to the larger transformation story. Regular 'state of the food system' reporting can maintain accountability while demonstrating progress.

Without sustained public support even the best-designed policies will fail. By investing in genuine participation, compelling narratives and cross-party consensus from the start, transformation becomes not something done to people but something achieved with them.

UK FOOD PLAN FOR 2050

3 essential transformations

A national opportunity for positive transformational change

Change is inevitable, and we must shape it. We have an historic opportunity to transform our food system, for a sustainable, prosperous & secure future.

these 3 transformations will:

SAVE BILLIONS IN HEALTHCARE COSTS
by reducing diet-related disease and disability

STRENGTHEN NATIONAL RESILIENCE
against global supply disruptions

PROVIDE HEALTHY FOOD FOR OUR SOCIETY
by supporting fairer access to affordable, nutritious food

IMPROVE WATER QUALITY
by reducing pollution risks from agriculture

CREATE NEW RURAL JOBS
in land management, forestry and food processing

ENHANCE BIODIVERSITY
through more nature-sensitive farming

A sustainable, prosperous and secure UK

CHAPTER 5.

Conclusions and Recommendations

The UK food system stands at a crossroads. Transformation is not a choice but an inevitability – driven by climate impacts, geopolitical instability and mounting health costs. The question is not whether our food system will change, but whether we shape that change deliberately for public benefit or allow it to unfold chaotically through crisis. This Roadmap demonstrates that by orchestrating three interconnected transformations – in what we produce, how we use land and what we eat – the UK can build a food system that is healthier, fairer and more resilient. The pathway is technically feasible and brings extensive benefits, but success depends on acting now with the coordination, ambition and commitment that the scale of challenge demands.

THREE CORE TRANSFORMATIONS

Transforming the UK food system to improve resilience and better meet the needs of people and planet requires more than incremental technical change. Our analysis demonstrates that regardless of how social values, geopolitics or economics evolve, three interconnected transformations are essential.

The first transformation concerns resilient food production. By 2050, UK farms will operate as financially viable businesses within carbon budgets, producing the healthy foods our nation needs. Agriculture will feature integrated crop–livestock systems that enhance soil health and reduce import dependence. Domestic production of fruits, vegetables and plant proteins will have expanded dramatically, while livestock farming – though reduced in scale – remains valued for food and its additional roles in mixed farming systems, soil health, ecology and landscape management. Farms will generate renewable energy, deploy precision techniques, and operate within circular resource flows that strengthen both productivity and environmental stewardship.

The second transformation delivers smarter land use. UK landscapes will provide multiple benefits through integrated management – sequestering carbon, producing food, enhancing biodiversity and building climate resilience. Forest cover will rise from 14% to at least 20%, while restored peatlands shift from carbon sources to sinks. The 2.5 million hectares of UK land transitioning to woodland and energy crops will be carefully planned, ensuring food security through greater productivity on remaining farmland.[198] Land management will balance private interests with public goods, creating multifunctional landscapes that serve national priorities.

The third transformation enables healthier diets. Most UK citizens will routinely meet nutritional guidelines, with food environments actively supporting healthy choices as the default. Ultra-processed foods high in fat, salt and sugar will occupy a diminished role as consumption shifts towards whole foods, fruits, vegetables and wholegrains. This dietary shift will drive and be reinforced by changes in domestic agriculture, creating a virtuous cycle where what we grow aligns with what we need for improved health.[199]

SEVEN SYSTEMIC BENEFITS FROM FOOD SYSTEM TRANSFORMATION

The transformations we describe cannot be separated. Changes in diet enable, and are enabled by, shifts in farming, which facilitate and are facilitated by land use change. Together, they create a dynamic cycle of benefits. Our analysis shows that coordinated action across government, industry and civil society can create a food system that is more productive, healthier and more resilient than today's – and compatible with net zero goals.

The transformations represent a major opportunity to address multiple challenges together. The net zero by 2050 target may be a useful statutory prompt, but the rationale for, and benefits of, food system transformation extend far beyond the question of emissions reduction.

Public health improvements: As we have seen, poor diet is a key driver of ill health in the UK. The dietary shifts needed to address climate change align with public health recommendations and could significantly improve the quality of life of the UK population.

Enhanced food security: Producing more of our national demands, while moderating those demands through dietary change, will improve food security. By using UK agricultural land more efficiently to grow food for direct human consumption rather than for animal feed, we can strengthen self-sufficiency without the need for more agricultural land in the UK or overseas.

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.

National economic resilience: Climate change and geopolitical tensions are creating an increasingly unpredictable operating environment for the food system. The transformations we set out would enhance resilience to climate impacts and supply chain disruptions, while creating new economic opportunities in growing sectors like horticulture, agroforestry and land management. Over time, a healthier population would reduce pressures on the NHS and help improve the productivity of the UK workforce and hence national economic growth.

Improved water quality and resources: Lower 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, which is particularly important as climate change increases pressure on water resources.

Longer-term viability for rural economies: A clearer strategic plan for UK food and farming will help provide security and confidence for those businesses involved in food production and distribution, and in land management for nature and sequestration. A robust plan over the long term will help underpin the development of local rural economies across the UK.[200]

Achieving net zero: Bringing down net GHG emissions from the food system sufficiently to ensure the UK achieves its net zero goal by 2050 will deliver our international obligations in the fight against climate change. Moreover, showing sufficient progress along this path will strengthen the UK's influence in international climate negotiations and help encourage and persuade other countries to strengthen their efforts.

TEN PRIORITY ACTIONS

The necessary transformation in agriculture, land use and diet requires coordinated actions. This research distils these, and identifies practical steps to accelerate this transformation. Our report has broken down these steps into those that can (or must) occur in phases and those that require consistent attention to ensure the pathway is successful.

To deliver these transformations and realise the multiple benefits they offer, we have identified ten priority actions that must be taken urgently:

1. **Reform agricultural subsidies** to prioritise sustainable production, carbon sequestration, and biodiversity – while establishing transition funds to support farm diversification, new supply chains and infrastructure – for a just transition better aligned with climate adaptation, emissions reduction and improved national food security.

2. **Set targets for dietary change and animal numbers**, so that progress in reducing consumption of the highest emitting foods can be monitored and more actively managed. Public procurement can be used to build new opportunities for suppliers, with one goal to make healthy and sustainable options more straightforward and affordable. Targets could be legislated for through a Good Food Nation Act to establish a statutory obligation on government and public bodies to give effect to food system transformation.

3. **Require major food businesses to publish food system transition plans** with measurable targets aligned with national climate and health objectives. The NHS *Fit for the Future* plan contains welcome steps but financial incentives for healthier food need to be extended far beyond soft drinks.

4. **Create a National Food System Transformation Committee** reporting through the Cabinet Office, with cross-departmental authority to coordinate food, farming and climate policy. The Committee should oversee the three core transformations we set out to 2050, reporting to the Prime Minister.

5. **Develop more effective food systems data** to track progress, promote transparency and accountability, and inform evidence-based decision-making. Monitoring and reporting requirements for food businesses need to be used to drive innovation along supply chains and inform public sector food procurement.

6. **Introduce measures to protect and strengthen food security** and ensure trade policies align with domestic transformation goals. Place food security on a par with energy security, as equally essential to national security. Trade deals require adequate scrutiny so as not to compromise the UK's food security and domestic production capacity.

7. **Take advantage of emerging opportunities to offset emissions and inset within supply chains.** Ensure carbon markets work to deliver incentives for change in land management, including adequate systems of monitoring, reporting and verification for buyers' and sellers' confidence. Establish a British quality standard for carbon calculator tools for estimating agricultural emissions.

8. **Develop integrated 'Food and Land Strategies'** at national and regional levels that balance production, environmental and social needs. Integrate current and new land use frameworks with large-scale changes in food production. Drive land use change at the sub-national and sub-regional levels, rather than leave it to the market.

9. **Use citizens' assemblies and other deliberative tools** to engage and build public understanding and consent for system-wide change, protecting it from culture war politics. Use new tools of dialogue and decision-making to gain common understandings among citizens and farmers, build consensus and handle complex trade-offs.

10. **Expand interdisciplinary research** on socioeconomic aspects of food transitions, focusing on behaviour change, implementation and distributional effects. Make interdisciplinary research the norm for agriculture and food systems research.

A PIVOTAL OPPORTUNITY

This is an historic opportunity to address climate goals, public health, nature restoration and food security, building broader support while implementing policies that are robust across different future scenarios.

The transformations we describe represent more than a response to climate targets. They offer a way to build a food system that works better for everyone – strengthening farm businesses, improving the nation's health, enhancing food security and restoring nature. The material forces of climate change and geopolitical instability mean transformation is coming whether we shape it or not. The choice is ours: managed change that protects livelihoods and builds resilience, or chaotic adjustment forced by crisis.

The UK has the expertise, institutions and growing public determination to lead this change. Our scenario analysis and modelling shows that regardless of how the world evolves, if we are to grasp a sustainable future the three core transformations are essential. But success requires moving beyond incremental adjustments to embrace the scale of change needed. This means political leadership that can build and sustain consensus across party lines, protecting food system transformation from short-term politics and culture wars.

Time is our scarcest resource. Every year of delay makes transformation harder and more costly. The benefits – healthier families, thriving rural communities, enhanced biodiversity and reduced long-term risks from climate change – will take time to fully materialise. But by acting now with coordination and purpose, we can ensure these benefits are realised while there is still time to manage change fairly.

We call on all parties, public institutions, industry and civil society to unite behind this Roadmap – recognising that the health of our people, the vitality of our countryside and the security of our nation depend on getting this right. Change is coming to our food system, but how we shape it is our choice to make.

Appendices

A. AFN NETWORK+ COMMISSIONED RESEARCH PROJECTS AND WEBINARS

Table 4. Research projects commissioned under the AFN Network+ initiative

PI Name	PI Institution	Project Name	Year
Samuel Eze	Harper Adams University	Scope of Regenerative Agriculture Practices in the UK – who is doing what and where?	2023
Daniel McKay Fletcher	Scotland's Rural College	Developing an interactive web application for personalised forecasting of slurry emissions	2023
Toritseju Begho	Scotland's Rural College	Harnessing insights from social and behavioural sciences to increase UK consumers' awareness and acceptance of alternative proteins.	2023
Amy Burnett	Middlesex University	Farmers as empowered intermediaries in natural capital markets	2023
Shailesh Shrestha	Scotland's Rural College	Mapping incentives for change in the transition to Net Zero	2023
Ashraf Alkhtib	Nottingham Trent University	On-farm optimisation of faba beans for use in poultry diets	2023
David Williams	University of Leeds	Quantifying the net zero potential for regenerative agriculture	2023
Maria Traka	Quadram Institute	Development of a sustainability data map for the UK dairy food chain: is the UK on track to achieving net zero within the dairy food chain?	2023
Ronald Ranta	Kingston University	Kingston Community Food Growing: Towards Net Zero through Inclusion	2023
Rob Graham	Scotland's Rural College	Food Waste to Fertiliser: a community-based venture to reframe household food waste and transform it to fertiliser	2023
Naomi Fox	Scotland's Rural College	Moving towards net-zero through improving animal health	2023
Shannon McLaughlin	Queen's University Belfast	GROW	2023

PI Name	PI Institution	Project Name	Year
Emma Roe	University of Southampton	Changing chicken for net zero: Practices and beliefs from the poultry industry.	2023
Zainab Oyetunde-Usman	Rothamsted Research	What happens on the farm, does not stay on the farm	2023
Alexandros Stratakos	University of the West of England	Circular Fertiliser: Assessing The Potential Of Digestate For Indoor Farms	2023
Richard Francksen	University of Cumbria	Regenerative Agriculture and Net-Zero: mapping the evidence	2023
Mackenzie Fong	Newcastle University	Exploring the implementation, impact, and acceptability of 'planet friendly' menus in Newcastle primary schools	2024
Mark Wilson	University of Bath	Developing an assessment tool to measure the outcomes of social prescribing of healthy food	2024
Casey Ryan	University of Edinburgh	AgForC: Carbon accounting in agroforestry to meet net zero	2024
Helena Knight	Cardiff University	Net zero transitioning: redefining assumptions behind access to low-carbon food in resource-constrained communities	2024
David Johnson	Lancaster University	Monitoring farmland interventions for carbon capture and nature recovery	2024
Katharina Watson	Royal Agricultural University	Breeding better beef and sheep: co-designed breeding strategies to achieve net zero	2024
Chiara Tornaghi	Coventry University	Agroecological food production for health and net-zero: exploring implementation pathways for an agroecological urbanism	2024
Lídia Cabral	Institute of Development Studies	Roots of change: a just wilding transition for the agri-food system	2024
Naomi Beingessner	The James Hutton Institute	Triggering environmental transformation on large land holdings	2024
Stephen Axon	University of Stirling	Scoping the potential of insect protein in university student diets in the UK	2024
Karen Rial-Lovera	Royal Agricultural University	Delivering regenerative agriculture in practice: a farmers-led prioritisation for net-zero	2024
Lucie Büchi	University of Greenwich	Empowering farmers: a participatory approach to soil organic carbon assessment	2024

PI Name	PI Institution	Project Name	Year
Stephanie Horn	University of Stirling	Expanding the big five: achieving zero emissions by increasing seafood consumption diversity	2024
Michelle Cain	Cranfield University	Environmental trade-offs in UK beef production	2024
Aimee Morse	University of Gloucestershire	Integrating local authority climate policies	2024

Table 5. The AFN Network+ Webinar Series

Date	Title	Presenter	Number of participants
17 March 2023	Land use strategy, food and net zero	Dustin Benton (Green Alliance)	96
21 April 2023	Retailer supply chains – barriers and opportunities to cutting emissions	Stephen MacKenzie (WRAP)	65
24 April 2023	How to save the planet & our health through food	Henry Dimbleby (National Food Strategy)	150
12 May 2023	Net zero and dietary shift – how psychology and poverty determine choices	Charlotte Hardman (University of Liverpool)	75
9 June 2023	Agroforestry – an opportunity for sustainable UK food systems	Stephen Briggs (Abacus Agriculture)	96
7 July 2023	Carbon markets – a sequestration v food dilemma, or a big opportunity?	Emily Norton (Farm Foresight) and Jake Freestone (Green Farm Collective)	128
13 September 2023	Government for an agri-food revolution – lessons from Whitehall	Jill Rutter (Institute for Government) and Neil Ward (University of East Anglia)	154
11 October 2023	Young Farmers and the drive to net zero	Richard Payne (Harper Adams University), Sophie Gregory (dairy farmer), Luke Cox (National Federation of Young Farmers' Clubs)	117
14 November 2023	What next for food and farming at the UNFCCC COP?	Tim Benton (Chatham House)	101
24 November 2023	Breaking out of business as usual – alternative paths for UK agri-food	Neil Ward (University of East Anglia)	92

Date	Title	Presenter	Number of participants
13 December 2023	The 'undeserving poor': How food system transformation is middle class and why this needs to change	Dominic Watters (SingleDad Social Work)	149
17 January 2024	Aiming for net zero in food & farming – what are the wins and trade-offs?	Pete Falloon (Met Office)	201
8 February 2024	Food security under pressure: UK vegetable & salad crops in an era of climate change – Part 1 on horticulture	Lee Stiles (Lea Valley Growers)	118
23 February 2024	Food security under pressure: UK vegetable & salad crops in an era of climate change – Part 2 on fruit	Ali Capper (British Apples & Pears)	68
7 March 2024	The peatland dilemma – should we continue to cultivate and if so, how?	Heiko Balzter (University of Leicester)	169
12 April 2024	Methane, muck and money – are we missing a trick with manure?	Andy Atkins (International Fugitive Emissions Abatement Association) and Neil Ward (University of East Anglia)	100
20 May 2024	Systems thinking: how to address highly complex problems	Gerald Midgley (University of Hull)	222
19 June 2024	Using systems thinking to transform our food: Beans as an analytical lens	John Ingram (University of Oxford)	99
23 July 2024	What I've learnt about climate change policy and agri-food	Chris Stark (Former Chief Executive, Climate Change Committee)	280
11 September 2024	Alternative proteins – what's in it for farmers & land use?	Tom MacMillan (Royal Agricultural University), Lydia Collas (Green Alliance) and Stuart Roberts (farmer)	145
16 October 2024	Labour's first 100 days – where are we heading on food, farming, health & climate?	Hannah Brinsden (The Food Foundation) and Andrew Meredith (Farmers Weekly)	177
7 November 2024	Inheritance tax changes – what do they mean for farming & net zero?	Emily Norton (Farm Foresight) and Jason Beedell (Strutt & Parker)	164
20 November 2024	'World building' and 'behaviour change' – how to make sustainable diets easy	Lauren Leak-Smith and Ed Whincup (Behavioural Insights Team)	179

Date	Title	Presenter	Number of participants
13 December 2024	AI & reducing agricultural emissions – risks, opportunities & research gaps	Andrew French (University of Nottingham), Paddy Tarbuck (UK Agri-Tech Centre) and James Strong (Aberystwyth University)	106
21 January 2025	Civil food resilience and UK preparedness for food system shocks	Tim Lang (City St George's University of London)	323
28 February 2025	Why carbon markets aren't a good model for investing in nature recovery	Alex Teytelboym (University of Oxford)	239
20 March 2025	Power in the food system – how to shift it for citizens, farmers and nature	Charlie Taverner & Mhairi Brown (Food, Farming & Countryside Commission)	201
7 April 2025	CCC answers your questions on net zero, farming, diets & land	Indra Thillainathan and Sandra Bogelein (Climate Change Committee)	148
25 April 2025	Time to throw off 'nanny state' fears – what do UK citizens want from their food?	Mhairi Brown (Food, Farming & Countryside Commission)	118
23 May 2025	Animal welfare, net zero & the food transition – trade-offs & opportunities	Gareth Arnott (Queen's University Belfast) and Francesca Johansen (Teagasc)	102
16 June 2025	Inspiring a food system transformation – what can we learn from WW2?	Neil Ward (University of East Anglia)	125
24 July 2025	Could weight-loss jabs help or hinder sustainable dietary shift?	Victoria Stevens (Bramble Partners)	97
12 September 2025	De-risking the farming transition: what can we do?	Zainab Oyetunde-Usman (Rothamsted Research), Carolien Samson (Oxbury Bank), Doug Wanstall (farmer and consultant)	167

B. FUTURE FOOD CALCULATOR / MODELLING APPROACH

The Future Food Calculator was developed using Python, a general-purpose programming language, and GitHub, an online version-control and code-management platform.[201] 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 Streamlit,[202] a Python package designed for quick user interface development, and a cloud service for app hosting. The Calculator was initially devised under the FixOurFood project by Juan Pablo Cordero and Sarah Bridle[203] and further developed with the AFN team. It relies on four main datasets: the UK Centre for Ecology and Hydrology 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 model operates by using user-defined parameter values, set via interaction with sliders, to dictate the behaviour of multiple modelling 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. 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 ways:

- **Open Source Design**: Code is open access and available on a public repository. All modelling choices are transparent and customisable, enabling users to scrutinise and adjust underlying assumptions and parameters.
- **Modular Structure**: The model is designed for extendibility, allowing the incorporation of additional complexity and datasets as needed.
- **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 characterise 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 utilisation 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.

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 or production as necessary (see elasticity parameter below). 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 (gCO_2e/g food). These factors account for CO_2, CH_4 and N_2O emissions, using IPCC-recommended global warming potential factors. To contextualise 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 ε=0 means all changes originate from domestic production, whereas ε=1 implies that only imports adjust, fully decoupling consumption from production.

The AFN Network+ Scenarios

We quantified slider positions for the AFN Network+ 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 consumption of meat and dairy products, but without quantitative values. We assigned values according to the relative narratives for each scenario, with Scenario D having the largest reduction and Scenario A having 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 the self-sufficiency ratio (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 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 A.

- In Scenario C (Self-sufficiency for security):
  - 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 have relatively high adoption rates of 10%.
  - Significant reduction in stocking density (-30%); high uptake of low-carbon farming, nitrogen efficiency practices.

- In Scenario D (The 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 and 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 SSR and Scenario C reaching an SSR above 100%. The key features of the scenarios are set out in Table 2. 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 ($MtCO_2e$ / 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.

- 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 are reduced 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. The size of the effect is small relative to afforestation and BECCS because the slider is the percentage of agricultural land on peatland that is restored, 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, cf. 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 CO_2e 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 modelling choices are easily visible, the model can be both scrutinised and used to scrutinise other modelling efforts. We view this as a fundamental and necessary aspect of evidence-based public policy.
- **Accessibility**: Open access tools like the Future Food 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 and collective development where resources are allocated more efficiently, instead of repeating work on already existing solutions to common problems.

Table 6. Input and Output Data from the Future Food Calculator

Scenario / Data	Baseline	AFN (A) Build Back Fast Again	AFN (B) Circular Worlds	AFN (C) Self-sufficiency for Security	AFN (D) The Right to Food	CCC CB7 Balanced Pathway
Population projection	**Medium**	**Zero migration**	**Medium**	**Zero migration**	**Medium**	**Medium**
Yield change projection	0	0	0	-0.27	0	0.16
Trade elasticity	0.5	0	0	0	0	0.5
Change in ruminant consumption (%)	0	-10	-60	-60	-70	-40
Change in dairy cattle consumption (%)	0	-10	-50	-33	-60	-20
Change in pig & poultry consumption (%)	0	10	-50	15	-60	-33
Pulses (%)	0	50	500	200	500	100
Fruit and veg (%)	0	-20	70	50	150	20
Food waste reduction (%)	0	25	50	80	60	51
UK land under forest (%)	13.17	18.17	28.17	23.17	33.17	18
Arable to BECCS (%)	0	25	10	10	3	7
Lowland peat restored (%)	0	20	25	20	30	75
Upland peat restored (%)	0	50	60	50	75	90
Horticulture growth (%)	0	-20	70	400	50	-10
Soil carbon (pasture)[a]	0	80	100	90	100	100
Methane inhibitors[b]	0	15	25	15	35	100
Manure management[c]	0	30	60	50	75	100
Animal breeding[d]	0	10	20	10	30	100
Agroforestry on arable	0	0	15	10	5	10
Soil carbon (arable)[a]	0	80	100	90	100	100
Nitrogen efficiency	0	20	40	80	100	100

a Proportion of land that changes to improved soil management for carbon sequestration
b Proportion of farmers adopting methane inhibitors
c Proportion of farmers adopting manure management techniques to improve soil sequestration
d Proportion of livestock bred using advanced breeding techniques to reduce GHG emissions
The Future Food Calculator website includes details of all modelling assumptions: https://futurefoodcalculator.org/.

C. RESEARCH PRIORITIES – AT A GLANCE

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 coordination on healthy and sustainable food across government departments? What steps can be taken to avoid the risk of party politicisation of food reforms, and 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 through 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 guided to ensure optimum co-benefits (sequestration, flood risk, biodiversity, recreation) and to manage the risk of 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 UK agriculture, including through learning from other countries' experience?

7. What would be the impacts on UK production, exports and land use from large-scale dietary shift in UK consumption (e.g. away from meat and dairy)? 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 food system transformation 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 and nature 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 can the environmental efficiency of food waste cycles be improved?

10. How can companies who do not currently have science-based environmental, social and governance reporting, best be supported to shift focus from Scope 1 to Scope 3 GHG emissions?

D. AUTHOR CONTRIBUTIONS STATEMENT

Conceptualisation: Neil Ward, Elta Smith, Tim Benton, Stefan Kepinski, Angelina Sanderson Bellamy, Sarah Bridle, Jez Fredenburgh, Ali Morpeth and Emily Norton.

Writing – original draft: Neil Ward, Elta Smith, Ali Morpeth, Tim Benton, Veronica Moran, Juan Pablo Cordero, Angelina Sanderson Bellamy, Sarah Bridle and Stefan Kepinski.

Formal analysis (qualitative workshop analysis): Angelina Sanderson Bellamy, Neil Ward, Elta Smith, Tim Benton, Stefan Kepinski.

Formal analysis (quantitative modelling): Juan Pablo Cordero, Sarah Bridle.

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(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 (Planeatry Alliance), Ifeyinwa Kanu (Intellidigest Ltd).

Consultation meetings to inform the development of the Future Food Calculator were conducted with: Chatham House; Climate Change Committee; Defra (various teams); Eunomia; Green Alliance; Joint Nature Conservation Committee; Met Office; National Trust; Scotland's Rural College.

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 2025. 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. ChatGPT was used to suggest refinements to improve clarity and 'dejargonise' the Executive Summary, which was then further extensively edited by the writing team. Editorial support was provided by Ben Dare.

Acknowledging contributions

Our approach to acknowledging contributions is based on the Contributor Role Taxonomy (CRediT) system (https://credit.niso.org/). Being listed as participating in an AFN workshop does not imply any responsibility or support for all the analysis and recommendations in this report.

Cite as:

Ward, N., Smith, E., Morpeth, A. Benton, T., Moran, V., Fredenburgh, J., Cordero, J.P., Dare, B., Sanderson Bellamy, A., Bridle, S., Kepinski, S., Youngman, T., Balzter, H., Barber, G., Batchelar, J., Frewer, L., Godfray, C., Hasnain, S., Kanu, I., Jackson, A., MacMillan, T., Macready, A., Marsden, T., Nayak, R., Oyetunde-Usman, Z., Pearson, S., Smith, P., Stewart, D., Watson, C., Watson, M., Willcock, S., Adekanmbi, A., Alkhtib, A., Aufenaste, J., Balme, H., Bell, C., Bisley, I., Blair, K., Boyko, R., Cabral, L., Chadwick, M., Cottee, J., Creeth, R., Crossley, D., Duncan-Duggal, J., Dunn, M., Dyson, B., Eagles, S., Edgar, D., Edwards, F., Falloon, P., Fletcher, I., Fong, M., Harrison, R., Haslam, J., Hawkes, J., He, P., Hickman, R., Hoebe, P., Holland, S., Horn, S., Horne, B., Inegbedion, G., Jarvis, T., Jones, A., Jones, K., Kindred, D., Kirby-Smith, J., Knight, H., Lait, R., Lane, L., Lipkins, Z., Lockyear, A., Lu, Y., McInnes, K., McKay Fletcher, D., Marston, M., Maye, D., Measures, A., Mercer, L., Mesa Medina, J., Morgan, J., Morse, A., Mulrooney, H., Naydani, C., Pahalagedara, I., Phillips, M., Pounds, A., Puranik, M., Rathnayaka, S., Roe, E., Russell, H., Russell, S., Simmonds, P., Spiro, A., Stetkiewicz, S., Stout, S., Stratford, L., Surendran, A., Sykes, R., Teschner, R., Verfuerth, C., Wakefield, S., Watters, D., Whatford, L., Wilding, S., Wilson, E., Woodward, H., Zolghadri, A., Zurek, M. (2025) *Roadmap for Resilience: A UK Food Plan for 2050 – Technical Report*. Bristol: AFN Network+.

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167 This issue was the focus of an AFN Network+ 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/

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183 This issue was the focus of an AFN Network+ 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/

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